



# INDIAN OIL CORPORATION LIMITED MARKETING DIVISION



**CIVIL SPECIFICATION 2023**  
wef 1<sup>st</sup> July 2023





## **FOREWARD**

The Civil Work Specifications are very comprehensive and useful documents in execution of works. These specifications not only give the standards for engineering materials but also serve as guidelines for execution of works, mode of measurements, etc.

Considering the emerging technology and good practices in the field, it is felt necessary to revise the first version of Civil Work Specifications which was published in 2013 in two volumes.

The new revision of Civil Specifications covers many new items and construction technologies, which are now being used in various construction activities. The main objective is to bring awareness and provide guidelines for safe practices in the field. It will help our Engineers to understand detailed specifications at elementary level and help them to execute the work. We are hopeful that this revision shall help and bring confidence during execution, to our Engineers.

Specifications of several items have been updated and improved by making them more comprehensive. Similarly, specifications of some items have been revised wherever it is felt necessary. Specification of items which have become obsolete over a period / not in use, have been deleted. Further, specifications for many new Items, Technologies & Materials have been added. These topics has been incorporated in the present revision considering future need in the field.

Civil Specifications 2023 is applicable wef 1<sup>st</sup> July 2023 and will replace the existing Civil Specifications 2013 (Vol 1 & 2). In the event of any variation between our internal issued guidelines/specifications on a particular item and these specifications, then the specifications included in tender shall take precedence.

We would take this opportunity to compliments our Engineers who have contributed for this exercise. This Civil Specifications 2023 is being released with the approval of ED (Engg & Pj), HO.

Necessary precaution has been taken during preparation of this specifications document, to make as correctly as possible. It is, however, possible that some errors might have crept in inadvertently. In case any error or omission is noticed, it may be brought to the notice of the CGM (Engg), HO.

Suggestions for improvement are always welcome.

Team HO Engg  
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# GENERAL



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## 0 GENERAL

### 0.1 INTRODUCTION

- 0.1.1 Reference mentioned herein shall be applicable to all sections to the extent the context permits and are intended to supplement the provisions in the particular section. In case of any discrepancy/ deviation, the provisions in the particular section shall take precedence.

### 0.2 RATE

- 0.2.1 The rates for all items of work unless clearly specified otherwise shall include cost of all labour, materials and other inputs involved in the execution of the items.

### 0.3 INTERPRETATIONS

- 0.3.1 The Executive Director (Engg. & Project), Marketing Head Office shall be the sole deciding authority as to the meaning, interpretation and implications for various provisions of the specifications. His decision in writing shall be final.
- 0.3.2 Wherever any reference is made to any Indian Standard, it shall be taken as reference to the latest edition with all amendments issued thereto. In the event of any variation between these specifications and the Indian Standard, the former shall take precedence over the latter.

### 0.4 DEFINITIONS

The following terms and expressions in the specifications shall have the meaning or implication hereby assigned to them unless otherwise specified elsewhere.

- 0.4.1 **Contractor:** The Contractor shall mean the individual or firm or company whether incorporated or not undertaking the works and shall include the legal personal representatives of such individual or the persons composing such firm or company, or the successors of such individual or firm or company and the permitted assignees of such individual or firm of company.
- 0.4.2 **Engineer- in-Charge:** The 'Engineer-in- Charge' means the Engineer officer who shall supervise and be in-charge of the work and who shall sign the contract on behalf of the corporation.
- 0.4.3 **Site:** The 'site' shall mean the land/ or other places on, in, into or through which the work is to be executed under the contract or any adjacent land, path or street through which the work is to be executed under the contract, or any adjacent land, path or street which may be allotted or used for the purpose of carrying out the contract.
- 0.4.4 **Store:** The 'store' shall mean the place of issue of materials included in the appropriate schedule of a contract for issue by the corporation. In all other cases 'Store' shall mean any location of the organization.
- 0.4.5 **IS:** The standards, specification and code of practices issued by the Bureau of Indian Standards.
- 0.4.6 **Best:** The word 'best' when used shall mean that in the opinion of the Engineer-in-Charge, there is no superior material/ article and workmanship obtainable in the market and trade respectively. As far as possible the standard required shall be specified in preference to the word 'best'.
- 0.4.7 **Department:** 'Department' shall mean Engineering Department, Marketing Division.

### 0.5 FLOOR AND LEVELS

#### 0.5.1 Building

- 0.5.1.1 Floor 1 is the lowest floor above the ground level in the building unless otherwise specified in a particular case. The floors above floor 1 shall be numbered in sequence as floor 2, floor 3 and so on. The number shall increase upwards.



**0.5.1.2 Floor level:** For floor 1, top level of finished floor shall be the floor level and for all other floors above floor 1, top level of the structural slabs shall be the floor level.

**0.5.1.3 Plinth level:** Floor 1 level or 1.2 m above the ground level whichever is lower shall be the plinth level.

## **0.5.2 SPECIAL STRUCTURES**

**0.5.2.1** For structures like retaining walls, wing walls, chimneys, overhead reservoirs/ tanks and other elevated structures, where elevations/ heights above a defined datum level have not been specified and identification of floors cannot be done as in case of building. Level, at 1.2 m above the ground level shall be the floor 1 level as well as plinth level. Level at a height of 3.5 m above floor 1 level will be reckoned as floor 2 level and level at a height of 3.5 m above the floor 2 level will be floor 3 level and so on, where the total height above floor 1 level is not a whole number multiple of 3.5 metres. Top most floor level shall be the next in sequence to the floor level below even if the difference in height between the two upper most floor levels is less than 3.5 metres.

## **0.6 FOUNDATION AND PLINTH**

The work in foundation and plinth shall include:

- (a) For buildings: All works up to 1.2 metre above ground level or up to floor 1 level whichever is lower:
- (b) For abutments, piers and well steining: all works up to 1.2 m above the bed level:
- (c) For retaining wall, wing walls, compound walls, chimneys, overhead reservoirs/ tanks and other elevated structures: All works up to 1.2 metre above the ground level:
- (d) For reservoirs/ tanks (other than overhead reservoirs/ tanks): All works up to 1.2 metre above the ground level:
- (e) For basements: All works up to 1.2 m above ground level or up to floor 1 level whichever is lower.

**Note:** Specific provision shall be made in the estimate for such situations where the foundation level more than 3 (three) metre depth from the plinth for all types of structures mentioned above.

## **0.7 MEASUREMENTS**

**0.7.1** In booking dimensions, the order shall be consistent and in the sequence of length, width and height or depth or thickness.

**0.7.2** Rounding off: Rounding off where required shall be done in accordance with IS: 2-1960. The number of significant places rounded in the rounded off value should be as specified.

## **0.8 MATERIALS**

**0.8.1** Samples of all materials to be used on the work shall be got approved by the contractor from the Engineer-in-Charge well in time. The approved samples duly authenticated and sealed shall be kept in the custody of the Engineer-in-Charge till the completion of the work. All materials to be provided by the contractor shall be brand new and as per the samples approved by the Engineer-in-Charge.

**0.8.2** Materials obtained by the contractor from the sources approved by the Corporation shall be subjected to the Mandatory tests. Where such materials do not conform to the relevant specifications, the matter shall be taken up by the Engineer-in-Charge for appropriate action against the defaulters. In all such cases, necessary documents in original and proof of payment relating to the procurement of materials shall be made available by the contractor to the Engineer-in-Charge.

**0.8.3** Samples, whether submitted for approval to govern bulk supplies or required for testing before use and also the sample of materials bearing 'Standard mark', if required for testing, shall be provided



free of cost by the contractor. All other incidental expenditure to be incurred for testing of samples e.g., packaging, sealing transportation, loading, unloading etc. including testing charges shall be borne by the contractor.

**0.8.4** The materials, supplied by the corporation shall be deemed to be complying with the specifications.

**0.8.5** Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric effects due to rain, sun, wind and moisture to avoid deterioration.

**0.8.6** Materials like timber, paints etc. shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials and explosives shall be stored in accordance with the relevant rules and regulations or as approved by Engineer-in-Charge in writing so as to ensure desired safety during storage.

**0.8.7** The unit weight of materials unless otherwise specified shall be reckoned as given in IS: 1911-1967.

## **0.9 SAFETY IN CONSTRUCTION**

**0.9.1** The contractor shall employ only such methods of construction, tools and plant as are appropriate for the type of work or as approved by Engineer-in-Charge in writing.

**0.9.2** The contractor shall take all precautions and measures to ensure safety of works and workman and shall be fully responsible for the same. Safety pertaining to construction works such as excavation, centering and shuttering, trenching, blasting, demolition, electric connections, scaffolds, ladders, working platforms, gangway, mixing of bituminous materials, electric and gas welding, use of hoisting and construction machinery shall be governed by IOCL safety code, relevant safety codes and the direction of Engineer-in-Charge.

## **0.10 ABBREVIATIONS**

The following abbreviations wherever they appear in the specifications, shall have the meaning or implication hereby assigned to them:

Abbreviations	Full Form
Mm	Millimetre
Cm	Centimetre
M	Metre
Km	Kilometre
Mm <sup>2</sup> /sqmm	Square Milimetre
Cm <sup>2</sup> /sqcm	Square centimetre
Dm <sup>2</sup> /sqdm	Square decimetre
M <sup>2</sup> /sqm	Square metre
Cm <sup>3</sup> / cubic cm	Cubic centimetre
Dm <sup>3</sup> / cubic dm	Cubic decimetre
M <sup>3</sup> /cum	Cubic metre
MI	Millilitre
KI	Kilolitre
Gm	Gram
Kg	Kilogram
Q	Quintal



T	Tonne
Fps system	Foot pound second system
°C	Degree Celsius temperature
Fig	Figure
Re/Rs	Rupee/ Rupees
No	Number
Dia	Diameter
AC	Asbestos cement
CI	Cast Iron
GC	Galvanized corrugated
GP	Galvanized plain
GI	Galvanized iron
PVC	Polyvinyl chloride
RCC	Reinforced cement concrete
SW	Stone ware
SWG	Standard wire Gauge

#### 0.11 GENERAL NOTES ON TESTING OF MATERIALS

1. Testing is not mandatory if total quantity of material to be used in the work is less than the minimum specified quantity. At least one test may be conducted if the total quantity of material to be Used in the work is minimum specified quantity or more. However. Engineer-in-Charge shall ensure the quality of materials used in the work.
2. If the "part there of" quantity is less than the minimum specified quantity. it is not mandatory to test the part quantity.
3. Where minimum quantity is not specified, it may be treated as 5% at the quantity prescribed for one test. However, Engineer-in-Charge has to satisfy him set thereof with the quality of materials based on the MTC or otherwise.

A random sample procedure shall be adopted to ensure samples are collected covering the entire period of procurement of materials.





# CARRIAGE OF MATERIAL



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### LIST OF BUREAU OF INDIAN STANDARD CODES

SI No.	I.S. No.	Subject
1	IS 4082	Stacking & storage of construction materials and components at site – Recommendations
2	IS 1141	Seasoning of Timber – Code of Practice
3	IS 2062	Hot Rolled Medium and High Tensile Structural Steel- Specification



# 1 CARRIAGE OF MATERIAL

## 1.0 GENERAL

The carriage and stacking of materials shall be done as directed by the Engineer-in- Charge. Any tools and plants, required for the work shall be arranged by the Contractor. The carriage of materials includes loading within a lead of 50 metres, unloading and stacking within a lead of 50 metres.

## 1.1 RESPONSIBILITY FOR LOSS OR DAMAGE

Loading, carriage, unloading and stacking shall be done carefully to avoid loss or damage to the materials. In case of any loss or damage, recovery shall be effected from the Contractor at twice the Departmental issue rates of the materials. If the departmental issue rates of the materials are not available then the recovery shall be effected at twice the prevailing market rates as determined by the Engineer-in-Charge.

## 1.2 MODE OF CARRIAGE

Depending upon the feasibility and economy, the Engineer-in -Charge shall determine the mode of carriage viz. whether by mechanical or animal transport or manual labour.

## 1.3 LEAD

**1.3.1** All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and as approved by Engineer-in-Charge alongwith reasons in writing.

**1.3.2** Carriage by manual labour shall be reckoned in units of 50 metres or part thereof.

**1.3.3** Carriage by animal and mechanical transport shall be reckoned in one km unit. Distances of 0.5 km or more shall be taken as 1 km and distance of less than 0.5 km shall be ignored. However, when the total lead is less than 0.5 km, it will not be ignored but paid for separately in successive stages of 50 metres subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km by mechanical/ animal transport.

## 1.4 GENERAL CONSIDERATION FOR STACKING AND STORAGE

**1.4.1** Planning of Storage Layout - For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipment with proper access and proper manoeuvrability of the vehicles carrying the material. While planning the layout, the requirements of various materials, components and equipment at different stages of construction shall be considered. The storage & stacking check list is given in Table 1.1. For further details refer IS- 4082

**1.4.2** Material shall be stored in such a manner as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.

## 1.5 PROTECTION AGAINST ATMOSPHERIC AGENCIES

Materials stored at site, depending upon the individual characteristics, shall be protected from atmospheric actions, such as rain, sun, winds and moisture to avoid deterioration.

## 1.6 PROTECTION AGAINST FIRE AND OTHER HAZARDS

**1.6.1** Materials like timber, coal, paints, etc. shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials like kerosene and petrol, shall be stored in accordance with the relevant rules and regulations so as to ensure the desired safety during storage. Stacks shall not be piled so high as to make them unstable under fire fighting conditions and in



general they shall not be more than 4.5 m in height. The provisions given in IS 13416 (part 5) shall be followed.

## **1.7 STACKING AND STORAGE OF MATERIALS**

### **1.7.1 Cement**

#### **1.7.1.1 In case cement is received in bags**

Cement shall be stored at the work site in a building or a shed which is dry, leakproof and as moisture proof as possible. The building or shed for storage should have minimum number of windows and close-fitting doors and these should be kept closed as far as possible.

- 1.7.1.2** Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them. Cement bags shall be stacked off the floor on wooden planks in such a way as to keep about 150 mm to 200 mm clear above the floor. The floor may comprise of lean cement concrete or two layers of dry bricks laid on well consolidated earth. A space of 600 mm minimum shall be left around between the exterior walls and the stacks (see Fig. 1.1)

In the stacks the cement bags shall be kept close together to reduce circulation of air as much as possible. Owing to pressure on the bottom layer of bags sometimes 'house pack' is developed in these bags. This can be removed easily by rolling the bags when the cement is taken out for use. Lumped bags, if any should be removed and disposed off.

- 1.7.1.3** The height of stack shall not be more than 10 bags to prevent the possibility of lumping up under pressure. The width of the stack shall be not more than four bags length or 3 metres. In stacks more than 8 bags high, the cement bags shall be arranged alternately length-wise and cross-wise so as to tie the stacks together and minimize the danger of topping over. Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received; a label showing date of receipt of cement shall be put on each stack to know the age of cement.

- 1.7.1.4** For extra safety during the monsoon, or when it is expected to store for an unusually long period, the stack shall be completely enclosed by a water proofing membrane such as polyethylene, which shall close on the top of the stack. Care shall be taken to see that the waterproofing membrane is not damaged any time during use.

- 1.7.1.5** Cement in gunny bags, paper bags and polyethylene bags shall be stored separately.

#### **1.7.2 In case cement is received in drums –**

These shall be stored on plane level ground, as far as possible near the concrete mixing place. After taking out the required quantity of cement, the lid of the drum shall be securely tied to prevent ingress of moisture.

#### **1.7.3 In case cement is received in silos –**

The silos shall be placed near the concrete batching plant. Proper access shall be provided for the replacement of silos.

- 1.7.4** Different types of cements shall be stacked and stored separately.

## **1.8 BRICKS**

- 1.8.1** Bricks shall be stacked in regular tiers as and when they are unloaded to minimize breakage and defacement. These shall not be dumped at site.

- 1.8.2** Bricks stacks shall be placed close to the site of work so that least effort is required to unload and transport the bricks again by loading on pallets or in barrows. Building bricks shall be loaded or



unloaded a pair at a time unless palletized. Unloading of building bricks or handling in any other way likely to damage the corners or edges or other parts of bricks shall not be permitted.

- 1.8.3** Bricks shall be stacked on dry firm ground. For proper inspection of quality and ease in counting the stacks shall be 50 bricks long, 10 bricks high and not more than 4 bricks in width, the bricks being placed on edge, two at a time along the width of the stack. Clear distance between adjacent stacks shall not be less than 0.8 m. Bricks of each truck load shall be put in one stack.
- 1.8.4** Bricks of different types, such as clay bricks, clay fly ash bricks, fly ash lime bricks, sand lime (calcium silicate) bricks, auto-clave bricks etc. shall be stacked separately. Bricks of different classification and size consideration (such as, conventional and modular) shall be stacked separately.

Also bricks of different types, such as, solid, hollow and perforated shall be stacked separately.

## **1.9 BLOCKS**

- 1.9.1** Blocks are available as hollow and solid concrete blocks, hollow and solid light weight concrete blocks, autoclaved aerated concrete blocks, concrete stone masonry blocks and soil based blocks.
- 1.9.2** Blocks shall be unloaded one at a time and stacked in regular tiers to minimize breakage and defacement. These shall not be dumped at site. The height of the stack shall not be more than 1.2m. The length of the stack shall not be more than 3.0 m, as far as possible and the width shall be of two or three blocks.
- 1.9.3** Normally blocks cured for 28 days only should be received at site. In case blocks cured for less than 28 days are received, these shall be stacked separately. All blocks should be water cured for 10 to 14 days and air cured for another 15 days; thus no blocks with less than 28 days curing shall be used in building construction.
- 1.9.4** Blocks shall be placed close to the site of work so that least effort is required for their transportation.
- 1.9.5** Blocks manufactured at site shall be stacked at least for required minimum curing period as given in 1.9.3.
- 1.9.6** The date of manufacture of the blocks shall be suitably marked on the stacks of blocks manufactured at factory or site.

## **1.10 FLOOR, WALL AND ROOF TILES**

- 1.10.1** Floor, wall and clay roof tiles of different types, such as, cement concrete tiles (plain, coloured and terrazzo) and ceramic tiles (glazed and unglazed) shall be stacked on regular platform as far as possible under cover in proper layers and in tiers and they shall not be dumped in heaps. In the stack, the tiles shall be so placed that the mould surface of one faces that of another. Height of the stack shall not be more than one metre. During unloading, these shall be handled carefully so as to avoid breakage.
- 1.10.2** Tiles of different quality, size and thickness shall be stacked separately to facilitate easy removal for use in work. Tiles when supplied by manufacturers packed in wooden crates, shall be stored in crates. The crates shall be opened one at a time as and when required for use.
- 1.10.3** Ceramic tiles and clay roof tiles are generally supplied in cartons which shall be handled with care. It is preferable to transport these at the site on platform trolleys.

## **1.11 AGGREGATES**

- 1.11.1** Aggregates shall be stored at site on a hard dry and level patch of ground. If such a surface is not available, a platform of planks or old corrugated iron sheets, or a floor of bricks, or a thin layer of lean concrete shall be made so as to prevent contamination with clay, dust, vegetable and other foreign matter.



**1.11.2** Stacks of fine and coarse aggregates shall be kept in separate stock piles sufficiently removed from each other to prevent the material at the edges of the piles from getting intermixed. On a large job, it is desirable to construct dividing walls to give each type of aggregates its own compartment. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum.

**1.11.3** Unless specified otherwise or necessitated by site conditions stacking of the aggregates should be carried out in regular stacks. The suggested sizes for stacks are as follows:

SI No	Material	Size of Stack (in m)		
		Length	Breadth	Height
(i)	Soling Stone	5.0	2.0	0.50
		Or 5.0	1.0	0.50
(ii)	Coarse Aggregates	2.0	2.0	0.50
		Or 5.0	5.0	1.00
		Or 5.0	1.0	0.50
(iii)	Fine Aggregates	2.0	2.0	0.50
		Or 5.0	5.0	1.00
		Or 5.0	1.0	0.50

## 1.12 FLY ASH

**1.12.1** Fly ash shall be stored in such a manner as to permit easy access for proper inspection and identification of each consignment. Fly ash in bulk quantities shall be stored in stack similar to fine aggregates as specified in para 1.11 to avoid any intrusion of foreign matter. Fly ash in bags shall be stored in stacks not more than 10 bags high.

## 1.13 STEEL

**1.13.1** For each classification of steel, separate areas shall be earmarked. It is desirable that ends of bars and sections of each class be painted in distinct separate colours

**1.13.2** Steel reinforcement shall ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. It is desirable to coat reinforcement with cement wash before stacking to prevent scaling and rusting

**1.13.3** Bars of different classification, sizes and lengths shall be stored separately to facilitate issues in such sizes and lengths so as to minimize wastage in cutting from standard lengths.

**1.13.4** In case of long storage, reinforcement bars shall be stacked above ground level by at least 150 mm. Also in coastal areas or in case of long storage a coat of cement wash shall be given to prevent scaling and rusting

**1.13.5** Structural steel of different classification, sizes and lengths shall be stored separately. It shall be stored above ground level by at least 150 mm upon platforms, skids or any other suitable supports to avoid distortion of sections. In coastal areas or in case of long storage suitable protective coating of primer paint shall be given to prevent scaling and rusting.

## 1.14 ALUMINIUM SECTIONS





- 1.14.1** Aluminium sections of different classification, sizes and lengths shall be stored separately, on a level platform under cover. The aluminium sections shall not be pulled or pushed from the stack nor shall be slid over each other, to protect the anodizing layer.

### **1.15 DOORS, WINDOWS AND VENTILATORS**

- 1.15.1** General - While unloading, shifting handling and stacking timber or other lignocellulosic material based, metal and plastic door and window frames and shutters, care shall be taken that the material is not dragged one over the other as it may cause damage to the surface of the material particularly in the case of decorative shutters. The material should be lifted and carried preferably flat avoiding damage of corners or sides.
- 1.15.2** Metal and plastic doors, windows and ventilators shall be stacked upright (on their sills) on level ground preferably on wooden battens and shall not come in contact with dirt and ashes. If received in crates they shall be stacked according to manufacturer's instructions and removed from the crates as and when required for the work.
- 1.15.3** Metal and plastic frames of doors, windows and ventilators shall be stacked upside down with the kick plates at the top. These shall not be allowed to stand for long in this manner before being fixed so as to avoid the door frames getting out of shape and hinges being strained and shutters drooping.
- 1.15.4** During the period of storage all metal doors, windows and ventilators shall be protected from loose cement and mortar by suitable covering such as tarpauline. The tarpauline shall be hung loosely on temporary framing to permit circulation of air to prevent condensation.
- 1.15.5** All timber and other lignocellulosic material-based frames and shutters shall be stored in a dry and clean covered space away from any infestation and dampness. The storage shall preferably be in well ventilated dry rooms. The frames shall be stacked one over the other in vertical stacks with cross battens at regular distances to keep the stack vertical and straight. These cross battens should be of uniform thickness and placed vertically one above the other. The door shutters shall be stacked in the form of clean vertical stacks over the other and at least 80 mm above ground on pallets or suitable beams or rafters. The top of the stack shall be covered by a protecting cover and weighted down by means of scantlings or other suitable weights. The shutter stack shall rest on hard and level ground.
- 1.15.6** If any timber or other lignocellulosic material-based frame or shutter becomes wet during transit, it shall be kept separate from the undamaged material. The wet material may be dried by stacking in shade with battens in between adjacent boards with free access of dry air generally following the guidance laid down in IS 1141.
- 1.15.7** Separate stacks shall be built up for each size, each grade and each type of material. When materials of different sizes grades and types are to be stacked in one stack due to shortage of space, the bigger size shall be stacked in the lower portion of the stacks. Suitable pallets or separating battens shall be kept in between the two types of material.

### **1.16 ROOFING SHEETS**

- 1.16.1** Roofing sheets shall be stored and handled in such a manner as not do damage them in any way.
- 1.16.2** Plain and corrugated asbestos cement sheets shall be stacked horizontally to a height of not more than one meter on a firm and level ground, with timber or other packing beneath them. If stacked in exposed position, they shall be protected from damage by the winds.

Asbestos cement sheets of same variety and size shall be stacked together. Damage sheets shall not be stacked with sound materials. All damaged sheets shall be salvaged as early as possible.



**1.16.3** Corrugated galvanized iron sheets and aluminium sheets shall be stacked horizontally to a height of not more than 0.5 m on a firm and level ground, with timber or other packing beneath them. To protect them from dust and rain water, these shall be covered with tarpaulin or polyethylene sheets.

**1.16.4** Plastic sheets and glass reinforced plastic (GRP) sheets shall be stacked under a shed to a height of not more than 0.5 m on a firm and level ground with timber or other packing beneath them.

**1.17 GYPSUM BOARDS, PLYWOOD, FIBREBOARD, PARTICLE BOARD, BLOCK BOARD, ETC.**

**1.17.1** These boards shall be stored flat in a covered clean and dry place. Different sizes and types of each of these boards shall be stacked separately.

**1.17.2** The board shall be stacked on a flat platform on which a wooden frame shall be constructed with 50mm x 25 mm battens in such a way that it will give support to all four edges and corners of the boards with intermediate battens placed at suitable intervals to avoid warping.

**1.17.3** The boards shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warping wherever necessary.

**1.17.4** The boards shall be unloaded and stacked with utmost care avoiding damage to the corners and surface. In case of decorative plywood and decorative boards, the surfaces of which are likely to get damaged by dragging one sheet over another it is advisable that these are lifted as far as possible in pairs facing each other.

**1.18 GLASS SHEETS**

**1.18.1** It is important that all glass sheets whether stored in crates or not shall be kept dry. Suitable covered storage space shall be provided for the safe storage of the glass sheets. In removing glass sheets from crates, great care shall be taken to avoid damages. The glass sheets shall be lifted and stored on its long edges against a vertical wall or other support with the first sheet so placed that its bottom edge is 25 mm from the vertical support. The stacks shall be of not more than 25 panes and shall be supported at two points by fillets of wood at 300 mm from each end. The whole stack shall be as close and as upright as possible.

**1.18.2** The glass sheets of different sizes, thickness and type shall be stacked separately. The distance between any two stacks shall be of the order of 400 mm.

**1.19 CAST IRON, GALVANIZED IRON AND ASBESTOS CEMENT PIPES AND FITTINGS**

**1.19.1** The pipes shall be unloaded where they are required when the trenches are ready to receive them.

**1.19.2** Storage shall be done on firm, level and clear ground and wedges shall be provided at the bottom layer to keep the stack stable.

**1.19.3** The stack shall be in pyramid shape or the pipes length-wise and cross-wise in alternate layers. The pyramid stack is advisable in smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5 m.

**1.19.4** Each stack shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible.

**1.19.5** Cast iron detachable joints and fittings shall be stacked under cover separately from the asbestos cement pipes and fittings.

**1.19.6** Rubber rings shall be kept clean, away from grease, oil heat and light.

**1.20 POLYETHYLENE PIPES**

**1.20.1** Natural polyethylene pipe should be stored under cover and protected from direct sunlight.



However, black polyethylene pipes may be stored either under cover or in the open.

- 1.20.2** Coils may be stored either on edges or stacked flat one on top of the other, but in either case they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surface
- 1.20.3** Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set.
- 1.20.4** Storage of pipes in heated areas exceeding 27° C should be avoided.

#### **1.21 UNPLASTICIZED PVC PIPES**

- 1.21.1** The pipe should be given adequate support at all times. Pipes should be stored on a reasonably flat surface free from stones and sharp projections so that the pipe is supported throughout its length. In storage, pipe racks should be avoided. Pipe should not be stacked in large piles, especially under warm temperature conditions as the bottom pipes may distort, thus giving rise to difficulty in jointing. Socket and spigot pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid lopsided stacks.
  - 1.21.1.1** It is recommended not to store pipe inside another pipe.
  - 1.21.1.2** On no account should pipes be stored in a stressed or bent condition or near the sources of heat.
  - 1.21.1.3** Pipes should not be stacked more than 1.5 m high. Pipes of different sizes and classes should be stacked separately.
- 1.21.2** The ends of pipe should be protected from abrasion particularly those specially prepared for jointing either spigot or socket solvent welded joints or shouldered for use with couplings.
- 1.21.3** In tropical conditions, pipes should be stored in shade. In very cold weather, the impact strength of PVC is reduced making it brittle and more care in handling shall be exercised in wintry condition.
- 1.21.4** If due to unsatisfactory storage or handling a pipe becomes kinked, the damaged portion should be cut out completely. Kinking is likely to occur only on very thin walled pipes.

#### **1.22 BITUMEN, ROAD TAR, ASPHALT, ETC.**

- 1.22.1** All types of bitumen, road tar, asphalt, etc, in drums or containers shall be stacked vertically on their bottoms in up to 3 tiers. Leaky drums shall be segregated. Empty drums shall be stored in pyramidal stacks neatly in rows.

#### **1.23 WATER**

- 1.23.1** Wherever water is to be stored for construction purposes this shall be done in proper storage tanks to prevent any organic impurities getting mixed up with it.

#### **1.24 OIL PAINTS**

- 1.24.1** All containers of paints, thinners and allied materials shall preferably be stored in a separate room on floors with sand cushions. The room shall be well-ventilated and free from excessive heat, sparks of flame and direct rays of sun. The containers of paint shall be kept covered or properly fitted with lid and shall not be kept open except while using. The containers of paints have expiry date marked by the manufacturers, which should be highlighted so as to facilitate use of paint within due period.

#### **1.25 SANITARY APPLIANCES**

- 1.25.1** All sanitary appliances shall be carefully stored under cover to prevent damage. When accepting and storing appliances, advance planning shall be made regarding the sequence of removal from the



store to the assembly positions. Supporting brackets shall be so stored as to be readily accessible for use with the appliances.

## **1.26 OTHER MATERIALS**

**1.26.1** Small articles like nails, screws, nuts and bolts, door and window fittings, polishing stones, protective clothing, spare parts of machinery, linings, packing, water supply and sanitary fittings, electrical fittings, insulation board, etc, shall be kept in suitable and properly protected store rooms. Valuable small material such as, copper pipes and fittings shall be kept under lock and key.

## **1.27 MEASUREMENTS**

Length, breadth and height of stacks shall be measured correct to a cm. The quantity shall be worked out in cubic metre correct to two places of decimal. The volume of stacks shall be reduced by percentages as shown against each for looseness in stacking to arrive at the net quantity for payment. No reduction shall be made in respect of articles or materials for which mode of payment is by length or weight or number.

### **1.27.1 Earth**

**1.27.1.1** In loose stacks such as cart loads, lorry loads, etc. – 20%

**1.27.1.2** In fills consolidated by light mechanical machinery – 10%

**1.27.1.3** In fills consolidated by heavy mechanical machinery but not under OMC (Optimum Moisture Content) - 5%

**1.27.1.4** In fills consolidated by heavy mechanical machinery at OMC - Nil

**1.27.1.5** Consolidated fills in confined situation such as under floors. etc. – Nil

### **1.27.2 Other Materials**

**1.27.2.1** Manure or sludge - 8%

**1.27.2.2** Moorum, building rubbish Lime and sand - Nil

**1.27.2.3** Stone metal, 40 mm nominal size and above - 7.5%

**1.27.2.4** Coarse aggregate/ stone metal below 40 mm nominal size - Nil

**1.27.2.5** Soling stone/ Boulder 100 mm and above - 15%

**1.27.2.6** Excavated rocks - 50%

## **1.28 RATE**

The rate for carriage of materials is inclusive of all the operations described above.



**Table 1.1: Storage and Stacking Check List**

(Clause 1.4.1)

Sl. No.	Material/ Component	Base			Stack				Types of Cover		
		Firm level ground	Hard floor	Off floor	Heaps	Tiers	Flat	Vertical	Open	Open but covered	Under shed
1	Cement			√		√					√
2	Stone and aggregates										
a	Stone, aggregates, fly ash and cinder	√			√				√		
b	Veneering stones	√				√		√	√		
3	Bricks and blocks	√			√				√		
4	Tiles										
a	Clay and concrete floor, wall and roof tiles	√				√	√		√		
b	Ceramic tiles		√			√	√				√
5	Steel	√					√		√		
6	Aluminium sections		√				√				√
7	Door, windows and ventilators		√					√			√
8	Roofing sheets	√									
a	AC	√				√	√				
b	GI and Aluminium sheets					√	√			√	
c	Plastic sheets		√			√	√				√
9	Boards like Plywood, Particle boards, Fibre Boards, Block Boards		√			√	√				√



	and Gypsum Boards										
10	Glass sheets		√				√			√	
11	CI, GI and AC Pipes and Fittings					√					
a	Pipes	√			√	√		√			
b	CI and GI fittings		√			√				√	
c	AC Fittings		√			√		√			
12	Polyethylene Pipes			√	√	√				√	
13	Unplasticized PVC Pipes	√			√	√		√			
14	Bitumen, Road Tar, Asphalt etc in Drums	√			√			√			
15	Oil Paints		√		√						√
16	Sanitary appliances			√		√					√

## TYPICAL SKETCH FOR CEMENT GODOWN

Sub Head: Carriage  
Clause: 1.7.1.2

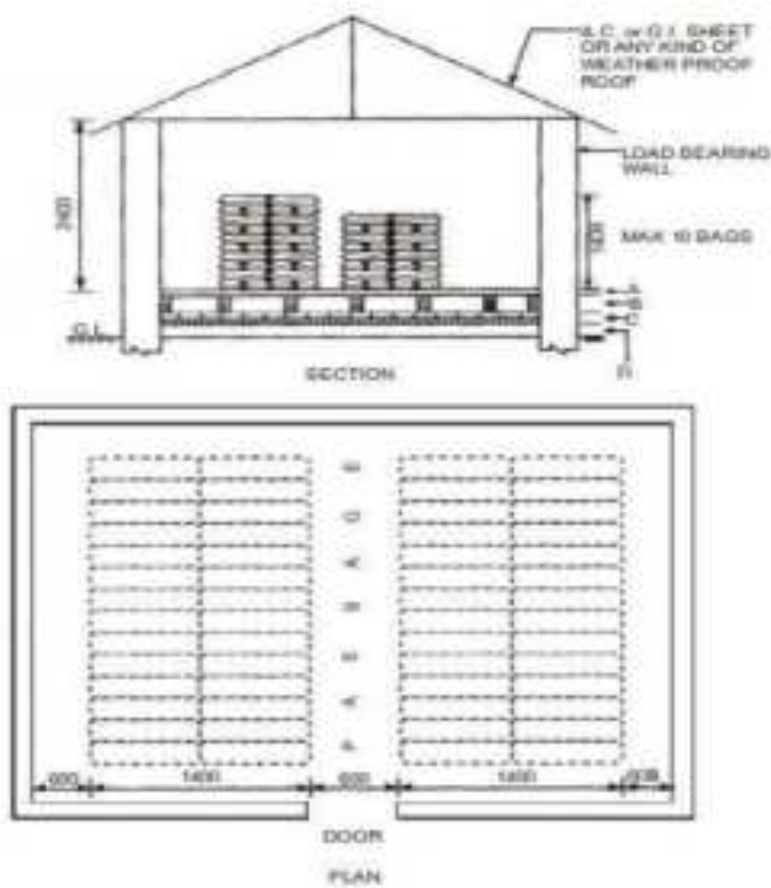


Figure 1.1: Typical Arrangement in Cement Godown

A = Planks

B = Wooden Battens

C = 150 Dry Bricks in two Layers or Lean Cement Concrete

D = 150 Consolidated Earth

Drawing not to scale

All Dimensions in milimeters





# EARTHWORK



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### LIST OF BUREAU OF INDIAN STANDARD CODES

Sl No.	I.S. No.	Subject
1	IS 632	Gamma - BHC (Lindane) emulsifiable concentrates
2	IS 1200 (Part-1)	Method of measurement of earth work
3	IS 1200 (Part-27)	Method of measurement of earth work (by Mechanical Appliances)
4	IS 4081	Safety code for Blasting and related drilling operation
5	IS 4988 (Part IV)	Excavators
6	IS 6313 (Part-II)	Anti-Termite measures in buildings (pre -constructional)
7	IS 6313(Part-III)	Anti-Termite Measures in Buildings for existing buildings
8	IS 6940	Methods of test for pesticides and their formulations
9	IS 8944	Chlorpyrifos emulsifiable concentrates
10	IS 8963	Chlorpyrifos - Technical specifications
11	IS 2138	Earth moving Equipment



## 2 EARTHWORK

### 2.0 DEFINITIONS

**Deadmen or Tell Tales:** Mounds of earth left undisturbed in pits dug out for borrowing earth.

**Burjis:** Short pillars of brick/ stone having top surface finished with cement plaster for marking etc.

**Formation or Profile:** Final shape of the ground after excavation or filling up.

**Foul condition:** Filthy and unhygienic conditions where physical movements are hampered such as soil mixed with sewage or night soil.

**Lead:** All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by Engineer-in-Charge along with reasons in writing.

Carriage by manual labour shall be reckoned in units of 50 metres or part thereof.

Carriage by animal and mechanical transport shall be reckoned in one km. unit. Distances of 0.5 km. or more shall be taken as 1 km. and distance of less than 0.5 km. shall be ignored. However, when the total lead is less than 0.5 km., it will not be ignored but paid for separately in successive stages of 50 metres subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km. by mechanical/animal transport.

**Lift:** The vertical distance for removal with reference to the ground level. The excavation up to 1.5 metres depth below the ground level and depositing the excavated materials up to 1.5 metres above the ground level are included in the rate of earth work. Lifts inherent in the lead due to ground slope shall not be paid for.

**Safety rules:** Safety rules as laid down by the statutory authority and as provided in General Conditions of contract shall be followed.

### 2.1 CLASSIFICATION OF SOILS

#### 2.1.0 The earthwork shall be classified under the following categories and measured separately for each category:

- (a) **All kind of soils:** Generally, any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.), lime concrete mud concrete and their mixtures which for excavation yields to application of picks, shovels, jumper, sacrifiers, ripper and other manual digging implements.
- (b) **Ordinary rock:** Generally, any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard laterite, hard conglomerate and un-reinforced cement concrete below ground level.  
  
If required light blasting may be resorted to for loosening the materials but this will not in any way entitle the material to be classified as 'Hard rock'.
- (c) **Hard rock:** Generally, any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.



- (d) **Hard rock (blasting prohibited):** Hard rock requiring blasting as described under (c) but where the blasting is prohibited for any reason and excavation has to be carried out by chiselling, wedging, use of rock hammers and cutters or any other agreed method.

## **2.2 ANTIQUITIES AND USEFUL MATERIALS**

- 2.2.1** Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer-in-Charge and shall be the property of the Government.
- 2.2.2** Any material obtained from the excavation which in the opinion of the Engineer-in-Charge is useful shall be stacked separately in regular stacks as directed by the Engineer-in-Charge and shall be the property of the Corporation.

## **2.3 PROTECTIONS**

- 2.3.1** Excavation where directed by the Engineer-in-Charge shall be securely barricaded and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights and/or written using fluorescent reflective paint as directed by engineer in charge during the night to avoid accident.
- 2.3.2** The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes and chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. However, if any service is damaged during excavation shall be restored in reasonable time.
- 2.3.3** Excavation shall not be carried out below the foundation level of the adjacent buildings until underpinning, shoring etc. is done as per the directions of the Engineer-in-Charge for which payment shall be made separately.
- 2.3.4** Any damages done by the contractor to any existing work shall be made good by him at his own cost. Existing drains pipes, culverts, overhead wires, water supply lines and similar services encountered during the course of execution shall be protected against damage by the contractor. The contractor shall not store material or otherwise occupy any part of the site in manner likely to hinder the operations of such services.

## **2.4 SITE CLEARANCE**

- 2.4.1** Before the earth work is started, the area coming under cutting and filling shall be cleared of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30cm measured at a height of one meter above ground level and rubbish removed up to a distance of 50 meters outside the periphery of the area under clearance. The roots of trees and saplings shall be removed to a depth of 60cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower, and the holes or hollows filled up with the earth, rammed and levelled.
- 2.4.2** The trees of girth above 30 cm measured at a height of one meter above ground shall be cut only after permission of the Engineer-in-Charge is obtained in writing. The roots of trees shall also be removed as specified in 2.4.1. Payment for cutting such trees and removing the roots shall be made separately.
- 2.4.3** Existing structures and services such as old buildings, culverts, fencing, water supply pipelines, sewers, power cables, communication cables, drainage pipes etc. within or adjacent to the area if required to be diverted/removed, shall be diverted/dismantled as per directions of the Engineer-in-Charge and payment for such diversion/dismantling works shall be made separately.
- 2.4.4** In case of archaeological monuments within or adjacent to the area, the contractor shall provide necessary fencing all-round such monuments as per the directions of the Engineer-in-Charge and



protect the same properly during execution of works. Payment for providing fencing shall be made separately.

**2.4.5** Lead of 50 m mentioned in the 'Schedule of Quantities' is the average lead for the disposal of excavated earth within the site of work. The actual lead for the disposal of earth may be more or less than the 50 m for which no cost adjustment shall be made in the rates.

**2.4.6** Disposal of Earth shall be disposed off at the specified location or as decided by the Engineer-in- Charge. The contractor has to take written permission about place of disposal of earth before the earth is disposed off, from Engineer-in-Charge.

## **2.5 SETTING OUT AND MAKING PROFILES**

**2.5.1** A masonry pillar to serve as a benchmark will be erected at a suitable point in the area, which is visible from the largest area. This benchmark shall be constructed as per Fig. 2.1 and connected with the standard benchmark as approved by the Engineer-in-Charge. Necessary profiles with strings stretched on pegs, bamboos or 'Burjis' shall be made to indicate the correct formation levels before the work is started. The contractor shall supply labor and material for constructing benchmark, setting out and making profiles and connecting benchmark with the standard benchmark at his own cost. The pegs, bamboos or 'Burjis' and the benchmark shall be maintained by the contractor at his own cost during the excavation to check the profiles.

**2.5.2** The ground levels shall be taken at 5 to 15 meters intervals (as directed by the Engineer-in- Charge) in uniformly sloping ground and at closer intervals where local mounds, pits or undulations are met with. The ground levels shall be recorded in field books and plotted on plans. The plans shall be drawn to a scale of 5 meters to one cm or any other suitable scale decided by the Engineer-in-Charge. North direction line and position of benchmark shall invariable be shown on the plans. These plans shall be signed by the contractor and the Engineer-in-Charge or their authorized representatives before the earth work is started. The labour required for taking levels shall be supplied by the contractor at his own cost.

## **2.6 BLASTING**

**2.6.0** Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to blasting operation.

Note: In ordinary rock blasting operations shall not be generally adopted. However, the contractor may resort to blasting with the permission of the Engineer-in-Charge, but nothing extra shall be paid for such blasting operations.

The contractor shall obtain license from the competent authority for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Act, 1884 as amended up to date and the Explosive Rules, 1983. The contractor shall purchase the explosives fuses, detonators, etc. only from a licensed dealer. The contractor shall be responsible for the safe transportation, storage and custody as per explosive rules and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives. The Engineer-in-Charge or his authorized representative shall have the right to check the contractor's store and account of explosives. The contractor shall provide necessary facilities for this.

The contractor shall be responsible for any dam age arising out of accident to workmen, public or property due to storage, transportation and use of explosive during blasting operation.

**2.6.1** Blasting operations shall be carried out under the supervision of a responsible authorized agent of the contractor (referred subsequently as agent only), during specified hours as approved in writing by the Engineer-in-Charge. The agent shall be conversant with the rules of blasting. In case of blasting with dynamite or any other high explosive, the position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the contractor's agent. Bore holes shall be of a size



that the cartridge can easily pass down. After the drilling operation, the agent shall inspect the holes to ensure that drilling has been done only at the marked locations and no extra hole has been drilled. The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular notch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the notch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape. The maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited. Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations have been done by the agent for the misfired boreholes.

- i. The contractor's agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator. After this a fresh detonator, primer and fuse shall be placed in the misfired holes and fired, or
- ii. The holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired holes shall also explode along with the new one.

Before leaving the site of work, the agent of one shift shall inform the another agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent.

The Engineer-in-Charge shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

### **2.6.2 General Precautions**

For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200 meters from the blasting site. Audio warning by blowing whistle shall be given before igniting the fuse.

Blasting work shall be done under careful supervision and trained personnel shall be employed. Blasting shall not be done within 200 meters of an existing structure, unless specifically permitted by the Engineer-in-Charge in writing.

All procedures and safety precautions for the use of explosives drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081, safety code for blasting and related drilling operation.

### **2.6.3 Precautions Against Misfire**





The safety fuse shall be cut in an oblique direction with a knife. All saw dust shall be cleared from inside of the detonator. This can be done by blowing down the detonator and tapping the open end. No tools shall be inserted into the detonator for this purpose.

If there is water present or if the bore hole is damp, the junction of the fuse and detonator shall be made water tight by means of tough grease or any other suitable material.

The detonator shall be inserted into the cartridge so that about one third of the copper tube is left exposed outside the explosive. The safety fuse just above the detonator shall be securely tied in position in the cartridge. Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.

If a misfire has been found to be due to defective fuse, detonator or dynamite, the entire consignment from which the fuse detonator or dynamite was taken shall be got inspected by the Engineer-in-Charge or his authorized representative before resuming the blasting or returning the consignment.

## **2.7 EXCAVATION IN ALL KINDS OF SOILS**

- 2.7.1** All excavation operations manually or by mechanical means shall include excavation and 'getting out' the excavated materials. In case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one meter or half the depth of excavation, whichever is more, clear off the edge of excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the items of excavation stating lead.
- 2.7.2** During the excavation the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or undercutting shall not be done.
- 2.7.3** In firm soils, the sides of the trenches shall be kept vertical up to a depth of 2 meters from the bottom. For greater depths, the excavation profiles shall be widened by allowing steps of 50 cms on either side after every 2 meters from the bottom. Alternatively, the excavation can be done so as to give slope of 1: 4 (1 horizontal: 4 vertical). Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or sides sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding the stepping, sloping or shoring to be done for excavation deeper than 2 meters.
- 2.7.4** The excavation shall be done true to levels, slope, shape and pattern indicated by the Engineer-in-Charge. Only the excavation shown on the drawings with additional allowances for centering and shuttering or as required by the Engineer-in-Charge shall be measured and recorded for payment.
- 2.7.5** In case of excavation for foundation in trenches or over areas, the bed of excavation shall be to the correct level or slope and consolidated by watering and ramming. If the excavation for foundation is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/bed concrete for foundations. Soft/defective spots at the bed of the foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.
- 2.7.6** While carrying out the excavation for drain work care shall be taken to cut the side and bottom to the required shape, slope and gradient. The surface shall then be properly dressed. If the excavation is done to a depth greater than that shown on the drawing or as required by the Engineer-in-Charge, the excess depth shall be made good by the contractor at his own cost with stiff clay puddle at places where the drains are required to be pitched and with ordinary earth, properly watered and rammed, where the drains are not required to be pitched. In case the drain is required to be pitched, the back filling with clay puddle, if required, shall be done simultaneously as the pitching work proceeds. The brick pitched storm water drains should be avoided as far as possible in filled-up areas and loose soils.



- 2.7.7** In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling in with earth duly watered, consolidated and rammed.
- 2.7.8** In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, additional filling wherever required on the account shall be done by the contractor at his own cost.
- 2.7.9** The excavation shall be done manually or by mechanical means as directed by Engineer-in-Charge considering feasibility, urgency of work, availability of labor /mechanical equipment and other factors involved. Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor will any extra payment be made on this account.

## **2.8 EXCAVATION IN ORDINARY/HARD ROCK**

- 2.8.1** All excavation operations shall include excavation and 'getting out' the excavated matter. in case of excavation for trenches, basements, water tanks etc. 'getting out' shall include throwing the excavated materials at a distance of at least one metre or half the depth of excavation, whichever is more, clear off the edge or excavation. In all other cases 'getting out' shall include depositing the excavated materials as specified. The subsequent disposal of the excavated material shall be either stated as a separate item or included with the item of excavation stating lead.
- 2.8.2** During the excavation, the natural drainage of the area shall be maintained. Excavation shall be done from top to bottom. Undermining or under cutting shall not be done.
- 2.8.3** Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to the blasting operations. Blasting operations shall be done as specified in Para 2.6 and chiseling shall be done to obtain correct levels, slopes, shape and pattern of excavation as per the drawings or as required by the Engineer-in-Charge and nothing extra shall be payable for chiseling.
- 2.8.4** Where blasting operations are prohibited or are not practicable, excavation in hard rock shall be done by chiseling.
- 2.8.5** In ordinary rock excavation shall be carried out by crowbars, pick axes or pneumatic drills and blasting operation shall not be gene rally adopted. Where blasting operations are not prohibited and it is practicable to resort to blasting for excavation in ordinary rock, contractor may do so with the permission of the Engineer-in-Charge in writing but nothing extra shall be paid for this blasting. Blasting shall be done as specified in Para 2.6.
- 2.8.6** If the excavation for foundations or drains is done to a depth greater than that shown in the drawings or as required by the Engineer-in-Charge. The excess depth shall be made good by the contractor at his own cost with the concrete of the mix used for levelling/ bed concrete for foundations. Soft/ defective spots at the bed of foundations shall be dug out and filled with concrete (to be paid separately) as directed by the Engineer-in-Charge.
- 2.8.7** In all other cases where the excavation is taken deeper by the contractor, it shall be brought to the required level by the contractor at his own cost by filling with earth duly watered, consolidated and rammed.
- 2.8.8** In case the excavation is done wider than that shown on the drawings or as required by the Engineer-in-Charge, filling wherever required on this account shall be done by the contractor at his own cost.
- 2.8.9** Only the excavation shown on the drawings or as required by the Engineer-in-Charge shall be measured and recorded for payment except in case of hard rock, where blasting operations have been resorted to,



excavation shall be measured to the actual levels, provided the Engineer-in-Charge is satisfied that the contractor has not gone deeper than what was unavoidable.

- 2.8.10** The excavation shall be done manually or by mechanical means as desired by Engineer-in-Charge considering feasibility, urgency of work, availability of labour /mechanical equipment and other factors involved Contractor shall ensure every safety measures for the workers. Neither any deduction will be made nor will any extra payment be made on this account.

## **2.9 EARTH WORK BY MECHANICAL MEANS**

Earth work by mechanical means involves careful planning keeping in view site conditions i.e., type of soil, nature of excavation, distances through which excavated soil is to be transported and working space available for employing these machines. The earth moving equipment should be accordingly selected.

The earth moving equipment consists of excavating and transporting equipment. Excavating equipment may be further classified as excavators and tractor based equipment.

### **2.9.1 Excavators**

**Excavators generally used at site are as follows:**

- i. **Dipper-shovel:** It is used for excavating against a face or bank consisting of open-top bucket or dipper with a bottom opening door, fixed to an arm or dipper stick which slides and pivots on the jib of the crane. It is suitable for excavating all clay chalk and friable materials and for handling rock and stone. However, it is not suitable for surface excavation for which a skimmer is used.
- ii. **Backhoe:** It is similar to face shovel except that the dipper stick pivots on the end of the jib and the dipper or bucket works towards the chassis and normally has no bottom door but is emptied by swinging away from the chassis to invert the bucket. It may be designed to carry both a front-mounted bucket loading mechanism and a rear mounted backhoe. It is mainly used to excavate trenches and occasionally used for the excavation of open areas such as small basements.
- iii. In the backhoe mode the bucket lifts, swings and discharges materials while the under carriage is stationary. When used in the 'loader' mode, the machine loads or excavated through forward motion of the machine, and lifts, transports and discharges materials.
- iv. **Skimmer:** This arrangement is similar to the face shovel except that in this case the bucket slides on rollers directly along the jib and thus has a more restricted movement. It is used for surface excavation and levelling in conjunction with transport to haul away the excavated material.
- v. **Dragline:** It is usually fitted with a long slender boom or jib and the bucket, which in operation faces towards the machine and has no door, is supported by cable only as on a crane. It works from the side of the excavation at normal ground level and is used for excavating large open excavations such as basements when the depth is beyond the limit of the boom of a backhoe. It is commonly used for open cast mining operations.
- vi. **Clamshell:** It consists of two hinged half-buckets or jaws pivoted to a frame which is suspended by cable from a long jib of an excavation. The grab is used for deep excavations of limited area on all types of soil except rock. Crane and Grab is a variant of this type of equipment.

### **2.9.2 Tractor-Based Equipment**

It is a self-propelled crawler or wheeled machine used to exert a push or pull force through mounted equipment. It is designed either as attachments to normal tracked or wheeled tractors or as machines in which the earth moving attachments and the tractor are designed as a single integrated unit. A tractor, which is hydraulically operated, can be rigged as:



- i. **Loaders:** It is used for loading, light dozing, scraping and grabbing operations, lifting and transporting the materials (loose earth, rubble, sand, gravel aggregate etc.) at various sites through forward motion of the machine.
- ii. **Tractor Shovel:** This consists of a tipping bucket at the front attached by strong pivoted arms or booms to the frame of the machine. It is used for stripping top soil, excavating against a face, bulldozing and for loading spoil or loose materials. It is similar to crawler dipper-shovel.
- iii. **Trench Digger:** It operates on the same principle as a backhoe excavator except that the bucket is controlled by hydraulic rams instead of cables and pulleys.
- iv. **Scraper:** Scrapers provide unique capability to excavate, load, haul and dump materials. Scrapers are available in various capacities by a number of manufacturers with options such as self - loading with elevators, twin engines or push-pull capability. They are cost effective where the haul distance is too long for bulldozers, yet too short for trucks. This distance typically ranges from 120 m to 1200 m; however, the economics should be evaluated for each project. Scraper has an open bowl with a cutting edge positioned between the axles, which cuts, loads, transports, discharges and spreads through forward motion of the machine. Loading through forward motion of the machine can be assisted by a powered mechanism (elevator) fixed to the scraper bowl.
- v. **Bulldozer and Angle-dozer:** The most common equipment used for clearing and levelling activities is a bulldozer. The terms bulldozer is used to define a tractor mounted with a dozing blade. The bulldozer consists of a rectangular steel blade with renewable cutting edge set at right angles (capable of only tilting but not angling) to the direction of travel and attached by steel arms to the side frames of a crawler tractor. It may be used for excavating natural soil or for moving loose soil or debris, which is pushed forward as the tractor forces it ahead
- vi. **Angledozer** is capable of both tilting and angling.

### 2.9.3 Transporting Equipment

- i. **Dumpers:** These are self-propelled wheeled machines, having an open body. It is designed for the transport of excavated materials and consists of a shallow tipping hopper or skip mounted on a wheeled chassis, such as, power barrow, dumper, multi-skip dumpers, high discharge dumpers, dump truck, etc. These can be rear dump, side dump or bottom dump.
- ii. **Vibratory Roller:** It is a single Drum Vibratory Roller for compaction of embankments, etc. The smooth drum version is for compaction of granular and mixed soil. The sheepsfoot Roller consists of a hollow cylindrical steel drum or drums on which projecting feet are mounted. These feet penetrate into the fill as a roller moves forward and cause compaction. The geometry of the foot may be sheep, club pyramid, cone or cylinder foot. Such rollers are employed for compaction (densification) of cohesive and semi-cohesive soils.

## 2.10 FILLING

**2.10.1** The earth used for filling shall be free from all roots, grass, shrubs, rank vegetation, brushwood, tress, sapling and rubbish.

**2.10.2** Filling with excavated earth shall be done in regular horizontal layers each not exceeding 20 cm in depth. All lumps and clods exceeding 8 cm in any direction shall be broken. Each layer shall be watered and consolidated with steel rammer or ½ tonne roller. Where specified, every third and top must layer shall also be consolidated with power roller of minimum 8 tonnes. Wherever depth of filling exceeds 1.5 meter vibratory power roller shall be used to consolidate the filing unless otherwise directed by Engineer-in-Charge. The top and sides of filling shall be neatly dressed. The contractor shall make good all subsidence and shrinkage in earth fillings, embankments, traverses etc. during execution and till the completion of work unless otherwise specified.



## 2.11 MEASUREMENTS

- 2.11.1** The length and breadth of excavation or filling shall be measured with a steel tape correct to the nearest cm. The depth of cutting or height of filling shall be measured, correct to 5 mm, by recording levels before the start of the work and after the completion of the work. The cubical contents shall be worked out to the nearest two places of decimal in cubic metres.
- 2.11.1.1** In case of open footings up to the depth of 1.5 metres, all-round excavation of 30 cm. beyond the outer dimension of footing shall be measured for payment to make allowances for centering and shuttering. Any additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.
- 2.11.1.2** In case of open footings/Rafts at a depth of more than 1.5 metre, all-round excavation of 75 cm shall be measured for payment to make allowance for centering and shuttering. Additional excavation beyond this limit shall be at the risk and cost of the contractor and shall not be measured for payment.
- 2.11.2** In case the ground is fairly uniform and where the site is not required to be leveled, the Engineer-in-Charge may permit the measurements of depth of cutting or height of filling with steel tape, correct to the nearest cm. In case of borrow pits, diagonal ridges, cross ridges or dead-men, the position of which shall be fixed by the Engineer-in-Charge, shall be left by the contractor to permit accurate measurements being taken with steel tape on the completion of the work. Deduction of such ridges and dead men shall be made from the measurements unless the same are required to be removed later on and the earth so removed is utilized in the work. In the latter case nothing extra will be paid for their removal as subsequent operation.
- 2.11.3** Where ordinary rock and hard rock is mixed. The measurement of the excavation shall be made as specified in para 2.11.1 and 2.11.2. The two kinds of rock shall be stacked separately and measured in stacks. The net quantity of the two kinds of rocks shall be arrived at by applying deduction of 50% to allow for voids in stacks. If the sum of net quantity of two kinds of rocks exceeds the total quantity of the excavated material, then the quantity for each type of rock shall be worked out from the total quantity in the ratio of net quantities in stack measurements of the two types of rocks. If in the opinion of the Engineering-in-charge stacking is not feasible, the quantity of ordinary and hard rock shall be worked out by means of cross-sectional measurements.
- 2.11.4** Where soil, ordinary rock and hard rock are mixed, the measurements for the entire excavation shall be made as specified in para 2.11.1 and 2.11.2. Excavated materials comprising hard rock and ordinary rock shall be stacked separately, measured, and each reduced by 50% to allow for voids to arrive at the quantity payable under hard rock and ordinary rock. The difference between the entire excavation and the sum of the quantities payable under hard rock and ordinary rock shall be paid for as excavation in ordinary soil or hard soil as the case may be.
- 2.11.5** Where it is not possible or convenient to measure the depth of cutting by recording levels as specified in para 2.11.1, quantity of excavation shall be worked out from filling. The actual measurements of the fill shall be calculated by taking levels of the original ground before start of the work after site clearance and after compaction of the fill as specified and the quantity of earth work so computed shall be reduced by 10% in case of consolidated fills and by 5% in case the consolidation is done by heavy mechanical machinery to arrive at the net quantity of excavation for payment. No such deduction shall, however, be made in case of consolidation by heavy mechanical machinery at optimum moisture content, or when the consolidated filling is in confined situations such as under floors.
- 2.11.6 Recording Measurements for Earth Levelling Work.**
- 2.11.6.1 Level Books:** In case of levelling operations and earthwork, measurements are required to be recorded in level books in addition to Measurement Books. The Level Books should be numbered, accounted for and handled like Measurement Books.



#### **2.11.6.2 Preparatory Works:** Before starting the earth work, following steps should be taken:

1. Original ground levels should be recorded in the Level Book in the presence of the contractor or his authorized representative and should be signed by him and the site engineer who records the levels. All the local mounds and depressions should be indicated clearly in the drawing and the field Level Book and should be checked by the site engineer before the levelling work is started.
2. Plans showing initial levels, location of bench marks and reduced levels, should be prepared and signed by both the parties and attached to the agreement before commencement of the work.
3. A suitable baseline should be fixed with permanent masonry pillars at distances not exceeding 150 meters to provide a permanent reference line for facilitating check work. The base line (s) should be entered in the Level Book with co-ordinates. These baselines should be maintained till the final payment for the work has been made.
4. While recording the levels, it should be ensured that the circuit is closed by taking final levels of the starting point or any other point, the R.L. of which was previously determined.

#### **2.11.6.3 Test Check of the Levels**

1. The site engineer should exercise test check at least to the extent of 50%, and the Site-in-Charge at least to the extent of 10%. where the value of this item of work exceeds 10% of the tender acceptance power of the Assistant Engineer.
2. The test check of the levels should be carried out independently by each officer, and the readings should be recorded in the prescribed Level Book in red ink against the old levels which should be neatly scored out wherever necessary. If the test check carried out reveals serious mistakes in the original levels, these should be taken or re-taken and re-checked.
3. The test check carried out by an officer should be as representative as possible for the entire work done.
4. On completion of work, the levels should again be recorded in the Level Book and the contractor's signatures obtained. These levels should also be test checked by the IOCL Officials to the same extent as indicated in (1) within one month of the date of completion of the earth work, and according to the procedure as laid down in the case of initial levels as indicated above.
5. The formation levels as per final execution of the work should be compared with the proposed formation levels and the work got rectified within permissible tolerance.

#### **2.11.6.4 Payment of Leveling Work**

1. Every fourth running bill and the final bill should be paid on the basis of levels.
2. Intermediate payments can, however, be made on the basis of borrow pit measurements. The Engineer-in-Charge should take care that the quantities thus assessed are not in any case more than the actual work done.

#### **2.11.6.5 Large Scale Leveling Work**

1. In case of large-scale levelling work involving both cutting and filling, an accurate site plan should be prepared before the work is commenced. The portions requiring cutting and filling shall then be divided into squares and corresponding squares into filling, which are complementary to the squares in cutting given the same number.
2. A table may be written upon the plan showing leads involved between the various complementary squares. This would form a lead chart for the work to be done.
3. Before the work of levelling is commenced, the lead chart shall be checked by the IOCL Officials in the presence of the contractor or his authorized representative and his signatures shall be obtained on the





same. This should form an integral part of the contract and should be duly signed by both the integral parties before commencement of the work.

4. The quantity payable for earthwork shall be lower of the quantity derived from cutting or filling. The payment for lead shall be based on lead chart prepared in the aforesaid manner.

#### **2.11.6.6 Import of Earth**

In case of earth to be imported, the area from where the earth is to be imported, should be pre-determined wherever possible before the start of the work, and wherever feasible, the average lead should be worked out and stipulated in the tender. After this is determined, initial levels of the area to be filled should be recorded. The levels should be properly checked during the progress of work and on completion.

### **2.12 RATES**

#### **2.12.1 Rates for Earthwork shall include the following:**

- (a) Excavation and depositing excavated material as specified.
- (b) Handling of antiquities and useful material as specified on para 2.2.
- (c) Protection as specified in para 2.3.
- (d) Site clearance as specified in para 2.4.
- (e) Setting out and making profiles as specified in para 2.5.
- (f) Forming (or leaving) dead - men or 'Tell Tales' in borrow pits and their removal after measurements.
- (g) Bailing out or pumping of rain water from excavations.
- (h) Initial lead of 50 m and lift of 1.5 m.
- (i) Blasting operations for hard rock as specified in para 2.6.

**2.12.2** No deduction shall be made from the rate if in the opinion of the Engineer- in-charge, operations specified in para 2.12.1 (b) to (h) are not required to be carried out on any account whatsoever.

### **2.13 SURFACE EXCAVATION**

**2.13.1** Excavations exceeding 1.5 m in width and 10 sqm. on plan but not exceeding 30 cm. in depth in all types of soils and rocks shall be described as surface excavation and shall be done as specified in para 2.7 and 2.8.

#### **2.13.2 Measurements**

The length and breadth shall be measured with a steel tape correct to the nearest cm. and the area worked out to the nearest two places of decimal in square meters.

**2.13.3** Rate shall be as specified in para 2.12.

### **2.14 ROUGH EXCAVATION AND FILLING**

**2.14.1** Excavation for earth from borrow pits, cutting hill side slopes etc. shall be described as rough excavation and shall be done as specified in para 2.7, 2.8 and 2.9.

**2.14.2** Wherever filling is to be done, the earth from excavation shall be directly used for filling and no payment for double handling of earth shall be admissible. Filling of excavated earth shall be done as specified in para 2.10. In case of hill side cutting, where the excavated materials are thrown down the hill slopes, payment for filling excavated earth shall not be admissible.

**2.14.3** Measurements shall be as specified in para 2.11.



**2.14.4** Rates shall be as specified in para 2.12.

**2.15 EXCAVATION OVER AREA (ALL KINDS OF SOIL)**

**2.15.1** This shall comprise:

- (a) Excavation exceeding 1.5 m in width and 10 sqm on plan and exceeding 30 cm in depth.
- (b) Excavation for basements, water tanks etc.
- (c) Excavation in trenches exceeding 1.5 m in width and 10 sqm on plan.

**2.15.2** Excavation shall be done as specified in para 2.7.

**2.15.3** Measurements shall be as specified in para 2.11.

**2.15.4** Rates shall be as specified in para 2.12.

**2.16 EXCAVATION OVER AREA (ORDINARY/ HARD ROCK)**

**2.16.1** This shall comprise:

- (a) Excavation exceeding 1.5 m in width and 10 sqm on plan and exceeding 30 cm in depth.
- (b) Excavation for basements, water tanks etc.
- (c) Excavation in trenches exceeding 1.5 m in width and 10 sqm on plan.

**2.16.2** Excavation shall be done as specified in para 2.8 and 2.9.

**2.16.3** Measurements shall be as specified in para 2.11.

**2.16.4** Rates shall be as specified in para 2.12.

**2.17 EXCAVATION IN TRENCHES FOR FOUNDATIONS AND DRAINS (ALL KINDS OF SOIL)**

**2.17.1** This shall comprise excavation exceeding 1.5 m in width and 10 sqm on plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)

**2.17.2** Excavation shall be done as specified in para 2.7.

**2.17.3** Measurements shall be as specified in para 2.11.

**2.17.4** Rates shall be as specified in para 2.12.

**2.18 EXCAVATION IN TRENCHES FOR FOUNDATIONS AND DRAINS (ORDINARY/ HARD ROCK)**

**2.18.1** This shall comprise excavation exceeding 1.5 m in width and 10 sqm on plan and to any depth in trenches (excluding trenches for pipes, cables, conduits etc.)

**2.18.2** Excavation shall be done as specified in para 2.8 and 2.9.

**2.18.3** Measurements shall be as specified in para 2.11.

**2.18.4** Rates shall be as specified in para 2.12.

**2.19 EXCAVATION IN TRENCHES FOR PIPES, CABLES ETC. AND REFILLING**

**2.19.1** This shall comprise excavation not exceeding 1.5 mts in width or 10 sqm on plan and to any depth trenches for pipes, cables etc. and returning the excavated material to fill the trenches after pipes, cables etc. are laid and their joints tested and passed and disposal of surplus excavated material up to 50 m lead.

**2.19.2 Width of Trench**





- (a) Up to one metre depth the authorized width of trench for excavation shall be arrived at by adding 25 cm to the external diameter of pipe (not socket/ collar) cable, conduit etc. Where a pipe is laid on concrete bed/ cushioning layer, the authorized width shall be the external diameter of pipe (not socket/ collar) plus 25 cm or the width of concrete bed/ cushioning layer whichever is more.
- (b) For depths exceeding one metre, an allowance of 5 cm per metre of depth for each side of the trench shall be added to the authorized width (that is external diameter of pipe plus 25 cm) for excavation. This allowance shall apply to the entire depth of the trench. In firm soils the sides of the trenches shall be kept vertical upto depth of 2 metres from the bottom. For depths greater than 2 metres, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every two metres from bottom.
- (c) Where more than one pipe, cable, conduit etc, are laid, the diameter shall be reckoned as the horizontal distance from outside to outside of the outermost pipes, cable, conduit etc.
- (d) Where the soil is soft, loose or slushy, width of trench shall be suitably increased or side sloped or the soil shored up as directed by the Engineer-in-Charge. It shall be the responsibility of the contractor to take complete instructions in writing from the Engineer-in-Charge regarding increase in the width of trench. Sloping or shoring to be done for excavation in soft, loose or slushy soils.

**2.19.3 Excavation:** Shall be done as specified in para 2.7, 2.8 and 2.9.

#### **2.19.4 Refilling**

Filling in trenches shall be commenced soon after the joints of pipes, cables, conduits etc. have been tested and passed. The space all-round the pipes, cables conduits etc. shall be cleared of all debris, brick bats etc. Where the trenches are excavated in hard/ soft soil, the filling shall be done with earth on the side and top of pipes in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the excavated earth is used for filling. In case of excavation trenches in ordinary/ hard rock, the filling upto a depth of 30cm above the crown of pipe, cable, conduits etc. shall be done with fine material like earth, moorum or pulverized/ decomposed rock according to the availability at site. The remaining filling shall be done with boulders of size not exceeding 15cm mixed with fine material like decomposed rock, moorum or earth as available to fill up the voids, watered, rammed and consolidated in layers not exceeding 30 cm. Excavated material containing deleterious material, salt peter earth et c. shall not be used for filling. Ramming shall be done with iron rammers where feasible and with blunt ends of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, cables, conduits etc. laid in the trenches.

#### **2.19.5 Measurements**

**2.19.5.1** Trenches for pipes, cables, conduits etc. shall be measured in running meter correct to the nearest cm in stages of 1.5 m depth and described separately as under:

- (a) Pipes, cables, conduits etc. not exceeding 80 mm dia.
- (b) Pipes, cables, conduits etc. exceeding 80 mm dia but not exceeding 300 mm dia.
- (c) Pipes, cables, conduits etc. exceeding 300 mm dia.

**2.19.5.2** Where two or more categories of each work are involved due to different classification of soil within the same stage of trench depth or where the soil is soft loose or slushy requiring increase in the width of trench or sloping sides or shoring, trenches for pipes, cables, conduits, etc. shall be measured in cubic meters as specified in para 2.10. Extra excavation, if any, on account of collar/ socket of pipes shall neither be measured nor paid for separately.

#### **2.19.6 Rates**



The rate shall be as specified in para 2.12 and shall also include the cost of refilling and all other operations described above.

## **2.20 PLANKING AND STRUTTING**

**2.20.1** When the depth of trench in soft/loose soil exceeds 2 metres, stepping, sloping and/ or planking and strutting of sides shall be done. In case of loose and slushy soils, the depths at which these precautions are to be taken, shall be determined by the Engineer-in-Charge according to the nature of soil.

Planking and strutting shall be 'close' or 'open' depending on the nature of soil and the depth of trench. The type of planking and strutting shall be determined by the Engineer-in-Charge. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of trenches from collapse. Engineer-in-Charge should take guidance from IS: 3764 for designing the shoring and strutting arrangements and specifying the profile of excavation.

### **2.20.2 Close Planking and Strutting**

Close planking and strutting shall be done by completely covering the sides of the trench generally with short upright, members called 'poling boards'. These shall be 250x38 mm in section or as directed by the Engineer-in-Charge.

The boards shall generally be placed in position vertically in pairs. One board on either side of cutting. These shall be kept apart by horizontal wallings of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies, or as directed by Engineer-in-Charge. The length and diameter of the ballies strut shall depend upon the width of the trench. Typical sketch of close timbering is given in Fig. 2.2.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical 'wallings' which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be taken in the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed.

The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried, unless required by the Engineer-in-Charge to be left permanently in position.

### **2.20.3 Open Planking and Strutting**

In case of open planking and strutting, the entire surface of the side of the trench is not required to be covered. The vertical boards 250 mm wide & 38 mm thick, shall be spaced sufficiently apart to leave unsupported strips of 50 cm average width. The detailed arrangement, sizes of the timber and the distance apart shall be subject to the approval of the Engineer-in-Charge. In all other respect, specifications for close planking and strutting shall apply to open planking and strutting. Typical sketch of open planking and strutting is given in fig. 2.2.

### **2.20.4 Measurements**

The dimensions shall be measured correct to the nearest cm and the area of the face supported shall be worked out in square metres correct to two places of decimal.

**2.20.4.1** Works shall be grouped according to the following:

- (a) Depth not exceeding 1.5 m.
- (b) Depth exceeding 1.5m in stages of 1.5 m.

**2.20.4.2** Planking and strutting to the following shall be measured separately:



- (a) Trenches
- (b) Areas- The description shall include use and waste of raking shores.
- (c) Shafts, walls, cesspits, manholes and the like
- (d) Where tightly driven close but jointed sheeting is necessary as in case of running sheeting is necessary as in case of running sand the item shall be measured separately and packing of cavities behind sheeting with suitable materials included with the item.
- (e) Planking and strutting required to be left permanently in position shall be measured separately.

#### **2.20.5 Rates**

Rates shall include use and waste of all necessary timber work as mentioned above including fixing and subsequent removal.

### **2.21 EXCAVATION IN WATER MUD OR FOUL POSITION**

**2.21.1** All water that may accumulate in excavations during the progress of the work from springs, tidal or river seepage, broken water mains or drains (not due to the negligence of the contractor), and seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and/or pumping out water from excavations and/or pumping out water from excavations and construct diversion channels, bunds, sumps, coffer dams etc. as may be required. Pumping shall be done directly from the foundation trenches or from a sump outside the excavation in such a manner as to preclude the possibility of movement of water through any fresh concrete or masonry and washing away parts of concrete or mortar. During laying of concrete or masonry and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from concrete or masonry by effective means.

Capacity and number of pumps, location at which the pumps are to be installed, pumping hours etc. shall be decided from time to time in consultation with the Engineer-in-Charge.

Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby.

To prevent slipping of sides, planking and strutting may also be done with the approval of the Engineer-in-Charge.

#### **2.21.2 Classification**

The earth work for various classification of soil shall be categorized as under:

- (a) **Work in or under water and/or liquid mud:**

Excavation, where water is met with from any of the sources specified in para 2.21.1 shall fall in this category. Steady water level in the trial pits before the commencement of bailing or pumping operations shall be the sub-soil water level in that area.

- (b) **Work in or under foul position:**

Excavation, where sewage, sewage gases or foul conditions are met with from any source, shall fall in this category. Decision of the Engineer-in-Charge whether the work is in foul position or not shall be final.

#### **2.21.3 Measurements**

**2.21.3.1** The unit, namely, meter depth shall be the depth measured from the level of foul position/ subsoil water level and up to the center of gravity of the cross-sectional area of excavation actually done in the



conditions classified in para 2.21.2. Meter depth shall be reckoned correct to 0.1 m, 0.05 m or more shall be taken as 0.1 m and less than 0.05 m ignored. The extra percentage rate is applicable in respect of each item but the measurements shall be limited only to the quantities of earth work actually executed in the conditions classified in para 2.21.2.

- 2.21.3.2** In case earth work in or under foul position is also in or under water and/or liquid mud, extra payment shall be admissible only for the earth work actually executed in or under foul position.
- 2.21.3.3** Pumping or bailing out water met within excavations from the sources specified in para 2.21.1 where envisaged and specifically ordered in writing by the Engineer-in-Charge shall be measured separately and paid. Quantity of water shall be recorded in kiloliters correct to two places of decimal. This payment shall be in addition to the payment under respective items of earthwork and shall be admissible only when pumping or bailing out water has been specifically ordered by the Engineer-in-Charge in writing.
- 2.21.3.4** Planking and strutting or any other protection work done with the approval of the Engineer-in-Charge to keep the trenches dry and/ or to save the foundations against damage by corrosion of rise in water levels shall be measured and paid for separately.
- 2.21.3.5** Bailing or pumping out water, accumulated in excavation, due to rains is included under respective items of earthwork and is not to be paid separately.

#### **2.21.3.6 Rates**

The rates for respective items described above shall include cost of all the operations as may be applicable.

**Note:** NIT approving authority may make work specific special conditions considering magnitude of works, soil and water table condition etc.

### **2.22 EARTH WORK FOR MAJOR WORKS: DELETED**

### **2.23 FILLING IN TRENCHES, PLINTH, UNDER FLOOR ETC.**

#### **2.23.1 Earth**

Normally excavated earth from same area shall be used for filling. Earth used for filling shall be free from shrubs, rank, vegetation, grass, brushwood, stone shingle and boulders (larger than 75mm in any direction), organic or any other foreign matter. Earth containing deleterious materials, salt peter earth etc. shall not be used for filling. All clods and lumps of earth exceeding 8 cm in any direction shall be broken or removed before the earth is used for filling.

#### **2.23.2 Filling**

The space around the foundations and drains in trenches shall be cleared of all debris, brick bats etc. The filling shall be done in layers not exceeding 20 cm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. In case of filling under floor, the finished level of filling shall be kept to the slope intended to be given to the floor.

#### **2.23.3 Measurements**

- 2.23.3.1** Filling Side of Foundations: The cubical contents of bed concrete levelling course and masonry/ concrete in foundations up to the ground level shall be worked out and the same deducted from the cubical contents of earthwork in excavation for foundations already measured under the respective item of earth work to arrive at the quantity for filling sides of foundation. The quantity shall be calculated correct to two places of decimal.



**2.23.3.2** Filling in Plinth and under Floors: Depth of filling shall be the consolidated depth. The dimensions of filling shall be on the basis of pre-measurement correct to the nearest cm and cubical content worked out in cubic meters correct to two places of decimal.

#### **2.23.4 Rates**

The rates include cost of all the operations described above.

### **2.24 SAND FILLING IN PLINTH**

#### **2.24.1 Sand**

Sand shall be clean and free from dust organic and foreign matter and its grading shall be within the limits of grading zone IV or V specified in Section 3 'Mortars'.

#### **2.24.2 Filling**

Sand filling shall be done in a manner similar to earth filling in plinth specified in para 2.23.3.2. except that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the Engineer-in-Charge has inspected and approved the sand filling.

#### **2.24.3 Measurements**

The length, breadth and depth of consolidated sand shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic meters correct to two places of decimal.

#### **2.24.4 Rates**

The rates include the cost of material and labor involved in all the operations described above.

### **2.25 SURFACE DRESSING**

**2.25.1** Surface dressing shall include cutting and filling up to a depth of 15 cm and clearing of shrubs, rank vegetation, grass, brushwood, trees and saplings of girth up to 30 cm measured at a height of one meter above the ground level and removal of rubbish and other excavated material up to a distance of 50 meters outside the periphery of the area under surface dressing. High portions of the ground shall be cut down and hollows depression filled up to the required level with the excavated earth so as to give an even, neat and tidy look.

#### **2.25.2 Measurements**

Length and breadth of the dressed ground shall be measured correct to the nearest cm and the area worked out in square meters correct to two places of decimal.

#### **2.25.3 Rates**

The rates shall include cost of labor involved in all the operations described above.

### **2.26 JUNGLE CLEARANCE**

**2.26.0** Jungle clearance shall comprise uprooting of rank vegetation, grass, brushwood, shrubs, stumps, trees and saplings of girth up to 30 cm measured at a height of one meter above the ground level. Where only clearance of grass is involved, it shall be measured and paid for separately.

#### **2.26.1 Uprooting of Vegetations**

The roots of trees and saplings shall be removed to a depth of 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower. All holes or hollows formed due to removal of roots shall be filled up with earth rammed and levelled. Trees, shrubs, poles, fences, signs, monuments, pipelines, cable etc., within or adjacent to the area which are not required to be disturbed



during jungle clearance shall be properly protected by the contractor at his own cost and nothing extra shall be payable.

#### **2.26.2 Stacking and Disposal**

All useful materials obtained from clearing and grubbing operation shall be stacked in the manner as directed by the Engineer-in-Charge. Trunks and branches of trees shall be cleared of limbs and top and stacked neatly at places indicated by the Engineer-in-Charge. The materials shall be the property of the Government. All unserviceable materials which in the opinion of the Engineer-in-Charge cannot be used or auctioned shall be removed up to a distance of 50 m outside the periphery of the area under clearance. It shall be ensured by the contractor those unserviceable materials are disposed off in such a manner that there is no likelihood of getting mixed up with the materials meant for construction.

#### **2.26.3 Clearance of Grass**

Clearing and grubbing operation involving only the clearance of grass shall be measured and paid for separately and shall include removal of rubbish upto a distance of 50 m outside the periphery of the area under clearance.

#### **2.26.4 Measurements**

The length and breadth shall be measured correct to the nearest cm and area worked out in square meters correct to two places of decimal.

#### **2.26.5 Rates**

The rate includes cost of all the operation described above.

**Note:** Jungle clearance and clearance of grass are not payable separately for the earth work specified in para 2.13 to 2.19.

### **2.27 FELLING TREES**

#### **2.27.1 Felling**

While clearing jungle, growth trees above 30 cm girth (measured at a height of one metre above ground level) to be cut, shall be approved by the Engineer-in-Charge and then marked at site. Felling trees shall include taking out roots upto 60 cm below ground level or 30 cm below formation level or 15 cm below sub-grade level, whichever is lower.

All excavation below general ground level arising out of the removal of trees, stumps etc. shall be filled with suitable material in 20 cm layers and compacted thoroughly so that the surfaces at these points conform to the surrounding area. The trunks and branches of trees shall be cleared of limbs and tops and cut into suitable pieces as directed by the Engineer-in-Charge.

#### **2.27.2 Stacking and Disposal**

Wood, branches, twigs of trees and other useful material shall be the property of the Government. The serviceable materials shall be stacked in the manner as directed by the Engineer-in-Charge up to a lead of 50m.

All unserviceable material, which in the opinion of Engineer-in-Charge cannot be used or auctioned shall be removed from the area and disposed off as per the directions of the Engineer-in-Charge. Care shall be taken to see that unsuitable waste materials are disposed off in such a manner that there is no likelihood of these getting mixed up with the materials meant for construction.

#### **2.27.3 Measurements**

Cutting of trees above 30 cm in girth (measured at a height of one meter above level) shall be measured in numbers according to the sizes given below:



- (a) Beyond 30 cm girth, up to and including 60cm girth.
- (b) Beyond 60 cm girth, up to and including 120 cm girth.
- (c) Beyond 120 cm girth, up to and including 240 cm girth.
- (d) Above 240 cm girth.

#### 2.27.4 Rate

The rate includes the cost involved in all the operations described above. The contract unit rate for cutting trees above 30 cm in girth shall include removal of stumps as well.

### 2.28 ANTI-TERMITE TREATMENT

**2.28.0** Sub-terranean termites are responsible for most of the termite damage in buildings. Typically, they form nests or colonies underground. In the soil near ground level in a stump or other suitable piece of timber in a conical or dome shaped mound. The termites find access to the super-structure of the building either through the timber buried in the ground or by means of mud shelter tubes constructed over unprotected foundations.

Termite control in existing as well as new building structures is very important as the damage likely to be caused by the termites to wooden members of building and other household article like furniture, clothing, stationery etc. is considerable. Anti-termite treatment can be either during the time of construction i.e. pre-constructional chemical treatment or after the building has been constructed i.e. treatment for existing building.

Prevention of the termite from reaching the super-structure of the building and its contents can be achieved by creating a chemical barrier between the ground, from where the termites come and other contents of the building which may form food for the termites. This is achieved by treating the soil beneath the building and around the foundation with a suitable insecticide.

#### 2.28.1 Materials

**2.28.1.0 Chemicals:** Any one of the following chemicals in water emulsion to achieve the percentage concentration specified against each chemical shall be used:

- (a) Chlorphriphos emulsifiable concentrate of 20%
- (b) Lindane emulsifiable concentrate of 20%

Anti-termite treatment chemical is available in concentrated form in the market and concentration is indicated on the sealed containers, to achieve the specified percentage of concentration, Chemical should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemical with water in the required proportion to achieve the desired percentage of concentration, for example, to dilute chemical of 20 % concentration. 19 parts of water shall be added to one part of chemical for achieving 1% concentration.

Engineer-in-Charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized dealers, chemical shall be kept in the custody of the Engineer-in- Charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

**2.28.1.1 Measurements:** Concentrated chemical in sealed containers shall be measured in liters. Chemicals of different types and concentration shall be measured separately.

**2.28.1.2 Rate:** The Rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.





### 2.28.2 Safety Precautions

Chemical used for anti-termite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapors or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labelled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons using these chemicals shall be warned that absorption through skin is the most likely source of accidental poisoning. Particular care shall be taken to prevent skin contact with concentrates and prolonged exposure to dilute emulsion shall also be avoided. After handling the concentrates or dilute emulsion. Workers shall wash themselves with soap and water and wear clean clothing, especially before eating. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

Care should be taken in the application of chemicals to see that they are not allowed to contaminate wells or springs which serve as source of drinking water.

### 2.28.3 Anti-Termite Treatment: Constructional Measures

The construction measures specified below should be adopted for protection against subterranean termites originating both internally from within the plinth and externally from the area surrounding the building.

- i. Earth free from roots, dead leaves, or other organic matter shall be placed and compacted in successive horizontal layers of loose material not more than 200 mm thick. Dry brick shall be inserted at last 50 mm in brick masonry for providing apron floor around the periphery. [See Fig. 2.3(i)]
- ii. Brick on edge masonry in cement mortar shall be laid on the plinth wall. Dry brick shall be placed on the inner side of plinth wall for getting anticipated offset space for coarse sand and on the other side for installing anti-termite masonry groove. In the case of intermediate walls, dry bricks are placed on either side of the brick on edge masonry for getting offset space for coarse sand layer. [See Fig. 2.3(ii)]
- iii. The dry brick for the anti-termite groove shall be taken out and dense cement concrete 1:3:6 (1 cement: 3 sands: 6 coarse aggregates by volume) sub-floor carpet shall be laid casting the anti-termite groove in position. In case of internal partition walls, the cement concrete sub-floor shall be laid on either side over the dry bricks to sufficient extent for getting staggered vertical joints over the joint of plinth wall and earth filling. [See Fig. 2.3(iii)]
- iv. Superstructure masonry shall be raised over the dense cement concrete sub floor carpet and over-head jobs completed. [See Fig. 2.3) (iv)]
- v. The dry brick for coarse sand layer shall be removed and graded sand (of size 3 to 5 mm) layer at least 100 mm thick shall be compacted over the earth filling and underneath the partially laid dense cement concrete sub-floor carpet [See Fig. 2.3) (v)]
- vi. Dense cement concrete (1:3:6 mix.) sub-floor at least 75 mm thick shall be laid over the sand filling. Necessary finish may be provided to the cement concrete sub-floor carpet. [See Fig. 2.3) (vi)]
- vii. Dry brick provided for apron floor shall be taken out and 600 mm wide formation of earth in 1:30 slope shall be made. Over the formation, 75 mm thick lime concrete 1:3:6 (1 lime:3 sand: 6 coarse aggregates, by volume) shall be laid. [See Fig. 2.3) (vii)]
- viii. Over the 75 mm thick like concrete bed at least 25 mm thick cement concrete topping 1:2:4 (1 cement: 2 sand: 4 fine aggregate, by volume) shall be laid and 12 mm thick cement plaster shall be applied on foundation and plinth. [See Fig. 2.3) (viii)]





The final recommendations incorporating the constructional details given above (i to viii) are shown in Fig. 2.4.

#### 2.28.4 Anti-Termite Treatment: Treatment for Existing Building: Post Construction Treatment

##### 2.28.4.1 Material

- i. Chemicals: Any one of the following chemicals conforming to relevant Indian Standards in water emulsion may be used for soil treatment in order to protect a building from termite attack.

Chemical with Percent	Relevant Indian Standards (Active ingredient)	Concentration by weight
Chlorpyrifos 20EC	IS 8944	1.0
Lindane 20EC	IS 632	1.0

These chemicals are available in concentrated form in the market and concentration is indicated on the sealed containers. To achieve the specified percentage of concentration, chemicals should be diluted with water in required quantity before it is used. Graduated containers shall be used for dilution of chemicals with water in the required proportion to achieve the desired percentage of concentration. For example, to dilute chemical of 20 % concentration, 19 parts of water shall be added to one part of chemical for achieving 1% concentration. oil or kerosene-based solution of chlorpyrifos 20 EC or Lindane 20 EC, 1.0 percent (by weight) concentration is useful for treatment of wood. Engineer-in-Charge shall procure the chemical of required concentration in sealed original containers directly from the reputed and authorized representative. Chemical shall be kept in the custody of the Engineer-in-charge or his authorized representatives and issued for use to meet the day's requirements. Empty containers after washing and concentrated chemical left unused at the end of the day's work shall be returned to the Engineer-in-Charge or his authorized representative.

- ii. Measurements: Concentrated chemical in sealed containers shall be measured in litres. Chemicals of different types and concentration shall be measured separately.
- iii. Rate: The rate for the concentrated chemical shall include the cost of material, containers and all the operations involved in transportation and delivery at the place specified.
- iv. Safety Precautions: Chemical used for antitermite treatment are insecticides with a persistent action and are highly poisonous. This chemical can have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mists or swallowed.

The containers having emulsifiable concentrates shall be clearly labeled and kept securely closed in stores so that children or pet cannot get at them. Storage and mixing of concentrates shall not be done near any fire source or flame. Persons carrying out chemical soil treatments should familiarize themselves and exercise due care when handling the chemicals whether in concentrated or in diluted form. After handling the concentrates or dilute emulsion, worker shall wash themselves with soap and water and wear clean clothing especially before eating and smoking. In the event of severe contamination, clothing shall be removed at once and the skin washed with soap and water. If chemical has splashed into the eyes, they shall be flushed with plenty of soap and water and immediate medical attention shall be sought.

The use of chemical shall be avoided where there is any risk of wells or other water supplies becoming contaminated.

##### 2.28.4.2 Treatment

- i. Once the termites have ingress into the building, they keep on multiplying and destroy the wooden and cellulosic materials, and as such it becomes essential to take measures for protection against



termites. Anti-termite measures described below are necessary for the eradication and control of termites in existing building. To facilitate proper penetrations of chemical in to the surface to be treated, hand operated pressure pump shall be used. To have proper check for uniform penetration of chemical, graduated containers shall be used. Proper check should be kept so that the specified quantity of chemical is used for the required area during the operation. Chemical treatment for the eradication and control of sub-terranean termites in existing building shall be done as per IS 6313 (Part III). Treatment shall be got done only from the approved specialized agencies using the chemical procured directly by the Engineer-in-Charge from reputed and authorized dealers.

- ii. **Treatment along outside of foundations:** The soil in contact with the external wall of the building shall be treated with chemical emulsion at the rate of 7.5 liters per square meter of vertical surface of the sub-structure to a depth of 300 mm. To facilitate this treatment, a shallow channel shall be excavated along and close to the wall face. The chemical emulsion shall be directed towards the wall at 1.75 liters per running meter of the channel. Rodding with 12 mm diameter mild steel rods at 150 mm apart shall be done in the channel. If necessary, for uniform dispersal of the chemical to 300 mm depth from the ground level. The balance chemical of 0.5 liter per running meter shall then be used to treat the backfill earth as it is returned to the channel directing the spray towards the wall surface.

If there is a concrete or masonry apron around the building, approximately 12 mm diameter holes shall be drilled as close as possible to the plinth wall about 300 mm apart, deep enough to reach the soil below and the chemical emulsion pumped into these holes to soak the soil below at the rate of 2.25 litres per linear metre.

In soils which do not allow percolation of chemicals to desired depth, the uniform disposal of the chemical to a depth of 300 mm shall be obtained by suitably modifying the mode of treatment depending on site condition.

In case of RCC foundations the soil (backfill) in contact with the column sides and plinth beams along with external perimeter of the building shall be treated with chemical emulsion at the rate of 7.5 litres/sqm of the vertical surface of the structure to facilitate this treatment, trenches shall be excavated equal to the width of the shovel exposing the sides of the column and plinth beams upto a depth of 300 mm or upto the bottom of the plinth beams, if this level is less than 300 mm. The chemical emulsion shall be sprayed on the backfill earth as it is returned into the trench directing the spray against the concrete surface of the beam or column as the case may be.

- iii. **Treatment of Soil under Floors:** The points where the termites are likely to seek entry through the floor are the cracks at the following locations:

- (a) At the junction of the floor and walls as result of shrinkage of the concrete
- (b) On the floor surface owing to construction defects
- (c) At construction joints in a concrete floor, cracks in sections
- (d) Expansion joints in the floor

Chemical treatment shall be provided in the plinth area of ground floor of the structure, wherever such cracks are noticed by drilling 12 mm holes at the junction of floor and walls along the cracks on the floor and along the construction and expansion joints at the interval of 300 mm to reach the soil below. Chemical emulsion shall be squirted into these holes using a hand operated pressure pump to soak the soil below until refusal or upto a maximum of one litre per hole. The holes shall then be sealed properly with cement mortar 1:2 (1 cement: 2 coarse sand) finished to match the existing floors. The cement mortar applied shall be cured for at least 10 days as per instruction of Engineer-in-Charge.



- iv. **Treatment of Voids in Masonry:** The movement of termites through the masonry wall may be arrested by drilling holes in masonry wall at plinth level and squirting chemical emulsions into the holes to soak the masonry. The holes shall be drilled at an angle of 45 degree from both sides of the plinth wall at 300 mm intervals and emulsion squirted through these holes to soak the masonry using a hand operated pump. This treatment shall also be extended to internal walls having foundations in the soil. Holes shall also be drilled at wall corners and where door and window frames are embedded in the masonry or floor at ground. Emulsion shall be squirted through the holes till refusal or to a maximum of one litre per hole. Care shall be taken to seal the holes after the treatment.
- v. **Treatment at Points of Contact of Wood Work:** The wood work which has already been damaged beyond repairs by termites shall be replaced. The new timber shall be dipped or liberally brushed at least twice with chemical in oil or kerosene. All existing wood work in the building which is in contact with the floor or walls and which is infested by termites, shall be treated by spraying at the points of contacts with the adjoining masonry with the chemical emulsion by drilling 6 mm holes at a downward angle of about 45 degree at junction of wood work and masonry and squirting chemical emulsion into these holes till refusal or to a maximum of half a litre per hole. The treated holes shall then be sealed.
- vi. Infested wood work in chauhats, shelves, joints, purlins etc., in contact with the floor or the walls shall be provided with protective treatment by drilling holes of about 3 mm diameter with a downward slant to the core of the wood work on the inconspicuous surface of the frame. These holes should be at least 150 mm center to center and should cover in entire frame work. Chemicals shall be liberally infused in these holes. If the wood is not protected by paint or varnish two coats of the chemicals shall be given on all the surfaces and crevices adjoining the masonry.

**2.28.4.3 Measurements:** All dimensions shall be measured correct to a cm. The measurements shall be made of the surface actually provided with anti-termite treatment. Measurements shall be done separately for treatment of foundations, soils under floors, voids in masonry and wood work as detailed below:

- i. Treatment along outside of foundations: The measurements shall be made in running meters taking length along the plinth of the building.
- ii. Treatment of soil under floors: The measurements shall be made in square meters, inside clear dimensions of rooms, verandah etc. shall be taken.
- iii. Treatment of voids in masonry: The measurements shall be made in running meters along the plinth of the building.
- iv. Treatment of wood work: The measurements shall be made in running meters for chauhats, joints, purlins, beams etc.

#### **2.28.4.4 Rates**

The rate shall include the cost of labor and all other inputs (except concentrated chemical) involved in all the operations described above including drilling, refilling and making good the holes.

#### **2.28.4.5 Treatment of Electrical Fixtures**

If infestation in electrical fixture (like switch boxes in the wall) is noticed, covers of the switch boxes shall be removed and inside of such boxes shall be treated liberally with 5 per cent Malathion dusting powder. The covers of the switch boxes shall be refixed after dusting.

### **2.29 FILLING WITH FLYASH AND EARTH**

#### **2.29.1 Earth**

The earth shall be as specified under para 2.23.1.



### **2.29.2 Flyash**

Flyash be procured from nearest local power plant. To prevent dust, it should be kept moist by sprinkling of water.

### **2.29.3 Filling**

The space around the foundation and drains in trenches shall be cleared of all debris, brick bats etc. Filling with available excavated earth and fly ash shall be done in regular horizontal layers. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of crow bars where rammers cannot be used. Intermediate layer of compacted earth not exceeding 15 cm shall be placed after every four layers of compacted depth of fly ash (each layer should not exceed 15 cm). The sides and top layer of filling shall be done with earth having minimum compacted thickness of 30 cm. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches. In case of filling in embankment, consolidation of fly ash /earth shall be done with power roller to achieve soil density of 98%.

### **2.29.4 Measurement**

**2.29.4.1** Filling sides of foundations: The mode of measurements shall be the same, as specified in para 2.23.3.1.

**2.29.4.2** Filling in embankment: Depth of filling shall be the consolidated depth. The length, breadth and depth shall be measured with steel tape correct to the nearest cm and cubical contents worked out in cubic meters correct to two places of decimal.

### **2.29.5 Rates**

The rates include the cost of material and labour involved in all the operations described above.

## DESIGN FOR TEMPORARY BENCHMARK

Sub Head: Earthwork  
Clause: 2.5.1

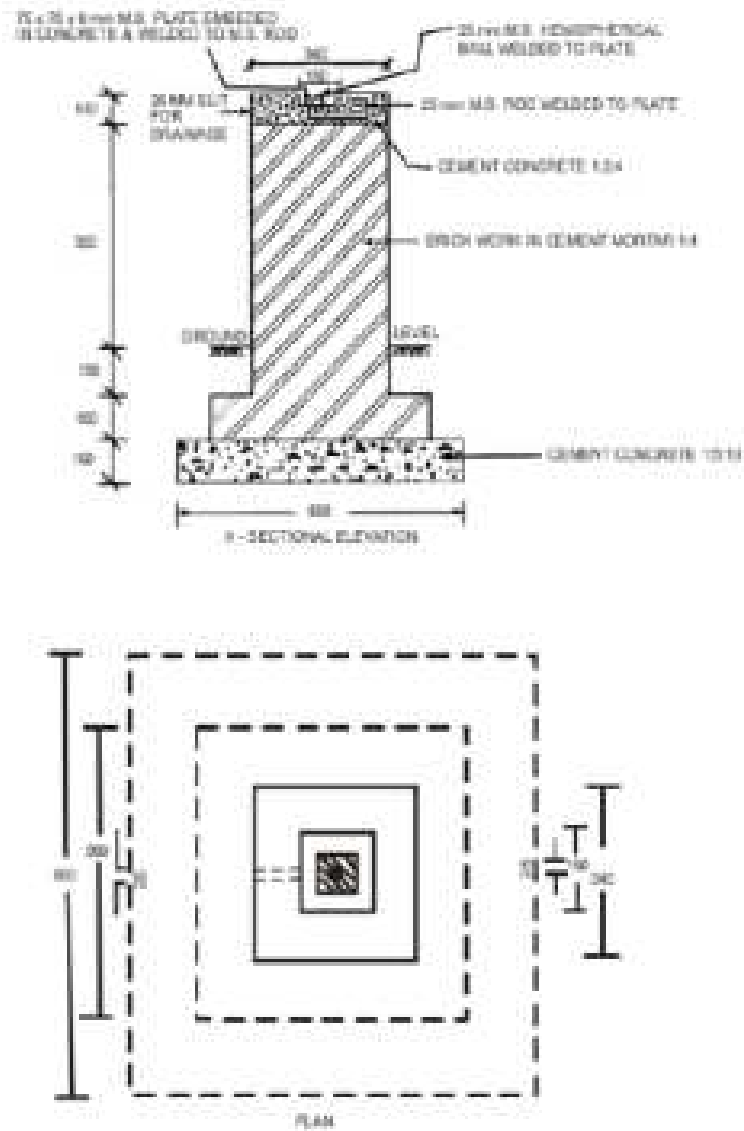


Figure 2.1 : Design for Temporary Site Benchmark

Drawing not to Scale  
All dimensions are in mm

## CLOSE AND OPEN PLANKING AND STRUTTING

Sub Head: Earthwork  
Clause: 2.20.2 & 2.20.3

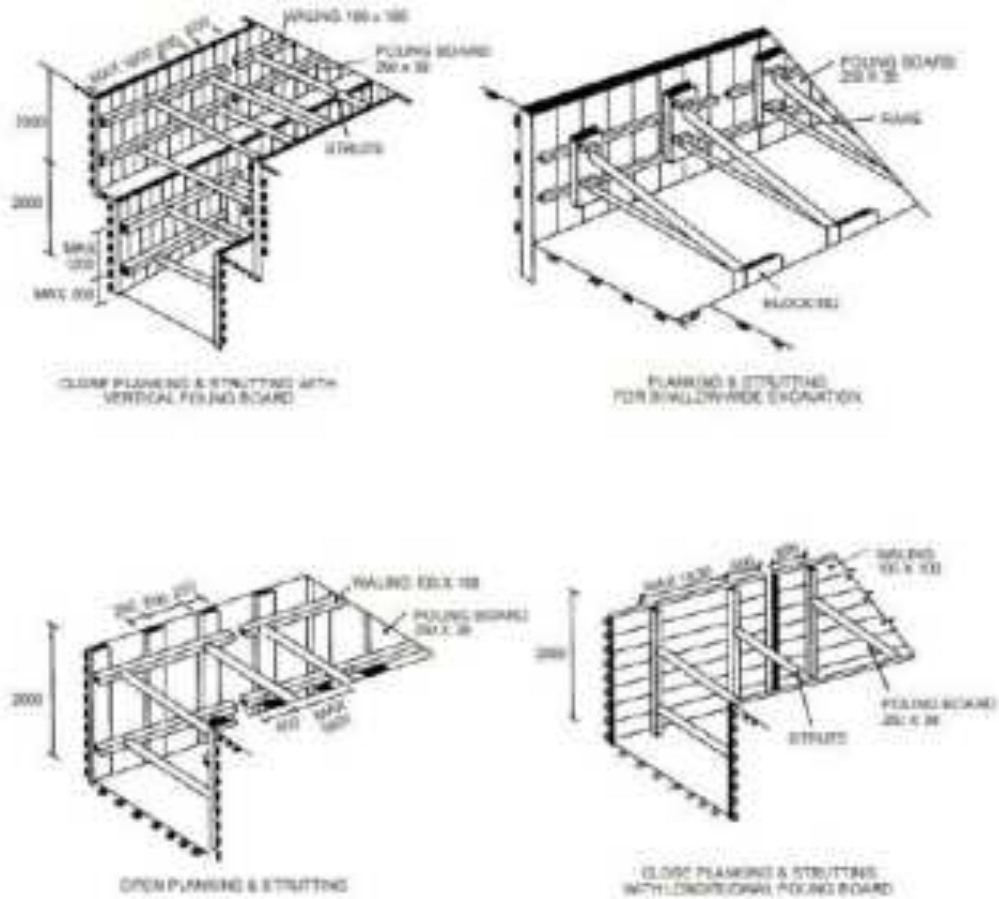


Figure 2.2 : Close & Open Planking & Strutting

Drawing not to Scale  
All dimensions are in mm

## ANTI TERMITE CONSTRUCTION STAGE 1

Sub Head: Earthwork  
Clause: 2.28.3(i)

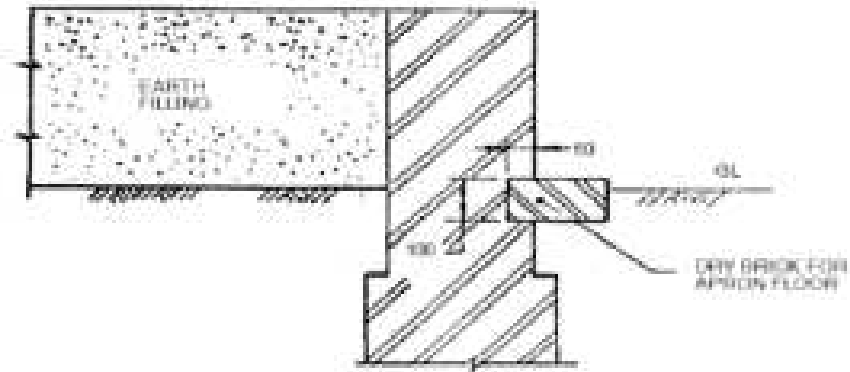


Figure 2.3(i) : Anti Termite Construction Stage 1

Drawing not to Scale  
All dimensions are in mm

## ANTI TERMITE CONSTRUCTION STAGE 2

Sub Head: Earthwork  
Clause: 2.28.3(ii)

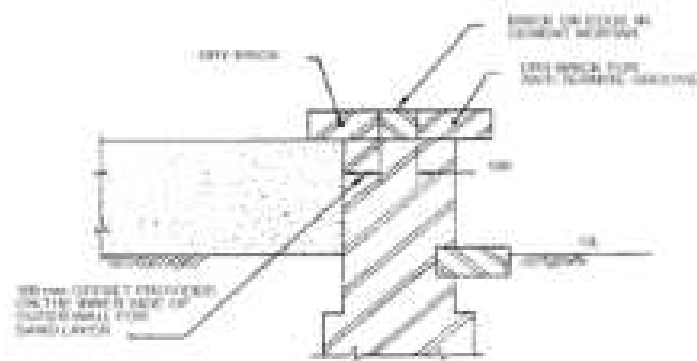


Figure 2.3(ii) : Anti Termite Construction Stage 2

Drawing not to Scale  
All dimensions are in mm

### ANTI TERMITE CONSTRUCTION STAGE 3

Sub Head: Earthwork  
Clause: 2.28.3(iii)

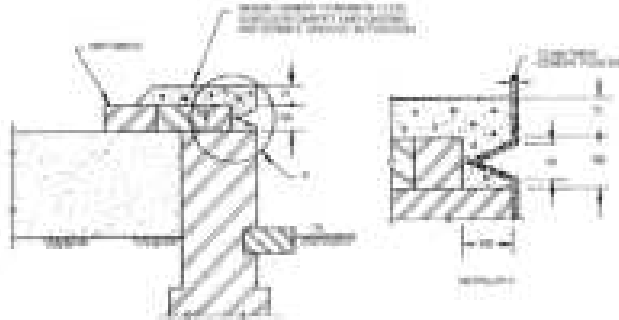


Figure 2.3(iii) : Anti Termite Construction Stage 3

Drawing not to Scale  
All dimensions are in mm

### ANTI TERMITE CONSTRUCTION STAGE 4

Sub Head: Earthwork  
Clause: 2.28.3(iv)

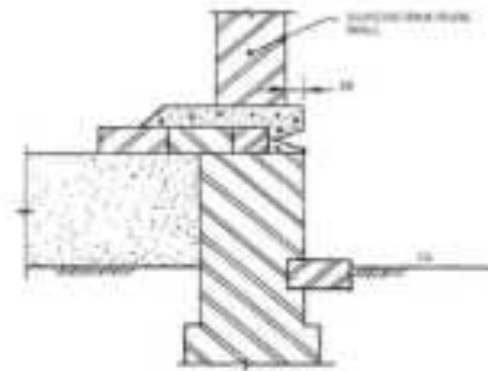


Figure 2.3(iv) : Anti Termite Construction Stage 4

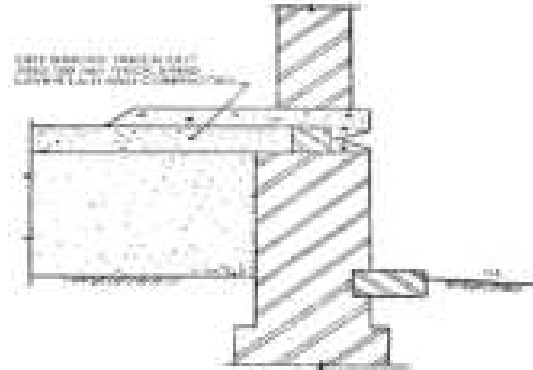
Drawing not to Scale  
All dimensions are in mm





## ANTI TERMITE CONSTRUCTION STAGE 5

**Sub Head: Earthwork**  
**Clause: 2.28.3(v)**

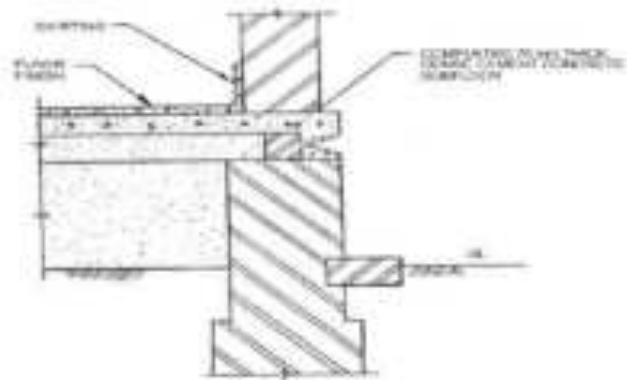


**Figure 2.3(v) : Anti Termite Construction Stage 5**

Drawing not to Scale  
All dimensions are in mm

## ANTI TERMITE CONSTRUCTION STAGE 6

**Sub Head: Earthwork**  
**Clause: 2.28.3(vi)**



**Figure 2.3(vi) : Anti Termite Construction Stage 6**

Drawing not to Scale  
All dimensions are in mm

## ANTI TERMITE CONSTRUCTION STAGE 7

Sub Head: Earthwork  
Clause: 2.28.3(vii)

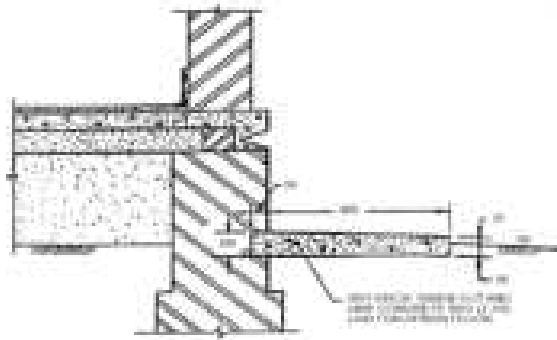


Figure 2.3(vii) : Anti Termite Construction Stage 7

Drawing not to Scale  
All dimensions are in mm

## ANTI TERMITE CONSTRUCTION STAGE 8

Sub Head: Earthwork  
Clause: 2.28.3(viii)

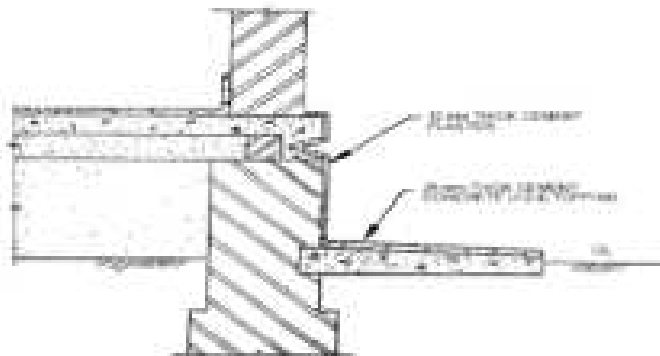


Figure 2.3(viii) : Anti Termite Construction Stage 8

Drawing not to Scale  
All dimensions are in mm





# MORTARS



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## LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
1	2	3	4	5	6	7
<b>Water</b>	3.1.1	(i) pH Value (ii) Limits of Acidity (iii) Limits of Alkalinity (iv) Percentage of solids (a) Chlorides (b) Suspended matter (c) Sulphates (d) Inorganic solids (e) Organic solids	Lab	<b>IS: 3025</b> Part-11 Part-22 Part-23 Part-15 Part-32 Part-17 Part-24 Part-18 Part-18	<ul style="list-style-type: none"> <li>One test at commencement of work for approval of each source and there after change of source and</li> <li>Thereafter, water from each source shall be got tested during the dry season before monsoon and again after the monsoon.</li> </ul> <p>Time period between two tests shall not exceed six months.</p>	Water from each source shall be got tested before the commencement of work and thereafter once in every three months till the completion of the work Water from municipal source need be tested only once in six months Number f Tests for each source shall be 3.
<b>Cement</b>	3.1.2	(a) Physical requirement (i) Fineness (ii) Soundness (iii) Setting time (Initial & Final) (iv) Compressive Strength (v) Consistency of standard cement paste	Lab	<b>IS: 4031</b>  Part-1 Part-3 Part-5  Part-6 Part-4	<ul style="list-style-type: none"> <li>Every 50 MT or part thereof. 100 MT or part thereof if cement brought at site in a day from single source is more than 200 MT.</li> <li>Each brand of cement brought to the site shall be tested as per this frequency.</li> </ul> <p><b>(Minimum Quantity: Each lot).</b></p>	Every 50 tonnes or pan there of Each brand of cement brought to site shall be tested as per this frequency  <b>(Minimum quantity: Each lot)</b>
<b>Sand</b>	3.1.3.1	Organic Impurities	Field	<b>IS: 2386</b> Part-2	One test at commencement of work for approval	Every 20 cum or part thereof or more frequently as



Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
					of each source and change of source and thereafter, One test for 40 cum or pat thereof. <b>(Minimum quantity: 20 cum).</b>	decided by Engineer-in-Charge <b>(Minimum quantity: 20 cum)</b>
	3.1.3.2	Sit Content	Field	<b>IS: 2386</b> Part-2	.....do.....	.....do.....
	3.1.3.4	Particle size Distribution	Field or laboratory as decide the by Engineer in-charge	<b>IS: 2386</b> Part-1	One test at commencement of work for approval of each source and change of source and thereafter, One test for 40 cum or pat thereof. <b>(Minimum quantity: 40 cum).</b>	40 cum or pat there of <b>(Minimum quantity: 40 cum)</b>
	3.1.3.5	Bulking of Sand	Field	<b>IS: 2386</b> Part-3	One test at commencement of work for approval of each source and change of source and thereafter, One test for 40 cum or pat thereof or more frequently as decided by the Engineer-in-charge <b>(Minimum quantity: 20 cum).</b>	Every 20 cum or part thereof or more frequently as decided by Engineer-in-Charge <b>(Minimum quantity: 20 cum)</b>





Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
Fly Ash	3.1.5 & 3.1.5.1	Total chloride in percent by mass. max	Lab	IS: 12423	One test at commencement of work for approval of each source and change of source and thereafter,  One test for 10 cum or part thereof or more frequently as decided by the Engineer-in-charge  <b>(Minimum quantity: 10 cum).</b>	Every 10 cum or part thereof or more  <b>(Minimum quantity: 10 cum)</b>
		Loss of ignition in percent by mass max	Lab	IS:1727	.....do.....	Frequency as decided by Engineer-in charge
		Fineness specific surface in m <sup>2</sup> /kg	Lab/ Field	Blaine's air permeability method IS 4031 part-2	.....do.....	.....do.....
		Compressive strength at 28 days in N/mm <sup>2</sup> Min	Lab	IS: 4031	One test at commencement of work for approval of each source and change of source and thereafter,  Every 10 cum or part thereof only in cases when fly ash is used as pozzolana in cement.  <b>(Minimum quantity: 10 cum).</b>	Only in cases when fly ash is used as pozzolana in cement  <b>(Minimum quantity: 10 cum).</b>



**Note:**

- i. In case cement has been stored for over Six (06) months from the date of manufacture or for any reason the stored cement shows sign of deterioration and contamination, it shall be tested prior to use in the work.
- ii. The sample shall be taken within three weeks of the delivery and all the tests shall be commenced within one week of sampling and not later than 03 months from the receipt of sample for testing.
- iii. After completion of previous test, if cement is stored more than 03 months, it shall be retested before use.



## LIST OF BUREAU OF INDIAN STANDARD CODES

SL. NO.	I.S. NO.	SUBJECT
1	IS 269	Specification for 33 grade ordinary Portland cement
2	IS 383	Specification for coarse and fine aggregate from natural source for concrete
3	IS 455	Specification for Portland slag cement
4	IS 460 (Part I)	Specification for test sieves: wire cloth test sieves
5	IS 650	Specification for standard sand for testing of cement
6	IS 12269	Specification for 53 grade ordinary Portland cement
7	IS 1344	Specification for calcined clay Pozzolana
8	IS 1489	Specification for Portland pozzolana cement
9	IS 1542	Specification for sand for plaster
10	IS 1727	Methods of Test for Pozzolanic materials
11	IS 2116	Specification for sand for masonry mortar
12	IS 2250	Code of practice for preparation and use of masonry Mortar
13	IS 2386 (Part-I)	Method of test for aggregate for concrete (Particle size and shape)
14	IS 2386 (Part-II)	Estimation of deleterious materials and organic impurities
15	IS 2386 (Part-III)	Specific gravity, density, voids, absorption and bulking
16	IS 3025	Method of sampling and test for water
17	IS 3466	Specification for masonry cementn
18	IS 3812 (Part I)	Specification for fly ash for use as pozzolana in cement mortar and concrete
19	IS 3812 (Part II)	Specification for fly ash for use as admixture in cement mortar and concrete
20	IS 4031 (Part I) to (Part XIII)	Method of Physical test for hydraulic cement
21	IS 4032	Method of chemical analysis of Hydraulic cement.
22	IS 8041	Rapid hardening Portland cement.
23	IS 8042	Specification for white cement
24	IS 8043	Hydrophobic Portland cement
25	IS 8112	Specification for 43 grade ordinary Portland cement
26	IS 11652	Woven HDPE sacks for packing cement



SL. NO.	I.S. NO.	SUBJECT
27	IS 11653	Woven polypropylene sacks for packing cement
28	IS 12174	Jute synthetic union bags for packing cement



## 3 MORTARS

### 3.0 GENERAL

Desirable properties of mortars for use in masonry are:

- (a) Workability
- (b) Water retentivity
- (c) Rate of stiffing
- (d) Strength
- (e) Resistance to rain penetration
- (f) Durability

### 3.1 MATERIALS

#### 3.1.1 Water

**3.1.1.1** Water used for mixing and curing shall be clean and free from injurious quantities of alkalis, acids, oils, salts, sugar, organic materials, vegetable growth or other substance that may be deleterious to bricks, stone, concrete or steel, potable water is generally considered satisfactory for mixing. The Ph value of water shall be not less than 6. The following concentrations represent the maximum permissible values: (of deleterious materials in water).

- (a) **Limits of Acidity:** To neutralize 100ml sample of water, using phenolphthalein as an indicator, it should not require more than 5ml of 0.02 normal NaOH. The details of test shall be as given in IS 3025 (part 22).
- (b) **Limits of Alkalinity:** To neutralize 100ml sample of water, using mixed indicator, it should not require more than 25ml of 0.02 normal H<sub>2</sub>SO<sub>4</sub>. The details of tests shall be as given in IS 3025 (part 23)-1986 (Reaffirm 2003).
- (c) **Percentage of Solids:** Maximum permissible limits of solids when tested in accordance with IS 3025 shall be as under:

Organic - 200mg/ litre

Inorganic - 3000 mg/ litre

Sulphates - 400 mg/ litre

Chlorides - 2000 mg/ litre for concrete not containing embedded steel and 500 mg./litre for reinforced concrete work.

Suspended matter - 2000 mg/ litre

The physical and chemical properties of ground water shall be tested along with soil investigation and if the water is not found conforming to the requirements of IS 456-2000, the tender documents shall clearly specify that the contractor has to arrange good quality water for construction indicating the source.

**3.1.1.2** Water found satisfactory for mixing is also suitable for curing. However, water used for curing shall not produce any objectionable stain or unsightly deposit on the surface.



**3.1.1.3** Sea water shall not be used for mixing or curing.

**3.1.1.4** Water from each source shall be tested before the commencement of the work. and thereafter once in every three months till the completion of the work. In case of ground water, testing shall also be done for different points of drawdown. Water from each source shall be got tested during the dry season before monsoon and again after monsoon.

### **3.1.2 Cement**

**3.1.2.1** The cement used shall be any of the following grade and the type selected should be appropriate for the intended use.

- (a) 33 grade ordinary Portland cement conforming to IS 269 – **2013**
- (b) 43 grade ordinary Portland cement conforming to IS 8112 – **2013**
- (c) 53 grade ordinary Portland cement conforming to IS 12269 – **2013**
- (d) Rapid hardening Portland cement conforming to IS 8041 – **1990, Reaffirm Apr 2014**
- (e) Portland slag cement conforming to IS 455 – **1989, Reaffirm Apr 2014**
- (f) Portland Pozzolana cement (flyash based) conforming to IS 1489 (Part 1) – **1991, Reaffirm Apr 2014**
- (g) Portland Pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2) – **1991, Reaffirm Apr 2014**
- (h) Hydrophobic cement conforming to IS 8043 – **1991, Reaffirm Apr 2014**
- (i) Low heat Portland cement conforming to IS 12600 – **1989, Reaffirm Apr 2014**
- (j) Sulphate resisting Portland cement conforming to IS 12330 – **1988, Reaffirm Apr 2014**
- (k) White cement conforming to IS 8042 – **1989, Reaffirm Apr 2014**

Different types of cement shall not be mixed together. In case more than one type of cement is used in any work, a record shall be kept showing the location and the types of cement used.

#### **3.1.2.2 Caution in Use of Cement Grade 53 in Construction:**

Because of the faster hydration process, the concrete releases heat of hydration at a much faster rate initially and release of heat is the higher in case of Grade 53. The heat of hydration being higher, the chances of micro-cracking of concrete is much greater. Thus, during initial setting period of concrete, the higher heat of hydration can lead to damaging micro-cracking within the concrete which may not be visible at surface. This cracking is different from shrinkage cracks which occurs due to faster drying of concrete in windy conditions.

The situation can be worse when we tend to increase the quantity of the cement in the concrete with a belief that such increases are better for both strength and durability of concrete. Thus, it is very essential to be forewarned that higher grade cement specially grade 53 should be used only where such use is warranted for making higher strength concrete and also where good quality assurance measures are in place, by which proper precaution are taken to relieve the higher heat of hydration through chilling of aggregates or by proper curing of concrete. There are instances where higher grade cement is being used even for low strength concrete, as, mortar or even for plastering. This can lead to unnecessary cracking of concrete/ surfaces.

Another issue to be cautioned against is the tendency of the manufacturers to project Grade 53 cement as stronger cement, whereas Grade 33 or 43 are enough to produce the concrete of desired characteristic strength. The scenario of method of production of cement by various manufacturers



should also be kept in mind while ordering various grades of cement. The ability to produce cements of particular fineness get fixed by the machinery installed by the manufacturers, and thus the ability to produce other various grades of cement by a particular manufacturer also gets limited. Whereas tendency today is to supply the consumer what the orders for by the manufacturers by simply stamping such grades on the bags. Thus, it is often observed that cement bags marked as grade 33 or 43 may really be containing cements of much higher grade.

**3.1.2.3 Compressive Strength:** Compressive strength requirement of each type of cement for various grades when tested in accordance with IS 4031 (part 6) shall be as under:

Sample	Strength in N/mm <sup>2</sup> not less than for		
Age at testing	Grade 33	Grade 43	Grade 53
72 + 1 hr	16	23	27
168 + 2 hrs	22	33	37
672 + 4 hrs	33	43	53

**3.1.2.4 Setting Time:** Setting time of cement of any type of any grade when tested by Vicat apparatus method described in IS 4031 (Part-5)-1988 (Reaffirm-2014) shall conform to the following requirement:

Initial setting time: Not less than 30 minutes

Final setting time: Not more than 600 minutes

**3.1.2.5 Supply:** The cement shall be packed in jute sacking bags conforming to IS 2580, double hessian bituminized (CRI type) or woven HDPE conforming to IS 11652. Woven polypropylene conforming to IS 11653, jute synthetic union conforming to IS: 12174, or any other approved composite bags, bearing the manufacturer's name or his registered trade mark if any, with grade batch no. and type of cement, with date of manufacturing of batch of cement. Every delivery of cement shall be accompanied by a producer's certificate conforming that the supplied cement conforms to relevant specifications. These certificates shall be endorsed to the Engineer-in-charge for his record.

Every consignment of cement must have identification marks on packages indicating date of manufacturing grade and type of cement batch no. etc. Cement brought to works shall not be more than 6 weeks old from the date of manufacture. Effective precautionary measures shall be taken to eliminate dust-nuisance during loading or transferring cement.

**3.1.2.6 Stacking and Storage:** Cement in bags shall be stored and stacked in a shed which is dry, leak proof and as moisture-proof as possible. Flooring of the shed shall consists of the two layers of dry bricks laid on well consolidated earth to avoid contact of cement bags with the floor. Stacking shall be done about 150 to 200 mm clear above the floor using wooden planks. Cement bags shall be stacked at least 450 mm clear off the walls and in rows of two bags leaving in a space of at least 600 mm between two consecutive rows. In each row the cement bags shall be kept close together so as to reduce air circulation. Stacking shall not be more than 10 bags high to avoid lumping under pressure. In stacks more than 8 bags high, the cement bags shall be arranged in header and stretcher fashion i.e. alternately lengthwise and crosswise so as to tie the stacks together and minimise the danger of toppling over.

A typical arrangement for storing and stacking of cement is shown in Fig. 1. of sub-head of Carriage of Materials.

Different types of cement shall be stacked and stored separately.



Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received.

For extra safety during monsoon, or when cement is expected to be stored for an unusually long period, each stack shall be completely enclosed by a water proofing membrane, such as polyethylene, which shall cover the top of the stack. Care shall be taken to see that the water proofing membrane is not damaged at any time during use.

Storage of cement at the work site shall be at the contractor's expense and risk. Any damage occurring to cement due to faulty storage in contractor's shed or on account of negligence on his part shall be the liability of the contractor.

### 3.1.3 Fine Aggregate

**3.1.3.1** Aggregate most of which passes through 4.75 mm IS sieve is known as fine aggregate. Fine aggregate shall consist of natural sand, crushed stone sand, crushed gravel sand stone dust or marble dust, fly ash and broken brick (Burnt clay). It shall be hard, durable, chemically inert, clean and free from adherent coatings, organic matter etc. and shall not contain any appreciable amount of clay balls or pellets and harmful impurities e.g. iron pyrites, alkalis, salts, coal, mica, shale or similar laminated materials in such form or in such quantities as to cause corrosion of metal or affect adversely the hardening, the strength, the durability or the appearance of mortar, plaster or concrete. The sum of the percentages of all deleterious material shall not exceed 5%. Fine aggregate must be checked for organic impurities such as decayed vegetation humus, coal dust etc. in accordance with the procedure prescribed in Appendix A of Chapter 3.

**3.1.3.2 Silt Content:** The maximum quantity of silt in sand as determined by the method prescribed in Appendix C of Chapter 3 shall not exceed 8%.

Fine aggregate containing more than allowable percentage of silt shall be washed as many times as directed by Engineer-in-Charge so as to bring the silt content within allowable limits for which nothing extra shall be paid.

**3.1.3.3 Grading:** On the basis of particle size, fine aggregate is graded in to four zones. The grading when determined in accordance with the procedure prescribed in Appendix B of Chapter 3 shall be within the limits given in Table 3.1 below. Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 micron IS sieve, by a total amount not exceeding 5 per cent, it shall be regarded as falling within that grading zone.

**TABLE 3.1**  
**Fine Aggregates (Clause 3.1.3)**

IS Sieve Size	Percentage passing for			
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV
10 mm	100	100	100	100
4.75 mm	90-100	90-100	90-100	95-100
2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 microns	15-34	35-59	60-79	80-100





300 microns	5-20	8-30	12-40	15-50
150 microns	0-10	0-10	0-10	0-15

**Note 1:** For crushed stone sands, the permissible limit on 150-micron sieve is increased to 20 per cent. This does not affect the 5 per cent allowance permitted in para 3.1.3.4 (e) (1) applying to other sieves.

**Note 2:** Allowance of 5% permitted in para 3.1.3.4 (e) (1) can be split up, for example it could be 1% on each of three sieves and 2% on another or 4% on one sieve and 1% on another.

**Note 3:** Fine aggregate conforming to Grading Zone IV shall not be used in reinforced cement concrete unless tests have been made to ascertain the suitability of proposed mix proportions.

**Note 4:** Sand requiring use for mortar for plaster work shall conform to IS 1542 and for masonry work shall conform to IS 2116.

**3.1.3.4** Type and grading of fine aggregate to be used shall be specified. Use of sea sand shall not be allowed, unless otherwise specified. Fine aggregate may further be sub-divided into following parts:

- Coarse sand shall be either river sand, pit sand, crushed stone sand, crushed gravel sand or a combination of the two. Badarpur sand available in Delhi generally falls in category of pit sand. It shall be clean, sharp, angular and gritty to touch and composed of hard siliceous material. Its grading shall fall within the limits of grading zone I, II, III of Table 3.1. Grading of sand shall conform to IS 2116 for use in Masonry work.
- Fine sand shall be either river sand or pit sand or a combination of the two. Its grading shall fall within the limits of Grading zone IV of Table 3.1. As a guideline, fine sand conforming to grading Zone IV can be generally obtained in Delhi by mixing one part of Badarpur sand and two parts of Jamuna Sand (by volume). Grading of sand shall conform to IS 1542 for use in plaster work.
- Stone dust/Gravel dust shall be obtained by crushing hard stones or gravel. Its grading shall fall within the limits of grading Zone, I, II, III or IV of Table 3.1.
- Marble dust shall be obtained by crushing marble. Its grading shall fall within the limits of Grading Zone IV of Table 3.1. Grading of Marble dust for use in Mortar shall be as per following table.

**Grading of Marble Dust**

IS Sieve	Percentage Passing
10 mm	100
4.75 mm	95-100
2.36 mm	95-100
1.18 mm	90-100
600 micron	80-100
300 micron	15- 50
150 micron	0- 15

- Sand for Masonry Mortar and for Plaster- Sand shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. Sand shall be hard durable, clean and free



from adherent coating and organic matter and shall not contain the amount of clay, silt and fine dust more than specified as under.

**Deleterious Material:** Sand shall not contain any harmful impurities such as iron, pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shale in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar. The maximum quantities of clay, fine silt, fine dust and organic impurities in the sand / Marble dust shall not exceed the following limits:

1)	Clay, fine silt and fine dust when determined in accordance with IS 2386 (Part II). In natural sand or crushed gravel sand & crushed stone sand	Not more than 5% by mass
2)	Organic impurities when determined in accordance with IS 2386 (Part II)	Colour of the liquid shall be lighter than that indicated by the standard specified in IS 2386 (Part II).

Grading of sand for use in masonry mortar shall be conforming to IS 2116 – 1980 (Reaffirm – 2012) (Table 3.2 below):

Grading of sand for use in plaster shall be conforming to IS 1542 (Table 3.2 below):

**TABLE 3.2**  
**Grading of Sand for use in Masonry Mortar and Plaster**

Grading of sand for use in masonry mortar		Grading of sand for use in plaster	
IS Sieve Designation	Percentage passing by mass	IS Sieve Designation	Percentage passing by mass
10 mm	100	10 mm	100
4.75 mm	100	4.75 mm	95 to 100
2.36 mm	90 to 100	2.36 mm	95 to 100
1.18 mm	70 to 100	1.18 mm	90 to 100
600 micron	40 to 100	600 micron	80 to 100
300 micron	5 to 70	300 micron	20 to 65
150 micron	0 to 15	150 micron	0 to 15

**Note:** For crushed stone sands, the permissible limit on 150 micron IS Sieve is increased to 20%, this does not affect the 5% allowance as per IS 2386 (Part 1).

**3.1.3.5 Bulking:** Fine aggregate, when dry or saturated, has almost the same Volume but dampness causes increase in volume. In case fine aggregate is damp at the time of proportioning the ingredients for mortar or concrete, its quantity shall be increased suitably to allow for bulkage, which shall be determined by the method prescribed in Appendix 'D' of Chapter 3.0 Table 3.3 gives the relation between moisture content and percentage of bulking for guidance only.

**TABLE 3.3**

Moisture content % age	Bulking % age (by volume)
2	15



3	20
4	25
5	30

**3.1.3.6 Stacking:** Fine aggregate shall be so stacked as to prevent dust and foreign matter getting mixed up with it as far as practically possible. Marble dust in dry condition shall be collected in bags and properly staked so as not to form lumps, suitable arrangements shall be made to protect it from moisture similar to those adopted for stacking of cement bags.

**3.1.3.7 Measurements:** As the fine aggregate bulks to a substantial extent when partially wet, measurements shall be taken when the stacks are dry or appropriate allowance made for bulking.

### 3.1.4 Broken Brick (Burnt Clay) Fine Aggregate

**3.1.4.1** Broken Brick (Burnt Clay) Fine Aggregate, also known as Surkhi, shall be made by grinding well burnt (but not under or over burnt) broken bricks as specified in IS 3068. It shall not contain any harmful impurities, such as iron pyrites, salts, coal, mica, shale or similar laminated or other materials in such form of quantity as to adversely affect hardening, strength, durability or appearance of the mortar. The maximum quantities of clay, fine silt, fine dust and organic impurities in Surkhi (all taken together) shall not exceed five per cent by weight. The particle size grading of Surkhi for use in lime mortars shall be within the limits specified in Table 3.4.

**TABLE 3.4**

IS Sieve Designation	Percentage passing (by wt)
4.75 mm	100
2.36 mm	90-100
1.18 mm	70-100
600 microns	40-100
300 microns	5-70
150 microns	0-15
75 microns	nil

**3.1.4.2 Stacking:** Surkhi shall be stacked on a hard surface or platform so as to prevent the admixture of clay, dust, vegetation and other foreign matter. It shall be also protected from rain and dampness and kept under adequate coverings.

**3.1.4.3 Measurements:** Surkhi shall be measured in regular stacks in cubic metres. Alternatively, it may be measured by weight when supplied in bags.

### 3.1.5 Fly Ash

Fly ash is finely divided residue resulting from the combustion of pulverized coal in boilers. Fly ash is the pulverized fuel ash extracted from the flue gases by any suitable process such as cyclone separation or electrostatic precipitation. The ash collected from the bottom of boilers is termed as bottom ash. Fly ash is finer than bottom ash. Siliceous fly ash (ASTM Class F) containing calcium oxide less than 10% by mass is normally produced from burning anthracite or bituminous coal and possesses pozzolanic properties. Calcareous fly ash (ASTM Class C) is produced by burning lignite or sub-bituminous coal and contains calcium oxide more than 10% by mass; the content could be as high as 25%. This fly ash has both hydraulic and pozzolanic properties. It shall be clean and free from any contamination of bottom



ash, grit or small pieces of pebbles. It is obligatory on the part of supplier/manufacture that the fly ash conforms to the requirements if mutually agreed upon & shall furnish a certificate to this effect to the purchaser or his representative.

**3.1.5.1 Characteristics:** The physical requirements of fly- ash shall be as specified in Annexure E of Chapter 3. The chemical properties of fly ash shall be as per IS 3812 (part 1 & 2) depending on the usage.

**3.1.5.2 Stacking:** Fly ash shall be protected from dirt collecting on it.

**3.1.5.3 Measurements:** Fly ash shall be measured in regular stacks in cubic metres. Alternatively, it may be measured by weight when supplied in bags.

## **3.2 PREPARATION OF MORTARS AND ITS GRADE**

### **3.2.0 Grade of Masonry Mortar**

The grade of masonry mortar will be defined by its compressive strength in N/mm<sup>2</sup> at the age of 28 days as determined by the standard procedure detailed in IS 2250.

**3.2.0.1** For proportioning the ingredients by volume, the conversion of weight into volume shall be made on the following basis:

(a) Burnt Clay Pozzolana	860 Kg/cum
(b) Coarse Sand (dry)	1280 kg/cum
(c) Fine sand (dry)	1600 kg/cum
(d) Fly Ash	590 kg/cum

For details of grades and criteria for selection of Masonry mortars see Appendix F of chapter-3.

### **3.2.1 Cement Mortar**

**3.2.1.1** This shall be prepared by mixing cement and sand with or without the addition of Pozzolana in specified proportions as per Appendix F.

**3.2.1.2 Proportioning:** Proportioning on weight basis shall be preferred taking into account specific gravity of sand and moisture content. Boxes of suitable size shall be prepared to facilitate proportioning on weight basis. Cement bag weighting 50 kg shall be taken as 0.035 cubic metre. Other ingredients in specified proportion shall be measured using boxes of size 40 x 35 x 25 cm. Sand shall be measured on the basis of its dry volume in the case of volumetric proportioning.

### **3.2.1.3 Mixing**

The mixing of mortar shall be done in mechanical mixers operated manually or by power as decided by Engineer-in-Charge. The Engineer-in-Charge may, however, permit hand mixing at his discretion taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixers or where item involving small quantities are to be done or if in his opinion the use of mechanical mixer is not feasible. In cases, where mechanical mixers are not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the commencement of the work.

- (a) **Mechanical Mixing:** Cement and sand in the specified proportions shall be mixed dry thoroughly in a mixer. Water shall then be added gradually and wet mixing continued for at least three minutes. Only the required quantity of water shall be added which will produce mortar of workable consistency but not stiff paste. Only the quantity of mortar, which can be used within 30 minutes of its mixing shall be prepared at a time. Mixer shall be cleaned with water each time before suspending the work.



- (b) **Hand Mixing:** The measured quantity of sand shall be levelled on a clean masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backwards and forwards, several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a masonry trough with just sufficient quantity of water to bring the mortar to a stiff paste of necessary working consistency.

**3.2.1.4 Precautions:** mortar shall be used as soon as possible after mixing and before it begins to set, and in any case within half hour, after the water is added to the dry mixture.

### **3.2.2 Cement Fly Ash Sand Mortar**

**3.2.2.1** This shall be prepared by mixing cement, fly ash and sand in specified proportions. Mixing shall be done in a mechanical mixer (operated manually or by power) unless otherwise permitted by the Engineer-in-Charge in writing. The Engineer-in-Charge may, however, permit hand mixing at his discretion, taking into account the nature, magnitude and location of the work and practicability of the use of mechanical mixer or where items involving small quantities are to be done or if in his opinion the use of mechanical mixer is not feasible. In case, where mechanical mixer is not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the commencement of the work.

#### **3.2.2.2 Proportioning:**

Proportioning on weight basis shall be preferred taking into account specific gravity of Fly Ash, sand and moisture content. Boxes of suitable size shall be prepared to facilitate proportioning on weight basis. Cement bag weighting 50 kg shall be taken as 0.035 cubic metre. Other ingredients in the specified proportions shall be measured using boxes of suitable sizes. Sand and fly ash shall be measured on the basis of their dry volume in the case of volumetric proportioning.

#### **3.2.2.3 Mixing**

- (a) **Mechanical Mixing:** Sand and fly ash in the specified proportions shall be mixed dry in a mixer and then the specified quantity of cement shall be added and mixed dry thoroughly. Water shall then be added gradually and wet mixing continued for at least one minute. Water shall be just sufficient to bring the mortar to the consistency of a workable paste. Only the quantity of mortar which can be used within 30 minutes of its mixing shall be prepared at a time.
- (b) **Hand Mixing:** The measured quantity of sand and fly ash shall be mixed dry on a clean masonry platform before adding specified quantity of cement to it. The resulting mixture of cement, sand and fly ash shall then be mixed thoroughly being turned over and over, backward several times till the mixture is of a uniform colour. The quantity of dry mix which can be used within 30 minutes shall then be mixed in a clean watertight masonry trough with just sufficient quantity of water, to bring the mortar to a stiff paste of necessary working consistency.

#### **3.2.2.4 Precautions:**

Shall be same as specified in para 3.2.1.4.



## APPENDIX A

### TEST FOR ORGANIC IMPURITIES (Clause 3.1.3.1)

The aggregate must also be checked for organic impurities such as decayed vegetation humus, coal dust etc.

What is called the colour test is reliable indicator of the presence of harmful organic matter in aggregate, except in the area where there are deposits of lignite.

Fill a 350 ml clear glass medicine bottle up to 70 ml mark with a 3% solution of caustic soda or sodium hydroxide. The sand is next added gradually until the volume measured by the sandy layer is 125 ml. The volume is then made upto 200 ml by addition of more of solution. The bottle is then stoppered and shaken vigorously and allowed to stand for 24 hours. At the end of this period, the colour of the liquid will indicate whether the sand contains a dangerous amount of matter. A colourless liquid indicates a clean sand free from organic matter. A straw-coloured solution indicates some organic matter but not enough to be seriously objectionable. Darker colour means that the sand contains injurious amounts and should not be used unless it is washed, and a retest shows that it is satisfactory.

Add 2.5 ml of two per cent solution of tannic acid in 10 per cent alcohol, to 97.5 ml of three per cent sodium hydroxide solution. Place in a 350 ml bottle, fix the stopper, shake vigorously and allow to stand for 24 hours before comparison with the solution above the sand.

Note: A three per cent solution of caustic soda is made by dissolving 3 g of sodium hydroxide in 100 ml of water, preferably distilled. The solution should be kept in a glass of bottle tightly closed with a rubber stopper. Handling sodium hydroxide with moist hands may result in serious burns. Care should be taken not to spill the solution for it is highly injurious to clothing, leather, and other materials.



**TEST FOR PARTICLE SIZE (SIEVE ANALYSIS)**  
(Clause 3.1.3.3)

**Apparatus:** Perforated plate sieves of designation 10 mm, 4.75 mm and fine mesh sieve of designation 2.36 mm, 1.18 mm, 600 micron, 300 micron and 150 micron should be used.

The balance or scale shall be such that it is readable and accurate to 0.1 per cent of the weight of the test sample.

Sample: The weight of sample available shall not be less than the weight given in the table below. The sample of sieving shall be prepared from the larger sample either by quartering or by means of a sample divider.

**TABLE SHOWING MINIMUM WEIGHTS FOR SAMPLING**

Maximum size present in substantial proportions (mm)	Minimum weight of sample for sieving (kg)
10	0.5
4.75	0.2
2.36	0.1

**Test Procedure:** The sample shall be brought to an air-dry condition before weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature of 100 degree to 110 degree centigrade. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest. Care shall be taken to ensure that the sieves are clean before use.

Each sieve shall be shaken separately over a clean tray until not more than a trace passes, but in any case, for a period of not less than two minutes. The shaking shall be done with a varied motion, backwards and forwards, left to right, circular clockwise and anti-clockwise, and with frequent jarring, so that the material is kept moving over the sieve surface in frequently changing directions. Materials shall not be forced through the sieve by hand pressure, but on sieves coarser than 20 mm, placing of particles is permitted. Lumps of fine material, if present may be broken by gentle pressure with fingers against the side of the sieve. Light brushing of underside of the sieve with a soft brush may be used to clear the sieve openings.

Light brushing with a fine camel hair brush may be used on the 150 micron IS sieve to prevent segregation of powder and blinding of apertures. Stiff or worn-out brushes shall not be used for this purpose and pressure shall not be applied to the surface of the sieve to force particles through the mesh.

On completion of sieving the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

**Reporting of Results:** The results shall be calculated and reported as:

- (a) The cumulative percentage by weight of the total sample passing each of the sieves, to the nearest whole number:  
or
- (b) The percentage by weight of the total sample passing one sieve and retained on the next smaller sieve, to the nearest 0.1 percent.



## APPENDIX C

### TEST FOR SILT CONTENT (Clause 3.1.3.2)

The sand shall not contain more than 8% of silt as determined by field test with measuring cylinder. The method of determining silt contents by field test is given below:

A sample of sand to be tested shall be placed without drying in a 200 ml measuring cylinder. The volume of the sample shall be such that it fills the cylinder upto 100 ml mark. Clean water shall be added upto 150 ml mark. Dissolve a little salt in the water in the proportion one tea spoon to half a litre. The mixture shall be shaken vigorously, the last few shakes being sidewise direction to level off the sand and the contents allowed to settle for three hours.

The height of the silt visible as settled layer above the sand shall be expressed as a percentage of the height of sand below. The sand containing more than the above allowable percentage of silt, shall be washed so as to bring the silt contents within allowable limits.





## APPENDIX D

### BULKING OF FINE AGGREGATES/SAND (FIELD METHODS) (Clause 3.1.3.5)

Two methods are suggested for determining the bulking of sand/fine aggregate. The procedure may be suitably varied, if necessary. Both depend on the fact that the volume of inundated sand/fine aggregate is the same if the sand/fine aggregate were dry.

**Method -1:** Put sufficient quantity of sand loosely into a container until it is about two-third full. Level off the top of the sand and push a steel rule vertically down through the sand at the middle to bottom, measure the height. Suppose this is 'X' cm. Empty the sand out of the container into another container where none of it is lost. Half fill the first container with water. Put back about half the sand and rod it with a steel rod, about 6 mm in diameter, so that its volume is reduced to a minimum. Then add the remainder and level the top surface of the inundated sand. Measure its depth at the middle with the steel rule. Suppose this is 'Y' cm.

The percentage of bulking of the sand due to moisture shall be calculated from the formula: Percentage bulking =  $(X/Y - 1) \times 100$

**Method-2:** In a 250 ml measuring cylinder, pour the damp sand, consolidate it by staking until it reached the 200 ml mark.

Then fill the cylinder with the water and stir the sand well (the water shall be sufficient to submerge the sand completely). It will be seen that the sand surface is now below its original level. Suppose the surface is at the mark of Y ml, the percentage of bulking of sand due to moisture shall be calculated from the formula.

Percentage bulking =  $(200/Y - 1) \times 100$



## APPENDIX E

### PHYSICAL REQUIREMENTS OF FLY ASH (Clause 3.1.5 & 3.1.5.1)

Sl. No	Characteristics	Requirement of Fly Ash	
		For use as Pozzolana	For use as admixture in Cement Mortar and concrete
1	2	3	4
i.	Fineness- Specific surface in $\text{m}^2/\text{kg}$ by Blaine's permeability method, min	320	200
ii.	Lime reactivity -average compressive strength in $\text{N/mm}^2$ Min	4.5	-
iii.	Compressive strength at 28 days in $\text{N/mm}^2$	Not less than 80 per cent of the strength of corresponding mortar cubes.	-
iv.	Soundness of autoclave test expansion of specimens, per cent, max	0.8	0.8
v.	Particles retained on 45 micron IS sieve (wet sieving) in percent, maximum	34	50

**APPENDIX F****CRITERIA FOR SELECTION OF MASONRY MORTARS**  
(Clauses 3.2.0, 3.2.0.1, 3.2.1.1)

- (a) The selection of masonry mortars from durability consideration will have to cover both the loading and exposure condition of the masonry. The masonry mortar shall generally be as specified below in (b) to (g).
- (b) In case of masonry exposed frequent to rain and where there is further protection by way of plastering or rendering or other finishes, the grade of mortar shall not be less than MM 0.7 but shall preferably be of grade MM 2. Where no protection is provided, the grade of mortar for external wall shall not be less than MM 2.
- (c) In case of load bearing internal walls, the grade of mortar shall preferably be MM 0.702 or more for high durability but in no case less than MM 0.5.
- (d) In the case of masonry work in foundations laid below damp proof course, the grade of mortar for use in masonry shall be as specified below.
- Where soil has little moisture, masonry mortar of grade not less than MM 0.7 shall be used.
  - Where soil is very damp, masonry mortar of grade preferably MM 2 or more shall be used. But in no case shall the grade of mortar be less than MM 2.
- (e) For masonry in building subject to vibration of machinery, the grade of mortar shall not be less than MM 3.
- (f) For parapets, where the height is greater than thrice the thickness, the grade of masonry mortar shall not be less than MM3. In case of low parapets the grade of mortar shall be the same as used in the wall masonry.
- (g) The grade of mortar for bedding joints in masonry with large concrete blocks shall not be less than MM 3.
- (h) The compressive strength shall be determined in accordance with the procedure given in IS 2250.
- (i) While mixing the pozzolanic material like fly ash in mortars Ordinary Portland cement only shall be use.

**Grade of Masonry Mortar (IS 2250)****(Clause 3.2.0)**

Sl. No.	Grade	Compressive strength at 28 days in N/mm <sup>2</sup>	Cement	Pozzolana (Fly Ash)	Sand
1	MM 0.7	0.7 to 1.5	1	---	8
2	MM 0.7	0.7 to 1.5	1	0.4*	10
3	MM 1.5	1.5 to 2.0	1	---	7
4	MM 1.5	1.5 to 2.0	1	0.4*	8.75
5	MM 3	3.0 to 5.0	1	----	6
6	MM 3	3.0 to 5.0	1**	0.21	4.2
7	MM 3	3.0 to 5.0	1	0.4*	7.5
8	MM 5	5.0 to 7.5	1	----	5



9	MM 5	5.0 to 7.5	1	0.4	6.25
10	MM 5	5.0 to 7.5	1	0.4	5
11	MM 7.5	7.5 & above	1	----	4
12	MM 7.5	7.5 & above	1**	0.2*	2.1
13	MM 7.5	7.5 & above	1	---	3
14	MM 7.5	7.5 & above	1	0.4	3.75

**Note:**

\* Pozzolana of minimum lime reactivity of 4 N/MM<sup>2</sup>

\*\* This ratio by volume correspondence approximately to cement Pozzolana ratio of 0.8:0.2 by weight. In this case, only ordinary Portland cement is to be used (see IS 269). Specifications for ordinary rapid hardening and low heat Portland Cement (Third revision).

**Note:** Compressive strength shall be determined in accordance with the Appendix -A-IS 2550.



# CONCRETE WORK



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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
1	2	3	4	5	6	7
<b>Stone Aggregate</b>	4.1.2.2	(a) Percentage of soft deleterious materials	Field or Laboratory	IS: 2386 Part-2	One test at commencement of work for approval of each source and thereafter for every change of source	For all quantities
	4.1.2.3	Particle size	Field/ Lab	IS: 2386 Part-1	One test at commencement of work for approval of each source and at every change of source and thereafter One test for 50 cum or part thereof for RCC works only. <b>(Minimum quantity: 45 cum).</b>	For every 45 cum or part thereof for RCC Work only for rest of items as decided by Engineer-in Charge. <b>(Minimum quantity:45 cum)</b>
	4.1.2.5	(a) Estimation of organic impurities	Field/ Lab	IS: 2386 Part-2	One test at commencement of work of approval of each source and change of source and thereafter,  One test for 50 cum or part thereof. <b>(Minimum</b>	For every 40cum or part Thereof. <b>(Minimum Quantity: 10 cum)</b>





Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
					<b>Quantity: 10 cum)</b>	
		(b) Surface moisture	Field/ Lab	IS:2386 Part-3	-do-	-do-
		(c) Determination of 10% fine value	Field/ Lab	IS:2386 Part-4	-do-	-do-
		(d) Specific gravity	Field/ Lab	IS:2386 Part-3	-do-	-do-
		(e) Bulk density	Field/ Lab	IS:2386 Part-3	-do-	-do-
		(f) Aggregate crushing strength	Field/ Lab	IS:2386 Part-4	-do-	-do-
<b>Concrete</b>	4.2.2	Slump test	Field	IS:2386 Part-4	One test at commencement of work of approval of each source and change of source and thereafter,  One test for 50 cum or part thereof. <b>(Minimum Quantity: 10 cum)</b> (Test procedure Appendix D)	15 cum or part thereof (Test procedure Appendix D)



## LIST OF BUREAU OF INDIAN STANDARD CODES

S. NO.	I.S. NO.	SUBJECT
1	IS 383	Specification for coarse and fine aggregate from natural sources for concrete.
2	IS 456	Plain and reinforced concrete - Code of practice
3	IS 516	Method of test for strength of concrete
4	IS 1199	Method of sampling and analysis of concrete
5	IS 1200 (Part II)	Method of measurement of building and civil engineering work (concrete work)
6	IS 1322	Specification for bitumen felt for water proofing and damp proofing.
7	IS 1791	General requirements for batch type concrete mixers
8	IS 2386	Method of test for aggregates for concrete
		(a) Part I - Particle size and shape
		(b) Part II - Estimation of deleterious materials and organic impurities
		(c) Part III - Specific gravity, density, voids absorption and bulking.
		(d) Part IV - Mechanical properties.
		(e) Part V - Soundness
9	IS 2505	General requirements for concrete vibrators - immersion type.
10	IS 2506	General requirements for concrete vibrators - screed board concrete vibrators
11	IS 2645	Specification for integral water proofing compounds for cement mortar and concrete
12	IS 3068	Specification for broken brick (burnt clay) coarse aggregate for use in concrete.
13	IS 3812	Specification for fly ash for use as Pozzolana and admixture in cement mortar and concrete.
14	IS 4656	Specification for form vibrators for concrete.
15	IS 7861 (Part-I)	Code of practice for extreme weather concreting (Part-I) recommended practice for hot weather concreting.
16	IS 7861 (Part-II)	Code of practice for extreme weather concreting (Part-II) recommended.
17	IS 9103	Specification for concrete admixtures.



## 4 CONCRETE WORK

### 4.1 MATERIAL

Water, cement, fine aggregate or sand and Surkhi, shall be as specified in Chapter 3.0 - Mortar.

#### 4.1.1 Coarse Aggregate

**4.1.1.1 General:** Aggregate most of which is retained on 4.75 mm IS Sieve and contains only as much fine material as is permitted in IS 383 for various sizes and grading is known as coarse aggregate. Coarse aggregate shall be specified as stone aggregate, gravel or brick aggregate and it shall be obtained from approved/ authorized sources.

- a. **Stone Aggregate:** It shall consist of naturally occurring (uncrushed, crushed or broken) stones. It shall be hard, strong, dense, durable and clean. It shall be free from veins, adherent coating and injurious amounts of disintegrated pieces, alkali, vegetable matter and other deleterious substances. It shall be roughly cubical in shape. Flaky and elongated pieces shall be avoided. **Aggregates from other than natural resources shall comply with the requirements of IS 383:2016.**
- b. **Gravel:** It shall consist of naturally occurring (uncrushed, crushed or broken) river bed shingle or pit gravel. It shall be sound, hard and clean. It shall be free from flat particles of shale or similar laminated material, powdered clay, silt, loam, adherent coating, alkali, vegetable matter and other deleterious substances. Pit gravel shall be washed if it contains soil materials adhering to it. These shall conform to IS 383 unless otherwise specified.
- c. **Brick Aggregate:** Brick aggregate shall be obtained by breaking well burnt or over burnt dense brick/ brick bats. They shall be homogeneous in texture, roughly cubical in shape and clean. They shall be free from unburnt clay particles. Soluble salt, silt, adherent coating of soil, vegetable matter and other deleterious substances. Such aggregate should not contain more than one percent of sulphates and should not absorb more than 10% of their own mass of water, when used in cement concrete. It shall conform to IS 3068 unless otherwise specified.
- d. **Light weight aggregate** such as sintered fly ash aggregate may also be used provided the Engineer-in-Charge is satisfied with the data on the proportion of concrete made with them.

**4.1.1.2 Deleterious Material:** Coarse aggregate shall not contain any deleterious material, such as pyrites, coal, lignite, mica, shale or similar laminated material, clay, alkali, soft fragments, sea shells and organic impurities in such quantity as to affect the strength or durability of the concrete. Coarse aggregate to be used for reinforced cement concrete. Coarse aggregate to be used for reinforced cement concrete shall not contain any material liable to attack the steel reinforcement. Aggregates which are chemically reactive with alkalis of cement shall not be used. The maximum quantity of deleterious material shall not be more than five percent of the weight of coarse aggregate when determined in accordance with IS 2386.

#### 4.1.1.3 Size and Grading

- i. Stone aggregate and gravel: It shall be either graded or single sized as specified. Nominal size and grading shall be as under:
  - a. Nominal sizes of graded stone aggregate or gravel shall be 40, 20, 16, or 12.5 mm as specified. For any one of the nominal sizes, the proportion of other sizes as determined by the method prescribed in Appendix A of Chapter 4 shall be in accordance with Table 4.1.

TABLE 4.1



**Graded Stone Aggregate or Gravel**

IS Sieve Designation	Percentage passing (by weight) for nominal size of			
	40 mm	20 mm	16 mm	12.5 mm
80 mm	100	-	-	-
63 mm	-	-	-	-
40 mm	95 to 100	100	-	-
20 mm	30 to 70	95 to 100	100	100
16 mm	-	-	90 to 100	-
12.5 mm	-	-	-	90 to 100
10 mm	10 to 35	25 to 55	30 to 70	40 to 85
4.75 mm	0 to 5	0 to 10	0 to 10	0 to 10

- b. Nominal sizes of single sized stone aggregate or gravel shall be 63, 40, 20, 16, 12.5 or 10 mm as specified. For any one of the nominal sizes, the proportion of other sizes as determined by the method prescribed in Appendix A of Chapter 4 shall be in accordance with Table 4.2.

**TABLE 4.2**

**Single Sized (Ungraded) Stone Aggregate or Gravel**

IS Sieve Designation	Percentage passing (by weight) for nominal size of					
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
80 mm	100	-	-	-	-	-
63 mm	85-100	100	-	-	-	-
40 mm	0-30	85-100	100	-	-	-
20 mm	0- 5	0-20	85-100	100	-	-
16 mm	-	-	-	85-100	100	-
12.5 mm	-	-	-	-	85-100	100
10 mm	0-5	0-5	0-20	0-30	0-45	85-100
4.75 mm	-	-	0-5	0-5	0-10	0-20
2.36 mm	-	-	-	-	-	0-5

- c. When stone aggregate or gravel brought to site is single sized (ungraded), it shall be mixed with single sized aggregate of different sizes in the proportion to be determined by field tests to obtain graded aggregate of specified nominal size. For the required nominal size, the proportion of other sizes in mixed aggregate as determined by method prescribed in Appendix A of Chapter 4 shall be in accordance with Table 4.1. Recommended proportions by volume for mixing of different sizes of single size (ungraded) aggregate to obtain the required nominal size of graded aggregate are given in Table 4.3.

**TABLE 4.3**

**Single Sized (Ungraded) Stone Aggregate or Gravel**



Cement concrete	Nominal size of graded aggregate required	Parts of single size aggregate of size				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1:6:12	63	9	-	3	-	-
1:6:12	40	-	9	3	-	-
1:5:10	63	7.5	-	2.5	-	-
1:5:10	40	-	7.5	2.5	-	-
1:4:8	63	6	-	2	-	-
1:4:8	40	-	6	2	-	-
1:3:6	63	4.5	-	1.5	-	-
1:3:6	40	-	4.5	1.5	-	-
1:3:6	20	-	-	4.5	-	1.5
1:2:4	40	-	2.5	1	-	1.5
1:2:4	20	-	-	3	-	1
1:2:4	12.5	-	-	-	3	1
1: 1 1/2:3	20	0	0	2	-	1

**Note:**

- The proportions indicated in Table 4.3 above are by volume when considered necessary, these proportions may be varied marginally by Engineer-in-Charge after making sieve analysis of aggregate brought to site for obtaining required graded aggregate. No adjustments in rate shall be made for any variation in the proportions so ordered by the Engineer-in-Charge. If single size coarse aggregate are not premixed at site to obtain the graded coarse aggregate required for the mix, the volume of single size aggregates required for the mix shall be suitably increased to account for reduction in total volume at the site of mixing.
- Brick Aggregate: Nominal size of brick aggregate shall be 40 mm and its grading shall be as specified in Table 4.4 when tested for sieve analysis for the method prescribed in Appendix A of Chapter 4.0.

**TABLE 4.4**

**Brick Aggregate**

IS Sieve Designation	Percentage passing (by weight)
75 mm	100
37.5 mm	95-100
20.0 mm	45-100
4.75 mm	0.50



**4.1.1.4** Stacking: Aggregate shall be stacked on a hard, dry and level patch of ground. When stack piling, the aggregate shall not form pyramids resulting in segregation of different sized materials. It shall be stacked separately according to nominal size of coarse aggregates. Stacking shall be done in regular stacks, of height not exceeding 100 cm.

**4.1.1.5** Testing: Coarse aggregate shall be tested for the followings (as per IS 2386)

- a. Determination of particle size and shape (Appendix A of Chapter 4)
- b. Estimation of organic impurities (as per IS 2386 - Part II)
- c. Surface moisture (Appendix B of Chapter 4)
- d. Determination of 10% fine value (Appendix C of Chapter 4)

**4.1.1.6** Measurements: The aggregates shall be measured in stacks and paid for after making a deduction of 7.5% of the gross measurements of stacks in respect of aggregates of nominal size 40 mm and above. No deduction from the gross measurements of the stacks is to be made in respect of aggregate of nominal size below 40 mm.

#### **4.1.2 Chemical Admixtures**

When required, admixtures of approved quality shall be mixed with concrete, as specified. The admixtures shall conform to IS 9103 and as specified in Chapter 5 - R.C.C.

**4.1.2.1** Admixtures may be any one of the following classes for use in concrete:

- a. Water Reducing Admixtures
- b. Retarding Admixtures
- c. Accelerating Admixtures.
- d. Water Reducing and Retarding Admixtures.
- e. Water Reducing and Accelerating Admixtures.
- f. Permeability reducing (water proofing) Admixtures.

**4.1.2.2** Liquid Admixtures: Admixtures introduced into the concrete as liquids generally fall into the following categories.

- a. Air Entraining.
- b. Water Reducing.
- c. Water Reducing Retarders.
- d. Retarders.
- e. Water Reducing Accelerators.
- f. Accelerators.

**4.1.2.3** Dosage of these admixtures may vary according to manufacturer's specification.

**4.1.2.4** Two or more admixtures may not be compatible in the same solution. It is therefore mandatory that when two admixtures manufactured by the same manufacturers are being used simultaneously, the manufacturer shall certify their compatibility. In case the two or more admixtures are produced by different manufacturers, then, before their use in concrete, test shall be performed by the manufacturer to establish their compatibility, all such test reports shall be furnished to the Engineer-in-Charge for his approval before their use in concrete.



- 4.1.2.5** Some admixture may be in the form of powder, particle or high concentration liquids which may require mixing with water prior to dosing. Under these conditions water in solution shall be considered as part of total water content in the batch in order to maintain the water-cement ratio.
- 4.1.2.6** Admixture manufacturer's recommendation shall be carefully followed so as to ensure complete solution of the product or to prepare a standard solution of uniform strength for easier use.
- 4.1.2.7** Certain admixtures may contain significant amounts of finely divided insoluble materials or active ingredients which may or may not be readily soluble. It is essential for such admixtures that precautions be taken to ensure that these constituents be kept in a state of uniform suspension before actual batching. When relatively small amounts of powdered admixtures are to be used directly, these shall be pre-blended with cement.
- 4.1.2.8** Admixtures are sold under various trade names and may be in the form of liquids or powders. The proprietary name and the net quantity of content shall be clearly indicated in each package or container of admixtures. The admixtures shall be uniform within each batch and uniform between all batches.
- 4.1.2.9** No admixtures shall be accepted for use in concrete unless these are tested in accordance with IS 9103 and the test results are approved by the Engineer-in-Charge.

## 4.2 CEMENT CONCRETE

### 4.2.1 Grades of Cement Concrete

The concrete shall be in grade designated as under:

**TABLE 4.5**

**Grades of Concrete**

Group	Grade Designation	Specified characteristic compressive strength of 150 mm Cube at 28 Days in N/mm <sup>2</sup>
(1)	(2)	(3)
Ordinary Concrete	M10	10
	M15	15
	M20	20
Standard Concrete	M25	25
	M30	30
	M35	35
	M40	40
	M45	45
	M50	50
	M55	55
	M60	60
High Strength Concrete	M65	65
	M70	70



	M75	75
	M80	80
	M85	85
	M90	90
	M95	95
	M100	100

**Notes:**

1. In the designation of concrete mix M refers to the mix and the number to the specified compressive strength of 150 mm size cube at 28 days, expressed in N/mm<sup>2</sup>.
2. For concrete of compressive strength greater than **M60**, design parameters given in the standard may not be applicable and the values may be obtained from specialized literatures and experimental results.

**4.2.1.1** The characteristic strength is defined as the strength of material below which not more than 5 percent of the test results are expected to fall.

**TABLE 4.6**

**Minimum Cement Content, Maximum Water-Cement Ratio and Minimum Grade of Concrete for Different Exposures with Normal Weight Aggregates of 20 mm Nominal; Maximum Size**

**(Clause 4.2.1.1)**

Sl. No.	Exposure	Plain Concrete			Reinforced Concrete		
		Minimum Cement Content kg/m <sup>3</sup>	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete	Minimum Cement Content kg/m <sup>3</sup>	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(i)	Mild	220	0.60	-	300	0.55	M20
(ii)	Moderate	240	0.60	M15	300	0.50	M25
(iii)	Severe	250	0.50	M20	320	0.45	M30
(iv)	Very Severe	260	0.45	M20	340	0.45	M35
(v)	Extreme	280	0.40	M25	360	0.40	M40

**Notes:**

1. Cement content prescribed in this Table is irrespective of the grades and types of cement and inclusive of mineral admixtures mentioned in para 5.9.1.3. The additions such as fly ash or ground granulated blast furnace slag may be taken into account in the concrete composition with respect to the cement content and water-cement ratio, if the suitability is established and as long as the maximum amounts taken into account do not exceed the limit of pozzolona and slag specified in IS





1489 (Part 1) and IS 455 respectively. Beyond which these additions though permitted, shall not be considered for these purposes.

2. Minimum grade for plain concrete under mild exposure condition is not specified.
3. The minimum cement content, maximum free water cement ratio and minimum grade of concrete are individually related to exposure.

The minimum grade of concrete for plain and reinforced concrete shall be as per Table 4.6.

- 4.2.1.2** Concrete of grades lower than those given in Table 4.6 may be used for lean concrete, foundation for masonry walls or temporary reinforced concrete construction.

## 4.2.2 Workability of Concrete

- 4.2.2.1** The concrete mix proportion chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. Suggested ranges of workability of concrete measured in accordance with IS 1199 are given below:

Placing Conditions	Degree of Workability	Slump (mm)
(1)	(2)	(3)
Blinding concrete: shallow sections: Pavements using pavers	Very low	See 4.2.2.2
Mass concrete: Lightly reinforced sections in slabs, beams, wall, columns, floors	Low	25-75
Hand placed pavements: canal lining, Strip footing	Medium	50-100
Heavily reinforced sections in slabs, beams, walls, columns:		
Slip formwork: Pumped concrete	Medium	75-100
Trench fill	High	100-150
Tremie concrete	Very High	See 4.2.2.3

**Note:** For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used (see also para 4.2.7)

- 4.2.2.2** In the 'very low' category of workability where strict control is necessary, for example, pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.
- 4.2.2.3** In the 'very high' category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

## 4.2.3 Concrete Mix Proportioning



**4.2.3.1** The determination of the proportion of cement, aggregate and water to attain the required strength shall be made as follows:

- By designing the concrete mix: such concrete shall be called 'Design mix concrete', for details reference may be made to RCC Chapter.
- By adopting nominal concrete mix: such concrete shall be called 'Nominal mix concrete'.

Design mix concrete is preferred to nominal mix. If design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of Engineer-in-Charge, which, however, is likely to involve a higher cement content.

**4.2.3.2 Nominal Mix Concrete:** Nominal Mix Concrete may be used for concrete of M20 or lower. The proportions of materials for nominal mix concrete shall be in accordance with Table 4.7.

The cement content of the mix specified in Table 4.7 for any nominal mix shall be proportionately increased if the quantity of water in the mix has to be increased to overcome the difficulty of placement and compaction, so that the water cement ratio as specified is not exceeded.

**TABLE 4.7**  
**Proportions for Nominal Mix Concrete**

(Clause 4.2.3.2)

Grade of Concrete	Total Quantity of Dry Aggregates by Mass per 50 kg of cement, to be taken as the Sum of the Individual Masses of Fine and Coarse Aggregates, Kg. Max	Proportion of Fine Aggregate to Coarse Aggregate (by Mass)	Quantity of Water per 50 kg of Cement, max Ltr.
(1)	(2)	(3)	(4)
M5	800	Generally 1:2 but subject to an upper limit of 1: 1 ½ and a lower limit of 1:2 ½	60
M7.5	625		45
M10	480		34
M15	330		32
M20	250		30

**Note:** The proportion of the fine to coarse aggregate should be adjusted from upper limit progressively as the grading of fine aggregate becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

**Note:** Quantity of water required from durability point of view may be less than the value given above.

#### Example

For an average grading of fine aggregate (that is, Zone II of Table 4 of IS 383), the proportions shall be 1:1 ½, 1:2 and 1:2 ½ for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.

#### 4.2.4 Batching

To avoid confusion and error in batching, consideration should be given to using the smallest practical number of different concrete mixed on any site or in any one plant. In batching concrete,



the quantity of both cement and aggregate shall be determined by mass; admixture, if solid, by mass: liquid admixture may however be measured in volume or mass: water shall be weighed or measured by volume in a calibrated tank (see also IS 4925).

For projects having sanctioned more than 100 Crores, the concrete shall be sourced from ready mixed concrete plant or from captive on site or off-site automatic batching and mixing plants. The concrete produced and supplied by ready mixed concrete plants shall be in accordance with IS 4926. In case of concrete from captive on site or off-site automatic batching and mixing plants, similar quality control shall be followed.

Ready-mixed concrete supplied by ready-mixed concrete plant shall be preferred. For large and medium project sites the concrete shall be sourced from ready-mixed concrete plants or from on site or off-site batching and mixing plants (see IS 4926).

- 4.2.4.1** In case of batch mixing plant at site the grading of aggregate shall be controlled by obtaining the coarse aggregate in different sizes and blending them in right proportions, the different sizes being stocked in separate stock piles. The material should be stock-piled for several hours preferably a day before use. The grading of coarse and fine aggregate should be checked as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge to ensure that the specified grading is maintained.
- 4.2.4.2** The accuracy of the measuring equipment shall be within  $\pm 2$  percent of the quantity of cement and mineral admixtures being measured and within  $\pm 3$  percent of the quantity of aggregate, chemical admixtures and water being measured. In a batching plant, the concrete production equipment shall be calibrated initially at the time of installation or reconditioning of the equipment and subsequently at the following intervals:
- a) Mechanical/knife edge system: At least once every two months.
  - b) Electrical/load cell system: At least once every three months.
- 4.2.4.3** All ingredients of concrete shall be used by mass except water and chemical admixtures which may be by volume.
- 4.2.4.4** Volume batching may be allowed only where weigh-batching is not practicable and provided accurate used in concrete have earlier been established. Allowance for bulking shall be made in accordance with IS 2386 (Part 3). The mass volume relationship should be checked as frequently as necessary, the frequency for the given job being determined by Engineer-in-Charge to ensure that the specified grading is maintained.
- 4.2.4.5** It is important to maintain the water cement ratio constant at its correct value. To this end, determination of moisture contents in both fine and coarse aggregates shall be made as frequently as possible, the frequency for a given job being determined by the Engineer-in-Charge according to weather conditions. The amount of the added water shall be adjusted to compensate for any observed variations in the moisture contents. For the determination of moisture content in the aggregates, IS 2386 (Part 3) may be referred to. To allow for the variation in mass for aggregate due to variations in their moisture content, suitable adjustments in the masses of aggregates shall be made. in the absence of exact data, only in the case of nominal mixes, the amount of surface water may be estimated from the values given in Table 4.8.

**TABLE 4.8**  
**Surface Water Carried by Aggregate**  
**(Clause 4.2.4.5)**



Sl No	Aggregate	Approximate Percent by mass	Quantity of Surface Water l/m <sup>3</sup>
(1)	(2)	(3)	(4)
(i)	Very wet sand	7.5	120
(ii)	Moderately wet sand	5.0	80
(iii)	Moist sand	2.5	40
(iv)	<sup>1)</sup> Moist gravel or crushed rock	1.25-2.5	20-40

<sup>1)</sup> Coarser the aggregate, less the water it will carry.

**4.2.4.6** No substitutions in materials used on the work or alteration in the established proportions, except as permitted in para 4.2.4.4 and 4.2.4.5 shall be made without additional tests to show that the quality and strength of concrete are satisfactory.

#### 4.2.5 Mixing

Concrete shall be mixed in mechanical batch type concrete mixers conforming to IS 1791 having two blades and fitted with power loader (lifting hopper type). Half bag mixers and mixers without lifting hoppers shall not be used for mixing concrete. In exceptional circumstances, such as mechanical breakdown of mixer, work in remote areas or power breakdown and when the quantity of concrete work is very small, hand mixing may be done with the specific prior permission of the Engineer-in-Charge in writing subject to adding 10% extra cement. When hand mixing is permitted, it shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the concrete is uniform in colour and consistency. Before mixing the brick aggregate shall be well soaked with water for a minimum period of two hours and stone aggregate or gravel shall be washed with water to remove, dirt, dust and other foreign materials. For guidance, the mixing time may be 1 1/2 to 2 minutes, for hydrophobic cement it may be taken as 2 1/2 to 3 minutes.

**4.2.5.1** Power Loader: Mixer will be fitted with a power loader complying with the following requirements.

- The hopper shall be of adequate capacity to receive and discharge the maximum nominal batch of unmixed materials without spillage under normal operating conditions on a level site.

**Note:** In such a case the volume of the maximum nominal batch of mixed material is 50% greater than the nominal mixed batch capacity.

- The minimum inside width of the feeding edge of the hopper shall be as specified below in Table 4.9.

**TABLE 4.9**

Nominal size of mixer (T, NT or R) litre	Minimum inside width of hopper feeding edge
140	1.0
200	1.1
280	1.2
375	1.4
500	1.5
1000	2.0



T = Tilting; NT = Non-tilting; R = Reverse

- c. The design of the loader shall be such that it allows the loading hopper to be elevated to such a height that the centre line of the chute plate of the hopper when in discharge position, is at an angle of not less than  $50^\circ$  to the horizontal. A mechanical device to aid discharge of the contents as quickly as possible from the hopper to the drum may also be provided. Even when a mechanical device is provided, it is recommended that the angle of centre line of the chute plate of the hopper when in discharge position, should be as large as practicable, preferably not less than  $40^\circ$  to horizontal.
- d. When the means of raising and lowering the loading hopper includes flexible wire ropes winding on to a drum or drums, the method of fastening the wire to rope to the drums shall be such as to avoid, as far as possible any tendency to cut the strands of the ropes and the fastening should preferably be positioned clear of the barrel of the drum for example, outside the drums flange. When the loading hopper is lowered to its normal loading position, these should be at least one and a half drums of rope on the drum.
- e. Clutch brake and hydraulic control lever shall be designed so as to prevent displacement by liberation or by accidental contact with any person.
- f. The clutch and brake control arrangements shall also be so designed that the operator can control the falling speed of the loader.
- g. Safety device shall be provided to secure the hopper in raised position when not in use.

**4.2.5.2 Mixing Efficiency:** The mixer shall be tested under normal working conditions in accordance with the method specified in IS 4643 with a view to check its ability to mix the ingredients to obtain concrete having uniformity within the prescribed limits. The uniformity of mixed concrete shall be evaluated by finding the percentage variation in quantity (mass in water) of cement, fine aggregate and coarse aggregate in a freshly mixed batch of concrete. The percentage variation between the quantities of cement, fine aggregate and coarse aggregates (as found by weighing in water) in the two halves of a batch and average of the two halves of the batch shall not be more than the following limits:

Cement	8%
Fine aggregate	6%
Coarse aggregate	5%

**4.2.5.3 Machine Mixing:** The mixer drum shall be flushed clean with water. Measured quantity of coarse aggregate shall be placed first in the hopper. This shall be followed with measured quantity of fine aggregate and then cement. In case fine aggregate is damp, half the required quantity of coarse aggregate shall be placed in the hopper, followed by fine aggregate and cement. Finally the balance quantity of coarse aggregate shall be fed in the hopper, & then the dry materials are slipped into the drum by raising the hopper. The dry material shall be mixed for at least four turns of the drum. While the drum is rotating, water shall be added gradually to achieve the water cement ratio as specified or as required by the Engineer-in-Charge. After adding water, the mixing shall be continued until concrete of uniform colour, uniformly distributed material and consistency is obtained. Mixing shall be done for at least two minutes after adding water. If there is segregation after unloading from the mixer, the concrete should be remixed.

The drum shall be emptied before recharging. When the mixer is closed down for the day or at any time exceeding 20 minutes, the drum shall be flushed cleaned with water.

**4.2.5.4 Hand Mixing:** When hand mixing has been specifically permitted in exceptional circumstances by the Engineer-in-Charge in writing, subject to adding 10% extra cement, it shall be carried out on a



smooth, clean and water tight platform of suitable size. Measured quantity of sand shall be spread evenly on the platform and the cement shall be dumped on the sand and distributed evenly. Sand and cement shall be mixed intimately with spade until mixture is of even colour throughout. Measured quantity of coarse aggregate shall be spread on top of cement sand mixture and mixing done by showlling and turning till the coarse aggregate gets evenly distributed the cement sand mixture. Three quarters of the total quantity of water required shall be added in a hollow made in the middle of the mixed pile and the material is turned towards the middle of pile with spade. The whole mixture is turned slowly over and again and the remaining quantity of water is added gradually. The mixing shall be continued until concrete of uniform colour and consistency is obtained. The mixing platform shall be washed and cleaned at the end of the day.

**4.2.5.5 Transportation and Handling:** Concrete shall be transported from the mixer to the place of laying as rapidly as possible by methods which will prevent the segregation or loss of any of the ingredients and maintaining the required workability.

During hot or cold weather, concrete shall be transported in deep containers, other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted.

#### **4.2.6 Placing**

The concrete shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be laid gently (not thrown) and shall be thoroughly vibrated and compacted before setting commences and should not be subsequently disturbed. Method of placing shall be such as to preclude segregation. Care shall be taken to avoid displacement of reinforcement or movement of form work and damage due to rains. As a general guidance, the maximum free fall of concrete may be taken as 1.5 metre.

#### **4.2.7 Compaction**

Concrete shall be thoroughly compacted and fully worked around embedded fixtures and into corners of the form work. Compaction shall be done by mechanical vibrator of appropriate type till a dense concrete is obtained. The mechanical vibrators shall conform to IS 2505, IS 2506, IS 2514 and IS 4656. To prevent segregation, over vibration shall be avoided.

Compaction shall be completed before the initial setting starts. For the items where mechanical vibrators are not to be used, the contractor shall take permission of the Engineer-in-Charge in writing before the start of the work. After compaction the top surface shall be finished even and smooth with wooden trowel before the concrete begins to set.

#### **4.2.8 Construction Joints**

Concreting shall be carried out continuously upto construction joints. The position and arrangement of construction joints shall be as shown in the structural drawings or as directed by the Engineer-in-Charge. Number of such joints shall be kept minimum. Joints shall be kept as straight as possible. Construction joints should comply with IS 11817.

**4.2.8.1** When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean and thoroughly wetted. For vertical joints, neat cement slurry, of workable consistency by using 2 kgs of cement per sqm shall be applied on the surface before it is dry. For horizontal joints, the surface shall be covered with a layer of mortar about 10 - 15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry of mortar shall be freshly mixed and applied immediately before placing of the concrete.



- 4.2.8.2** Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgement of particles of coarse aggregate. The surface shall be thoroughly wetted and all free water removed. The surface shall then be coated with neat cement slurry @ 2 kgs of cement per sqm. On this surface, a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work particular attention being paid to corners and close spots; work, thereafter, shall proceed in the normal way.

#### **4.2.9 Concreting under Special Conditions**

- 4.2.9.1 Work in Extreme Weather Conditions:** During hot and cold weather, the concreting shall be done as per the procedure set out in IS 7861 (Part-I)-1975 and IS 7861 (Part II)-1981 respectively. Concreting shall not be done when the temperature falls below 4.5°C. In cold weather, the concrete placed shall be protected against frost. During hot weather, it shall be ensured that the temperature of wet concrete does not exceed 38°C.

- 4.2.9.2 Under Water Concreting:** Concrete shall not be deposited under water if it is practicable to dewater the area and place concrete in the regular manner. When it is necessary to deposit concrete under water, the methods, equipment, materials and proportions of the mix to be used shall be submitted to and approved by the Engineer-in-Charge before the work is started.

Under-water concrete should have a slump recommended in para 4.2.2. The water-cement ratio shall not exceed 0.6 and may need to be smaller, depending on the grade of concrete or the type of chemical attack. For aggregates of 40 mm maximum particle size, the cement content shall be at least 350 kg/m<sup>3</sup> of concrete.

- 4.2.9.3 Concrete in Sea Water:** Concrete in sea-water or exposed directly along the sea-coast shall be at least M20 Grade in the case of plain concrete and M30 in case of reinforced concrete. The use of slag or Pozzolana cement is advantageous under such conditions.

- i. Special attention shall be given to the design of the mix to obtain the densest possible concrete: slag, broken brick, soft lime stone, soft sandstone, or other porous or weak aggregates shall not be used.
- ii. As far as possible, preference shall be given to precast members unreinforced, well-cured and hardened, without sharp corners, and having trowel-smooth finished surfaces free from crazing, cracks or other defect; plastering should be avoided.
- iii. No construction joints shall be allowed within 600 mm below low water-level or within 60 mm of the upper and lower planes of wave action. Where unusually severe conditions or abrasion are anticipated, such parts of the work shall be protected by bituminous or silico-fluoride coatings or stone facing bedded with bitumen.
- iv. In reinforced concrete structures, care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods.

#### **4.2.10 Curing**

Curing is the process of preventing loss of moisture from the concrete. The following methods shall be employed for effecting curing.

- 4.2.10.1 Moist Curing:** Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, Hessian or similar materials and kept constantly wet for at least 7 days from the date of placing concrete in case of ordinary Portland cement and at least 10 days where mineral admixtures or blended cements are used. The period





of curing shall not be less than 10 days for concrete exposed to dry and hot weather conditions. In the case of concrete where mineral admixtures or blended cements are used, it is recommended that above minimum periods may be extended to 14 days.

**4.2.10.2 Membrane Curing:** Approved curing compounds may be used in lieu of moist curing with the permission of the Engineer-in-Charge. Such compound shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set. Impermeable membrane such as polythene sheet covering the concrete surface may also be used to provide effective barrier against the evaporation.

**4.2.10.3** Freshly laid concrete shall be protected from rain by suitable covering.

**4.2.10.4** Over the foundation concrete, the masonry work may be started after 48 hours of its compaction but the curing of exposed surfaces of cement concrete shall be continued along with the masonry work for at least 7 days. And where cement concrete is used as base concrete for flooring, the flooring may be commenced before the curing period of base concrete is over but the curing of base concrete shall be continued along with top layer of flooring for a minimum period of 7 days.

#### **4.2.11 Testing of Concrete**

Testing of concrete shall be done as described in chapter of R.C.C.

#### **4.2.12 Form Work**

Form work shall be as specified in R.C.C. chapter and shall be paid for separately unless otherwise specified.

#### **4.2.13 Finishes**

Plastering and special finishes other than those, obtained through form work shall be specified and paid for separately unless otherwise specified.

#### **4.2.14 Durability of Concrete**

A durable concrete is one that performs satisfactorily in the working environment during its anticipated exposure conditions during service life. The materials and mix proportions shall be such as to maintain its integrity and, if applicable, to protect reinforcement from corrosion.

The factors influencing durability include:

- (a) The environment.
- (b) The cover to embedded steel.
- (c) The type and quality of constituent materials.
- (d) The cement content and water/ cement ratio of the concrete.
- (e) Workmanship, to obtain full compaction and efficient curing.
- (f) The shape and size of the member.

##### **4.2.14.1 Requirements for Durability**

**4.2.14.1.1 General Environment:** The general environment to which the concrete will be exposed during its working life is classified into five levels of severity, that is, mild, moderate, severe, very severe and extreme as described in Table 4.10.

**TABLE 4.10**

#### **Environmental Exposure Conditions**



Sl. No	Environment	Exposure Conditions
(1)	(2)	(3)
(i)	Mild	✓ Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area.
(ii)	Moderate	✓ Concrete surfaces sheltered from severe rain or freezing whilst wet Concrete exposed to condensation and rain ✓ Concrete continuously under water ✓ Concrete in contact or buried under non-aggressive soil/ ground water Concrete surfaces sheltered from saturated salt air in coastal area
(iii)	Severe	✓ Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation. ✓ Concrete completely immersed in sea water. Concrete exposed to coastal environment.
(iv)	Very severe	✓ Concrete surface exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet. ✓ Concrete in contact with or buried under aggressive sub-soil/ ground water.
(v)	Extreme	✓ Surface of members in tidal zone. ✓ Members in direct contact with liquid/ solid aggressive chemicals.

**Note:** For the purpose of determining exposure conditions, all places within a distance of 10 kms of coastal line, sea front would be treated as coastal area.

**4.2.14.1.2 Freezing and Thawing:** Where freezing and thawing actions under wet conditions exist, enhanced durability can be obtained by the use of suitable air entraining admixtures. When concrete lower than grade M 50 is used under these conditions, the mean total air content by volume of the fresh concrete at the time of delivery into the construction should be:

Nominal Maximum Size Aggregate (mm)	Entrained Air Percentage
20	5 ± 1
40	4 ± 1

**4.2.14.1.3 Exposure to Sulphate Attack:** For the very high sulphate concentration in Class 5 conditions given in Table 4.11, some form of lining such as polyethylene or polychloroprene sheet: or surface coating based on asphalt, chlorinated rubber, epoxy; or polyurethane materials should also be used to prevent access by the sulphate solution.

**4.2.14.1.4 Chlorides in Concrete:** The total amount of chlorides content (as Cl) in the concrete at the time of placing shall be as follows:



Sl. No.	Type of Use of Concrete	Maximum total Acid Soluble Chloride Content expressed as kg/m <sup>3</sup> of Concrete
(1)	(2)	(3)
(i)	Concrete containing metal and steam cured at elevated temperature and pre-stressed concrete	0.4
(ii)	Reinforced concrete or plain concrete containing embedded metal	0.6
(iii)	Concrete not containing embedded metal or any material requiring protection from chloride	3.0

4.2.14.1.5 Sulphates in Concrete: The total water-soluble sulphate content of the concrete mix, expressed as SO<sub>3</sub> should not exceed 4 per cent by mass of the cement in the mix. The sulphate content should be calculated as the total from the various constituents of the mix. The 4 per cent limit does not apply to concrete made with super sulphate cement complying with IS 6909.

**TABLE 4.11**  
**Requirements for Concrete Exposed to Sulphate Attack**  
**(Clause 4.2.14.1.3)**

SI No.	Classes	Concentration of sulphates, Expressed as SO3 Concrete.			Type of Cement	Dense, fully compacted made with 20 mm nominal maximum size Aggregates complying with IS 383	
		In Soil		In Ground Water (g/l)		Minimum Cement Content kg/m³	Maximum Free Water-Cement Ratio
		Total SO3 (%)	SO3 in 2:1 (Water Soil Extract) (g/l)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(i)	1	Traces (<0.2)	Less than 1.0	Less than 0.3	Ordinary Portland cement or Portland slag cement or Portland-Pozzolana cement	280	0.55
(ii)	2	0.2 to 0.5	1.0 to 1.9	0.3 to 1.2	Ordinary Portland cement or Portland slag cement or Portland Pozzolana cement	330	0.50



					Super sulphated cement or sulphate resisting Portland cement	310	0.50
(iii)	3	0.5 to 1.0	1.9 to 3.1	1.2 to 2.5	Super sulphated cement or sulphate resisting Portland cement	330	0.50
					Portland Pozzolana cement or Portland slag cement	350	0.45
(iv)	4	1.0 to 2.0	3.1 to 5.0	2.5 to 5.0	Super sulphated or sulphate resisting Portland cement	370	0.45
(v)	5	More than 2.0	More than 5.0	More than 5.0	Sulphate resisting Portland cement or super sulphated cement with protective coatings	400	0.40

#### Notes

1. Cement content given in this Table is irrespective of grades of cement.
2. Use of super sulphated cement is generally restricted where the prevailing temperature is above 40°C.
3. Super sulphated cement gives an acceptable life provided that the concrete is dense and prepared with a water-cement ratio of 0.4 or less, in mineral acids, down to pH 3.5.
4. The cement contents given in col. 7 of this Table are the minimum recommended. For SO<sub>3</sub> contents near the upper limit of any class, cement contents above these minimum are advised.
5. For severe conditions, such as thin sections under hydrostatic pressure on one side only and sections partly immersed, considerations should be given to a further reduction of water-cement ratio.
6. Portland slag cement conforming to IS 455 with slag content more than 50 per cent exhibits better sulphate resisting properties.
7. Where chloride is encountered along with sulphates in soil or ground water, ordinary Portland cement with C<sub>3</sub>A content from 5 to 8 per cent shall be desirable to be used in concrete, instead of sulphate resisting cement. Alternatively, Portland slag cement conforming to IS 455 having more than 50 per cent slag or a blend of ordinary Portland cement and slag may be used provided sufficient information is available on performance of such blended cements in these conditions.

#### 4.2.15 Measurements

- 4.2.15.1** Dimensions of length, breadth and thickness shall be measured correct to nearest cm. except for the thickness of slab and partition which shall be measured to nearest 5 mm. Areas shall be worked out to nearest 0.01 sq.m and the cubic contents of consolidated concrete shall be worked out to



nearest cum. Any work done in excess over the specified dimension or sections shown in the drawing shall be ignored.

**4.2.15.2** Concrete work executed in the following conditions shall be measured separately:

- a. Work in or under water
- b. Work in liquid mud
- c. Work in or under foul positions

**4.2.15.3** Cast-in-situ concrete and or precast concrete work shall be measured in stages described in the item of work, such as:

- a. At or near the ground level
- b. Upto specified floor level
- c. Between two specified floor levels
- d. Upto specified height above or depth below plinth level/ defined datum level.
- e. Between tow specified heights or depths with reference to plinth/defined datum level.

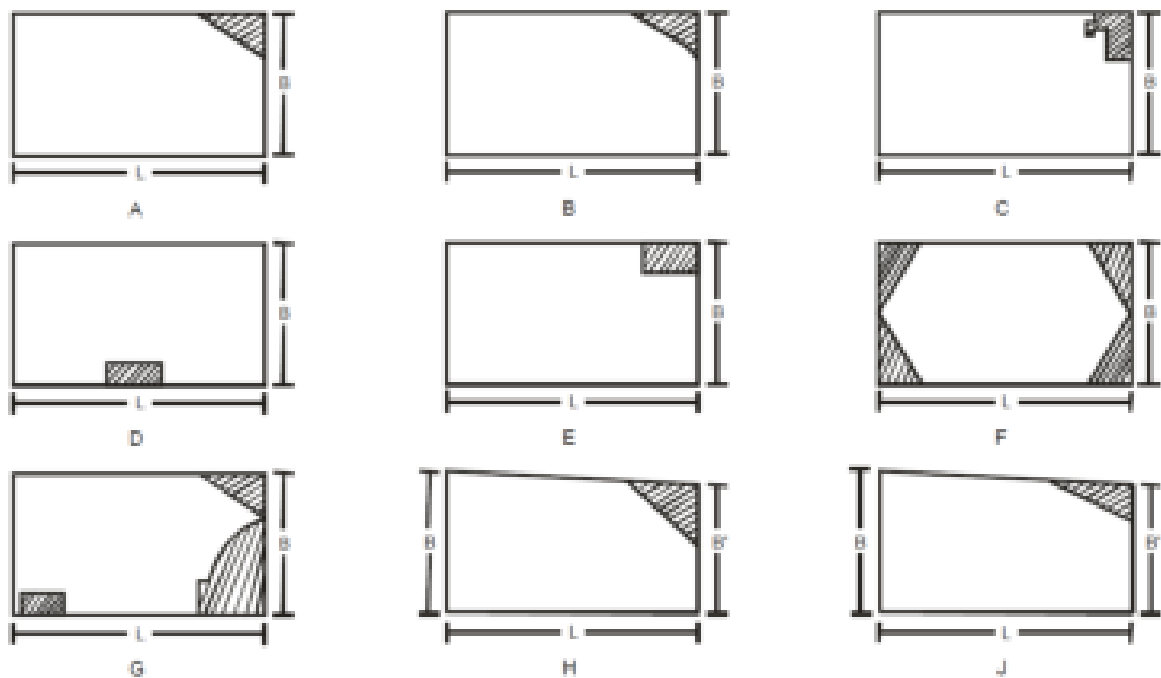
**4.2.15.4** No deduction shall be made for the following:

- a. Ends of dissimilar materials for example beams, posts, girders, rafters, purlins, trusses, corbels and steps upto 500 sq cm in cross sections.
- b. Opening upto 0.1 sq metre (1000 sq.cm)
- c. Volume occupied by pipes, conduits, sheathing etc. not exceeding 100 sq cm each in cross sectional areas.
- d. Small voids such as shaded portions in Figure A to J below when these do not exceed 40 s q cm each in cross section.

**Note:** In calculating area of opening, the thickness of any separate lintel or sill shall be included in the height. Nothing extra shall be payable for forming such openings or voids.

Area of Fig. A to G shall be  $= L \times B$

Area of Fig. H & J shall be  $= L \times \{\text{Average of B and B'}\}$



**4.2.15.5** Cast-in-situ and precast concrete work shall be measured separately.

**4.2.15.6** Cast-in-situ concrete shall be classified and measured as follows:

- a) Foundation, footings, bases for columns
- b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets etc.
- c) Shelves
- d) Slabs
- e) Chajjas including portions bearing on the wall
- f) Lintels, beams and bressummers
- g) Columns, piers abutments, pillars, post and struts
- h) Stair case including stringer beams but excluding landings.
- i) Balustrades, newels and sailing
- j) Spiral staircase (including landings)
- k) Arches
- l) Domes, vaults
- m) Shell roof, arch ribs and folded plates
- n) Chimneys and shaft.
- o) Breast walls, retaining, walls, return walls
- p) Concrete filling to precast components
- q) Kerbs, steps and the like



- r) String or lacing courses, parapets, copings, bed block, anchor blocks, plain window sills and the like
- s) Cornices and moulded windows sills.
- t) Louvers, fins, fascia.

Precast cement concrete solid article shall be measured separately and shall include use of moulds, finishing the top surfaces even and smooth with wooden trowel, before setting in position incement mortar 1: 2 (1 cement: 2 coarse sand). Plain and moulded work shall be measured separately and the work shall be classified and measured as follows:

Sl. No.	Classifications	Method of measurement
(i)	Wall panels	In square meters stating the thickness.
(ii)	String or lacing courses, coping, bed plates, plain windows sills, shelves, louvers, steps etc.	In cubic meters.
(iii)	Kerbs, edgings etc.	In cubic meters.
(iv)	Solid block work	In square metres stating the thickness or in cubic meters.
(v)	Hollow block work	In square metres stating the thickness or in cubic metres.
(vi)	Light weight partitions	In square metres stating the partition's thickness.

#### 4.2.16 Rate

The rate is inclusive of the cost of labour and materials involved in all the operations described above.

### 4.3 CEMENT- FLY ASH CONCRETE

- 4.3.0** Fly ash concrete shall be prepared by mixing graded coarse aggregate of nominal size as specified with fine aggregate, ordinary Portland cement and fly ash in specified proportions with required quantity of water. The recommended composition of cement fly ash concrete is as under:

**TABLE 4.12**

**Fly Ash Concrete Mixes**

Composition (Dry Volume)	Proportion (Dry Volume)	Compressive Strength at seven days
Lean Concrete (1:5:10)		28 kg/cm <sup>2</sup>
Cement (Ordinary Portland)	1.0	
Fly ash	2.5	
Sand	4.0	
Stone aggregate	11.0	
Lean Concrete (1:4:8)		



Cement (Ordinary Portland)	1.0	37 kg/cm <sup>2</sup>
Fly ash	2.0	
Sand	3.5	
Stone aggregate	9.0	

**Note:** No fly ash is to be added to Portland Pozzolana cement in any case which itself contains fly ash.

#### 4.3.1 Proportioning

Proportioning shall be done by volume. Boxes of suitable size shall be used for measuring fly ash, sand and aggregate. The internal dimensions of the boxes shall be generally 35x25x40 cm. deep or as otherwise approved by the Engineer -in-charge. The unit of measurement of cement shall be a bag of 50 kg. and this shall be taken as 0.035 cum. While measuring the aggregate, shaking, ramming or heaping shall not be done. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowances for bulkage shall be made as given in the chapter for mortar.

**4.3.2** Mixing shall be as specified in 4.2.5 except that the fly ash shall be placed in the hopper before cement in case of machine mixing.

**4.3.3** Placing and compaction shall be as specified in 4.2.6 and 4.2.7.

**4.3.4** Curing shall be as specified in 4.2.10.

**4.3.5** Form work shall be as specified in 4.2.12.

**4.3.6** Measurements shall be as specified in 4.2.15.

#### 4.3.7 Rate

Rate shall include the cost of materials and labour involved in all the operations described above.

### 4.4 DAMP PROOF COURSE

#### 4.4.1 Cement Concrete Layer

This shall consist of cement concrete of specified proportions and thickness. The surface of brick or stone masonry work shall be levelled and prepared before laying the cement concrete. Edge of damp proof course shall be straight, even and vertical. Side shuttering shall consist of steel forms and shall be strong and properly fixed so that it does not get disturbed during compaction and the mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the sides are removed, the surface should come out smooth without honeycombing. Continuity shall be maintained while laying the cement concrete layer and laying shall be terminated only at the predetermined location where damp-proof course is to be discontinued. There shall be no construction joints in the Damp Proof Course.

#### 4.4.2 Curing

Damp proof course shall be cured for at least seven days, after which it shall be allowed to dry.

#### 4.4.3 Application of Hot Bitumen

Where so directed, hot bitumen in specified quantity shall be applied over the dried up surface of cement concrete, properly cleaned with brushes and finally with a piece of cloth soaked in kerosene oil. Bitumen of penetration A 90 or equivalent where used shall be heated to a temperature of 160



$^{\circ} \pm 5^{\circ} \text{C}$ . The hot bitumen shall be applied uniformly all over, so that no blank spaces are left anywhere. It will be paid for separately.

#### **4.4.4 Water Proofing Materials**

Where so specified, water proofing material of approved quality shall be added to the concrete mixture in accordance with the manufacturer's specification stating the quantity of water proofing material in litres or kg per 50 kg or cement and will be paid for separately.

#### **4.4.5 Measurements**

The length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal. The depth shall not be less than the specified thickness at any section.

#### **4.4.6 Rate**

The rate is inclusive of the cost of materials and labour involved in all the operations described above except for the applications of a coat of hot bitumen and addition of water proofing materials which shall be paid for separately, unless otherwise specified.





## APPENDIX A

### DETERMINATION OF PARTICLE SIZE (Clause 4.1.2.3 & 4.1.2.5)

The apparatus, sample size and test procedure shall be same as specified in sub-head 'MORTARS'.

In order that the sieves shall not be overloaded, care must be taken to ensure that the maximum sieve loads shown in Table A-4.1 (below) are not exceeded at the completion of sieving.

**TABLE A-4.1**

I.S. Sieve Designation	Maximum weight for	
	45 cm dia sieve kg	30 cm dia sieve kg
45 mm	10	4.5
40 mm	8	3.5
31.5 mm or 22.1 mm	6	2.5
20 mm	4	2.0
16 mm or 12.5 mm	3	1.5
10 mm	2	1.0
5.6 mm	1.5	0.75
4.75 mm	1.0	0.50
3.35 mm	-	0.30

The sample weight taken will thus normally require several operations on each sieve. Each sieve should be taken separately over a clean tray or receiver until no more than a trace passes, but in any case, for not less than two minutes. Materials should not be forced through the apparatus but hand placing is permitted. A light brush should be used with fine sieves. The cumulative weight passing each sieve should be calculated as percentage of the total sample weight to the nearest whole number.



## APPENDIX B

### TEST FOR SURFACE MOISTURE (Clause 4.1.1.5)

Take a sample of wet aggregate and weigh it (A). Then place it in a frying pan and gently apply heat, meanwhile stirring with a glass rod until the surface moisture disappears. This is apparent when the aggregate loses its shining wet appearance and becomes dull, or when it just attains a free running condition. The saturated surface dry material is then weighed (B). Continue the heating thereafter until the moisture is evaporated and weigh the dry sample (C). The surface moisture is then calculated as follows:

$$\text{Surface moisture} = 100 \times (A-B)/C$$

It is expressed as a percentage of dry aggregate.



**DETERMINATION OF TEN PER CENT FINE VALUE**  
**(Clause 4.1.1.5)**

**Apparatus:** The apparatus for the standard test shall consist of the following:

- a) A 15 cm diameter open-ended steel cylinder, with plunger and base-plate, as shown in Fig. in the end of this appendix. The surfaces in contact with the aggregate shall be machined and case hardened or otherwise treated so as to have a diamond (VH) pyramid hardness number of not less than 650 VH.
- b) A straight metal tamping rod of circular cross-section 16 mm in diameter and 45 to 60 cm long, rounded at one end.
- c) A balance of capacity 3 Kg, readable and accurate to one gram.
- d) I.S. Sieve of sizes 12.5, 10 and 2.36 mm.
- e) A compression testing machine capable of applying a load of 50 tonnes and which can be operated to give a uniform rate of loading so that the maximum load in any test is reached in 10 minutes. This load may vary from 0.5 to 50 tonnes.
- f) For measuring the sample, a cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions:

Diameter	11.5 cm
Height	18.0 cm
- g) Means of measuring the reduction in the distance between the plates of the testing machine to the nearest one millimetre during the test (for example, dial gauge).

**Test Sample:** Material for the test shall consist of aggregate passing a 12.5 mm I.S. Sieve and retained on a 10 mm I.S. Sieve. The aggregate shall be tested in a surface dry condition. If dried by heating the period of drying shall not exceed four hours, the temperature shall be 100°C to 110°C and the aggregate shall be cooled to room temperature before testing.

The quantity of aggregate shall be such that the depth of material in the cylinder, after tamping as described below, shall be 10 cm.

The weight of material comprising the test sample shall be determined (weight A) and the same weight of sample shall be taken for the repeat test.

**Note:** About 6.5 kg of natural aggregate is required to provide the two test samples of light weight aggregate is required.

The measuring cylinder is filled in three layers of approximately equal depth with aggregate passing a 12.5 mm I.S. Sieve and retained on 10 mm I.S. Sieve. Each layer is subjected to 25 strokes from the tamping rod (16 mm dia and 45 to 60 cm long) rounded to one end, care being taken in case of weak materials not to break the particles. The surface of the aggregate shall be carefully levelled and the plunger inserted so that it rests horizontally on this surface.

**Test Procedure:** The apparatus, with the test sample and plunger in position, shall then be placed in the compression testing machine. The load shall be applied at a uniform rate so as to cause a total penetration of a plunger in 10 minutes of about: 15.0 mm for rounded or partially rounded aggregates (for example uncrushed gravel) 20 mm for nominal crushed aggregate & 24 mm for



honeycombed aggregate (for example expanded shales and slags). These figures may be varied according to the extent of the rounding or honey combing.

After reaching the required maximum penetration, the load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm I.S. Sieve. The fines passing the sieve shall be weighed, and this weight expressed as a percentage of the weight of the test sample. Normally, this percentage will fall within the range 7.5 to 12.5, but if it does not, a further test shall be made at a load adjusted appropriately, to bring the percentage fines within the range of 7.5 to 12.5.

A repeat test shall be made at the load that gives as percentage fines within the range 7.5 to 12.5.

**Calculations:** The mean percentage fines from the two tests at this load shall be used in the following formula to calculate the load required to give 10 percentage fines.

$$\text{Load required for 10 percent fines} = \frac{14+X}{Y+4}$$

Where X = Load in tonnes and

Y= mean percentage fines from two test at X tonnes load.

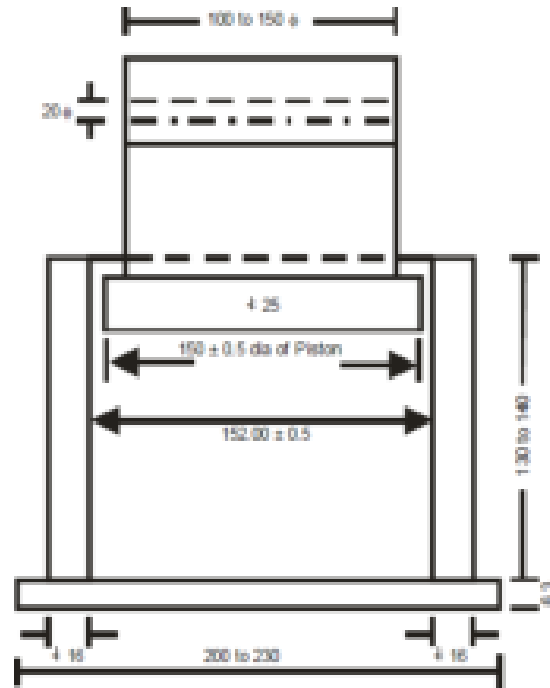
**Reporting of Results:** The load required to produce 10 percent fines shall be reported to the nearest whole number for loads of 10 tonnes or more, the nearest 0.5 tonne for loads of less than 10 tonnes.

The value expressed to the nearest 0.5 tonne should be as follows:

For normal concrete, not less than 5 tonnes.

For wearing surfaces, not less than 10 tonnes.

For granolithic concrete, not less than 15 tonnes.



Drawing not to Scale  
All dimensions in millimetres

Internal Diameter of Cylinder =  $152.0 \pm 0.5$

**Fig. C-4.1: Apparatus for Determination of Ten per cent Fine Value**

**SLUMP TEST**  
(Clause 4.2.2)

**Apparatus:** Mould shall consist of a metal frustum of cone having the following internal dimensions:

Bottom diameter.....20 cm

Top diameter.....10 cm

Height .....30 cm

The mould shall be of a metal other than brass and aluminium of at least 1.6 mm (or 16 BG) thickness. The top and bottom shall be open and at right angles to the axis of the cone. The mould shall have a smooth internal surface. It shall be provided with suitable foot pieces and handles to facilitate lifting it from the moulded concrete test specimen in a vertical direction as required by the test. A mould provided with a suitable guide attachment may be used.

Tamping rod shall be of steel or other suitable material 16 mm in diameter 60 mm long and rounded at one end.

**Procedure:** The internal surface of the mould shall be thoroughly cleaned and free from superfluous moisture and any set concrete before commencing the test. The mould shall be placed on a smooth horizontal, rigid and non-absorbent surface viz. levelled metal plate. The operator shall hold the mould firmly in place while it is being filled with test specimen of concrete. The mould shall be filled in four layers, each approximately one quarter of height of mould. Each layer shall be tamped with twenty five strikes of the rounded end of the tamping rod. The strokes shall be distributed in a uniform manner over the cross section of the mould and for the second and subsequent layers shall penetrate into the underlying layer. The bottom layer shall be tamped throughout its depth. After the top layer has been rodded, the concrete shall be struck off level with trowel or the tamping rod, so that the mould is exactly filled. Any mortar which shall leak out between the mould and the base plate shall be cleaned away. The mould shall be removed from the concrete immediately after filling by raising it slowly and carefully in a vertical direction. The moulded concrete shall then be allowed to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of specimen.

The above operations shall be carried out at a place free from vibration or shock, and within a period of two minutes after sampling.

**Result:** The slump shall be recorded in terms of millimetres of subsidence of the specimen during the test. Any slump specimen which collapses or shears off laterally give incorrect result; if this occurs, the test shall be repeated with another sample.

The slump test shall not be used for very dry mixes as the results obtained are not accurate.



# REINFORCED CEMENT CONCRETE WORK

CONCRETE WORK





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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedur e	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
1	2	3	4	5	6	7
<b>Reinforce d cement concrete (Nominal Mix)</b>	5.4.1	(a) Slump test	Field/ Lab	IS:1199	(i) One test for 10 cum of part thereof for columns. (ii) One test for 40 cum or part thereof for other R.CC work. <b>Minimum Quantity:</b> <b>(i) 5 cum in case of column.</b> <b>(i) 20 cum for other RCC work.</b>	(i) Every 5 cum or part thereof in case of column (ii) Every 20 cum or part thereof in case of slab beam and connected columns (i) One test for 20 cum for all other RCC work for all other small items and where RCC done in a day is less than 5 cum, tests may be carried out as required by Engineer-in- Charge. <b>Minimum Quantity:</b> <b>(ii) 5 cum in case of column.</b> <b>20 cum for other RCC work.</b>
	5.4.9.1	(b) Cube Test	Lab	IS:516	(i) One test for 10 cum of part thereof for columns. (ii) One test for 40 cum or pan thereof for other R.C.C work. <b>Minimum Quantity:</b> <b>(i) 5 cum in case of column.</b> <b>(ii) 20 cum for other RCC work.</b>	(i) Every 5 cum or part thereof in case of column (ii) Every 20 cum or part thereof in case of slab beam and connected columns (i) One test for 20 cum for all other RCC work for all other small items and where RCC done in a day is less than 5 cum, tests may be carried out as required by Engineer-in- Charge. <b>Minimum Quantity:</b> <b>(ii) 5 cum in case of column.</b> <b>20 cum for other RCC work.</b>
<b>Reinforce d Cement Concrete</b>	Coarse Aggregate s				50 cum or part thereof & also on each change of source	



Material	Clause	Test	Field/ Lab Test	Test Procedur e	Frequency of testing for construction work and EPC Project Work		Frequency of testing for maintenance work	
<b>(Design Mix)</b>	Fine Aggregates				50 cum or part thereof & also on each change of Source			
	Cement				50 MT or on each change of source			
	Fresh Concrete	(a) Slump test	Field/ Lab	IS:1199	As prescribed in Mortars section		50 cum for RCC work including in all other small location RCC done in a day is less than 50 cum test may be carried out as recured by Engineer in-Charge. <b>(Minimum quantity-10 cum)</b>	
		(b)Cube Test	Lab	IS:516	Quantity of concrete Delivered in a day /Lot (cum)	Number of samples	Quantity of concrete Delivered in a day /Lot (cum)	Number of samples
					1 to 10	1	1 to 5	1
					11 to 30	2	6 to 15	2
					31 to 60	3	16 to 30	3
					61 to 100	4	31 to 50	4
					101 and above	4 plus one Additio nal sample for each additio nal 50 cum or pat thereof	51 and above	4 plus one Additio nal sample for each additio nal 50 cum or pat thereof
					Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made Test of the sample is to be done in accordance with IS 516 <b>(Minimum Quantity :10 cum).</b>		Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made Test of the sample is to be done in accordance with IS 516 <b>(Minimum Quantity :10 cum).</b>	



Material	Clause	Test	Field/ Lab Test	Test Procedur e	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
<b>Reinforce d Cement Concrete (Ready Mix)</b>	Coarse Aggregate s		RMC plant Lab	IS: 2386	Test reports to be given by the RMC producer al every RMC supply of 100 cum or part thereof. <b>(Minimum Quantity :50 cum)</b>	As prescribed for RCC (Design Mi) for maintenance works.
	Fine Aggregate s Cement		RMC plant Lab	IS: 2386	-do-	As prescribed for RCC (Design Mix) for maintenance works.
			RMC plant Lab	IS:4031	-do-	As prescribed for RCC (Design Mix) for maintenance works.
	Fresh Concrete	(a) Slump test	Field/ Lab	IS: 1199	One test for 50 cum for R.C.C work including in all other small location. R.C.C done in a day is less than 50 cum, test may be carried out as required by Engineer-in- charge. IS: 1199 test <b>(Minimum quantity :10 cum)</b>	As prescribed for RCC (Design Mix) for maintenance works.
		(b) Cube Test	Lab	IS: 516	Quantit y of concret e Deliver ed (cum)	As prescribed for RCC (Design Mix) for maintenance works.
					1 to 100	
					101 and above	



Material	Clause	Test	Field/ Lab Test	Test Procedur e	Frequency of testing for construction work and EPC Project Work		Frequency of testing for maintenance work	
					Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made. Test of the sample is to be done in accordance with IS 516. <b>(Minimum 10 cum)</b>			
Steel for Reinforced cement concrete	5.1.3	(A) Physical Test and chemical tests		IS: 1599 IS: 1786 IS: 1608 IS: 1608 IS: 1608 IS: 1786	<b>Consig nment below 100 MT</b>  (i) Under 10 mm dia. one sample for each <b>25MT</b> or part thereof. (ii) 10mm to 16 mm dia. one sample for each <b>45MT</b> or part thereof (iii)over 16 mm dia. one sample for each <b>50MT</b> or part thereof	<b>Consig nment over 100 MT</b>  (i) Under 10 mm dia. one sample for each <b>40MT</b> or part thereof. (ii) 10mm to 16 mm dia. one sample for each <b>50MT</b> or part thereof (iii)over 16 mm dia. one sample for each <b>75MT</b> or part thereof	<b>Consig nment below 100 MT</b>  (i) Under 10 mm dia. one sample for each <b>25MT</b> or part thereof. (ii) 10mm to 16 mm dia. one sample for each <b>35MT</b> or part thereof (iii)over 16 mm dia. one sample for each <b>45 MT</b> or part thereof	<b>Consig nment over 100 MT</b>  (i) Under 10 mm dia. one sample for each <b>40MT</b> or part thereof. (ii) 10mm to 16 mm dia. one sample for each <b>45MT</b> or part thereof (iii)over 16 mm dia. one sample for each <b>50 MT</b> or part thereof
Consignment shall be defined as quantity included in single purchase voucher.								



Material	Clause	Test	Field/ Lab Test	Test Procedur e	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
Reinforced Cement Concrete (Design Mix) (Hardened Concrete)	4.2.14.1.4	Chloride content	Lab	IS 456 IS 14959	<ol style="list-style-type: none"> <li>1. One test at the time of concrete mix design with proposed source material</li> <li>2. Subsequently one test at start of work</li> <li>3. Subsequently one test at interval of every three months or change of source of any ingredient of concrete, whichever is earlier.</li> <li>4. Testing shall be done for each grade of concrete separately.</li> </ol> <p>Note: EIC/SEH may relax chloride testing for particular work depending upon availability of testing facility.</p>	Same as Construction work
Admixture	5.11.3.4	Chloride content	Lab	IS 9103 IS 6325	One test at the start of the work and subsequently on change of brand.	
Reinforced Cement Concrete (Design Mix) (Hardened Concrete)	4.2.14.1.4	Chloride content	Lab	IS 456 IS 14959	<ol style="list-style-type: none"> <li>1. One test at the time of concrete mix design with proposed source material.</li> <li>2. Subsequently one test at start of work.</li> <li>3. Subsequently one test at interval of every three months or change of source of any ingredients of concrete, whichever is earlier.</li> <li>4. Testing shall be done for each grade</li> </ol>	Same as Construction work



Material	Clause	Test	Field/ Lab Test	Test Procedur e	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
Admixture					<p>of concrete separately.</p> <p>Note: EIC/SEH may relax chloride testing for particular work depending upon availability of testing facility.</p>	
		Chloride content	Lab	IS 9103 IS 6925	RMC Manufacturer has to submit certificate at the start of the work and on change of brand.	





## LIST OF BUREAU OF INDIAN STANDARD CODES

S. NO.	I.S. NO.	SUBJECT
1	IS 226	Structural Steel
2	IS 2285	Methods for chemical analysis of steel (Issues in various parts)
3	IS 432 (Part I)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement part-I mild steel and medium tensile steel bars.
4	IS 432 (Part II)	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement - Part-II hard drawn steel wire.
5	IS 456	Code of Practices for plain and Reinforced concrete.
6	IS 516	Method of test for strength of concrete.
7	IS 716	Specification for pentachlorophenol
8	IS 1199	Method of sampling and analysis of concrete.
9	IS 1200 (Part II)	(a) Method of measurement of building and civil engineering work - concrete work
10	IS 1200 (Part V)	(b) Method of measurement of building and civil engineering work - concrete work (Part 5- Form work)
11	IS 1566	(c) Specification for hard drawn steel wire fabric for concrete requirement.
12	IS 1599	(d) Method for bend test
13	IS 1343	(e) Code of Practice for Pre-stressed Concrete
14	IS 1387	General requirements for the supply of metallurgical materials
15	IS 14687	Guidelines for falsework for concrete structures
16	IS 1608	Method for tensile testing of steel products
17	IS 1786	Specification for high strength deformed steel and wires for concrete reinforcement.
18	IS 1791	Specification for batch type concrete mixes
19	IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
20	IS 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction.
21	IS 4925	Batch plants specification for concrete batching and mixing plant
22	IS 4926	Ready - Mixed Concrete
23	IS 5522	Specification for Indian Standard Stainless Steel sheet and strips for utensils
24	IS 6523	Specification for precast reinforced concrete door, window frames
25	IS 10262	Recommended guidelines for concrete mix design



S. NO.	I.S. NO.	SUBJECT
26	IS 13311 (Part I)	Indian standard for non-destructive testing of concrete. Method of test for ultrasonic pulse velocity
27	IS 13311 (Part II)	Indian standard for non-destructive testing of concrete. Method of testing by rebound hammer.
28	IS 14276	Indian standard for Cement bonded particle boards
29	IS 16172	Specification for Reinforcement couplers for mechanical splices of bars in concrete



## 5 REINFORCED CEMENT CONCRETE WORK

### 5.0 GENERAL

Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by Engineer-in-Charge according to the nature of work. Reinforced cement concrete work shall comprise of the following which may be paid separately or collectively as per the description of the item of work.

- a) Form work (Centering and Shuttering)
- b) Reinforcement
- c) Concreting: (1– Cast-in-situ), (2 – Precast)

### 5.1 MATERIALS

**5.1.0** Water, cement, fine and coarse aggregate shall be as specified under respective clauses of chapter 03 mortars and chapter 04 concrete work as applicable.

**5.1.1** Fly Ash admixed cement concrete (FACC) and fly ash Blended cements in Cement Concrete (PPCC) in RCC structures.

**5.1.2** Fly ash Blended Cements conforming to IS 1489 (Part I) may be used in RCC structures as per guidelines given below:

#### 5.1.2.1 General

- i. IS 456- 2000 Code of Practice for Plain and Reinforced Concrete (as amended up to date) shall be followed in regard to Concrete Mix Proportion and its production as under:
  - a) The concrete mix design shall be done as “Design Mix Concrete” as prescribed in clause-9 of IS 456 mentioned above.
  - b) Concrete shall be manufactured in accordance with clause 10 of above mentioned IS 456 covering quality assurance measures both technical and organizational, which shall also necessarily require a qualified Concrete Technologist to be available during manufacture of concrete for certification of quality of concrete.
- ii. Minimum M -25 grade of concrete shall be used in all structural elements made with RCC both in load bearing and framed structure.
- iii. The mechanical properties such as modulus of elasticity, tensile strength, creep and shrinkage of fly ash mixed concrete or concrete using fly ash blended cements (PPCs) are not likely to be significantly different and their values are to be taken same as those used for concrete made with OPC.
- iv. To control higher rate of carbonation in early ages of concrete both in fly ash admixed as well as PPC based concrete, water/binder ratio shall be kept as low as possible, which shall be closely monitored during concrete manufacture.

If necessitated due to low water/binder ratio, required workability shall be achieved by use of chloride free chemical admixtures conforming to IS 9103. The compatibility of chemical admixtures and super plasticizers with each set OPC, fly ash and /or PPC received from different sources shall be ensured by trials.

- i. In environment subjected to aggressive chloride or sulphate attack in particular, use of fly ash admixed or PPC based concrete is recommended. In cases, where structural concrete is exposed to excessive magnesium sulphate, fly ash substitution/content shall be limited to 18% by weight. Special type of



cement with low  $C_3A$  content may also be alternatively used. Durability criteria like minimum binder content and maximum water /binder ratio also need to be given due consideration in such environment.

- ii. Wet curing period shall be enhanced to a minimum of 10 days or its equivalent. In hot & arid regions, the minimum curing period shall be 14 days or its equivalent.

#### **5.1.2.2 Use of Fly ash Admixed Cement Concrete (FACC) in RCC structures**

There shall be no bar on use of FACC in RCC structures subject to following additional conditions.

- i. Fly ash shall have its chemical characteristics and physical requirements etc. conforming to IS 3812 (part I & II) and shall be duly certified.
- ii. To ensure uniform blending of fly ash with cement in conformity with IS 456, a specific facility needs to be created at site with complete computerized automated process control to achieve design quality or with similar facility from Ready Mix Concrete (RMC) plants.
- iii. As per IS 1489 (Part-I) maximum 35% of OPC by mass is permitted to be substituted with fly ash conforming to IS 3812 (Part -I) and same is reiterated.
- iv. Separate storage for dry fly ash shall be provided. Storage bins or silos shall be weather proof and permit a free flow and efficient discharge of fly ash. The filter or dust control system provided in the bins or silos shall be of sufficient size to allow delivery of fly ash maintained at specified pressure to prevent undue emission of fly ash dust, which may interfere weighing accuracy.

#### **5.1.2.3 Use of Fly Ash Blended Cements in Cement Concrete (PPCC) in RCC Structures**

- i. Subject to General Guidelines detailed out as above, PPC manufactured conforming to IS 1489 (Part-I) shall be treated at par with OPC for manufacture of Design Mix concrete for structural use in RCC.
- ii. Till the time, BIS makes it mandatory to print the %age of fly ash on each bag of cement, the certificate from the PPC manufacture indicating the same shall be insisted upon before allowing use of such cements in works.
- iii. While using PPC for structural concrete work, no further admixing of fly ash shall be permitted.

### **5.1.3 Steel for Reinforcement**

#### **5.1.3.1** The steel used for reinforcement shall be any of the following types:

- a) Mild steel and medium tensile bars conforming to IS 432 (Part I)
- b) High strength deformed steel bars conforming to IS 1786
- c) Hard drawn steel wire fabric conforming to IS 1566
- d) Structural steel conforming to Grade A of IS 2062
- e) Thermo-mechanically treated (TMT) Bars.

#### **5.1.3.2** Elongation percent on gauge length is 5.65 A where A is the cross sectional areas of the test piece.

#### **5.1.3.3** Mild steel is not recommended for the use in structures located in earthquake zone subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.

#### **5.1.3.4** Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS 2751.



**Nominal mass/weight:** The tolerance on mass/ weight for round and square bars shall be the percentage given in Table 5.1 of the mass/ weight calculated on the basis that the masses of the bar/ wire of nominal diameter and of density 7.85 gm/ cubic cm or 0.00785 gm/ cubic mm.

**TABLE 5.1**

**Tolerance on Nominal Mass**

Nominal size in mm	Tolerance on the Nominal Mass per cent		
	Batch	Individual sample +	Individual sample for coil (x) only
a) Upto and including 10	±7	-8	±8
b) Over 10, up to and including 16	±5	-6	±6
c) Over 16	±3	-4	±4

+ for individual sample plus tolerance is not specified

(x) for coil batch tolerance is not applicable,

Tolerance shall be determined in accordance with method given in IS 1786.

- 5.1.3.5** High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 5.2.

**TABLE 5.2**

Sl. No	Property	Fe 415	Fe 415D	Fe 500D	Fe 550D
(i)	0.2 percent proof stress/yield stress, Min, N/mm <sup>2</sup>	415.0	415.0	500.0	550.0
(ii)	TS/YS ratio, N/mm <sup>2</sup>	≥1.10, but TS not less than 485.0 N/mm <sup>2</sup>	≥1.12, but TS not less than 500.0 N/mm <sup>2</sup>	≥1.10, but TS not less than 565.0 N/mm <sup>2</sup>	≥1.08, but TS not less than 600.0 N/mm <sup>2</sup>
(iii)	Elongation, percent, Min. on gauge length $5.56 \sqrt{A}$ , where A is the cross-sectional area of the test piece.	14.5	18.0	16.0	14.5
(iv)	Total elongation at maximum force, percent, Min on gauge length $5.65 \sqrt{A}$ , where A is the cross-sectional area of the test piece	-	5	5	5

TS/YS ratio refers to ratio of tensile strength to the 0.2 percent proof stress or yield stress of the test piece.



**Tests:** Selection and preparation of Test sample:

All the test pieces shall be selected by the Engineer-in- Charge or his authorized representative either-

a) From cutting of bars

Or

b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-Charge or his authorized representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be annealed or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

**Tensile Test:** The tensile strength, percentage elongation, percentage total elongation at maximum force and 0.2 percent proof stress of bars/wires shall be determined in accordance with requirements of IS 1608 read in conjunction with IS 2062.

**Bend Test:** This shall be done as per IS 1599 & IS 1786.

**Retest:** This shall be done as per IS 1786.

**Rebend test:** This shall be done as per IS 1786.

**5.1.3.6** Chemical composition of reinforcement bars shall be as per Table 5.3 as follows:

**TABLE 5.3**

Constituent	Maximum Per cent			
	Fe 415	Fe 415 D	Fe 500 D	Fe 550 D
Carbon	0.30	0.25	0.25	0.25
Sulphur	0.060	0.045	0.040	0.040
Phosphorus	0.060	0.045	0.040	0.040
Sulphur and Phosphorus	0.110	0.085	0.075	0.075

**5.1.3.7 Thermo Mechanically treated reinforcement bars:**

- There is no BIS code for TMT bars. The available code BIS 1786 pertains to HSD Bars. Therefore, there should be no stipulation that TMT bars should conform to relevant BIS code.
- The TMT bars are being produced under valid license from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licenses to various producers to produce TMT Bars.
- The TMT bars shall conform to IS 1786 pertaining to Fe 415 D or Fe 500 D or Fe 550 D grade of steel as specified.
- In design and construction of reinforced concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermo mechanical treatment process of Grade Fe 415, Fe 500 and Fe 550 having elongation more than 14.5% and conform to other requirements of Fe 415 D, Fe 500 D and Fe 550 D respectively of



IS1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

#### 5.1.4 Stacking and Storage

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

### 5.2 FORM WORK (CENTRING & SHUTTERING)

#### 5.2.1 Form Work

Form work shall include all temporary or permanent forms or moulds required for forming the concrete which is cast-in-situ, together with all temporary construction required for their support.

#### 5.2.2 Design & Tolerance in Construction

Form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings with the tolerance given below.

(a)	Deviation from specified dimension of cross section of columns and beams	+10 mm -5 mm
(b)	Deviation from dimensions of footings	
	(i) Dimension in Plan	+ 50 mm -10 mm
	(ii) Eccentricity in plan	0.02 times the width of the footing in the direction of deviation but not more than 50 mm.
	(iii) Thickness	+50mm, or $\pm 0.05$ times the specified thickness Whichever is less

(Note- These tolerances apply to concrete dimensions only, and not to positioning of vertical steel or dowels).

#### 5.2.3 General Requirement

It shall be strong enough to withstand the dead and live loads and forces caused by ramming and vibrations of concrete and other incidental loads, imposed upon it during and after casting of concrete. It shall be made sufficiently rigid by using adequate number of ties and braces, screw jacks or hard board wedges where required shall be provided to make up any settlement in the form work either before or during the placing of concrete.

Form shall be so constructed as to be removable in sections in the desired sequence, without damaging the surface of concrete or disturbing other sections, care shall be taken to see that no piece is keyed into the concrete.

##### 5.2.3.1 Material for Form Work

- Propping and Centering: All propping and centering should be either of steel tubes with extension pieces or built up sections of rolled steel.

##### 5.2.3.2



- a) **Centering/Staging:** Staging should be as designed with required extension pieces as approved by Engineer-in-Charge to ensure proper slopes, as per design for slabs/ beams etc. and as per levels as shown in drawing. All the staging to be either of Tubular steel structure with adequate bracings as approved or made of built-up structural sections made from rolled structural steel sections.
- b) In case of structures with two or more floors, the weight of concrete, centering and shuttering of any upper floor being cast shall be suitably supported on one floor below the top most floor already cast.
- c) Form work and concreting of upper floor shall not be done until concrete of lower floor has set at least for 14 days.

**5.2.3.3 Shuttering:** Shuttering used shall be of sufficient stiffness to avoid excessive deflection and joints shall be tightly butted to avoid leakage of slurry. If required, rubberized lining of material as approved by the Engineer-in-Charge shall be provided in the joints. Steel shuttering used for concreting should be sufficiently stiffened. The steel shuttering should also be properly repaired before use and properly cleaned to avoid stains, honey combing, seepage of slurry through joints etc.

- a) Runner Joists: RSJ, MS Channel or any other suitable section of the required size shall be used as runners.
- b) Assembly of beam head over props. Beam head is an adopter that fits snugly on the head plates of props to provide wider support under beam bottoms.
- c) Only steel shuttering shall be used, except for unavoidable portions and very small works for which 12 mm thick water proofing ply of approved quality may be used.

**5.2.3.4** Form work shall be properly designed for self weight, weight of reinforcement, weight of fresh concrete, and in addition, the various live loads likely to be imposed during the construction process (such as workmen, materials and equipment). In case the height of centering exceeds 3.50 metres, the prop may be provided in multi-stages. A typical detail of multistage shuttering is given in Fig. 5.9.

**5.2.3.5 Camber:** Suitable camber shall be provided in horizontal members of structure, especially in cantilever spans to counteract the effect of deflection. The form work shall be so assembled as to provide for camber. The camber for beams and slabs shall be 4 mm per metre (1 to 250) or as directed by the Engineer-in-Charge, so as to offset the subsequent deflection, for cantilevers the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-Charge.

5.2.3.5.1 Typical arrangement of form work for 'beams, columns and walls' are shown in Figures 5.1 to 5.8 and form secured by wall ties is shown in Fig. 5.3.

**5.2.3.6 Walls:** The form faces have to be kept at fixed distance apart and an arrangement of wall ties with spacer tubes or bolts is considered best. A typical wall form with the components identified is given in Fig. 5. 1. 5. 2 & 5. 3. The two shutters of the wall are to be kept in place by appropriate ties, braces and studs, some of the accessories used for wall form are shown in Fig. 5.3.

**5.2.3.7 Removal of Form work (Stripping Time):** In normal circumstance and where various types of cements are used, forms, may generally be removed after the expiry of the following periods:

Type of Form work	Minimum period Before Striking Form work for OPC 33 grade	Minimum period Before Striking Form work for OPC 43 grade	Minimum period Before Striking Form work for PPC
(a) Vertical form work to columns, walls, beams	16-24 h	16-24 h	24-36 h





(b) Soffit form work to slabs (Props to be refixed immediately after removal of formwork)	3 days	3 days	4 days
(c) Soffit form work to beams (Props to be refixed immediately after removal of formwork)	7 days	7 days	10 days
(d) Props to slabs: (1) Spanning upto 4.5m (2) Spanning over 4.5m	7 days 14 days	7 days 14 days	10 days 20 days
(e) Props to beams and arches: (1) Spanning upto 6m (2) Spanning over 6m	14 days 21 days	14 days 21 days	20 days 30 days

**Note 1:** For other types of cement, the stripping time recommended for ordinary Portland cement may be suitably modified. Generally If Portland Pozzolana or low heat cement or OPC with direct addition of fly ash has been used for concrete, the stripping time will be 10/ 7 of the period stated for OPC with 43 grade cement above.

**Note 2:** The number of props left under, their sizes and disposition shall be such as to be able to safely carry the full dead load of the slabs, beam or arch as the case may be together with any live load likely to occur during curing or further construction.

**Note 3:** For rapid hardening cement, 3/7 of above periods for OPC 33 grade will be sufficient in all cases except for vertical side of slabs, beams and columns which should be retained for at least 24 hours.

**Note 4:** In case of cantilever slabs and beams, the centering shall remain till structures for counter acting or bearing down have been erected and have attained sufficient strength.

**Note 5:** Proper precautions should be taken to allow for the decrease in the rate of hardening that occurs with all types of cement in cold weather and accordingly stripping time shall be increased.

**Note 6:** Work damaged through premature or careless removal of forms shall be reconstructed within 24 hrs.

#### 5.2.4 Surface Treatment

**5.2.4.1 Oiling the Surface:** Shuttering gives much longer service life if the surfaces are coated with suitable mould oil which acts both as a parting agent and also gives surface protections.



A typical mould oil is heavy mineral oil or purified cylinder oil containing not less than 5% pentachlorophenol conforming to IS 716 well mixed to a viscosity of 70-80 centipoises.

After 3 -4 uses and also in cases when shuttering has been stored for a long time, it should be recoated with mould oil before the next use.

The second categories of shuttering oils / leavening agents are Polymer based water soluble Compounds. They are available as concentrates and when used diluted with water in the ratio of 1:20 or as per manufacturer specifications. The diluted solution is applied by brush applications on the shuttering both of steel as well as ply wood. The solution is applied after every use.

**5.2.4.2** The design of form work shall conform to sound Engineering practices and relevant IS codes.

#### **5.2.5 Inspection of Form Work**

Proper form work should be adopted for concreting so as to avoid honey combing, blow holes, grout loss, stains or discoloration of concrete etc. Proper and accurate alignment and profile of finished concrete surface will be ensured by proper designing and erection of form work which will be approved by Engineer-in-Charge.

Shuttering surface before concreting should be free from any defect/ deposits and full cleaned so as to give perfectly straight smooth concrete surface. Shuttering surface should be therefore checked for any damage to its surface and excessive roughness before use.

##### **5.2.5.1 Erection of Form Work (Centering and shuttering):**

Contractor to take care of following before placing the reinforcement;

- (a) Any member which is to remain in position after the general dismantling is done, should be clearly marked.
- (b) Material should be checked to ensure that, wrong/ rejected items are not used.
- (c) If there are any excavations nearby which may influence the safety of form works, corrective and strengthening action must be taken.
- (d) The steel members should be installed as given below.
  - i. The bearing soil must be sound and well prepared and the sole plates shall bear well on the ground.
  - ii. Sole plates shall be properly seated on their bearing pads or sleepers.
  - iii. The bearing plates of steel props shall not be distorted.
  - iv. The steel parts on the bearing members shall have adequate bearing areas.
- (e) Safety measures to prevent impact of traffic, scour due to water etc. should be taken. Adequate precautionary measures shall be taken to prevent accidental impacts etc.
- (f) Bracing, struts and ties shall be installed along with the progress of form work to ensure strength and stability of form work at intermediate stage. Steel sections (especially deep sections) shall be adequately restrained against tilting, overturning and form work should be restrained against horizontal loads. All the securing devices and bracing shall be tightened.
- (g) The stacked materials shall be placed as catered for, in the design.
- (h) When adjustable steel props are used. They should:
  - 1. Be undamaged and not visibly bent.
  - 2. Have the steel pins provided by the manufacturers for use.
  - 3. Be restrained laterally near each end.



4. Have means for centralizing beams placed in the forkheads.
- (i) Screw adjustment of adjustable props shall not be over extended.
  - (j) Double wedges shall be provided for adjustment of the form to the required position wherever any settlement/ elastic shorting of props occurs. Wedges should be used only at the bottom end of single prop. Wedges should not be too steep and one of the pair should be tightened/ clamped down after adjustment to prevent shifting.
  - (k) No member shall be eccentric upon vertical member.
  - (l) The number of nuts and bolts shall be adequate.
  - (m) All provisions of the design and/or drawings shall be complied with.
  - (n) Cantilever supports shall be adequate.
  - (o) Props shall be directly under one another in multistage constructions as far as possible.
  - (p) Guy ropes or stays shall be tensioned properly.
  - (q) There shall be adequate provision for the movements and operation of vibrators and other construction plant and equipment.
  - (r) Required camber shall be provided over long spans.
  - (s) Supports shall be adequate, and in plumb within the specified tolerances.

#### **5.2.5.2 Guidelines for Multistage Centering:**

The proper handling the situation of multistage centering in buildings or where height of casting of concrete is higher than normal height of 3.5 M or where higher loadings are coming during casting of concrete or large span structures and in situations of casting of some special structures like Domes, Vaults etc.

In all situations, centering/scaffolding/staging for casting of these structures should be properly designed by a qualified and experienced person/agency having past experience in design of false work (centering) for concrete structures and should be proof checked by similar experienced person/agency and it should be properly approved and issued to contractor by Engineer-In-Charge. The provisions of clause 7 of IS:14687 may be referred for design of false work (centering).

A method statement for erection and dismantling of the centering/scaffolding/staging and process of concreting shall be prepared by contractor and submitted to Engineer-in-Charge for approval and the work shall be commenced only after approval of method statement by Engineer-in-Charge. The provisions of clause 9 of IS:14687 may be referred for erection of false work (centering), safety precautions and other site operations, pertaining to false work (centering).

Experienced form watcher shall be engaged during erection, concreting and dismantling for early detection of any movement or instability in the system. The field engineers shall ensure that the specifications and provisions of BIS codes are strictly followed.

A detailed programme of field safety inspection of centering/scaffolding/form work of such structures during different stages should be chalked out and strictly followed.

Provision of safety net, fall arresting system including other safety gears, for workers, working over these structures shall be made in contract and should be followed strictly.

#### **5.2.6 Measurements**

##### **5.2.6.1 General:** The form work shall include the following:



- (a) Splayed edges, notching, allowance for overlaps and passing at angles, sheathing battens, strutting, bolting, nailing, wedging, easing, striking and removal.
- (b) All supports, struts, braces, wedges as well as mud sills, piles or other suitable arrangements to support the form work.
- (c) Bolts, wire, ties, clamps, spreaders, nails or any other items to hold the sheathing together.
- (d) Working scaffolds, ladders, gangways, and similar items.
- (e) Filleting to forms top chamfered edges of splayed external angles not exceeding 20mm wide to beams, columns and the like.
- (f) Where required, the temporary openings provided in the forms for pouring concrete, inserting vibrators, and cleaning holes for removing rubbish from the interior of the sheathing before pouring concrete.
- (g) Dressing with oil to prevent adhesion and
- (h) Raking or circular cutting

**5.2.6.2 Classification of Measurements:** Where it is stipulated that the form work shall be paid for separately, measurements shall be taken of the area of shuttering in contact with the concrete surface. Dimensions of the form work shall be measured correct to a cm. The measurements shall be taken separately for the following.

- (a) Foundations, footings, bases of columns etc. and for mass concrete
- (b) Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
- (c) Suspended floors, roofs, landings, shelves and their supports and balconies.
- (d) Lintels, beams, plinth beams, girders, bressummers and cantilevers.
- (e) Columns, pillars, piers, abutments posts and struts.
- (f) Stairs (excluding landings) except spiral staircase.
- (g) Spiral staircases (including landings)
- (h) Arches, Domes, vaults, shells roofs, arch ribs, curvilinear shaped folded plates
- (i) Extra for arches, domes, vaults exceeding 6 m span other than curvilinear shaped
- (j) Chimneys and shafts.
- (k) Well steining.
- (l) Vertical and horizontal fins individually or forming box, louvers and bands, facias and eaves board
- (m) Waffle or ribbed slabs.
- (n) Edges of slabs and breaks in floors and walls (to be measured in running metres where below 200 mm in width or thickness).
- (o) Cornices and mouldings.
- (p) Small surfaces, such as cantilevers ends, brackets and ends of steps, caps and boxes to pilasters and columns and the like.
- (q) Chullah hoods, weather shades, Chajjas, corbels etc. including edges and
- (r) Elevated water reservoirs.



- 5.2.6.3** Centering, and shuttering where exceeding 3.5 metre height in one floor shall be measured and paid for separately.
- 5.2.6.4** Where it is not specifically stated in the description of the item that form work shall be paid for separately, the rate of the RCC item shall be deemed to include the cost of form work.
- 5.2.6.5** No deductions from the shuttering due to the openings/ obstructions shall be made if the area of each openings/ obstructions does not exceed 0. 4 square metre. Nothing extra shall be paid for forming such openings.
- 5.2.6.6** Form work of elements measured under categories of arches, arch ribs, domes, spiral staircases, well steining, shell roofs, curvilinear folded plates & curvilinear eaves board, circular shafts & chimneys shall not qualify for extra rate for circular work.
- 5.2.6.7** Extra for circular work shall be admissible for surfaces circular or curvilinear in plan or in elevation beyond the straight edge of supporting beam in respective mode of measurement. However, there may be many different types of such structures. In such cases, extra payment shall be made judiciously after deducting areas where shuttering for circular form work is not involved.

### **5.2.7 Rate**

The rate of the form work includes the cost of labour and materials required for all the operations described above.

## **5.3 REINFORCEMENTS**

### **5.3.1 General Requirements**

Steel conforming to Para 5.1.3 for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coating which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall be used for removing the rust.

- 5.3.1.1 Assembly of Reinforcement:** Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by Engineer-in-Charge. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-Charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or 11/4 times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps/ splices shall be staggered as per directions of the Engineer-in-Charge. But in no case the overlapping shall be provided in more than 50% of cross-sectional area at one section.

- 5.3.1.2 Bonds and Hooks Forming End Anchorages:** Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.

- (a) **U-Type Hook** - In case of mild steel plain bars standard U type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter equal to four times the diameter of the bar.

**Note:** In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawings.

- (b) **Bends** - Bend forming anchorage to a M.S. plain bar shall be bent with and internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.



**5.3.1.3 Anchoring Bars in Tension:** Deformed bars may be used without end anchorages provided, development length equipment is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per IS: 456.

**5.3.1.4 Anchoring Bars in Compression:** The anchorage length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of hooks, bend and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.

**5.3.1.5 Binders, stirrups, links etc.:** In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times and nominal size of bar.

### **5.3.2 Welding of Bars**

Wherever facility for electric arc welding or gas pressure welding is available, welding of bars can be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in-Charge. Welding shall be as per IS 2751 and 9417.

### **5.3.3 Placing in Position**

**5.3.3.1** Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer-in-Charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-Charge.

**5.3.3.2** The bars shall be kept in correct position by the following methods:

- (a) In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1 cement: 2 coarse sand) about 4x4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.
- (b) In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 m or at shorter spacing to avoid sagging.
- (c) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them or with block of cement mortar 1:2 (1 cement: 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.
- (d) In case of other R.C.C. structure such as arches, domes, shells, storage tanks etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-Charge.

**5.3.3.3 Tolerance on Placing of Reinforcement:** Unless otherwise specified by the Engineer-in-Charge, reinforcement shall be placed within the following tolerances:

Tolerance in spacing

- (a) For effective depth, 200 mm or less +10 mm
- (b) For effective depth, more than 200 mm + 15 mm

**5.3.3.4 Bending at Construction Joints:** Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position care should be taken to ensure that at no time the radius of the bend is less than 4 bar diameters for plain mild steel or 6 bar diameter for deformed bars. Care shall also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

**5.3.3.5 Cover:** The minimum nominal cover to meet durability requirements shall be as follows:



Exposure	Nominal Concrete cover in mm not less than
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

**Notes:**

- For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
- Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm.
- For exposure condition 'severe' and 'very severe' reduction of 5 mm may be made, where concrete grade is M35 and above.
- Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 16A of IS 456.

#### 5.3.4 Measurement

Reinforcement including authorized spacer bars and lappages shall be measured in length of different diameter, as actually (not more than as specified in the drgs) used in the work nearest to a centimetre and their weight calculated on the basis of standard weight given in Table 5.4 below. In case actual unit weight of the bars is less than standard unit weight, but within variation, in such cases weight of reinforcement shall be calculated on the basis of actual unit weight. Wastage and unauthorized overlaps shall not be paid for. Annealed steel wire required for binding or tack welding shall not be measured, its cost being included in the rate of reinforcement.

Where tack welding is used in lieu of binding, such welds shall not be measured. Chairs separators etc. shall be provided as directed by the Engineer-in-Charge and measured separately and paid for.

**TABLE 5.4**

**Cross Sections Area and Mass of Steel Bar**

Nominal Size mm	Cross Sectional Area Sq.mm	Mass per metre Run Kg.
6	28.3	0.222
8	50.3	0.395
10	78.6	0.617
12	113.1	0.888
16	201.2	1.58
20	314.3	2.47
25	491.1	3.85
28	615.8	4.83
32	804.6	6.31





36	1018.3	7.99
40	1257.2	9.86
45	1591.1	12.49
50	1964.4	15.42

**Note:** These are as per clause 6.2 of IS 1786.

### 5.3.5 Rate

The rate for reinforcement shall include the cost of labour and materials required for all operations described above such as cleaning of reinforcement bars, straightening, cutting, hooking bending, binding, placing in position etc. as required or directed including tack welding on crossing of bars in lieu of binding with wires.

### 5.3A STEEL FOR REINFORCEMENT READY TO USE “CUT & BEND”

**5.3A.1** Cut and bend rebars are customised reinforced steel bars required at construction sites. These shall be made from specialized machinery ensuring exact precision, ready to use pre-cut and pre-bent as per approved drawings. The steel used for reinforcement shall be the following types.

(a) Thermo-mechanically treated (TMT) Bars.

**5.3A.2** Elongation percent on gauge length is  $5.65\sqrt{A}$ , where A is the cross sectional area of the test piece.

**5.3A.3** Welding of reinforcement bars covered in this specification shall be done in accordance with the requirement of IS 2751.

**Nominal mass/weight:** - The tolerance on mass/weight for round and square bars shall be the percentage given in Table 5.4A of the mass/weight calculated on the basis that the masses of the bar/wire of nominal diameter and of density 7.85 Kg/cm<sup>3</sup> or 0.00785 kg/mm<sup>3</sup>.

**TABLE 5.4A**

**Tolerance on Nominal Mass**

Nominal size in mm	Tolerance on the Nominal Mass per cent		
	Batch	Individual Sample <sup>+</sup>	Individual Sample for coil (x) only
(a) Upto and including 10	±7	-8	±8
(b) Over 10, upto and including 16	±5	-6	±6
(c) Over 16	±3	-4	±4

+ for individual sample plus tolerance is not specified

(x) for coil batch tolerance is not applicable

Tolerance shall be determined in accordance with method given in IS 1786.

**5.3A.4** High strength deformed bars & wires shall conform to IS 1786. The physical properties for all sizes of steel bars are mentioned below in Table 5.4B.

**TABLE 5.4B**



**Nominal size in mm Tolerance on the Nominal Mass per cent**

Sl. No.	Property	Fe 500 D	Fe 550 D
(i)	0.2 Per cent Proof stress/yield stress, Min, N/mm <sup>2</sup>	500.0	550.0
(ii)	TS/YS ratio, N/mm <sup>2</sup>	≥1.10, but TS not less than 565.0 N/mm <sup>2</sup>	≥1.08, but TS not less than 600.0 N/mm <sup>2</sup>
(iii)	Elongation per cent, Min. on gauge length $5.65 \sqrt{A}$ , where A is the cross-sectional area of the test piece.	16.0	14.5
(iv)	Total elongation at maximum force, percent, Min on gauge length $5.65 \sqrt{A}$ , where A is the cross-sectional area of the test piece.	5	5

TS/YS ratio refers to ratio of tensile strength to the 0.2 percent proof stress or yield stress of the test piece.

**Tests:** Selection and preparation of Test sample.

All the test pieces shall be selected by the Engineer-in-charge or his authorized representative either-

(a) From cutting of bars

Or

(b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-in-charge or his authorized representative.

The test piece obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test piece shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

**Tensile Test:** The tensile strength, percentage elongation, percentage total elongation at maximum force and 0.2 percent proof stress of bars/wires shall be determined in accordance with requirements of IS 1608 read in conjunction with IS 2062.

**Bend Test:** This shall be done as per IS 1599 & IS 1786.

**Retest:** This shall be done as per IS 1786.

**Rebend test:** This shall be done as per IS 1786.

**5.3A.5** Chemical composition of reinforcement bars shall be as per Table 5.4C as follows:

**TABLE 5.4C**

Constituent	Maximum Per cent	
	Fe 500 D	Fe 550 D
Carbon	0.25	0.25



Sulphur	0.040	0.040
Phosphorus	0.040	0.040
Sulphur and Phosphorus	0.075	0.075

#### 5.3A.6 Thermo Mechanically treated reinforcement bars:

- (a) There is no BIS code for TMT bars. The available code BIS 1786 pertains to HSD Bars. Therefore, there should be no stipulation that TMT bars should conform to relevant BIS code.
- (b) The TMT bars shall conform to IS 1786 pertaining to Fe 500 D or Fe 550 D grade of steel as specified.
- (c) In design and construction of reinforcement concrete building in seismic zone III and above, steel reinforcement of Grade Fe 415 D shall be used. However, high strength deformed steel bars, produced by thermomechanical treatment process of grade Fe 500 and Fe 550 having elongation more than 14.5% and conform to other requirements of Fe 500 D and Fe 550 D respectively of IS 1786 may also be used for reinforcement. In future, latest provision of IS 456 and IS 13920 or any other relevant code as modified from time to time shall be applicable.

#### 5.3A.7 Assembly of Rebars

**5.3A.7.1** The rebars shall be bent correctly and precisely to the size and shape as shown in the detailed drawing or as directed by Engineer-in-charge. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25 mm or  $1\frac{1}{4}$  times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted light. The overlaps/splices shall be staggered as per direction of the Engineer-in-charge. But in no case the overlapping shall be provided in more than 50% of cross-sectional area at one section.

**5.3A.7.2 Bonds and Hooks Forming End Anchorages:** Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement.

**5.3A.7.3 Anchorages Bars in Tension:** Deformed bars may be used without end anchorages Development length of bars will be determined as per IS: 456.

**5.3A.7.4 Anchorages Bars in Compression:** The anchorages length of straight bar in compression shall be equal to the 'Development length' of bars in compression as specified in IS: 456. The projected length of bend and straight length beyond bend, if provided for a bar in compression, shall be considered for development length.

**5.3A.7.5 Binders, stirrups, link etc:** In case of binders, stirrups, link etc. the straight portion beyond the curve at the end shall be not less than eight times the nominal size of bar.

#### 5.3A.8 Welding of Bars

Wherever facility for electric arc welding or gas pressure welding is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in-charge. Welding shall be as per IS 2751 and 9417.

#### 5.3A.9 Placing in Position

**5.3A.9.1** Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer-in-charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.



Tack welding in crossing bars shall also be permitted in lieu of binding with steel wire if approved by Engineer-in-charge.

**5.3A.9.2** The bars shall be kept in correct position by the following methods:

- In case of beam and slab construction pre-cast cover blocks in cement mortar 1:2 (1 cement : 2 coarse sand) about 4 x 4 cm section and of thickness equal to the specified cover shall be placed between the bars and shuttering, so as to secure and maintain the requisite cover of concrete over reinforcements.
- In case of cantilevered and doubly reinforced beams of slabs, the vertical distance between the horizontal bars shall be maintained by introducing chairs, spacers or support bars of steel at 1.0 metre or at shorter spacing to avoid sagging.
- In case of columns and walls, the vertical bars shall be kept in position by means of timber templates with slots accurately cut in them or with block of cement mortar 1:2 (1 cement : 2 coarse sand) of required size suitable tied to the reinforcement to ensure that they are in correct position during concreting.
- In case of other R.C.C. structure such as arches, domes, shells, storage tank etc. a combination of cover blocks, spacers and templates shall be used as directed by Engineer-in-charge.

**5.3A.9.3 Tolerance on Placing of Reinforcement:** Unless otherwise specified by the Engineer-in-charge, reinforcement shall be placed within the following tolerances.

Tolerance in spacing

- For effective depth, 200 mm or less + 10 mm
- For effective depth, more than 200 mm + 15 mm

**5.3A.9.4 Bending at Construction Joints:** Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original position, care should be taken to ensure that at no time the radius of the bend is less than 6 bars diameter. Care should also be taken when bending back bars to ensure that the concrete around the bar is not damaged.

**5.3A.9.4 Cover:** The minimum nominal cover to meet durability requirements shall be as under:

Exposure	Nominal Concrete cover in mm not less than
Mild	20
Moderate	30
Severe	45
Very severe	50
Extreme	75

**Note:**

- For main reinforcement upto 12 mm diameter bar for mild exposure the nominal cover may be reduced by 5 mm.
- Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by + 10 mm.
- For exposure condition 'severe' and 'very severe' reduction of 5 mm may be made, where concrete grade is M 35 and above.
- Nominal cover to meet specified period of fire resistance shall not be less than as given in Table 16A of IS 456.



#### **5.3A.10 Measurement**

The Measurement shall be as specified under para 5.3.4

#### **5.3A.11 Rate**

The Measurement shall be as specified under para 5.3.5

### **5.3B REINFORCEMENT COUPLERS**

#### **5.3B.1 General requirement of material**

Reinforcement coupler shall have adequate strength, length and internal threads as per manufacturer's design to be able to meet the performance requirement as per IS Code. All reinforcement coupler shall be finished smooth and shall be free from burrs, cracks and other manufacturing defects. The threads shall be clearly formed and shall be free from imperfections. The nominal sizes of reinforcement couplers based on their internal diameter shall correspond to the size of bars covered under IS Code 1786. Each coupler should be identifiable by marks/ brands which indicate name of manufacture or their brand name, class designation, nominal size and grade of reinforcement for which it is intended and BIS standard mark.

#### **5.3B.2 Performance Requirement:**

All reinforcement couplers shall meet the performance requirements as per IS Code 16172 clause 9.2, 9.3, 9.4 and 9.5.1. Class H couplers in addition to above shall also meet requirement of clause 9.5.2 of IS Code 16172: 2014. The static tensile test shall constitute acceptance test.

**5.3B.3 Sampling and criteria for conformity:** Sampling and criteria for conformity shall be as per Annexure F of IS Code 16172: 2014.

**5.3B.4 Installation procedure/ instructions:** The manufacturer/ supplier shall provide written installation instructions. The installation instructions shall be clear and understandable. The described installation procedure of reinforcement coupler shall be repeatable and able to achieve its performance under different job site circumstances.

**5.3B.5 Measurement:** The reinforcement couplers shall be measured in numbers.

**5.3B.6 Rate:** The rate shall be inclusive of all materials & labour involved in fixing parallel threaded couplers to reinforcement bars.

### **5.4 CONCRETING**

**5.4.0** The concrete shall be as specified under chapter 4 concrete work. The proportion by volume or by the weight of ingredients shall be as specified.

#### **5.4.1 Consistency**

The concrete which will flow sluggishly into the forms and around the reinforcement without any segregation of coarse aggregate from the mortar shall be used. The consistency shall depend on whether the concrete is vibrated or hand tamped, it shall be determined by slump test as prescribed in sub-head 4 concrete work under workability - requirement.

#### **5.4.2 Placing of Concrete**

**5.4.2.1** Concreting shall be commenced only after Engineer-in-Charge has inspected the centering, shuttering and reinforcement as placed and passed the same. Shuttering shall be clean and free from all shavings, saw dust, pieces of wood, or other foreign material and surfaces shall be treated as prescribed in para 5.2.4.



- 5.4.2.2** In case of concreting of slab and beams, wooden plank or cat walks of chequered MS plated or bamboo chalties or any other suitable material supported directly on the centering by means of wooden blocks or lugs shall be provided to convey the concrete to the place of deposition without disturbing the reinforcement in any way. Labour shall not be allowed to walk over the reinforcement.
- 5.4.2.3** In case of columns and wall, it is desirable to place concrete without construction joints. The progress of concreting in the vertical direction shall be restricted to one metre per hour.
- 5.4.2.4** The concrete shall be deposited in its final position in a manner to preclude segregation of ingredients. In deep trenches and footings concrete shall be placed through chutes or as directed by the Engineer-in-Charge. In case of columns and walls, the shuttering shall be so adjusted that the vertical drop of concrete is not more than 1.5 metres at a time.
- 5.4.2.5** During cold weather, concreting shall not be done when the temperature falls below 4.5°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone.
- 5.4.2.6** During hot weather precaution shall be taken to see that the temperature of wet concrete does not exceed 38°C. No concrete shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge.
- 5.4.2.7** It is necessary that the time between mixing and placing of concrete shall not exceed 30 minutes so that the initial setting process is not interfered with.

#### **5.4.3 Compaction**

It shall be as specified in sub-head of Concrete Work of this specification.

- 5.4.3.1** Concrete shall be compacted into dense mass immediately after placing by means of mechanical vibrators designed for continuous operations complying with IS 2505, IS 2506, IS 2514 and IS 4656. The Engineer-in-Charge may however relax this condition at his discretion for certain items depending on the thickness of the members and feasibility of vibrating the same and permit hand compaction instead. Hand compaction shall be done with the help of tamping rods so that concrete is thoroughly compacted and completely worked around the reinforcement, embedded fixtures, and into corners of the form. The layers of concrete shall be so placed that the bottom layer does not finally set before the top layer is placed. The vibrators shall maintain the whole of concrete under treatment in an adequate state of agitation; such that de-aeration and effective compaction is attained at a rate commensurate with the supply of concrete from the mixers. The vibration shall continue during the whole period occupied by placing of concrete, the vibrators being adjusted so that the centre of vibrations approximates to the centre of the mass being compacted at the time of placing.
- 5.4.3.2** Concrete shall be judged to be properly compacted, when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface. When this condition has been attained, the vibrator shall be stopped in case of vibrating tables and external vibrators. Needle vibrators shall be withdrawn slowly so as to prevent formation of loose pockets in case of internal vibration. In case both internal and external vibrators are being used, the internal vibrator shall be first withdrawn slowly after which the external vibrators shall be stopped so that no loose pocket is left in the body of the concrete. The specific instructions of the makers of the particular type of vibrator used shall be strictly complied with. Shaking of reinforcement for the purpose of compaction should be avoided. Compaction shall be completed before the initial setting starts, i.e. with 30 minutes of addition of water to the dry mixture.
- 5.4.3.3** In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set. Sprinkling of dry cement while finishing shall not be resorted to.

#### **5.4.4 Construction joints**



- 5.4.4.1** Joints are a common source of weakness and, therefore, it is desirable to avoid them. If this is not possible, their number shall be minimized. Concreting shall be carried out continuously up to construction joints, the position and arrangement of which shall be indicated in Fig 5.26 or as directed by Engineer-in-Charge.
- 5.4.4.2** In case of columns the joints shall be horizontal and 10 to 15 cm below the bottom of the beam running into the column head. The portion of the column between the stepping off level and the top of the slab shall be concreted with the beam.
- 5.4.4.3** When stopping the concrete on a vertical plane in slabs and beams and approved stop board (see Fig. 26C) shall be placed with necessary slots for reinforcement bars or any other obstruction to pass the bars freely without bending. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined or feather joints shall not be permitted. Any concrete flowing through the joints of stop board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set.
- 5.4.4.4** When the work has to be resumed, the joint shall be thoroughly cleaned with wire brush and loose particles removed. A coat of neat cement slurry at the rate of 2.75 kg of cement per square metre shall then be applied on the roughened surface before fresh concrete is laid.

#### **5.4.5 Expansion Joints**

Expansion joints shall be provided as shown in the structural drawings or as indicated in Fig. 5.10 to 5.25 or as directed by Engineer-in-Charge, for the purpose of general guidance. However it is recommended that structures exceeding 45 m in length shall be divided by one or more expansion joints. The filling of these joints with bitumen filler, bitumen felt or any such material and provision of copper plate, etc. shall be paid for separately in running metre. The measurement shall be taken two places of decimal stating the depth and width of joint.

#### **5.4.6 Curing**

After the concrete has begun to harden i.e. about 1 to 2 hours after its laying, it shall be protected from quick drying by covering with moist gunny bags, sand, canvass Hessian or any other material approved by the Engineer-in-Charge. After 24 hours of laying of concrete, the surface shall be cured by ponding with water for a minimum period of 7 days from the date of placing of concrete in case of OPC and at least 10 days where mineral admixtures or blended cements are used. The period of curing shall not be less than 10 days for concrete exposed to dry and hot weather condition.

#### **5.4.7 Rectification of Surface Defects of Minor nature**

In case of roof slabs the top surface shall be finished even and smooth with wooden trowel, before the concrete begins to set. Sprinkling of dry cement while finishing shall not be resorted to.

- 5.4.7.1** Immediately on removal of forms, the R.C.C. work shall be examined by the Engineer-in-Charge, before any defects are made good.
- (a) The work that has sagged or contains honey combing to an extent detrimental to structural safety or architectural concept shall be rejected as given in Para 5.4.9.4 for visual inspection test.
  - (b) Surface defects of minor nature may be accepted. On acceptance of such a work by the Engineer-in-Charge, the same shall be rectified as follows:
    - 1. Surface defects which require repair when forms are removed, usually consist of bulged due to movement of forms, ridges at form joints, honey-combed areas, damage resulting from the stripping of forms and bolt holes, bulges and ridges are removed by careful chipping or tooling and the surface is then rubbed with a grinding stone. Honey-combed and other defective areas must be chipped out,



the edges being cut as straight as possible and perpendicularly to the surface, or preferably slightly under cut to provide a key at the edge of the patch.

2. Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of fine sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers not more than 10mm thick and each layer is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surrounding concrete by floating, rubbing or tooling on formed surfaces by pressing the form material against the patch while the mortar is still plastic.
  3. Large and deep patches require filling up with concrete held in place by forms. Such patches are reinforced and carefully dowelled to the hardened concrete.
  4. Holes left by bolts are filled with mortar carefully packed into places in small amounts. The mortar is mixed as dry as possible, with just enough water so that it will be tightly compacted when forced into place.
  5. Tiered holes extending right through the concrete may be filled with mortar with a pressure gun similar to the gun used for greasing motor cars.
  6. Normally, patches appear darker than the surrounding concrete, possibly owing to the presence on their surface of less cement laitance. Where uniform surface colour is important, this defect shall be remedied by adding 10 to 20 percent of white Portland cement to the patching mortar, the exact quantity being determined by trial.
  7. The same amount of care to cure the materials in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp Hessian may be used but in some locations it may be difficult to hold it in place. A membrane curing compound in these cases will be most convenient.
- (c) Wherever required, the exposed surface of R.C.C. work shall be plastered with cement mortar 1:3 (1 cement: 3 fine sand) of thickness not exceeding 6 mm to give smooth and even surface true to line and form. This plastering will be measured and paid separately under plastering item.
- (d) The surface which is to receive plaster or where it is to be joined with brick masonry wall, shall be properly roughened immediately after the shuttering is removed, taking care to remove the laitance completely without disturbing the concrete. The roughening shall be done by hacking. Before the surface is plastered, it shall be cleaned and wetted so as to give bond between concrete and plaster. RCC work shall be done carefully so that the thickness of plaster required for finishing the surface is not more than 6 mm.
- (e) The surface of RCC slab on which the cement concrete or mosaic floor is to be laid shall be roughened with brushes while the concrete is green. This shall be done without disturbing the concrete.

#### 5.4.8 Strength of Concrete

The compressive strength on the work tests for different mixed shall be as given in Table 5.5 below:

**TABLE 5.5**

**Concrete Mix (Nominal Mix on Volume basis) Compressive Strength in (Kg/ sq cm)**

Concrete Mix (Nominal Mix on Volume basis)	Compressive Strength in (Kg/ sq cm)	
	7 days	28 days
1:1:2	210	315





1:1.5:3	175	265
1:2:4	140	210

#### 5.4.9 Testing of Concrete

**5.4.9.0** Regular mandatory tests on the workability of the fresh concrete shall be done to achieve the specified compressive strength of concrete. These will be of two types

- (a) Mandatory Lab Test
- (b) Mandatory Field Test

Results of Mandatory Field Test will prevail over mandatory Lab Test.

**5.4.9.1** Cube Test for Compressive Strength of Concrete - Mandatory Lab Test: Mandatory tests shall be carried out as prescribed in Appendix A of Chapter 5.

**5.4.9.2** Additional Test: Additional test, if required, shall be carried out as prescribed in Appendix B of Chapter 5.

**5.4.9.3** Slump Test: This test shall be carried out as prescribed in sub-head 4 of concrete.

**5.4.9.4** Visual Inspection Test: The concrete will be inspected after removal of the form work as described in Para 5.4.7.2 The question of carrying out mandatory test or other tests described in Appendix A and B (Para 5.4.9.1 and 5.4.9.2) will arise only after satisfactory report of visual inspection.

The concrete is liable to be rejected if:

- i. It is porous or honeycombed as per Para 5.4.7.2 (a).
- ii. Its placing has been interrupted without providing a proper construction joint.
- iii. The reinforcement has been displaced beyond tolerance specified or construction tolerances have not been met.

However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer-in-Charge at the risk and cost of the contractor.

#### 5.4.10 Standard of Acceptance - for Nominal Mix

**5.4.10.1** Mandatory Lab Test: For concrete sampled and tested as prescribed in Appendix A of Chapter 5, the following requirement shall apply.

**5.4.10.2** Out of six sample cubes, three cubes shall be tested at 7 days and remaining three cubes at 28 days.

##### 5.4.10.3 7 days Tests

**Sampling:** The average of the strength of three specimens shall be accepted as the compressive strength of the concrete provided the variation in strength of individual specimen is not more than  $\pm 15\%$  of the average. Difference between the maximum and minimum strength should not exceed 30% of average strength of three specimens. If the difference between maximum and minimum strength exceeds 30% of the average strength, then 28 days test shall have to be carried out.

**Strength:** If the actual average strength of sample accepted in para 'sampling' above is equal to or higher than specified strength upto  $\pm 15\%$  then strength of the concrete shall be considered in order.

In case the actual average strength of sample accepted in the above para is lower than the specified or higher by more than 15% then 28 days test shall have to be carried out to determine the compressive strength of concrete cubes.

##### 5.4.10.4 28 days Test





- (a) The average of the strength of three specimen be accepted as the compressive strength of the concrete provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.
- (b) If the actual average strength of accepted sample exceeds specified strength by more than 30% the Engineer-in-Charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 130% only for computation of strength.
- (c) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% then strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.
- (d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-Charge (see Para 5.4.13.2).
- (e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-Charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of contractor. If, however the Engineer-in-Charge so desires, he may order additional tests (See Appendix B of Chapter 5) to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the contractor.

#### **5.4.11 Measurements**

**5.4.11.1** Dimensions shall be measured nearest to a cm except for the thickness of slab which shall be measured correct to 0.5 cm. The areas shall be worked out nearest to 0.01 Sq. mt. The cubical contents shall be worked out to nearest 0.01 cubic metre.

**5.4.11.2** Reinforced cement concrete whether cast-in-situ or precast shall be classified and measured separately as follows.

- (a) All work upto plinth level.
- (b) Wall (any thickness) including attached pilasters, buttresses plinth and string course, fillets, column, pillars, piers, abutments, post and struts etc. upto floor five level.
- (c) Beams, Suspended floors, roofs having slope upto 15°, landings, balconies, shelves, chajjas, lintels, bands, plain window sills, stair-cases and spiral stair-case above plinth level up to floor five level.
- (d) Kerbs, steps and the like
- (e) Arches, arch ribs, domes, vaults, shells, folded plate and roofs having slope more than 15° up to floor five level.
- (f) Chimneys and shafts up to floor five level.
- (g) Well steining
- (h) Vertical and horizontal fins individually or forming box louvers, facias and eaves boards above plinth level up to floor five level.

**5.4.11.3** Work under the following categories shall be measured separately.

- (a) All other items up to floor five level.
- (b) Extra for RCC work above floor five level for each four floors or part thereof.
- (c) R.C.C. above roof level shall be measured along with



- (d) R.C.C. Work in floor just below.

**5.4.11.4** No deduction shall be made for the following:

- (a) Ends of dissimilar materials (e.g. Joists, beams, post, girders, rafter, purlins, trusses, corbels steps etc.) upto 500 sq cm in cross-section.
- (b) Opening upto 0.1 sqm.

**Note:** In calculating area of openings upto 0.1 sqm the size of opening shall include the thickness of any separate lintels or sills. No extra labour for forming such openings or voids shall be paid for.

- (c) The volume occupied by reinforcement.
- (d) The volume occupied by water pipes, conduits etc. not exceeding 25 sq cm each in cross sectional area. Nothing extra shall be paid for leaving and finishing such cavities and holes.

**5.4.11.5** Measurement shall be taken before any rendering is done in concrete members. Measurement will not include rendering. The measurement of R.C.C. work between various units shall be regulated as below:

- (a) Slabs shall be taken as running continuously through except when slab is monolithic with the beam. In that case it will be from the face to face of the beam.
- (b) Beams shall be measured from face to face of columns and shall be including haunches, if any, between columns and beam. The depth of the beam shall be from the bottom of slab to the bottom of beam if beam and slab are not monolithic. In case of monolithic construction where slabs are integrally connected with beam, the depth of beam shall be from the top of the slab to the bottom of beam.
- (c) The columns measurements shall be taken through.
- (d) Chajjas along with its bearing on wall shall be measured in cubic metre nearest to two places of decimal. When Chajjas is combined with lintel, slab or beam, the projecting portion shall be measured as Chajjas, built in bearing shall be measured as per item of lintel, slab or beam in which Chajjas bears.
- (e) Where the band and lintels are of the same height and the band serves as lintel the portion of the band to be measured as lintel shall be for clear length of opening plus twice the overall depth of band.

**5.4.12 Tolerances**

Subject to the condition that structural safety is not impaired and architectural concept does not hamper, the tolerances in dimensions of R.C.C. members shall be as specified in the drawings. Whenever these are not specified, the permissible tolerance shall be decided by the Engineer-in-Charge after consultations with the Designer, if necessary.

When tolerances in dimensions are permitted, following procedure for measurement shall apply.

- (a) If the actual dimension of R.C.C. members do not exceed or decrease the design dimensions of the members plus or minus tolerance limit specified above, the design dimensions shall be taken for the purpose of measurement.
- (b) If the actual dimensions exceed the design dimensions by more than the tolerance limit, the design dimensions only shall be measured for the purpose of payment.
- (c) If the actual dimensions decrease more than the tolerance limit specified, the actual dimensions of the RCC members shall be taken for the purpose of measurement and payment.



- (d) For acceptance of RCC members whose dimensions are not exactly as per design dimensions, the decision of Engineer-in-Charge shall be final. For the purpose of payment, however, the clarification as given in Para a, b & c above shall apply.

#### **5.4.13 Rate**

**5.4.13.1** The rate included the cost of materials and labour involved in all the operations described above except for the cost of centering and shuttering, finishing & reinforcement.

**5.4.13.2** On the basis of mandatory lab tests, in case of actual average compressive strength being less than specified strength but upto 70% of specified strength, the rate payable shall be in the same proportion as actual average compressive strength bears to specified compressive strength.

##### **Example:**

1. If average compressive strength is 80% of specified strength, then the rate payable shall be 80% of agreement rate, if acceptable by Engineer-in-Charge.
2. In case average compressive strength is less than 70% of the specified strength, the work represented by the sample shall be rejected.
3. However, on the basis of mandatory field tests, where they prevail, the rates of the work represented by samples showing actual compressive strength less than specified strength shall be worked out as per Para 5.4.10.5 (D-3) above. In addition, Engineer-in-charge may order for additional tests (see Appendix B of chapter 5) to be carried out at the cost of contractor to ascertain if the portion of structure where in concrete represented by the samples had been used, can be retained on the basis of these tests. Engineer-in-Charge may take further remedial measures as necessary to retain the structure at the risk and cost of the contractor.

**5.4.13.3** DELETED.

**5.4.13.4** No extra payment for richer mix which projects into any member from another member during concreting of junctions of beams and columns etc. will be made except to the extent structurally considered necessary and when so indicated in the structural drawings. The payment for work done under items of different mix shall be limited strictly to what is indicated in the structural drawings.

### **5.5 ENCASING ROLLED STEEL SECTIONS**

#### **5.5.1 General Requirements**

Before concrete work is started, the Engineer-in-Charge shall check that all rolled steel sections to be encased, have been erected truly in position. The sections shall be unpainted and shall be wire brushed to remove the loose rust/ scales etc. Where so specified, un-galvanised metal, having mesh or perforations large enough to permit the free passage of 12.5 mm nominal size aggregate through them shall be wrapped round the section to be encased and paid for separately.

#### **5.5.2 Wrapping**

**5.5.2.1** In case of columns, the wrapping shall be arranged as illustrated in Fig. 5.27 to pass through the centre of the concrete covering. The wrapping of the entire length of the columns be carried out in stages and no stage shall cover more than 1.5 metre of height of columns. Successive wrappings shall be carried out only after the immediate adjacent wrapping has been encased in concrete. The surface and edges of the flanges of the steel columns shall have a concrete cover of not less than 50mm. The wrappings of the successive stages shall be tied together.

**5.5.2.2** In the case of beams and grillages, the wire mesh or expanded metal shall be wrapped round the lower flange of the beam as illustrated in Fig. 5.28 and the wrapping shall be suspended by wire hangers 5



mm diameter placed at about 1.2 metres centres. The surfaces and edges of the steel sections shall have a concrete cover of not less than 50mm. The wrapping shall pass through the centre of the concrete covering at the edges and soffits of the flanges.

**5.5.3 Form Work shall be as prescribed in para 5.2.**

**5.5.4 Concreting**

Concrete shall consist of a mix of 1:1.5:3 (1 cement: 1.5 coarse sand (Zone III): 3 graded stone aggregate of 20 mm nominal size) unless a richer mix is specified. The mix shall be poured solidly around the steel sections and around the wrapping by vibrating the concrete into position. Consistency of concrete, placing of concrete and its compaction, curing, finishing and strength of concrete shall be as described in para 5.4.

**5.5.5 Measurements**

The length shall be measured correct to one cm and other dimensions correct of 0.5 cm. The cement concrete shall be measured as per gross dimensions of the encasing exclusive of the thickness of plaster. No deduction shall be made for the volume of steel sections, expanded metal, mesh or any other reinforcement used therein. However, in case of boxed stanchions or girders, the boxed portion only shall be deducted.

Fabric reinforcement such as expanded metal shall be measured separately in square metres stating the mesh and size of strands.

The description shall include the bending of the fabric as necessary, Racking or circular cutting and waste shall be included in the description.

**5.5.6 Rate**

The rate shall include the cost of materials and labour required for all the operations described above except the cost of fabric reinforcement. The cost of providing and erecting steel section and wire hangers shall be paid for separately.

**5.6 PRECAST REINFORCED CONCRETE**

**5.6.1 General Requirements**

Precast reinforced concrete units such as columns, fencing posts, door and window frames, lintels, chajjas, copings, sills, shelves, slabs, louvers etc. shall be of grade of mix as specified and cast in forms or moulds. The forms/ moulds shall be of fibre glass or of steel sections for better finish. Provision shall be made in the forms and moulds to accommodate fixing devices such as nibs, clips, hooks, bolts and forming of notches and holes. The contractor may precast the units on cement or steel platform which shall be adequately oiled provided the surface finish is of the same standard as obtained in form. Each unit shall be cast in one operation.

**5.6.2 Concrete used for precasting the units should be well proportioned, mixed, placed and thoroughly compacted by vibrations or tamping to give a dense concrete free from voids and honey combing.**

**5.6.3 Precast articles shall have a dense surface finish showing no coarse aggregate and shall have not cracks or crevices likely to assist in disintegration of concrete or rusting of steel or other defects that would interfere with the proper placing of the units. All angle of the precast units with the exception of the angles resulting from the splayed or chamfered faces shall be true right angles. The arises shall be clean and sharp except those specified or shown to be rounded. The wearing surface shall be true to the lines. On being fractured, the interior of the units should present a clean homogeneous appearance.**



**5.6.4** The longitudinal reinforcement shall have a minimum cover of 12 mm or twice the diameter of the main bar, whichever is more, unless otherwise directed in respect of all items except fencing posts or electric posts where the minimum cover shall be 25 mm.

**5.6.5 Curing**

After having been cast in the mould or form the concrete shall be adequately protected during setting in the first stages of hardening from shocks and from harmful effects of frost, sunshine, drying winds and cold. The concrete shall be cured at least for 7 days from the date of casting.

The precast articles shall be matured for 28 days before erection or being built in so that the concrete shall have sufficient strength to prevent damage to units when first handled.

**5.6.6 Marking**

Precast units shall be clearly marked to indicate the top of member and its location and orientation in the structure.

Precast units shall be stored, transported and placed in position in such a manner that they will not be overstressed or damaged.

**5.7 PRECAST CEMENT CONCRETE JALI**

**5.7.0** The jali shall be of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 6 mm nominal size) reinforced with 1.6 mm thick mild steel wire, unless otherwise specified.

**5.7.1 Fixing**

The jali shall be set in position true to plumb and level before the joints sills and soffits of the openings are plastered. It shall then be properly grouted with cement mortar 1: 3 (1 cement: 3 coarse sand) and rechecked for levels. Finally the jambs, sills and soffits shall be plastered embedding the jali uniformly on all sides.

**5.7.2 Measurements**

The jali shall be measured for its gross superficial area. The length and breadth shall be measured correct to a cm. The thickness shall not be less than that specified.

**5.7.3 Rate**

The rate shall be inclusive of materials and labour involved in all the operations described above except plastering of jambs, sills and soffits, which will be paid for under relevant items of plastering.

**5.7A EXPANSION JOINT COVERING WITH CEMENT BONDED PARTICLE BOARD**

**5.7A.1 Materials:**

Species of wood which do not hinder the process of setting of cement shall be used. Suitable additives such as sodium silicate conforming to IS 381:1995 and aluminum sulphate conforming IS260 shall be used to prevent inhibitive effect of setting & cement when other services are used. Also cement conforming to IS 8112 shall be used.

Tolerance in thickness

- i. Un-sanded boards  
6mm to 12mm: + 1mm
- ii. Sanded boards  
(For all thickness): + 0.3mm



### 5.7A.2 Physical Requirements:

**5.7A.2.1 Workability:** The boards shall not crack or split when drilled, sawed or nailed perpendicular to surface. For nailing perpendicular to surface a pre-bore of 0.8 times the diameter of the nail shall be made. Other requirements shall be as stated in Table 1 (i.e. requirement of physical and mechanical properties of cement bonded particle boards) of IS 14276.

**5.7A.2.2 Sampling and Inspection:** In any consignment, all the boards of the same dimensions and manufactured under similar condition of product shall be grouped together to constitute a lot. The number of boards to be selected from a lot, method of selection, test specimen and number of specimen shall be in accordance with IS Code : 14276

**5.7A.2.3 Criteria for conformity:** A lot shall be considered as conforming to the requirement of the specification if the sample and test specimen pass the requirements prescribed in clause 10 of IS Code 14276. In case of failure, double the number of samples shall be taken from the lot for testing. The lot shall be considered to have passed if all these samples conform to the requirement as specified in clause 10 of IS Code:14276.

**5.7A.3 Measurement:** The length of sheet shall be measured correct to a cm.

**5.7A.4 Rate:** The rate shall be inclusive of all materials and labour involved in fixing cement bonded wood particle board over expansion joints.

### 5.7B EXPANSION JOINT COVERING WITH STAINLESS STEEL GRADE 304

#### 5.7B.1 Material:

General requirement to the supply of material shall conform to IS 1387. Stainless steel sheets and strips shall be free from harmful defects such as scale, rust, blisters, laminations, cracked edges and seams.

**5.7B.2 Chemical composition:** It shall be as given in table 1 of IS 5522 with permissible variations between specified analysis and check analysis as per table 2 of IS 5522 when the analysis of steel carried out according to IS :228 and its relevant parts.

**5.7B.3 Tolerances:** The tolerances for thickness shall be as per clause 10.1 of IS 1387.

**5.7B.4 Mechanical properties:** The mechanical properties of the material shall be as per Table-3 of IS 1387

**5.7B.5 Frequency of sampling:** One test shall be made on each coil and for every 100 sheets for each size of the same cast.

**5.7B.6 Measurement:** The length of sheet shall be measured, correct to a cm.

**5.7B.7 Rate:** The rate shall be inclusive of all material and labour involved in fixing stainless steel plate over expansion joints.

### 5.8 DESIGN MIX

#### 5.8.0 Definition

Design mix concrete is that concrete in which the design of mix i.e. the determination of proportions of cement, aggregate & water is arrived as to have target mean strength for specified grade of concrete. The minimum mix of M25 shall be used in all structural elements in both load bearing & RCC framed construction.

#### 5.8.1 Mix Design and Proportioning

**5.8.1.1** Mix proportions shall be designed to ensure that the workability of fresh concrete is suitable for conditions of handling and placing, so that after compaction it surrounds all reinforcement and



completely fills the formwork. When concrete is hardened, it shall have the stipulated strength, durability and impermeability.

- 5.8.1.2** Determination of the proportions by weight of cement, aggregates and water shall be based on design of the mix.
- 5.8.1.3** As a trial the manufacturer of concrete may prepare a preliminary mix according to provisions of SP: 23. Reference may also be made to ACI 211.1-77 for guidance.
- 5.8.1.4** Mix design shall be tried and the mix proportions checked on the basis of tests conducted at a recognized laboratory approved by the Engineer-in-Charge.
- 5.8.1.5** All concrete proportions for various grades of concrete shall be designed separately and the mix proportions established keeping in view the workability for various structural elements, methods of placing and compacting.
- 5.8.1.6** Before using an admixture in concrete, its performance shall be evaluated by comparing the properties of concrete with the admixture and concrete without any admixture. Chloride content of admixture should be declared by the manufacturer of admixture and shall be within limits stipulated by IS: 9103.

## **5.8.2 Standard Deviation**

- 5.8.2.1** Standard deviation calculations of test results based on tests conducted on the same mix design for a particular grade designation shall be done in accordance with IS 456. The assumed standard deviation is mentioned in Table 5.5A.

**TABLE 5.5A**

Grade of Concrete	Assumed Standard Deviation N/mm <sup>2</sup>
M 10	3.5
M 15	
M 20	4.0
M 25	
M 30	5.0
M 35	
M 40	
M 45	
M 50	
M 55	
M 60	

### **Notes:**

1. The above values correspond to the site control having proper storage of cement, weigh batching of all materials, controlled addition of water, regular checking of all materials, aggregate grading and moisture content and periodical checking of workability and strength. Where there is deviation from the above, the values given in the above table shall be increased by 1 N/mm.





2. For grades above M 60, the standard deviation shall be established by actual trials based on assumed proportions, before finalizing the mix.

### 5.8.3 Acceptance Criteria

**5.8.3.1 Compressive Strength:** The concrete shall be deemed to comply with the strength requirements when both the following condition are met:

- (a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in col 2 of Table 5.6.
- (b) Any individual test result complies with the appropriate limits in col. 3 of Table 5.6.

**5.8.3.2 Flexural Strength:** When both the following conditions are met, the concrete complies with the specified flexural strength.

- (a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least  $0.3 \text{ N/mm}^2$ .
- (b) The strength determined from any test result is not less than the specified characteristic strength less than  $0.3 \text{ N/mm}^2$ .

**5.8.3.3 Quantity of Concrete Represented by Strength Test Results:** The quantity of concrete represented by a group of four consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches. For the individual test result requirements given in col 3 of table 5.6 or in item (b) of para 5.8.3.2. Only the particular batch from which the sample was taken shall be at risk. Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m<sup>3</sup>.

**5.8.3.4** If the concrete is deemed not to comply pursuant to para 5.8.3 the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

**5.8.3.5** Concrete of each grade shall be assessed separately.

**5.8.3.6** Concrete is liable to be rejected if it is porous or honey-combed, its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified, or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measured to the satisfaction of the Engineer-in- Charge.

### 5.8.4 Cement Content of Concrete

**5.8.4.1** For all grades of concrete manufactured/produced, minimum cement content in the concrete shall be 330 kg per cubic metre of concrete. Also, irrespective of the grade of concrete the maximum cement content shall not be more than 500 kg per cubic metre of concrete. These limitations shall apply for all types of cements of all strengths.

**5.8.4.2** Actual cement content in each grade of concrete for various conditions of variable shall be established by design mixes within the limits specified in Para 5.8.4.1 above.

### 5.8.5 Water Cement Ratio and Slump

**5.8.5.1** In proportioning a particular mix, the manufacturer/ producer/ contractor shall give due consideration to the moisture content in the aggregates, and the mix shall be so designed as to restrict the maximum free water cement ratio to less than 0.5.

**5.8.5.2** Due consideration shall be given to the workability of the concrete thus produced. Slump shall be controlled on the basis of placement in different situations. For normal methods of placing concrete, maximum slump shall be restricted to 100 mm when measured in accordance with IS 1199.

**TABLE 5.6**





## Characteristic Compressive Strength Compliance Requirement

(Clause 5.8.3.1 and 5.8.3.3)

Specified Grade	Mean of the Group of 4 Non-Overlapping Consecutive Test Results in N/mm <sup>2</sup> (Min)	Individual Test Results in N/mm <sup>2</sup> (Min)
(1)	(2)	(3)
M 15 and above	$\geq f_{ck} + 0.825 \times \text{established standard deviation}$ (Rounded off to nearest 0.5 N/mm <sup>2</sup> ) Or $f_a + 3 \text{ N/mm}$ whichever is greater	$\geq f_{ck} - 3 \text{ N/mm}^2$

### NOTE-

1. In the absence of established value of standard deviation, the values given in Table 5.5A may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.
2. For concrete of quantity up to 30m<sup>3</sup> (where the number of samples to be taken is less than four as per frequency of sampling given in para 5.11.5(d)), the mean of test results of all such samples shall be  $f_{ck} + 4 \text{ N/mm}^2$ , minimum and the requirement of minimum individual test results shall be  $f_{ck} - 2 \text{ N/mm}$ , minimum. However, when the number of samples is only one as per para 5.11.5, the requirement shall be  $f_{ck} + 4 \text{ N/mm}^2$ , minimum.

### 5.8.6 Approval of Design Mix

**5.8.6.1** The producer/ manufacturer/ contractor of concrete shall submit details of each trial mix of each grade of concrete designed for various workability conditions to the Engineer-in-Charge for his comments and approval. Concrete of any particular design mix and grade shall be produced/ manufactured for works only on obtaining written approval of the Engineer-in-Charge.

**5.8.6.2** For any change in quality/ quantity in the ingredients of a particular concrete, for which mix has been designed earlier and approved by the Engineer-in-Charge, the mix has to be redesigned and approval obtained again.

## 5.9 READY MIXED CONCRETE (as per IS 4926)

### 5.9.1 Materials

**5.9.1.1 Selection and Approval of Materials:** Materials used should satisfy the requirements for the safety, structural performance durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between IS 4926 and materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

**5.9.1.2 Cement:** Cement used for concrete shall be in accordance with the requirements of IS 456.

**5.9.1.3 Mineral Admixtures:** Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

**5.9.1.4 Aggregates:** Aggregates used for concrete shall be in accordance with the requirement of IS 456. Unless otherwise agreed testing frequencies for aggregates in plant shall be as given IS 4926.



#### 5.9.1.5 Chemical Admixtures

- i. Use of chemical admixtures shall be permitted in accordance, with the provisions of IS 456 and IS 9103.
- ii. It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and then determine the dosage required to give the desired effect.
- iii. Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.
- iv. When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.
- v. The amount of admixture added to mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

**5.9.1.6 Water:** Water used shall be in accordance with the requirement of IS 456. Unless otherwise agreed, the testing frequencies for water shall be as given in Annex A. The use of re-cycled water is encouraged as long as concrete of satisfactory performance can be produced and steps are taken to monitor the buildup of chlorides in any recirculated water and that any subsequent adjustments to the mix design are made to ensure that any overall limit on chloride contents is satisfied. The addition of any recycled water shall be monitored and controlled to meet these requirements. The total amount of water added to the mix shall be recorded in the production record. The water content of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer's production staff and truck-mixer, drivers shall be made aware of the appropriate responses to variations in concrete consistency of a particular mix caused by normal variations in aggregate moisture content or grading.

#### 5.9.2 General Requirements

**5.9.2.1 Basis of Supply:** Ready-mixed concrete shall be supplied having the quality and the quantity in accordance with the requirement agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with requirements of IS 456.

All concrete will be supplied and invoiced in terms of cubic metres (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

**5.9.2.2 Transport of Concrete:** Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid re-handling or moving the concrete horizontally by vibration. If required by the purchaser the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser to place the concrete as rapidly as possible. The purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 minutes of arrival on site. Concrete shall be transported in a truck-mixer unless the purchaser agrees to the use of nonagitating vehicles. When non -agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

**5.9.2.3 Time in Transport:** The general requirement is that concrete shall be discharged from the truck-mixer within 2 h of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced. The time of loading shall start



from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.

Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

### 5.9.3 Sampling and Testing of Ready-Mixed Concrete

**5.9.3.1 Point and Time of Sampling:** For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (see Annex A). The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying in concrete as per the requirement given in this standard or otherwise agreed to where so permitted in the standard.

**5.9.3.2 Workability:** The test for acceptance is to be performed upon the producer's delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producer's vehicle is delayed on site due to lack of preparedness on behalf of the purchaser then the responsibility passes to the purchaser after a delay of more than 30 min.

The workability shall be within the following limits on the specified value as appropriate: Slump  $\pm 25$  mm or  $1/3$  of the specified value, whichever is less.

Compacting factor :  $\pm 0.03$ , where the specified value is 0.90 or greater,  
 $\pm 0.04$ , where the specified value is less than 0.90 but more than 0.80,  
 $\pm 0.05$ , where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (see IS 9103) Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

### 5.9.3.3 Specified Strength

- i. Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his sampling and testing or may enter into an arrangement with the producer to provide his testing requirements.
- ii. Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready-mixed concrete industry method of production control should be one sample for every 50 m<sup>3</sup> of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (see also IS 456). In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at  $72 \pm 2$  h or at 7 days or compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose the value should be arrived at based on actual testing. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.
- iii. The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m<sup>3</sup> or 50 batches, whichever is the greater frequency.

**5.9.3.4 Additional Compliance Criteria:** Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance frequency of assessment, method of test and significance result.



**5.9.3.5 Non-Compliance:** The action to be taken in case of non-compliance shall be declared and mutually agreed upon.

#### **5.9.4 Information to be Supplied by the Purchaser**

**5.9.4.1** The purchaser shall provide to the producer the details of the concrete mix or mixes required by him and all pertinent information on the use of the concrete and the specified requirements. Prior to supply taking place, it is recommended that a meeting is held between the purchaser and the producer. Its objective to clarify operational matters such as notice to be given prior to delivery, delivery rate, the name of the purchasers authorized representative who will coordinate deliveries, any requirements for additional services such as pumping, on site testing or training etc.

**5.9.4.2 Designed Mixes:** Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information is conveyed to the producer. In order to assist in this, the format given in Annex B may be completed and forwarded to the producer at the time of enquiry.

**5.9.4.3 Prescribed Mixes:** The concrete mix shall be specified by its constituent materials and the properties or quantities of those constituents to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the producer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format given in Annex B may be followed with suitable modifications as applicable to prescribed mixes.

#### **5.9.5 Information to be Supplied by the Producer**

When requested, the producer shall provide the purchaser with the following information before any concretes is supplied:

- (a) Nature and source of each constituent material
- (b) Source of supply of cement
- (c) Proposed proportions or quantity of each constituent/ m<sup>3</sup> of fresh concrete
- (d) Generic type(s) of the main active constituent(s) in the admixture
- (e) Whether or not the admixture contains chlorides and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture
- (f) Where more than one admixture is used, confirmation of their compatibility
- (g) Initial and final setting time of concrete when admixture is used at adopted dosage (tested as per IS 8142).

#### **5.9.6 Production and Delivery**

##### **5.9.6.1 Materials Storage and Handling**

- i. Cement: Separate storage for Different types and grades of cement shall be provided. Containers may be used to store cement of different types provided these are emptied before loading new cement. Bins or silos shall be weatherproof and permit free flow and efficient discharge of the cement. In case, the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected, if it fails to conform to any of the requirements given in the relevant Indian Standard.
- ii. Dry Pulverized Fuel Ash and Other Mineral Admixtures: Suitable separate arrangement for storage of pulverized fuel ash, silica fume, metakeolin, rice husk ash, ground granulated blast furnace slag such as for cement, shall be provided, in the plants utilizing these materials.
- iii. Aggregates (Coarse and Fine): Stockpiles shall be free draining and arranged to avoid contamination and to prevent intermingling with adjustment material.



- iv. Water: An adequate supply shall be provided and when stored on the plant such storage facilities shall be designed to minimize the risk of contamination.
- v. Chemical Admixtures: Tanks or drums containing liquid admixtures shall be clearly labelled for identification purposes and stored in such a way to avoid damage, contamination or the effects of prolonged exposure to sunlight (if applicable). Agitation shall be provided for liquid admixture, which are not stable solutions.

#### 5.9.6.2 Mixing

- i. Washing out Water: Before loading concrete materials or mixed concrete into either a stationary mixer or truck mixer any water retained in the mixing drum for washing out purposes shall be completely discharged.
- ii. Stationary or Central Mixers: Stationary mixers shall not be loaded in excess of the manufacturer's rated capacity. The mixing time shall be measured from the time all the materials required for the batch, including water, are in the drum of the mixer. The mixing time shall not be less than that recommended by the manufacturer. Where a continuous mixing plant is used, the complete mixing time shall be sufficient to ensure that the concrete is of the required uniformity.
- iii. Truck Mixers: When a truck mixer is used for the partial or complete mixing of concrete, mixing shall be considered to commence from the moment when all the materials required for the batch, including water, are in the rotating drum of the mixer.

Truck or agitators shall not be loaded in excess of the manufacturer's rated capacity. In order to produce a satisfactory mix, and where there is no data available to establish different period and speed of revolutions, mixing shall continue for not less than 60 revolutions of the truck mixer drum at a rate of not less than 7 revolutions/min. All completely truck mixed concrete shall be visually inspected for uniformity prior to leaving the plant.

When a truck mixer or agitator is used for transporting concrete which has been mixed before leaving the plant, the concrete shall be agitated during transit and remixed at the site for at least 2 min so that the concrete is of the required uniformity.

- iv. Condition of Mixers: Stationary and truck mixers shall be maintained in an efficient and clean condition with no appreciable build up of hardened concrete or cement in the mixing drum, on the mixing blades, or on the loading hopper or discharge chutes.

**5.9.6.3 Delivery Ticket:** Immediately before discharging the concrete at the point of delivery, the producer or his representative shall provide the purchaser with a preprinted delivery ticket for each delivery of concrete on which is printed, stamped or written the minimum information detailed invoicing as per Annex D.

#### 5.9.7 Quality Control

Quality control of ready-mixed concrete to be achieved through, forward control, immediate control and retrospective control.

**5.9.7.1 Mix Performance:** The producer shall be responsible for ensuring that suitable control procedures are in place ensure for Design and Prescribed mixes.

**5.9.7.2 Stock Control of Materials:** The producer shall operate a materials stock control procedure to enable verification of total quantities used and to confirm that only approved materials have been received.

**5.9.7.3 Complaints:** The producer shall have a procedure in place to enable the diagnosis and correction of faults identified from complaints.

#### 5.9.8 Records



Records shall be maintained by the producer to provide confirmation of the quality and quantity of concrete produced. The records shall be retained for the purposes of these requirements for a period of at least one year. They shall cover the following aspect:

(a) Production and delivery:

- i. Batching instruction
- ii. Batching Records,
- iii. Delivery tickets, and
- iv. Equipment calibration and plant maintenance.

(b) Materials and production control:

- i. Concrete production and materials purchase, usage and stocks, and
- ii. Certificates or test results for materials.

(c) Production quality Control: Control test results.

## **5.10 PLACING CONCRETE BY PUMPING**

### **5.10.1 General**

Concrete conveyed by pressure through either rigid pipes or flexible hoses and discharged directly into the desired area is termed as pumped concrete.

Method of applying pressure to concrete is by pumps. Pumps to be used shall be either of the two types as mentioned below:

- (a) Piston type pumps
- (b) Squeeze pressure type pumps.

Compressed air pressure pumps shall not be used in the works.

### **5.10.2 Pumping Equipments**

**5.10.2.1 Piston Pumps:** Piston pump to be used in the works shall consist of a receiving hopper for mixed concrete, an inlet valve, an outlet valve, and the pump shall be a twin-piston pump.

The two pistons shall be so arranged that one piston retracts when the other is moving forward and pushing concrete into the pipeline to maintain a reasonably steady flow of concrete. Single piston pumps shall not be acceptable.

Inlet and outlet valve shall be any one of the following types:

- i. Rotating plug type
- ii. Sliding plate type
- iii. Guided plunger type
- iv. Swing type
- v. Flapper type
- vi. Or any combination of the above.

The pistons shall be mechanically driven using a crank or chain or hydraulically driven using oil or water. The receiving hopper shall have a minimum capacity of 1.0 cum and the hopper shall be fitted with remixing rotating blades capable of maintaining consistency and uniformity of concrete.





The primary power for pumps may be supplied by gasoline, diesel, or electric motors. The primary power unit and the pump unit may be truck, trailer or skid mounted.

**5.10.2.2 Squeeze Pressure Pumps:** Squeeze pressure pumps shall consist of a receiving hopper fitted with re-mixing blades. Re-mixing blades shall be such that these can push the concrete into the flexible hose connected at the bottom of the hopper. The flexible hose shall pass through a metal drum around the inside periphery of the drum and come out through the top part of the drum. The drum shall be maintained under a very high degree of a vacuum during operation. The drum shall be so fitted with hydraulically operation metal rollers., which when rotating, create a squeeze pressure on the flexible hose carrying concrete and forces the concrete out into the pipe line.

**5.10.2.3 Effective Range and Discharge of Pumps:** Effective range of pumps to be used in the work shall be decided after studying the site conditions. However, the minimum horizontal range shall not be less than 150 metres and minimum vertical range shall not be less than 50 metres. Selection of pumps bases on discharge capacity shall be decided after studying the requirements for the project. Discharge capacity shall be worked out by the contractors and approval obtained from the Engineer-in-Charge. As a guideline figure the contractor may assume a discharge capacity of 15 cubic metre/hour/pump.

**5.10.2.4 Pipe Lines:** All concrete carrying pipe lines shall generally be rigid pipe lines. Flexible pipe lines may only be used at bend curves in lines or at discharge ends if required. Placements of flexible units shall be done judiciously and connected to the pipe lines only when it meets the approval of the Engineer-in-Charge.

(a) **Rigid Line/ Hard Line/ Slick line:** Such lines shall be made either of steel or plastic. Aluminium alloy pipes shall not be used. Minimum pipeline diameter shall be 100 millimetres and shall have normal maximum length of 3 metre in each section connected through couplers.

(b) **Flexible Pipe Line:** Flexible lines shall be made out of rubber or spiral wound flexible metal or plastic. The pipe shall again be such that they are in sections of 3 metre length each and connected through couplers. These pipes shall be such that they are interchangeable with rigid lines. While installing flexible units, care shall be taken that there are no links in the pipeline, which is a normal tendency with these pipes having diameter 100 mm and above.

**5.10.2.5 Couplers:** Couplers to be used for connecting pipeline sections (either hard or flexible) shall have adequate strength to withstand stresses due to handling, misalignments, poor support to pipelines etc. For horizontal runs of pipes and for vertical run upto 30 metre height the couplers shall be rated for a minimum pressure of 35 kg/ cm square. Couplers used for rising runs between 30 metre and 50 metre heights shall have a minimum pressure rating of 50 kg/cm square. Couplers shall be designed to allow for replacement of any pipe section without displacing other sections. These shall provide for the full internal cross section. These shall provide for the full internal cross section with no constructions or service which may disrupt the smooth flow of concrete. For pipelines of size 150 mm and above, double toggled type coupler with a thick rubber gasket and secondary wedge-take-up is recommended. Types of couplers that may be used shall be any of the following:

- (a) Grooved end coupler
- (b) One piece extended lever swing type couplers
- (c) And full flow oil line type couplers.

**5.10.2.6 Other Accessories:** Other accessories which shall be catered for, are as under:

- (a) Back up pump of rigid and flexible pipes of varying lengths of similar rating/specifications
- (b) Curved sections of rigid pipes
- (c) Swivel joints and rotary distributors



- (d) Pin and gate valves to prevent back flow in pipe lines
- (e) Switch valves to direct the flow into another pipe lines
- (f) Connection devices to fill forms from the bottom up
- (g) Splints, rollers, and other devices for protection of conduit over rock concrete Reinforcing steel and form and to provide lifting and lashing points in the pipe lines
- (h) Transitions for connecting different sizes of pipe sections
- (i) Air vents for downward pumping.
- (j) Clean out equipment.

For concreting of columns, walls and scattered small placement, recommendation is made for special cranes or power-controlled booms carrying pipe lines with a pendant type concrete delivery hose.

#### 5.10.2.7 Lubricating of Pipe Line

Before pumping concrete into the pipeline, the line shall be lubricated with a properly designed mortar/grout lubricant. This shall be ensured by starting the pumping operation with a properly designed mortar, or with a batch of regular concrete with the coarse aggregate omitted. The quantity of mortar required as lubricant is dependent on the smoothness and cleanliness of the pipelines. As a guide line for a 100 mm diameter pipe line of 100 metre length, 0.08 cum to 0.10 cum of mortar should normally be adequate, but this shall not be taken as specified, and the contractor shall establish his requirements.

The quantity of mortar that comes out of the delivery end of the pipeline shall not be used in place of the concrete work. However, with the approval of Engineer-in-Charge, this mortar may be used as bedding mortar against construction joints. The rest of the mortar shall be wasted. Lubrication shall be maintained as long as the pumping of concrete continues.

### 5.11 GUIDELINES FOR FIELD PRACTICE

#### 5.11.1 Sampling and Testing (Materials):

##### 5.11.1.1 Aggregates

- i. Supplier of aggregates shall furnish the following information before the material is delivered to site:
  - (a) Precise location of source from where the material is to be supplied.
  - (b) Trade group of principal rock type as per table 5.7 below:
  - (c) Presence or reactive mineral

**TABLE 5.7**

Trade group name of	Granite, Gabbro,
Aggregates to be used for concrete	Dolerite, Rhyolite, Basalt, Quartzite, Gneiss.

- ii. The supplier shall also furnish reports on test results giving the following information for approval to Engineer-in-Charge before delivery of material at site:
  - (a) Specific gravity
  - (b) Bulk Density
  - (c) Moisture content





- (d) Absorption Value
- (e) Aggregate crushing strength
- (f) Aggregate impact value
- (g) Abrasion value
- (h) Flakiness index
- (i) Elongation Index
- (j) Limits of deleterious substances in the aggregate
- (k) Soundness of aggregate
- (l) Potential reactivity of aggregates.

All tests shall be conducted by supplier in accordance with IS 2386 (Part-I to VIII).

**5.11.1.2 Cement:** Supplier of cement shall furnish the following documents: -

- (a) Certificate confirming that chemical composition and physical characteristics are within the stipulated values for types of cement supplied as per relevant codes.
- (b) Certificate confirming that the chloride content in the cement is not in excess of 0.05 percent of mass of cement.

**5.11.1.3 Water**

Water to be used in manufacturing and curing of concrete shall be tested before use. All such test results shall be submitted to the Engineer-in-Charge for his approval before water is used.

**5.11.1.4 Admixtures**

- i. Suppliers of Admixtures for concrete shall supply the following before any admixtures is approved by the Engineer-in-Charge for their used: - Certificate confirming that the use of a particular brand of admixture shall not be harmful to concrete in any way. Certificate confirming the exact dosage of admixture of a particular brand. Certificate stating the specific purpose for which the admixture is to be used. Special precautionary measures to be taken in the manufacturer of concrete when using the particular brand of admixture. Certificate confirming that the admixture conforms to specifications of IS 9103 or to ASTM-C260, ASTM - C10, ASTM - C 595 or to ASTM- C 618.
- ii. Engineer-in-Charge at his discretion may require tests to be performed to reconfirm the characteristic properties of any admixture. All such tests shall be done in accordance with IS: 9103.
- iii. All tests described in paras 5.4.8 to 5.4.10 above shall be done at the site laboratory or at a laboratory to be identified by the Engineer-in-Charge depending on the test to be conducted.
- iv. All tests shall be done in the presence of a representative nominated by the Engineer-in-Charge and a representative of the concrete Manufacturer/ Contractor when tests are performed at the site laboratory.
- v. Expenses for all materials used for testing, sampling procedures and testing including preparing reports shall be borne by the concrete Manufacturer/ Contractor.
- vi. Rate of concrete is inclusive of cost of admixtures. The contractor shall not be paid anything extra for admixtures required for achieving direct workability without any change in specified water cement ration for RCC/CC work.

**5.11.2 Sampling and Testing for Quality Control of Fresh Concrete**

Fresh concrete shall be tested for:



- (a) Slump
- (b) Compacting Factor/ Workability
- (c) Consistency
- (d) Weight per cubic metre, cement factor and air content

#### 5.11.2.1 Slump

- i. For concrete totally mixed in a central plant, slump shall be checked at:
  - (a) Immediately during loading of trucks
  - (b) Final placement location
  - (c) At placement location the slump measured shall conform to the design slump. Manufacturer of concrete shall adjust for loss of slump in transit and establish the requirements of design mix. All slump measurements shall be done within a period of 20 minutes from the time cement is added to the mixer.
- ii. For concrete entirely mixed in transit or for shrink mix concrete, slump reading shall be taken at:
  - (a) Point of discharge from delivery trucks
  - (b) Final placement location

In this case also, the slump measured at the final placement location shall conform to the design slump.
- iii. At placement locations, samples for checking slump shall be collected as desired by Engineer- in-charge
- iv. For all slump checks in the field at least two recordings shall be made and the average value taken as the recorded slump.
- v. Slump readings shall only be a guideline for concrete consistency and shall not be taken as the acceptability criteria for concrete placed at location. All slump tests shall be carried out in accordance with IS 1199.

#### 5.11.2.2 Compacting Factor

- i. For concrete whose ordered slump is 50 mm or less, compacting factor test shall be conducted at central batch plant in addition to slump tests mentioned above.
- ii. Compacting factor check shall be done at central batch plant if concrete is totally mixed in plant.
- iii. Laboratory tests for determining compacting factor of concrete shall be done as per manufacturer's requirements for establishing and controlling the design mix of concrete.
- iv. Compacting factor test shall not be taken as acceptance criteria and shall be treated only as a guideline to workability of concrete.

**5.11.2.3 Consistency of Concrete:** This test shall be performed only at the batching plant laboratory using a Vee-Bee Consist meter, for determining and predicting the slump of concrete. Number and frequency of these tests shall be based on requirements of the manufacturer of concrete. Care shall be taken in producing mix design of required characteristic strengths of concrete within limits of Vee-Bee- Degrees between 1.6 and 4.5 for concrete transported and placed by normal method and between 0.8 and 3.5 for concrete transported and placed by pumping methods.

**5.11.2.4 Weight, Cement Factor and Air contents Test:** Freshly mixed concrete for every type shall be tested in the batch plant laboratory for each batch of concrete produced to determine weight per cubic metre of freshly mixed concrete, cement factor in concrete and the air content of the concrete. Frequency



and number of tests shall be finalized by the manufacturer of concrete in consultation with the Engineer-in-Charge for his requirement of the mode of measurement of concrete produced.

The Engineer-in-Charge may at his discretion require further tests over and above those specified above in para 5.11.4.1 to be conducted on fresh concrete. The manufacturer and the placement contractor shall have to comply with all such requirements.

### 5.11.3 Sampling and Testing for Quality Control of Hardened Concrete

- i. Test on cube crushing strength of concrete in accordance and compliance with IS 456 and IS 456 shall be done as under:
  - (a) Sample of fresh concrete shall be taken from concrete at central batch plant mixer while loading delivery trucks or other transport.
  - (b) Test in specimens made from samples at the batch plant shall only be taken as guidelines test. Only in the case of doubtful result, the Engineer-in-Charge may refer to such guideline results for deciding on the quality of concrete.
  - (c) For truck mix concrete and shrink mix concrete guideline test specimens shall be made from samples collected at discharge location from mixing trucks. For this purpose first and last 15% of the load shall be omitted while collecting samples.
  - (d) Frequency of sampling shall be as given below in Table 5.8 for each grade of concrete of different workability's and for each type of specimens (field test specimens and guideline test specimens) for conducting 28 days crushing strength tests.

**TABLE 5.8**

Quantity of concrete Delivered (cum)	Number of samples
1 to 5	1
6 to 15	2
16 to 30	3
31 to 50	4
51 and above	4 plus one additional sample for each additional 50 m or part thereof

Each sample shall be of adequate quantity so that a minimum of 3 specimen cubes can be made test of the sample in accordance with IS 516.

- e. All test specimens shall be made compacted cured and tested in compliance with IS 516 and test result interpreted in accordance with IS 456 for acceptance of concrete strength, field specimens test results shall not be less than values given in Table 5.6.
- f. In addition to 28 day crushing strength test on specimens made at frequencies specified in para 4 above, early strength tests at 7 days shall also be conducted on field specimens as well as guideline test specimens. Frequency of sampling for this set of tests shall also be same as those specified in Table 5.8 above. 7 day strength shall conform to values given in Table 5.5. But these test results even if conforming to specified values shall only be taken a guideline value for projecting concrete strength and shall not be construed as conforming to specifications.
- g. For each grade of concrete and for all workability conditions with different water - cement ratios and compositions of admixtures, preliminary test shall be conducted for crushing strength on finalization to



design mix for each type of concrete. Such test shall be conducted both at 7 days and 28 days under laboratory conditions. Six test specimens shall be made for 7 days test and six test specimens shall be made for 28 days test. Average of the six test results of different periods shall not be less than those specified in Table 5.5.

- h. Crushing strengths on cubes shall also be conducted during the process of finalization of concrete design mix. Frequency and number of such tests shall be as per Mix of requirements of concrete manufacturer.
- i. All test specimens for conducting crushing strength shall be properly labelled for identification indicating:
  - a) Date of making specimen
  - b) Grade of concrete
  - c) Placement location
- j. In addition to crushing strength test on concrete, the Engineer-in-Charge may call for other tests on hardened concrete. The placement contractor and the manufacturer of concrete shall comply with all such instructions.

#### ii. **Non-destructive Tests**

- a. When the 28 days crushing values on field specimens and / or specimens and/ or specimens made for guideline test fall short of specified values, or in case of doubtful placement of concrete, the Engineer-in-Charge shall call for non-destruction tests on the structure. Such tests may be any one or a combination of the following:
  - 1. Rebound hammer test
  - 2. Windsor Penetration Probe test
  - 3. Pulse velocity (sonic or Ultrasonic) test
  - 4. Core test
  - 5. Load test
- b. Interpretation of rebound hammer, Windsor Probe and Pulse velocity test results shall rest with the Engineer-in-Charge.
- c. Core test, if ordered by the Engineer-in-Charge, shall be done in accordance with IS 516. Samples for such test shall be taken from locations to be identified by the Engineer-in-Charge and such samples shall be collected in compliance with IS: 1199.
- d. If felt necessary, the Engineer-in-Charge may instruct load testing for any part of the structure based on doubtful concrete strengths. Such test shall be carried out as per details to be provided by the Engineer-in-Charge in consultation with the structural consultants.
- e. The concrete manufacturer/ concrete placement contractor shall arrange for all test to be conducted in accordance with these specifications, including all necessary tools, plants, equipment and material, and shall be responsible for conducting all test at his cost.
- f. All test conducted shall be carried out by qualified technicians employed by the concrete manufacturer/ concrete placement contractor, in presence of authorized representative of the Engineer-in-Charge.
- g. Engineer-in-Charge shall alone decide where such tests are to be conducted. He may instruct tests to be conducted at laboratories other than the laboratory at concrete manufacturer place and such instructions shall be followed without claiming extra charges on this account.

### 5.12 EXPANSION JOINT SYSTEM



## 5.12.1 FLOOR JOINT

### 5.12.1.1 General requirement of material

The expansion joint system will be of extruded aluminium base members, self aligning /self centering arrangement and support plates etc. as per ASTM B221-02. The system shall be such that it provides floor to floor/ floor to wall expansion control system for various vertical locations in load application areas that accommodate multi directional seismic movement without stress to its components. The system shall consist of metal profiles with universal aluminium base member designed to accommodate various project conditions and finish floor treatments. The cover plate shall be designed of width and thickness required to satisfy projects movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self centering arrangement that freely rotates/ moves in all directions. The self-centering arrangements shall exhibit circular sphere ends that lock and slide inside the corresponding aluminium extrusion cavity to allow freedom of movement and flexure in all directions including vertical displacement. Provision of moisture barrier membrane in the joint system to have watertight joint is mandatory requirement. The scope of work includes all labour, materials, equipments and services and perform all operations required for complete installation of expansion joint system.

**5.12.1.2 Performance Requirement:** Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

**5.12.1.3 Approval of expansion joint system:** Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

**5.12.1.4 Installation of expansion joint system:** In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

**5.12.1.5 Measurement:** The length of expansion joint shall be measured, correct to a cm.

**5.12.1.6 Rate:** The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

## 5.12.2 WALL JOINT

### 5.12.2.1 General requirement of material

The expansion joint system related with wall joint (internal/ external) shall be of extruded aluminum base members, self aligning / centering arrangement and support plates as per ASTM B221-02. The material shall be such that it provides an Expansion joints systems suitable for vertical wall to wall/ wall to corner application, both new and existing construction in office buildings & complexes with no slipping down tendency amongst the components of the joint system. The Joint System shall utilize light weight aluminum profiles exhibiting minimal exposed aluminum surfaces mechanically snap locking the multicellular to facilitate movement. (Material shall confirm to ASTM 6063)

**5.12.2.2 Performance Requirement:** Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

**5.12.2.3 Approval of expansion joint system:** Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)



**5.12.2.4 Installation of expansion joint system:** In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

**5.12.2.5 Measurement:** The length of expansion joint shall be measured, correct to a cm.

**5.12.2.6 Rate:** The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.

### **5.12.3 ROOF JOINT**

#### **5.12.3.1 General requirement of material**

The expansion joint system for various roof locations shall be of extruded aluminum base members with, self aligning and self centering arrangement support plates as per ASTM B221-02. The system shall be such that provides that is capable to accommodating multidirectional seismic movement without stress to its components. System shall consist of metal profile that incorporates a universal aluminum base member designed to accommodate various project conditions and roof treatments. The cover plate shall be designed of width and thickness required to satisfy movement and loading requirements and secured to base members by utilizing manufacturer's pre-engineered self-centering arrangement that freely rotates/ moves in all directions. The self centering arrangement shall exhibit circular sphere ends that lock and slide inside the corresponding aluminum extrusion cavity to allow freedom of movement and flexures in all directions including vertical displacement. The joint system shall resists damage or deterioration from the impact of allying ice, exposure to UV, airborne contaminants and occasional foot traffic from maintenance personnel. Provision of moisture barrier membrane in the joint system to have watertight joint is mandatory requirement.

**5.12.3.2 Performance Requirement:** Material and works shall conform to the latest edition of reference specifications as specified in the item and to all applicable codes and requirement of local authorities having jurisdiction.

**5.12.3.3 Approval of expansion joint system:** Sample of expansion joint system along with manufacturers latest published literature for material specified herein, material test reports, shop drawings etc. shall be submitted for obtaining approval before material are delivered at the site. The expansion joint cover assembly should be from one source (from single manufacturer)

**5.12.3.4 Installation of expansion joint system:** In all cases the manufacturer's standard written instruction or specific instructions for installation shall be followed.

**5.12.3.5 Measurement:** The length of expansion joint shall be measured, correct to a cm.

**5.12.3.6 Rate:** The rate shall be inclusive of all material and labour involved in providing & fixing of expansion joint.



## APPENDIX A

### CUBE TEST FOR COMPRESSIVE STRENGTH OF CONCRETE - MANDATORY LAB TEST (Clause 5.4.9.1)

**A0** - One sample (consisting of six cubes 15x15x15 cm shall be taken as often as considered necessary by the Engineer-in-Charge. The test of concrete cubes shall be carried out in accordance with the procedure as described below. A register of cubes shall be maintained at the site of work in Appendix C. The casting of cubes, concrete used for cubes and all other incidental charge, such as curing, carriage to the testing laboratory and testing fees shall be borne by the contractors.

#### **A1 - Test Procedure**

##### **A-1.1 Mould**

The mould shall be of size 15 cm x 15 cm x 15 cm for the maximum nominal size of aggregate not exceeding 40 mm. For concrete with aggregate size more than 40 mm size of mould shall be specified by the Engineer-in-charge, keeping in view the fact that the length of size of mould should be about four times the size of aggregate.

The moulds for test specimens shall be made of non-absorbent material and shall be substantially strong enough to hold their form during the moulding of test specimens. They shall not vary from the standard dimensions by more than one percent. The moulds shall be so constructed that there is no leakage of water from the test specimen during moulding. All the cube moulds for particular site should, prior to use, be checked for accuracy in dimensions and geometric form and such test should at least be made once a year.

Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly without leakage. Glass plates not less than 6.5mm thick or plain metal not less than 12mm thick shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when moulded.

**Note:** Satisfactory moulds can be made from machine or steel castings, rolled metal plates or galvanized.

##### **A-1.2 Sample of Concrete**

Sample of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge or as directed by Engineer-in-Charge. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of concrete. The sampling operation should be spread over evenly to the entire discharging operation. The samples thus obtained shall be transported to the place of moulding of the specimen to counteract segregation. The concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete this sampled shall be noted for further reference. In case of paving concrete, samples shall be taken from the batch immediately after deposition of the sub grade. At least five samples shall be taken from different portion of the pile and these samples shall be thoroughly mixed before being used to form the test specimen. The sampling shall be spread as evenly as possible throughout the day. When wide changes occur during concreting, additional sample shall be taken if so desired by the Engineer-in-Charge.

##### **A-1.3 Preparation of Test Specimens**





The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. The samples of concrete obtained as described under the test specimen shall be immediately moulded by one of the following methods as indicated below:

When the job concrete is compacted by manual methods, the test specimen shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third of the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be rodded 35 times with 16 mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in uniform manner over the cross section of the mould and shall penetrate into underlying layer. The bottom layer shall be rodded through its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined plate. The whole process of moulding shall be carried out in such a manner as to preclude the change of the water cement ratio of the concrete, by loss of water either by leakage from the bottom or over flow from the top of the mould.

When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly moulded by hand rolling as described above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. Internal vibrators shall only be used when the concrete is required to be compacted in layers. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for top extent that there will be no mortar loss during vibrations. After vibrating the second layer enough concrete shall be added to bring level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of water-cement ratio of the concrete by loss of water, either by leakage for the bottom or over flow from the top of the mould.

#### **A-1.4 Curing and Storage of Test Specimen**

In order to ensure reasonably uniform temperature and moisture conditions during the first 24 hours for curing the specimen and to protect them from damage, moulds shall be covered with wet straw or gunny sacking and placed in a storage box so constructed and kept on the work site that its air temperature when containing concrete specimens shall remain 22°C to 33°C. Other suitable means which provide such a temperature and moisture conditions may be used.

Note: - It is suggested that the storage box be made of 25 mm dressed tongued and grooved timber, well braced with battens to avoid warping. The box should be well painted inside and outside and should be provided with a hinged cover and padlock.

The test specimen shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within 24° C to 30°C until the time of test. If storage in water is desired, a saturated lime solution shall be used.

#### **A-1.5 Testing**





The specimens shall be tested in accordance with procedure as described below:

- (a) The tests shall be made at an age of concrete corresponding to that for which the strengths are specified.
- (b) Compression tests shall be made immediately upon removal of the concrete test specimen from the curing room i.e. the test specimen shall be loaded in damp condition. The dimensions of the test specimens shall be measured in mm accurate to 0.5 mm.
- (c) The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.
- (d) The load shall be applied axially without shock at the rate of approximately 140 kg per sq.cm. per minute. The total load indicated by the testing machine at failure of test specimen shall be recorded and the unit compressive strength is calculated in kg per sq. cm. using the area computed from the measured dimension of the test specimen. The type of failure and Appearance of the concrete shall be noted.



## ADDITIONAL TESTS FOR CONCRETE (Clause 5.4.9.2)

### B-0

In case the concrete fails when tested as per the method prescribed in Appendix A, one or more of the following check tests may be carried out at the discretion of Engineer-in-Charge to satisfy the strength of the concrete laid. All testing expenditure shall be borne by the contractor, the number of additional tests to be carried out shall be determined by the Engineer-in-Charge. He shall be the final authority for interpreting the results of additional test and shall decide upon the acceptance or otherwise. His decision in this regard shall be final and binding. For the purpose of payment, the Hammering test results only shall be the criteria. Some of the tests are outlined below:

### B-1 REBOUND HAMMER TEST

If a rebound hammer is regularly used by trained personnel in accordance with procedure described in IS 13311 (part II) and a continuously maintained individual charts are kept showing a large number of reading and the relation between the reading and strength of concrete cubes made from the same batch of concrete, such charts may be used in conjunction with hammer readings to obtain an approximate indication of the strength of concrete in a structure for element. If calibration charts are available from manufactures, it can be used. When making rebound hammer test each result should be the average of at least 12 readings. Reading should not be taken within 20mm of the edge of concrete members and it may be necessary to distinguish between readings taken on a trowled face and those on a moulded face. When making the tests on a precast unit, special care should be taken to bed them firmly against the impact of the hammer.

### B-2 CUTTING CORES

This method involves drilling and testing cores from the concrete for determination of compressive strength. In suitable circumstances, the compressive strength of the concrete in the structure may be assessed by drilling cores from the concrete and testing. The procedure used shall comply with the requirements of IS 1199 and IS 516.

The points from which cores shall be taken shall be representative of the whole concrete and at least three cores shall be obtained and tested. If the average of the strength of all cores cut from the structure is less than the specified strength, the concrete represented by the cores shall be liable to rejection and shall be rejected if a static load test (B-5) either cannot be carried out or is not permitted by the Engineer-in-Charge.

### B-3 ULTRASONIC TEST

If an ultrasonic apparatus is regularly used by trained personnel in accordance with IS 13311 (part I) and continuously maintained individual charts are kept showing a large number of readings & the relation between the reading and strength of cubes made from the same batch of concrete, such charts may be used to obtain approximate indications of the strength of concrete in the structures. In cases of suspected lack of compaction or low cube strength the results obtained from the ultrasonic test results on adjacent acceptable section of the structures may be used for the purpose of assessing the strength of concrete in the suspected portion.

### B-4 LOAD TESTS ON INDIVIDUAL PRECAST UNITS

The load tests described in this clause are intended as check on the quality of the units and should not be used as substitute for normal design procedure. Where members require special testing. Such



special testing procedures shall be in accordance with the specification. Test loads shall be applied and removed incrementally.

#### **B-4.1 Non Destructive Tests**

The unit shall be supported at its designed point of support and loaded for five minutes with a load equal to the sum of the characteristic dead load plus one and a quarter time the characteristic imposed load. The deflection is then recorded. The maximum deflection after application of the load shall be in accordance with the requirements defined by the Engineer-in-Charge. The recovery is measured five minutes after the removal of the load and the load then reimposed.

The percentage recovery after the second loading shall be not less than that after the first loading nor less than 90% of the deflection recorded during the second loading. At no time during the tests, shall the unit show any sign of weakness or faulty construction as defined by the Engineer-in-Charge in the light of reasonable interpretation of relevant data.

#### **B-4.2 Destructive Tests**

The unit is loaded while supported at its design point of support and must not fail at its design load for collapse, within 15 minutes of time when the test load becomes operative. A deflection exceeding  $1/40$  of the test span is regarded as failure of the unit.

#### **B-4.3 Special Tests**

For very large units or units not readily amenable to the above test e.g. columns, the precast parts of composite beams and members designed for continuity or fixity, the testing arrangements shall be agreed upon before such units are cast.

### **B-5 Load Test of Structures or Parts of Structures**

The test described in this clause are intended as a check where there is a doubt regarding structural strength. Test loads are to be applied and removed incrementally.

#### **B-5.1 Age at Tests**

The test is to be carried as soon as possible after the expiry of 28 days from the time of placing of the concrete. When the test is for a reason other than the quality of concrete in the structure being in doubt, the test may be carried out earlier, provided that the concrete has already reached its specified characteristic strength.

#### **B-5.2 Test Load**

The test loads to be applied for the limit state of deflection and local damage are the appropriate design loads i.e. the characteristic dead and superimposed loads. When the limit state of collapse is being considered the test load shall be equal to the sum of characteristic dead load plus one and a quarter times the characteristic imposed load and shall be maintained for a period of 24 hours. In any of the test temporary supports of sufficient strength to take the whole load shall be placed in position underneath but not in contact with the members being tested. Sufficient precautions must be taken to safeguard persons in the vicinity of the structure.

#### **B-5.3 Measurement during Tests**

Measurements of deflection and crack width shall be taken immediately after applications of the load and, in the case of 24 hour sustained load test, at the end of 24 hour loaded period, after removal of the load and after 24 hour recovery period. Sufficient measurements shall be taken to enable side effect to be taken in account. Temperature and weather conditions shall be recorded during the tests.

#### **B-5.4 Assessment of Results**



In assessing the strength of a structure or a part of the structure following a loading test, the possible effects of variation in temperature and humidity during the period of the test shall be considered.

The following requirements shall be met:

- a. The maximum width of any crack measured immediately on application of the test load for local damage, is to be not more than  $2/3$  of the value of the appropriate limit state requirement.
- b. For members spanning between two supports the deflection measured immediately on application of the test load for deflection is to be not more than  $1/500$  of the effective span limits shall be agreed upon before testing cantilevered portions of structure.
- c. If maximum deflection in mm shown during 24 hour under load is less than  $40L^2/D$  where L is effective span in mm and D is overall depth of construction in mm, it is not necessary for the recovery to be measured and the requirement (D) does not apply, and
- d. If within 24 hours of the removal of test load for collapse as calculated in clause (a) a reinforced concrete structure does not show a recovery of at least 75 per cent of the maximum deflection shown during the 24 hour under load, the loading should be repeated. The structure should be considered to have failed to pass the test if the recovery after second loading is not at least 75 per cent of the maximum deflection shown during the second loading.

#### **B-6 DETERMINATION OF WATER SOLUBLE AND ACID SOLUBLE CHLORIDES IN CONCRETE**

Determination of water soluble and acid soluble chlorides in Concrete is done as per method of test given in IS 14959 (Part 1) which covers volumetric method of test as described below:

- a. **Quality of Reagents** - Unless otherwise specified, pure chemicals of analytical reagent grade and distilled water (see IS 1070) shall be used in the test.
- b. **Nitric Acid ( $\text{HNO}_3$ ) Concentrated (Specific Gravity 1.42)** - Prepare the solution, 6 N (approximately), by diluting 38ml of concentrated Nitric acid to 100 ml with distilled water.
- c. **Ferric Alum( $\text{FeNH}_4(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$ )** - Dissolve 10 g of ferric alum in 100 ml of distilled water and add 1 ml of Nitric acid.
- d. **Potassium Chromate 5% Solution** - Dissolve 5 g of potassium chromate ( $\text{K}_2\text{CrO}_4$ ) 100 ml of distilled water to form 5% Solution.
- e. Nitrobenzene
- f. **Silver Nitrate ( $\text{AgNO}_3$ ) Solution, 0.02 N** - Weigh 1.7 g of silver nitrate dried at  $160^\circ$  and cooled in desiccator, dissolve in distilled water and dilute to 500 ml in a volumetric flask. Standardize the silver nitrate solution against 0.02 N sodium chloride solution using potassium chromate solution as indicator (5 percent m/v) in accordance with the procedure given in IS 3025 (Part 32) and record the exact normality.  
  
Note: Sometimes it is difficult to make exactly 0.02N solution if the standard normality of the solution is less.
- g. **Ammonium thiocyanate ( $\text{NH}_4\text{SCN}$ ) Solution** - Weigh 1.7 g of ammonium thiocyanate ( $\text{NH}_4\text{SCN}$ ) and dissolve in one litre of distilled water in a volumetric flask. Shake well and standardize by titrating with 0.02 N silver nitrate solution using ferric alum solution as an indicator. Adjust the normality exactly to 0.02 N.
- h. **Sodium chloride ( $\text{NaCl}$ ) 0.02N** - Weigh 1.1692 g of sodium chloride ( $\text{NaCl}$ ) dried at  $105 \pm 2^\circ\text{C}$ , dissolve in distilled water and make upto 1000 ml in a volumetric flask.
- i. **Use of Filter Paper**



- j. In the methods prescribed in this standard, relative numbers of Whatman filter paper only have been prescribed since these are commonly used. However, any other suitable brand of filter papers with equivalent porosity may be used.
- k. **Procedure for Water Soluble Chloride** - Weigh 1000 $\pm$ 5 g of fresh mortar or concrete sample in a 2 litre capacity beaker and add 500 ml of distilled water (chloride free). Stir the mixture vigorously for 15 minutes. After allowing the mixture to stand for 10 to 15 minutes for settling, decant about 200 ml of the supernatant solution into a clean dry 250 ml capacity beaker. Immediately, filter the solution through Whatman filter paper No.1 and collect the filtrate. Pipette 50 ml of filtrate in a 250 ml capacity conical flask. Add 5 ml of 6 N Nitric acid. Add a known volume (X) preferably 25 ml or more of 0.02N silver nitrate solution. Add 1ml ferric alum and 5 ml nitrobenzene. Shake vigorously to coagulate the precipitate. Titrate the excess silver nitrate with 0. 02 N ammonium thiocyanate solution until a permanent faint reddish brown colour appears. Note down the volume (Y) of ammonium thiocyanate used.
- l. **Procedure for Acid Soluble Chloride** - Weigh about 1000  $\pm$  5 g of the fresh mortar or concrete sample in a 2 litre capacity beaker and add 50 ml of 6 N nitric acid and 450 ml of distilled water (chloride free) after stirring for few Minutes. Stir the mixture vigorously for 15 minutes. After allowing the mixture to stand for 10 to 15 minutes for settling, decant about 200 ml of the supernatant solution into a clean dry 250 ml capacity beaker. Immediately, filter the solution through Whatman filter paper No.1 and collect the filtrate.

Pipette 50 ml of filtrate in a 250 ml capacity conical flask. Add a unknown volume (X) preferably 25 ml or more of 0.02 N silver nitrate solution. Add 1 ml ferric alum and 5 ml of nitrobenzene. Shake vigorously to coagulate the precipitate. Titrate the excess silver nitrate with 0.02 N ammonium thiocyanate solution until a permanent faint reddish brown colour appears. Note down the volume (Y) of ammonium thiocyanate used.

**m. Calculation**

Calculate the percentage of chloride (acid soluble/water soluble) by mass of mortar or concrete as follows:

$$\text{Chloride, per cent} = 0.709 (X - Y)/m,$$

Where

X = volume of silver nitrate added, in ml; and

Y = volume of 0.02 N ammonium thiocyanate consumed.

m= mass of concrete sample taken for the test, in g.

Note: Interference of silver chloride particles (which are generated in situ) in titration by reacting with thiocyanate can be avoided by the addition of nitrobenzene which forms a film on silver chloride particles.



## APPENDIX C

### REGISTER OF WORK TEST OF CONCRETE (NOMINAL MIX) (Clause A-O of Appendix A)

(a)	Name of work	Concrete mix (by volume)	Compressive strength in kg/cm <sup>2</sup> on 7 days
(b)	Name of Contractor	1:1:2	210
(c)	Agreement No.	1:1.5:3	175
(d)	Sample No.	1:2:4	140
(e)	Identification mark		
(f)	Portion of work any quantity represented by sample		
(g)	Date and time of casting cube		
(h)	Proportion of mix/grade of concrete		

### 7 Days' Test (Clause 5.4.10.3)

(1)	Due date of test	Cube No.
(2)	Actual date of test	
(3)	Actual compressive strength of cubes (min. no. of cubes to be tested –three)	
	(a) Minimum strength	
	(b) Maximum strength	
	(c) Average strength of three cubes	
	(d) Difference between 3a and 3b	
	(e) Difference in % age in terms of average strength i.e. $\frac{3b-3a}{3c} \times 100$	
(4)	Specified compressive strength of concrete mix used	
(5)	(a) If 3(e) is more than 30%	Sample is not acceptable, then 28 days strength test shall be carried out.
(6)	(b) If 3(e) is equal to or less than 30% then proceed as below:	



(7)	(i) Difference between column 4 specified compressive strength and column 3 (c) i.e., actual average is higher, it will be denoted (+) and (-) if it is less.	
(8)	(ii) Difference in column 5(b) (i) terms of	$\frac{3c-(4)}{4} \times 100$
(9)	(iii) If the difference in column 5(b) (i) is +ve and the same in terms of % age of specified strength (4) i.e., value of col. 5(b) (ii) is within (+15% range)	Acceptable & strength is considered in order

### REGISTER OF WORK TEST FOR CONCRETE (NOMINAL MIX)

(a)	Name of Work	Concrete mix, (By volume)	Compressive strength kg/cm <sup>2</sup> in 28 days
(b)	Name of contractor	1:1:2	315
(c)	Agreement No	1:1.5:3	265
(d)	Sample No.	1:2:4	210
(e)	Identification mark		
(f)	Portion of work any quantity represented by sample		
(g)	Date and time of casting cube		
(h)	Proportion of mix/Grade of concrete		

### 28 Days' Test (Clause 5.4.10.4)

(1)	Due date of test	Cube No.
(2)	Actual date of test	
(3)	Actual compressive strength of cubes (min. no. of cubes to be tested –three)	
	(a) Minimum strength	



	(b) Maximum strength	
	(c) Average strength of three cubes	
	(d) Specified compressive strength of concrete mix used	
	(e) 70% specified strength	i.e. 70% of 3(d)
	(f) 130% of specified strength	i.e. 130% of 3(d)
(4)	If $3(b) = 3(f)$ and $3(a) > 3(e)$	Value of 3(c) shall be compressive strength of sample
(5)	If 3 (c) is more than 3(f)	EE may order further investigation
(6)	If any test value exceeds 3(f)	It should be restricted to 3(f) for computation of strength
(7)	If $3(c) > 3(d)$ but $< 3(f)$	Strength is in order and concrete accepted at full rates.
(8)	If $3(c) < 3(d)$ and $> 3(e)$	Concrete may be accepted at reduced rates in accordance with para 5.4.13.2
(9)	If $3(c) < 3(e)$	Work represented by this sample shall be rejected and action taken as prescribed in clause 5.4.10.4





## APPENDIX D

### LIST OF EQUIPMENTS FOR SITE LABORATORY AT GRASS ROOT PROJECTS

#### I. Aggregate Testing

SI	ITEMS	QUANTITY
1	Aggregate Testing	
	1. STANDARD SIEVES (INDIAN STANDARD)	
	(a) Set of coarse sieves 30 cm dia (GI sheet frames) with aperture size. (40 mm, 25 mm, 20 mm, 16 mm, 17.5 mm, 10 mm, 4.75 mm all with lid and pan)	1 set
	(a-1) Motorised sieve shaker for the above sieves	1 No.
	(b) Set of fine sieves 20 cm dia of brass with aperture size (4.75 mm, 2.36 mm, 1.18 mm, 600 mic, 300 mic, 150 mic, 75 mic all with lid and Pan)	1 set
	(b-1) Motorised sieve shaker for the above sieves.	1 No.
2	Flakiness & Elongation index screen	1 No.
3	Riffle sample divider slot width 25mm	1 No.
4	1 Los Angeles abrasion Testing Machine	1 No.
5	Bulk Density and voids of Aggregates cylindrical metal measures with capacity (3 ltr, 10 ltr, 15 ltr or 20 ltr)	1 No. each
6	Density basket of galvanized wire height 20 cm	1 No.
7	Pycnometer 1000 ml capacity with Brass	1 No.
8	Hot – Air Blower (Hair Dryer)	1 No.
9	Aggregate impact value apparatus with automatic blow counter	
10	Hot – plate 1000 to 2000 watts with regulator cum switch	1 No.
11	Drying pans (Frying pans)	2 Nos..
12	China clay dishes with dia 10 cm & 15 cm	2 Nos./each
13	Watch glasses for above 10 cm & 15 cm	2 Nos./each

#### II. Concrete Testing

SI	ITEMS	QUANTITY
1	Sieve Brushes	2 Nos.
2	Concrete cube moulds 15x15x15cm	3. Ultrasonic Test Equipment 1
3	Ultrasonic Test Equipment	1 No.
4	Pruning Rods 2 Kg weight length 40 cm and ramming face 25 mm <sup>2</sup>	4 Nos.
5	Extra Bottom plates for 15 cm cube mould	6 Nos.
6	Standard Vibration Table for gauging the cubes	2 Nos.



7	Compression Testing Machine with Electricity cum manually operated tamping unit with pressure guage preferable 30 cm dia, 0-150 tonne in 1 tonne divisions. Sensitivity 0.5 tonne.	1 No.
8	1 Air content measuring apparatus	1 No.
9	Slump test Apparatus complete	3 Nos.
10	Pocket concrete penetrometer 0 to 50kg/ sq.cm	1 No.
11	Baby Mixer Machine	1 No.
12	G.I. Tray approx. 1m x 1m with sides 10 cm high for hand mixing of concrete	2 Nos.
13	Concrete temperature measuring thermometer with Brass protection sheath 0-100 degree centigrade	2 Nos.

### III.Cement Testing

SI	ITEMS	QUANTITY
1	Mortar Cube Moulds 7.07x7.07x7.07 cm	10 Nos.
2	Standard sand Grade I, II, III	50 kgs./each
3	Mortar Cube vibrator	1 No.
4	Vicate needle apparatus Computer	1 No.
5	Blaine's Apparatus	1 No.

### IV. Weighing Equipment

SI	ITEMS	QUANTITY
1	Physical Balance Capacity 200 gms with weight pony	1 No.
2	Dial type spring balance preferable with zero correction knob capacity 100 kgs reading to ½ kg.	2 Nos.
3	Counter scale capacity 1 kg and 10 kg	1 No./ each
4	Weighing platform capacity 100 kg	1 No
5	Iron Weight of 5 kg, 2 kg, 1 kg, 500 gm, 200 gm, 100 gm	2 No./each
6	Brass Weight of 50 gm, 20 gm, 10 gm, 5 gm, 2 gm, 1 gm	2 No./each

### V. Water Measuring

SI	ITEMS	QUANTITY
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1.	5 litres, 2 litres, 1 litre, ½ litre	5 Nos./each
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#### VI. Glass and Plastic Ware

SI	ITEMS	QUANTITY
1	Measuring cylinder TPX or Poly propylene capacity 100 ml, 500 ml, 250 ml, 100 ml	2 Nos./each
2	Pyrex, corning or Borosil beakers with cover capacity 500 ml, 200 ml, 50 ml	2 Nos./each
3	Wash Bottles capacity 500 ml	2 Nos./each
4	Thermometers 1-100 degree centigrades/ max. and Min/ Dry and wet with table	1 No.

#### VII. Laboratory Tools

SI	ITEMS	QUANTITY
1	Set of box spanner ratchet	2 Nos.
2	Hammer 1lb	2 Nos.
3	Rubber Hammer	2 Nos.
4	Hacksaw with 6 blades	1 Nos.
5	Measuring tape 2 mtr	2 Nos.
6	Depth gauge 20cm	2 Nos.
7	Steel Foot Plate	2 Nos.
8	Vernier Calliper	2 Nos.

#### VIII. Miscellaneous Items

SI	ITEMS	QUANTITY
1	Trowels made from saw blade, 3 mm thick 16x10cm wooden handle	6 Nos.
2	Showels & Spade	6 Nos./each
3	Steel plates 5 mm thick 75x75 cm	2 Nos.
4	Plastic or G.I. Buckets 15 ltr, 10 ltr, 5 ltr	2 Nos.
5	Wheel Barrow	3 Nos.



6	Floor Brushes, hair dusters, scrappers, wire brush, paint brushes, shutter steel plat oil, kerosene with stove etc.	3 Nos.
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## ANNEXURE A

### SAMPLING OF CONCRETE (Clause 5.9.3)

After the truck mixer has re-mixed its delivery on site, allow at least the first one-third of a  $\text{m}^3$  of concrete to be discharged prior to taking any samples. Take at least 4 incremental samples from the remainder of the load avoiding sampling the last cubic metre of concrete. Thoroughly re-mix this composite sample either on a mixing tray or in the sampling bucket and proceed with the required testing.



## ANNEXURE B

### CONCRETE MIX INFORMATION TO BE SUPPLIED BY THE PURCHASER (Clauses 5.9.4.2 & 5.9.4.3)

RMC : .....

Contractor : .....

Site: .....

MIX CODE						
Grade (N/mm <sup>2</sup> ) (Characteristic strength)						
Minimum Cement Content (kg/m <sup>3</sup> )						
Mineral Additives (Pulverized fuel as h/Slag/Others) (kg/m <sup>3</sup> )						
Maximum Free water Cement Ratio						
Nominal Maximum Aggregate size						
Cement Type and Grade (if preferred)						
Target workability (Slump) (mm)						
Target workability at site						
Maximum Temperature of Concrete at the time of placing						
Class of sulphate Resistance (if applicable)						
Exposure condition (if applicable)						
Class of finish (if applicable)						
Mix Application						
Method of Placing						
Any other requirements (early strength workability retention, permeability testing, chloride content restriction, maximum cement content, etc.)						
Concrete Testing (Frequency)						
Material's Testing (any non-routine requirements)						



Alternatives to be offered: Yes/No						
Method of Curing to be used by contractor						
Quantity (m3)						

**Note:** Additional proforma for further information may be used, such as for specific test rates to be achieved for concrete or raw materials, exact method statements of the contractors proposed site practice.



**CALIBRATION AND WEIGHING EQUIPMENT ACCURACY**  
(Clauses 5.9.6.2 and 5.9.6.3)

C-1. The following limits shall apply to all ready-mixed concrete plants:

- (a) The accuracy, sensitivity and arrangement of the weighing devices shall be such as to enable the materials to be batched within the following tolerances:
- |                                |  |
|--------------------------------|--|
| (1) Cement, mineral:           | Within $\pm 2$ percent of the quantity of the constituent Admixtures being measured.     |
| (2) Aggregate, chemical: water | Within $\pm 3$ percent of the quantity of the constituent admixtures and being measured. |
- (b) Analogue scales shall have scale increments not exceeding 5 kg for cement and mineral admixtures, 25 kg for aggregate and 2 kg for water.
- (c) Preset controls shall be calibrated in increments not exceeding 5 kg for cement and mineral admixtures, 10 kg for aggregate and 2 kg for water.
- (d) For continuous mixer plants calibration shall be in increments not exceeding 10 kg/m<sup>3</sup> for cement and mineral admixtures, 25 kg/m<sup>3</sup> for aggregates and 10 l/m<sup>3</sup> for water.
- (e) Digital readouts shall have a scale increments not exceeding 2 kg for cement and mineral admixtures, 10 kg for aggregate and 10 for water.
- (f) At the time of installation, or reconditional the accuracy of the indicated mass at any point on the scale shall be within 0.25 percent of the full scale reading.
- (g) Any other time during the masonry operation the accuracy shall be within 0.50 percent of the full scale reading.
- (h) Chemical Admixture dispensers shall have scale increment for exceeding.

Ranger of scale in kg/l	Scale increment in Kg/l
0.1 - 0.5	0.01
0.5 - 1.0	0.02
1.0 - 10.0	0.2
more than 10.0	0.4(i)

All weighing and measuring equipment shall be tested and calibrated over its full working range at the following intervals:

- |                                      |                                  |
|--------------------------------------|----------------------------------|
| (1) Mechanical /knife edge systems : | At least once every two month    |
| (2) Electrical /load cell systems :  | At least once every three months |

Adequate and identified facilities shall be provided for the application of the test loads.

- (j) In the case of batch weighing systems testing and calibration shall be based on the application test loads to the weigh hoppers.
- (k) Checks on continuous weigh systems shall be based on comparison of preset quantities with those actually produced.





- (l) To achieve the required accuracy of calibration, a minimum of 500 kg of stamped weights are required, except that for low capacity scale an acceptable limit on the total mass of calibration weight would be 20 percent of the scale capacity.
- (m) When calibration of weighing equipment is carried out all personnel involved should be competent and fully trained, the procedures should be fully documented, and special attention should be paid to the health and safety aspects of the procedure.



## ANNEXURE C 1

### TEST FOR COMPRESSIVE STRENGTH OF CEMENT CONCRETE CUBES (DESIGN MIX)

Sl No	Particulars	Description
a	Name of Work	
b	Name of Agency/Contractor	
c	Agreement No.	
d	Sample No.	
e	Date of Casting cubes	
f	Whether admixture used (Y/N)	
g	Cement (OPC/PPC/Slag)	

### 7 Days and 28 Days Test Clause (5.8.3)

Sl	Particulars	Description
1	Sl. No	
2	Shift	
3	Date of taking sample	
4	Brief location of work and Quantity represented by sample	
5	Grade of mix	
6	Cube identification mark	
7	Sample taken in presence of	Sign. of Cont.
8		Sign. Of Site Engineer
9		Sign. of EIC
10	Date of Testing	
11	Wt. of Cube (gms)	
12	Density (kg/m)	
13	Crushing Load (KN)	
14	Compressive strength at age (N/mm <sup>2</sup> )	7 days
15		28 days
16		7 days



17	Average compressive strength of three specimens (A) N/mm <sup>2</sup>	28 days	
18	0.85 of (A) N/mm <sup>2</sup>		
19	I.IS of (A) N/mm <sup>2</sup>		
20	Validity of Sample (Yes/No)		
	<b>Note:</b> Invalid if individual specimen strength variation more than $\pm 15\%$ of (A)		
21	<b>ACCEPTANCE</b> (a) Mean of the group of 4 Non-Overlapping consecutive Test Results in N/mm (Min.) $\geq f_{ck} + 0.825 \times \text{established standard Deviation}$ (Rounded off to nearest 0.5 N/mm <sup>2</sup> ) or $f_{ck} + 3N / \text{mm}^2$ whichever is greater  (b) Individual Test Results in N/mm <sup>2</sup> (Min.) $\geq f_{ck} - 3N / \text{mm}^2$		
22	Tested in presence of	Sign. of Cont.	
23		Sign. of Site Engineer	
24		Sign. of EIC	
25	Remarks		

#### ACCEPTANCE CRITERIA-

- (1) Check whether individual cube compressive strength is within + 15% of the average compressive strength. If more
- (2) the test results of the sample are invalid.
- (3) Check compressive strength compliance requirement as per Table-11 of IS: 456 (Amendment No. 4) for means of group/shift test results and individual test results.

#### Notes

- (1) On the absence of established value of standard deviation, the values given in Table- 8 of IS: 456 (Amendment No. 4) may be assumed, and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.



- (2) For concrete of quantity up to 30m (where the numbers of samples to be taken is less than four as per the frequency of sampling given in clause 15.2.2 of IS: 456), the mean of test result of all such samples shall be  $f + 4 \text{ N/mm}^2$  (minimum) and the requirement of minimum individual test results shall be  $f - 2 \text{ N/mm}^2$  (minimum). However, when the number of sample is only one as per clause 15.2.2 of IS: 456 the requirement shall be  $f + 4 \text{ N/mm}^2$  (minimum).



**DELIVERY TICKET INFORMATION**  
(Clause 5.9.6.5)

**D-1** The following information shall be included in the delivery ticket to accompany the load to the purchaser:

- (a) Name or number of the ready-mixed concrete depot
- (b) Serial number of the ticket
- (c) Date
- (d) Truck number
- (e) Name of the Purchaser
- (f) Name and location of site
- (g) Grade or mix description of the concrete
- (h) Specified target workability
- (i) Minimum cement content (if specified)
- (j) Type of cement and grade (if specified)
- (k) Maximum free water-cement ratio (if specified)
- (l) Nominal maximum size of aggregate
- (m) Generic Type or name of any chemical and mineral admixtures included.
- (n) Quantity of concrete in m<sup>3</sup>
- (o) Time of loading
- (p) Signature of the plant operator
- (q) A statement warning the purchaser of the precautions needed to be taken when working with cement and wet concrete.

**D-2** On site the following information will be added:

- (a) Time of arrival on site.
- (b) Time when discharge was completed.
- (c) Any water/admixture added by the supplier to meet the specified workability.
- (d) Any extra water /admixture added at the request of the purchaser of the concrete, or his representative, and his signature.
- (e) Pouring location.
- (f) Signature of the purchaser or his representative conforming discharge of the load.

## TYPICAL SET UP OF STEEL WALL FORM WORK

Sub Head: R.C.C (Form Work)  
Clause: 5.2.3.6



Fig. 5.1A : Single Sided Wall Form (Adjustable)

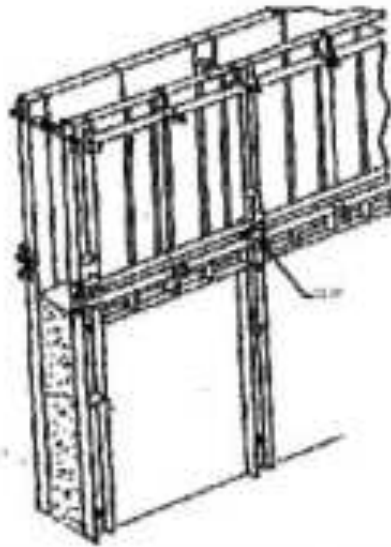


Fig. 5.1B : Double Sided Wall Form

Figure 5.1 : Typical Set Up of Steel Wall Form Work

All members are of Steel

## WALL FORM

Sub Head : RCC (Form Work)  
Clause: 5.2.3.6

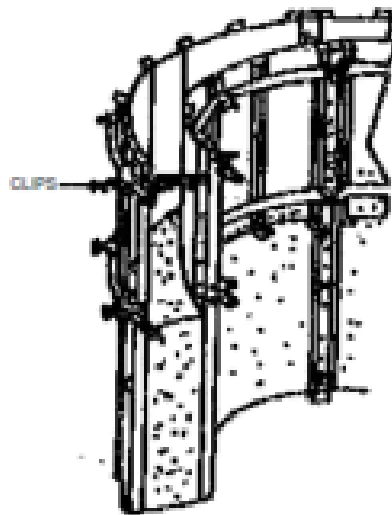


Figure 5.2 : Adjustable Curved Wall Form (Double Side)

All members are of Steel







## TYPICAL ARRANGEMENT OF COLUMN FORM WORK

Sub Head : R.C.C. (Form Work)  
Clause : 5.2.3.2

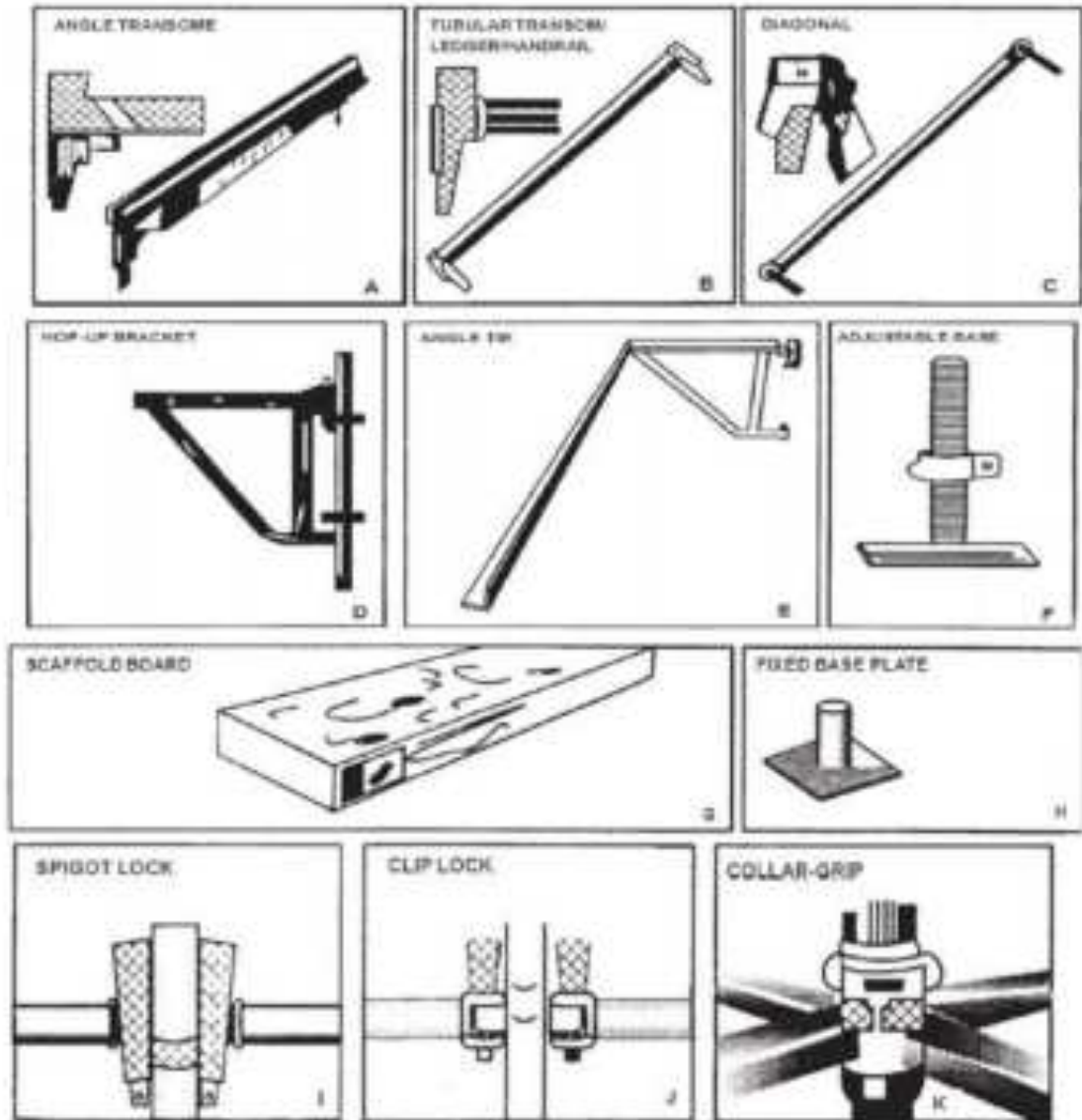


Figure 5.5 : Typical Standard Units of Form Work

## TYPICAL ARRANGEMENT OF COLUMN FORM WORK

Sub Head : R.C.C. (Form Work)

Clause : 5.2.3.2

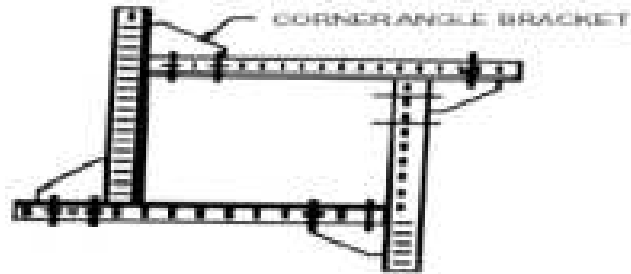


Fig. 5.6A : Four Sides Adjustable Column Form

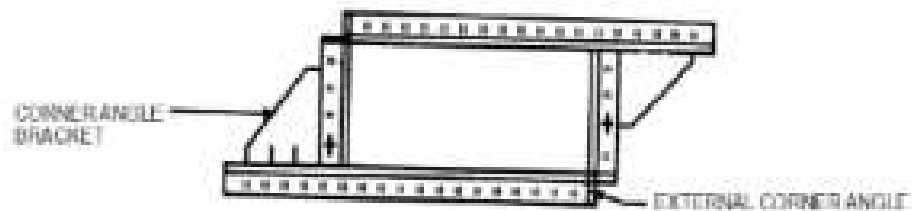


Fig. 5.6B : Two Sides Adjustable Column Form

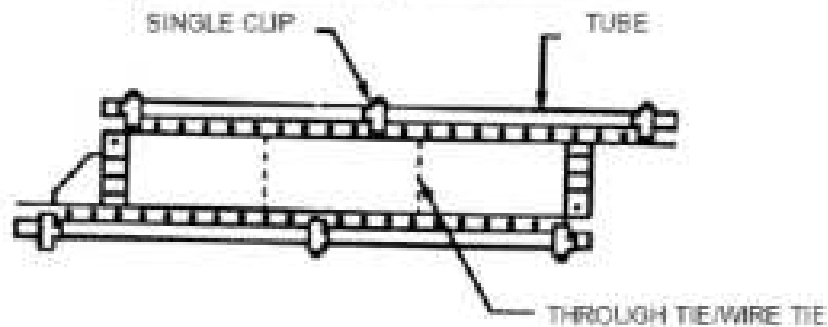


Fig. 5.6C : Column Form with Adjustable Shuttering Wall Form Type Panels

Figure 5.6 : Typical Arrangement of Column Form Work

All Members are of Steel

## TYPICAL COLUMN SHUTTERING

Sub Head : R.C.C. (Form Work)  
Clause : 5.2.3.2

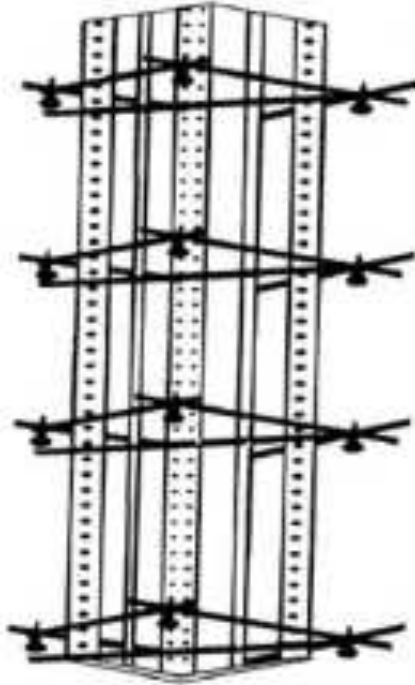


Figure 5.7 : Typical Column Shuttering

All Members are of steel

## TYPICAL DETAILS OF BEAM HEAD AND STIFFNER

Sub Head : R.C.C. (Form Work)

Clause : 5.2.3.3

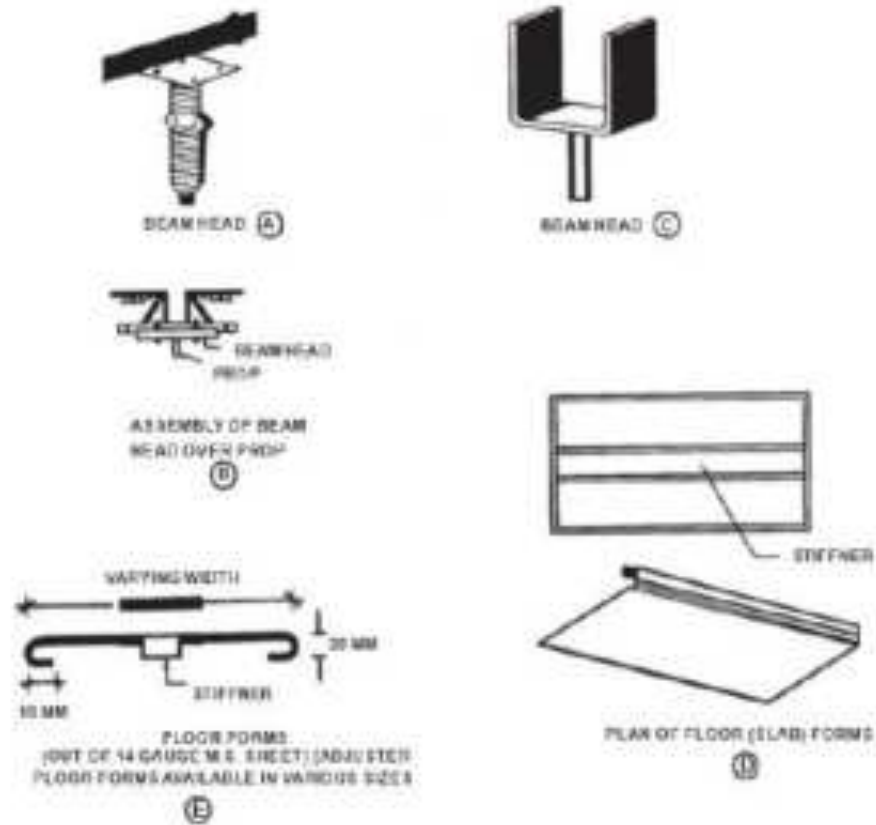


Figure 5.8 : Typical Details of Beam Head and Stiffener

All Members are of Steel

## TYPICAL DETAILS OF MULTISTAGE SHUTTRING

Sub Head : R.C.C. (Form Work)

Clause : 5.2.3.4

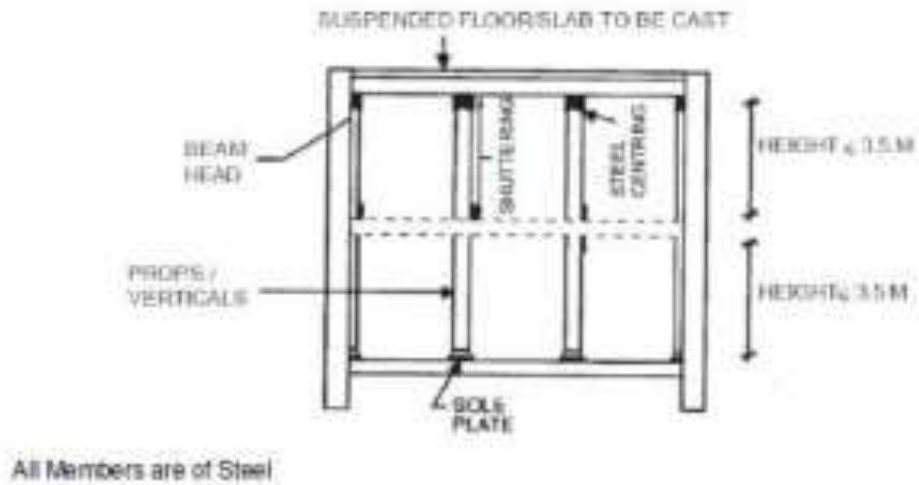


Fig. 5.9A : Suspended Floor – Multi Stage Shuttering (Vertical Section)

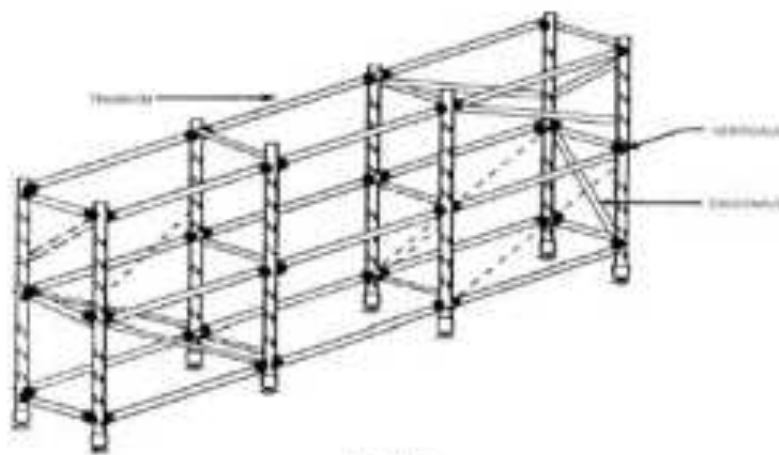


Fig. 5.9B

Figure 5.9 : Typical Details of Multi Stage Shuttering

## DETAILS OF EXPANSION JOINTS (IN VARIOUS LOCATIONS)

Sub Head : R.C.C.  
Clause : 5.4.5

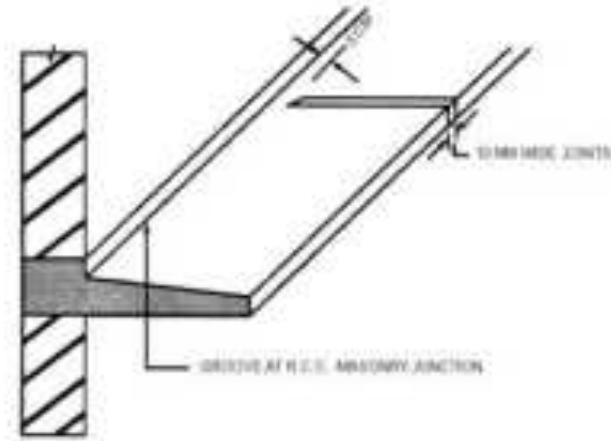


Figure 5.10 : Expansion Joints In Long Sun Shade

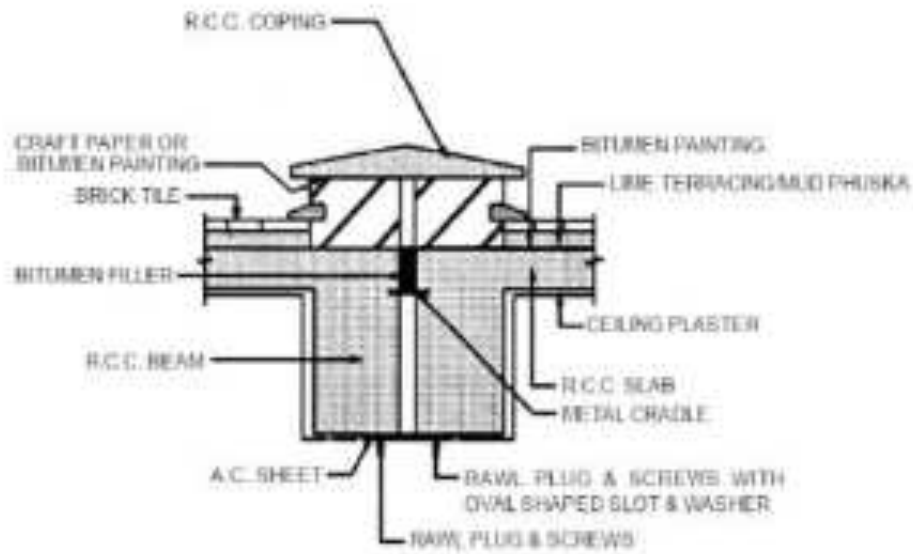


Figure 5.11 : Detail of Raised Type Expansion Joint at Roof

## EXPANSION JOINTS (CONTD.)

Sub Head : R.C.C.  
Clause : 5.4.5

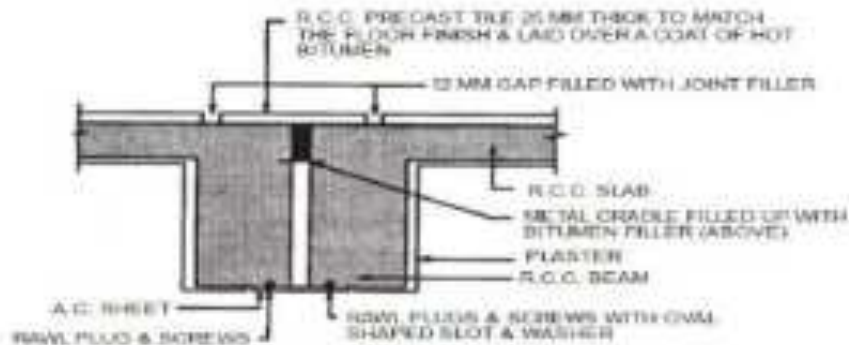


Figure 5.12 : Typical Details of Expansion Joint at Floor

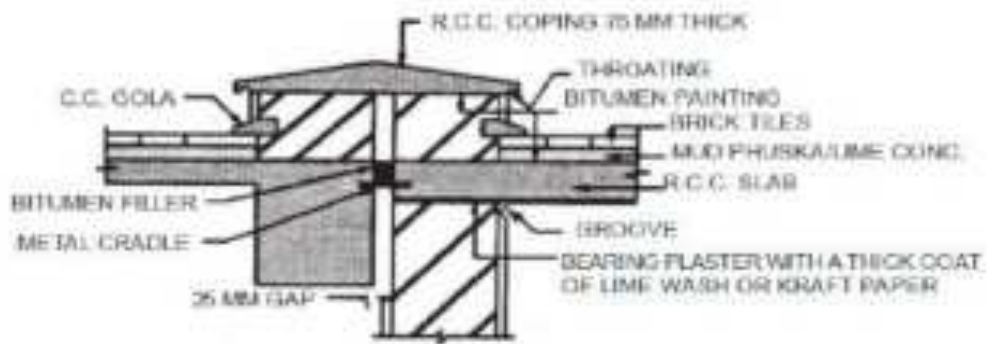


Figure 5.13 : Typical Details of Expansion Joint at Wall & Beam Junction

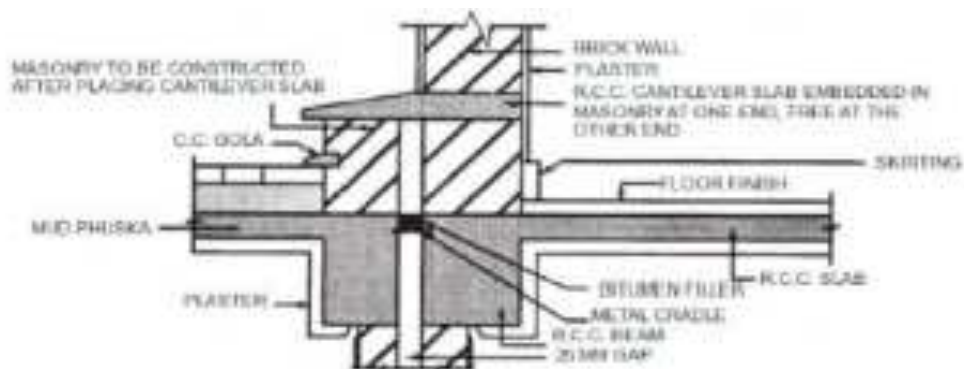
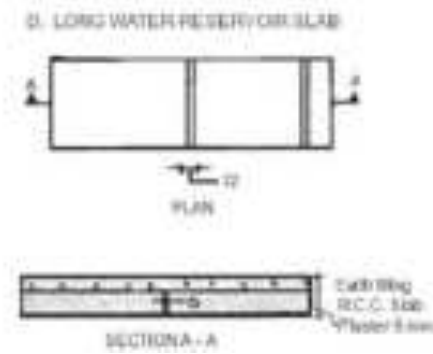


Figure 5.14 : Typical Details of Expansion Joint at Rood & Floor Junction







**Figure 5.18 : Long Water Reservoir Slab**

Drawing not to scale  
All dimensions are in mm

- A Hot Bitumen painting @ 1.7 kg/sqm
- B Bitumen filler
- C Rawl plugs & 50 mm screws @ 300 mm c/c
- D Asbesto sheet 150 mm wide or PVC sheet
- E Rawl plugs & screws with oval shaped slot & washers @ 300 mm c/c
- F Copper cradle

## EXPANSION JOINTS (CONTD.)

Sub Head : R.C.C.  
Clause : 5.4.5

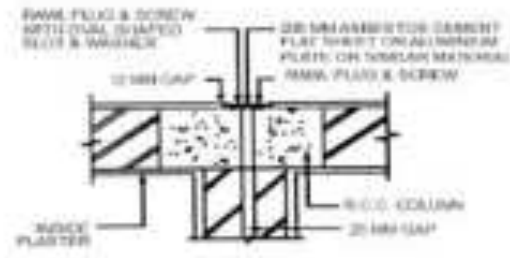


Figure 5.19 : Typical Details of Expansion Joint Covering on Outer Face of Column (Plan)

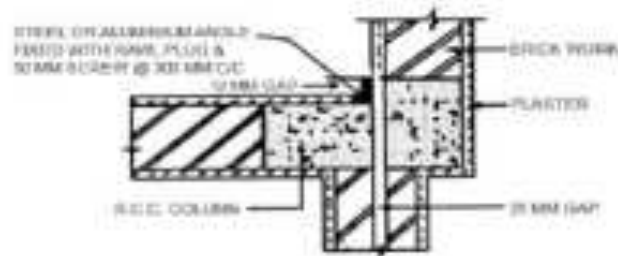


Figure 5.20 : Typical Details of Expansion Joints at Corner Column

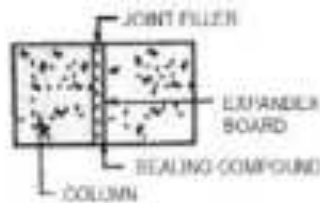


Figure 5.21 : Typical Detail of Expansion Joint at Isolated Twin Columns

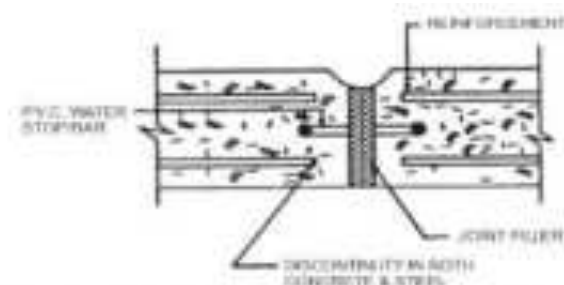


Figure 5.22 : Expansion Joint Subjected to Water Pressure (For Water Tanks)

## EXPANSION JOINTS (CONTD.)

Sub Head : R.C.C.

Clause : 5.4.5

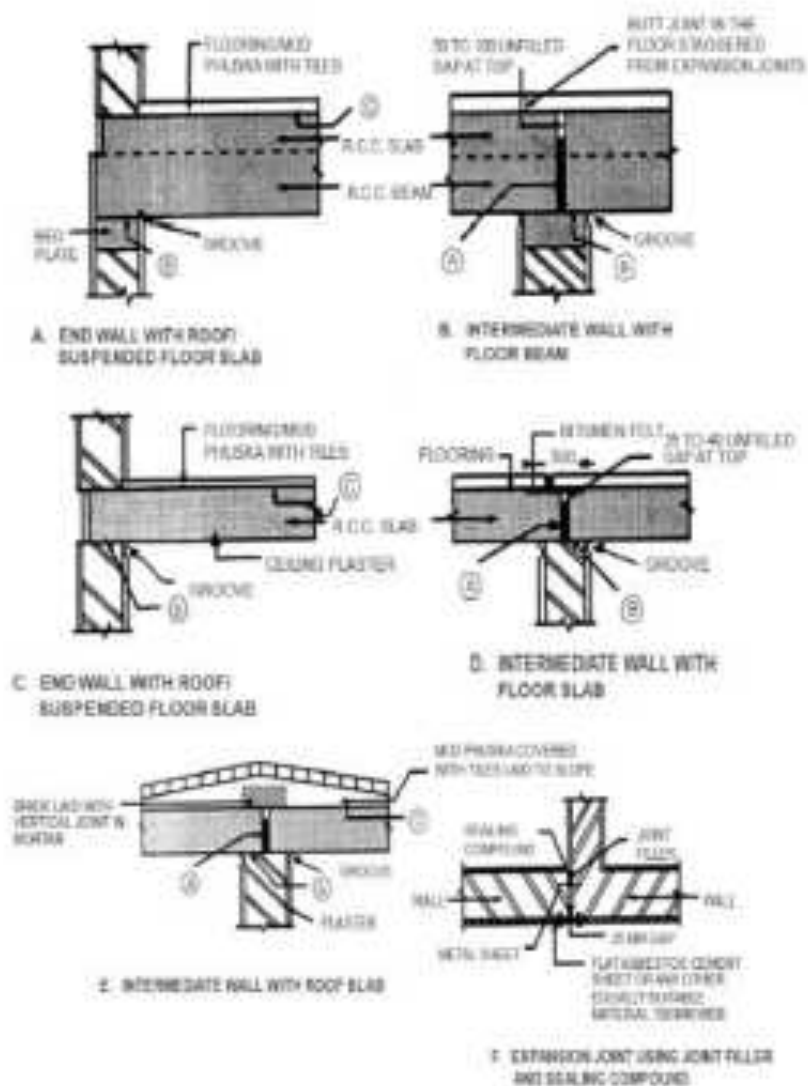


Figure 5.23 : Expansion Joint (Contd.)

- 12 MM EXPANSION JOINTS FILLED WITH BITUMEN IN FILLER OR IMPREGNATED FIBRE BOARD
- 6 MM CEMENT PLASTER 1:3 (1C : 3 F SAND) FINISHED WITH AFLOATING COAT OF NEAT CEMENT AND A THICK LAID WITH KRAFT PAPER BRICK LAID WITH VERTICAL JOINT IN MORTAR FLAT ASBESTOS CEMENT SHEET OR ANY OTHER EQUALLY SUITABLE MATERIAL 150 MM WIDE COAT OF LIME WASH OR LAID WITH KRAFT PAPER.
- HOT BITUMEN PAINTING @ 1.7 KG/SQM IN CASE OF ROOF SLAB/BREAM.
- HOT BITUMEN PAINTING @ 1.7 KG/SQM BELOW BRICK WALL ONLY ON SUSPENDED FLOOR BEAM/SLAB

Drawing not to scale.

All dimensions are in mm



## CONSTRUCTION JOINTS

Sub Head : R.C.C.  
Clause : 5.4.4

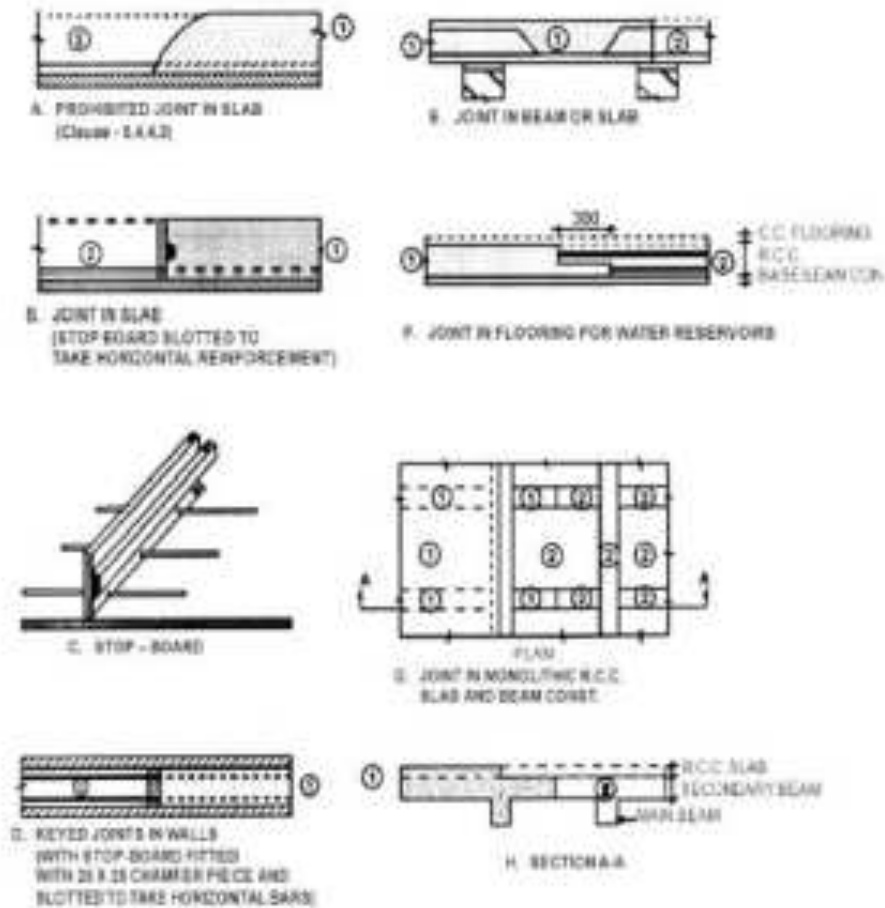


Figure 5.26 : Construction Joints

1. REPRESENTS FIRST PLACING OF CONCRETE
2. REPRESENTS SUBSEQUENT PLACING OF CONCRETE

Drawing not to scale  
All dimensions are in mm

## ENCASING ROLLED STEEL SECTION

Sub Head : R.C.C.  
Clause : 5.5.2

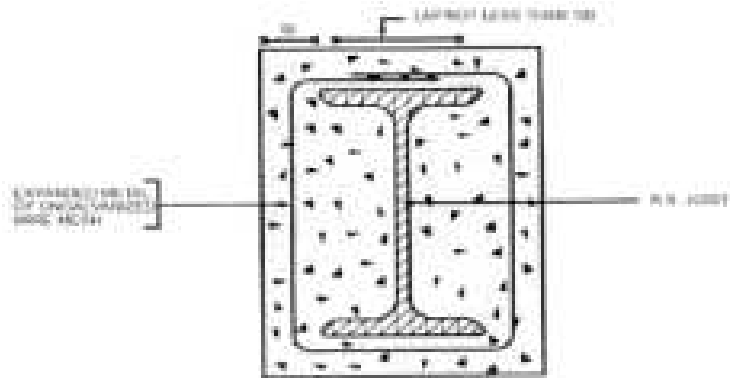


Figure 5.27 : Steel Column

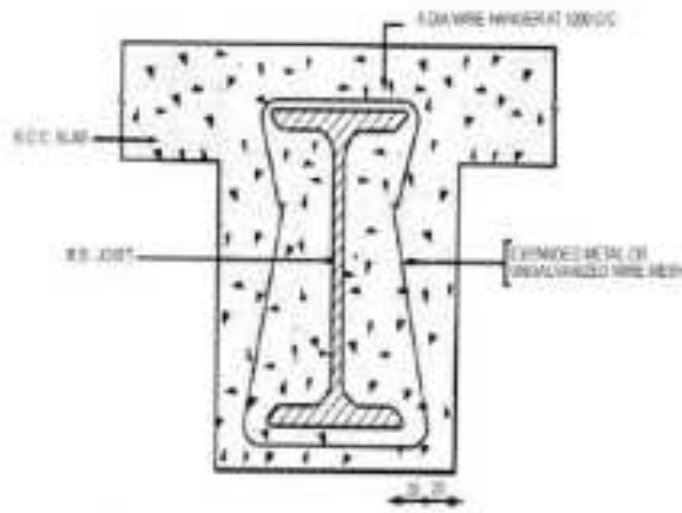


Figure 5.28 : Steel Beam with Slab

Normally cement concrete 1:2:4 (1 Cement : 2 Coarse Sand : 4 Graded Stone Aggregate 12.5 mm Nominal Size) shall be used.

Drawing not to scale  
All dimensions are in mm





# MASONRY WORK



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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
<b>Bricks/ Brick Tiles</b>	6.1.3 6.1.4 6.1.5	Testing of Bricks/Brick Tiles for dimensions Compressive strength, Water absorption and efflorescence	Lab	IS:3495 Part-1 Part-2 Part-3 IS:1077	One test for 50,000 Nos. or part thereof (Minimum Qty. 2000 nos.).	As per Table 6.3 and 6.4 (page No. 238)
<b>Sewer Bricks</b>	6.1.4	Dimensions Compressive strength Water absorption and Efflorescence	Lab	IS:6441 (Part-1) (Part-5) IS:3346 (Part-3) IS:6441 (Part-3)	One test for 100 cum or part thereof. (Minimum Qty. 5cum).	As per Table 6.3 and 6.4 (page No. 238)
<b>Burnt clay perforated building bricks</b>	6.1.5	-do-	Lab		-do-	-do-



## LIST OF BUREAU OF INDIAN STANDARD CODES

Sl. No.	IS No.	Subject
1	IS 249	Specification for Ordinary Portland cement (33 Grade)
2	IS 383	Specification for coarse and fine aggregate
3	IS 454	Plain and reinforced concrete - Code of practice
4	IS 712	Specification for building limes
5	IS 1077	Common burnt clay building bricks
4	IS 1200 (Part 3)	Method of measurements of brick works
7	IS 2212	Code of practice for brick work
8	IS 2222	Specification for burnt clay perforated building bricks
9	IS 2445	Specification for integral water proofing compounds for cement mortar and concrete
10	IS 2849	Specification for non-load bearing gypsum partition blocks, (Solid and hollow types)
11	IS 3344	Method of the determination of thermal conductivity of thermal insulation materials
12	IS 3495	Method of test for burnt clay building bricks
13	IS 3812	Specification for fly ash for use as pozzolana and admixture
14	IS 4082	Stacking & storage of construction materials and components at site – Recommendations
15	IS 4139	Specification of calcium silicate bricks
14	IS 4885	Specification for sewer brick
17	IS 5454	Methods of sampling of clay building bricks
18	IS 4441 (Part-1)	Methods for test for Autoclaved Cellular concrete Products: Determination of unit weight or bulk density and moisture content
19	IS 4441 (Part-2)	Methods for test for Autoclaved Cellular concrete Products: Determination of dry shrinkage
20	IS 4441 (Part-5)	Methods for test for Autoclaved Cellular concrete Products: Determination of compressive strength
21	IS 9103	Specification for concrete admixtures
22	IS 12894	Pulverized fuel ash lime bricks specification
23	IS 13757	Specification of burnt clay fly ash bricks



## 6 MASONRY WORK

### 6.0 TERMINOLOGY

#### **Bond**

The arrangement of the bricks in successive courses to tie the brick work together both longitudinally and transversely. The arrangement is usually designed to ensure that no vertical joint of one course is exactly over the one in the next course above or below it, and there is greatest possible amount of lap.

#### **Bed Joint**

Horizontal joint in brick work or masonry.

#### **Closer**

Any portion of a brick used in constructing a wall, to close up the bond next to the end brick of a course (See Fig. 6.3).

#### **Coping or Weathering**

The cover applied over or the geometrical form given to a part of structure to enable it to shed rain water.

#### **Corbel**

A cantilever projecting from the face of a wall to form a bearing (see Fig. 6.1D)

#### **Cornice**

Horizontal or ornamental feature projecting from the face of a wall (see Fig. 6.1D)

#### **Course**

A layer of bricks including bed mortar.

#### **Cross joint**

A joint other than a bed joint normal to the wall face.

#### **Efflorescence**

A powdery incrustment of salts left by evaporation. This may be visible on the surface or may be below surface. In the latter case, this is termed as crypto Efflorescence.

#### **Header**

A brick laid with its length across the wall.

#### **Indenting**

The leaving recesses into which future work can be bonded.

#### **Jamb**

The part of the wall at the side of an opening.

**Joint**

A junction of bricks.

**Jointing**

The operation of finishing joints as the masonry work proceeds.

**Pier**

A thickened section forming integral part of the wall placed at intervals along the wall primarily to increase the stiffness of the wall or to carry a vertical concentrated load. The thickness of a pier is the overall thickness including the thickness of the wall, or when bonded into one leaf of a cavity wall the thickness obtained by treating this leaf as an independent wall (see Fig. (6.1A, 6.1B)).

**Pillar**

Pillar means a detached masonry support. This can be rectangular, circular, elliptical etc. In case of rectangular pillar, the breadth shall not exceed three times the thickness and thickness itself shall not exceed more than thrice the length of brick (See Fig. 6.1C).

**Quoin**

An external corner in brick work, the term may also denote the brick used to form the quoin.

**Scaffolding**

A temporary erection of timber or steel work used in the construction, alteration, demolition or repairs of a building to support or to attend of the hoisting or lowering of workmen, their tools and materials. Scaffoldings are of two types, namely single and double scaffoldings. Single scaffolding consists of a row of verticals connected to wall by horizontal supported on and tied to the structure. Double scaffolding consists of two rows of verticals secured or leashed together with horizontal and diagonal bracings forming essentially a structure independent of the building. It may also connect to the structure at convenient points for the sake of better stability.

**Sill**

A brick work forming the lower boundary of door or window opening (see Fig. 6.1D).

**Spandrel**

The space between the haunches and the road decking of an arch.

**Strecher**

A brick laid with its length in the direction of the wall.

**String course**

A horizontal course projecting from a wall usually introduced at every floor level or windows or below parapet for imparting architectural appearance to the structure and also keeping off the rainwater. (See Fig. 6.1D).

**Templet**

A pattern of sheet metal used as a guide for setting out specific section and shape.



### Toothing

Bricks left projecting in alternate courses to bond with future work.

### Wall joint

A joint parallel to the wall face.

## 6.1 BRICKS/BRICK TILES/BRICK BATS

Bricks used in the masonry may be of the following type:

- (a) **Common Burnt Clay Bricks:** The Common Brunt Clay Bricks shall conform to IS: 1077 and shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warpage and organic matter, have a frog 100 mm in length 40 mm in width and 10 mm to 20 mm deep on one of its flat sides. Bricks made by extrusion process and brick tiles may not be provided with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.
- (b) **Fly Ash Lime Bricks (FALG Bricks): DELETED.**
- (c) **Clay Fly Ash Bricks:** The clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II shall confirm to IS 3812.
- (d) **Calcium Silicate Bricks:** The bricks shall conform to IS 4139. The Calcium silicate bricks shall be sound, compact and uniform in shape. Bricks shall be free from visible cracks, warpage, organic matter, large pebbles and nodules of free lime. Bricks shall be solid and with or without frog. The bricks shall be made of finely ground sand siliceous rock and lime. In addition, limited quantity of fly ash conforming to IS 3812 may be used in the mix. These bricks are also known as Fly Ash Sand Lime bricks in the construction industry.
- (e) **Tile Brick:** The bricks of 4 cm height shall be moulded without frogs. Where modular tiles are not freely available in the market, the tile bricks of F.P.S. thickness 44 mm (1-3/4") shall be used unless otherwise specified.
- (f) **Brick Bats:** Brick bats shall be obtained from well burnt bricks.
- (g) **Mechanized Autoclave Fly Ash Lime Brick:** These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side shall confirm to IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

### 6.1.1 Dimensions

The brick may be modular or non-modular. Sizes for both types of bricks/tiles shall be as per Table 6.1. While use of modular bricks/tiles is recommended, non-modular (FPS) bricks/tiles can also be used where so specified. Non-modular bricks/tiles of sizes other than the sizes mentioned in Table 6.1 may also be used where specified.

TABLE 6.1



Type of Bricks/ Tiles	Nominal Size mm	Actual Size mm
Modular Bricks	200 × 100 × 100 mm	190 × 90 × 90 mm
Modular tile bricks	200 × 100 × 40 mm	190 × 90 × 40 mm
Non-modular tile bricks	229 × 114 × 44 mm	225 × 111 × 44 mm
Non-modular bricks	229 × 114 × 70 mm	225 × 111 × 70 mm

### 6.1.2 Classification

Bricks/Brick tiles shall be classified on the basis of their minimum compressive strength as given below:

**TABLE 6.2**

Class Designation	Average compressive strength			
	Not less than		Less than	
	N/mm <sup>2</sup>	(kgf/cm <sup>2</sup> )	N/mm <sup>2</sup>	(Kgf/cm <sup>2</sup> )
12.5 (125)	12.5	(125)	15.0	150
10 (100)	10	(100)	12.5	125
7.5 (75)	7.5	(75)	10	100
5 (50)	5	(50)	7.5	75
3.5 (35)	3.5	(35)	5.0	50

The bricks shall have smooth rectangular faces with sharp corner and shall be uniform in colour and emit clear ringing sound when struck.

(Note: Upper limits specified in Table 6.2 are for calculating the average compressive strength in accordance with Appendix B of Chapter 6).

### 6.1.3 Sampling and Tests

Samples of bricks shall be subjected to the following tests:

- Dimensional tolerance.
- Water absorption.
- Efflorescence.
- Compressive strength.

**6.1.3.1 Sampling:** For carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken at random according to the size of lot as given in Table 6.3 below. The sample thus taken shall be stored in a dry place until tests are made. For the purpose of sampling, the following definition shall apply.

- Lot: A collection of bricks of same class and size, manufactured under relatively similar conditions of production. For the purpose of sampling a lot shall contain a maximum, of 50,000 bricks. In case a consignment has bricks more than 50,000 of the same classification and size and manufactured under relatively similar conditions of production, it shall be divided into lots of 50,000 bricks or part thereof.





- (b) **Sample:** A collection of bricks selected for inspection and/or testing from a lot to reach the decision regarding the acceptance or rejection of the lot.
- (c) **Defective:** A brick failing to meet one or more of the specified requirements.

**6.1.3.2** The samples shall be taken as below:

- i. **Sampling from a Stack:** When it is necessary to take a sample from a stack, the stack shall be divided into a number of real or imaginary sections and the required number of bricks drawn from each section. For this purpose bricks in the upper layers of the stack shall be removed to enable units to be sampled from places within the stack.

**Note:** For other methods of sampling i.e. sampling in motion and sampling from lorries or trucks, IS:5454 may be referred.

Scale of sampling and criteria for conformity for visual and dimensional characteristics:

Visual characteristics: The bricks shall be selected and inspected for ascertaining their conformity to the requirements of the relevant specification. The number of bricks to be selected from a lot shall depend on the size of lot and shall be in accordance with Col. 1 and 2 of Table 6.3 for visual characteristics in all cases and dimensional characteristics if specified for individual bricks.

- ii. **Visual Characteristics:** All the bricks selected above in accordance with Col. 1 and 2 of Table 6.3 shall be examined for visual characteristics. If the number of defective bricks found in the sample is less than or equal to the corresponding number as specified in Col. 3 of Table 6.3 the lot shall be considered as satisfying the requirements of visual characteristics, otherwise the lot shall be deemed as not having met the visual requirements.
- iii. **Dimensional Characteristics:** The number of bricks to be selected for inspecting the dimensions and tolerance shall be in accordance with Col. 1 and 4 of Table 6.3. These bricks will be divided into groups of 20 bricks at random and each of the group of 20 bricks thus formed will be tested for all the dimensions and tolerances. A lot shall be considered having found meeting the requirements of dimensions and tolerance if none of the groups of bricks inspected fails to meet the specified requirements.

**TABLE 6.3**

**Scale of Sampling and Permissible Number of Defectives for Visual and Dimensional Characteristics**

No of Bricks in the lot	For characteristics specified for individual bricks		For dimensional characteristics for group of 20 bricks
	No of bricks to be selected	Permissible no of defective in the sample	No of bricks to be selected
(1)	(2)	(3)	(4)
10001-35000	20	1	40
35001-50000	32	2	40

**Note:** In case the lot contains 10000 or less bricks the sampling shall be as per decision of the Engineer-in-Charge.

- iv. **Scale of Sampling and Criteria for Physical Characteristics:** The lot which has been found satisfactory in respect of visual and dimensional requirements shall be next tested for physical



characteristics like compressive strength, water absorption, efflorescence as specified in relevant material specification. The bricks for this purpose shall be taken at random from those already selected above. The number of bricks to be selected for each of these characteristics shall be in accordance with relevant columns of Table 6.4.

**TABLE 6.4**

**Scale of Sampling for Physical Characteristics**

Lot Size	Sample size for compressive strength, absorption efflorescence and water and	Permissible No. of defectives for efflorescence	Warpage	
			Sample Size	Permissible No of defects
(1)	(2)	(3)	(4)	(5)
2001-10000	5	0	10	0
10001-35000	5	0	10	0
35001-50000	10	1	20	1

**Note:** In case the lot contains 10000 or less bricks, the sampling shall be as per decision of Engineer-in-Charge.

- v. A lot shall be considered having satisfied the requirements of physical characteristics if the condition stipulated herein are all satisfied.

- (a) From the test results for compressive strength, the average shall be calculated and shall satisfy the requirements specified in relevant material specification.

**Note:** In case any of the test results for compressive strength exceeds the upper limit for the class of bricks, the same shall be limited to the upper limit of the class for the purpose of averaging.

- (b) Wherever specified in the material specification, the compressive strength of any individual bricks tested in the sample shall not fall below the minimum average compressive strength specified for the corresponding class of brick by more than 20 per cent.
- (c) From the test results for water absorption, the average for the bricks in the sample shall be calculated and shall satisfy the relevant requirements specification in material specification.
- (d) The number of bricks failing to satisfy the requirements of the efflorescence specified in the relevant specification should not be more than the permissible no. of defectives given in Col. 3 of Table 6.4.

**6.1.3.3 Dimensional Tolerances:** The dimensions of modular bricks when tested as described above as per procedure described in Appendix A of Chapter 6 shall be within the following limits per 20 bricks or locally available size as approved by Engineer-in-charge.

- (a) **For modular size**

Length 7320 to 3880 mm ( $3800 \pm 80$  mm)

Width 1740 to 1840 mm ( $1800 \pm 40$  mm)

Height 1740 to 1840 mm ( $1800 \pm 40$  mm) for 90 mm high bricks

740 to 840 mm ( $800 \pm 40$  mm) for 40 mm high bricks

- (b) **For non-modular bricks**



Length 4520 to 4480 mm ( $4400 \pm 80$  mm)

Width 2240 to 2140 mm ( $2200 \pm 40$  mm)

Height 1440 to 1340 mm ( $1400 \pm 40$  mm) for 70 mm high bricks

440 to 540 mm ( $400 \pm 40$  mm) for 30 mm high bricks

(c) **Brick Tiles**

740 to 840 mm ( $800 \pm 40$  mm) for 40 mm high brick tiles.

In case of non-modular bricks, % age tolerance will be  $\pm 2\%$  for group of 20 numbers of class 10 bricks, and  $\pm 4\%$  for other class of bricks.

**6.1.3.4 Compressive Strength:** The bricks, when tested in accordance with the procedure laid down in Appendix B of Chapter 6 shall have a minimum average compressive strength for various classes as given in Table 6.2. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any individual brick tested exceeds the upper limit specified in Table 6.2 for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified in Table for the purpose of calculating the average compressive strength.

**6.1.3.5 Water Absorption:** The average water absorption of bricks when tested in accordance with the procedure laid down in Appendix C of Chapter 6 shall be not more than 20% by weight.

**6.1.3.6 Efflorescence:** The rating of efflorescence of bricks when tested in accordance with the procedure laid down in Appendix D of Chapter 6 shall be not more than moderate.

**6.1.4 Sewer Bricks**

**6.1.4.1** Sewer bricks are intended for the lining of walls, roofs and floors of sewers used for ordinary sanitary (domestic) sewage. The general practice in the country is also to utilize common building bricks in the construction of sewers which is not satisfactory. However, these sewer bricks may not be suitable for sewers dealing with industrial effluent (sewage) for which the use of acid resistant bricks in accordance with IS 4840 may be considered. Sewer bricks shall conform to IS 4885.

**6.1.4.2 Dimensions and Tolerances**

**Dimensions:** The standard sizes of the sewer bricks shall be as follows:

Length mm	Width mm	Height mm
190	90	90
190	90	40

For sewers of special shapes, such as the oval sewers, the bricks may have to be suitable tapered to conform to the radii of curvature of the arches and barrels and sides of sewers.

**Tolerance:** The permissible tolerance on the dimensions specified in 6.1.4.2 shall be as follows:

Dimensions (mm)	Total tolerance for 20 bricks(mm)
190	$\pm 80$
90	$\pm 40$
40	$\pm 40$



**6.1.4.3 Compressive Strength:** The average compressive strength obtained on a sample of sewer bricks when tested in accordance with the procedure laid down in IS 3495 (Part I) shall be not less than 17.5 N/mm<sup>2</sup> (175 kgf/cm<sup>2</sup> approximately) and the individual strength of any brick shall be not less than 14 N/mm<sup>2</sup> (140 kgf/cm<sup>2</sup> approximately).

**6.1.4.4 Water Absorption:** The average value of water absorption for five bricks after 24 hour cold water immersion test when tested in accordance with IS 3495 (Part 2) shall not exceed 10 per cent of the average dry weight of the brick and the absorption for any individual brick shall not exceed 12 per cent.

**6.1.4.5 Efflorescence:** When the bricks are tested in accordance with the method laid down in IS 3495 (Part 3), the rating of efflorescence shall not be more than 'slight'.

#### **6.1.5 Burnt Clay Perforated Building Bricks**

**6.1.5.1 General Quality:** The bricks shall be made of suitable clay and shall be thoroughly burnt at the maturing temperature of clay. They shall be free from cracks, flaws and nodules of free lime. They shall have rectangular face with sharp straight edge at right angle. They shall be of uniform colour and texture. These bricks generally should conform to IS 2222.

**6.1.5.2 Dimensions and Tolerances:** The standard size of burnt clay perforated bricks shall be as follows:

Type of Brick	Length (L) mm	Width (W) mm	Height (H) mm
Modular	190	90	90
Non Modular	230	110	70

The permissible tolerances on the dimensions shall be as follows:

Dimension mm	Tolerance mm
70, 90	± 4
110, 190	± 7
230	± 10

**Note:** The tolerances specified above shall apply to measurements on individual bricks.

**6.1.5.3 Perforations:** The area of perforation shall be between 30% and 45% of the total area of the corresponding face of the bricks.

The perforation shall be uniformly distributed over the surface. In the case of rectangular perforations, the larger dimension shall be parallel to the longer side of the brick. The shorter side of the perforation shall be less than 20 mm in case of rectangular perforations and less than 25 mm diameter in case of circular perforations.

The area of each perforation shall not exceed 500 mm<sup>2</sup>.

The thickness of any shell shall not be less than 15 mm and that of any web not less than 10 mm.

**6.1.5.4 Compressive Strength:** The bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) shall have a minimum average compressive strength of 7 N/ mm<sup>2</sup> on net area.



The compressive strength of any individual brick tested shall not fall below the minimum compressive strength specified for the corresponding class of bricks. The lot shall then be checked for next lower class of brick.

- 6.1.5.5 Water Absorption:** The bricks when tested in accordance with the procedure laid down in IS 3495 (parts 1 to 4): after immersion in cold water for 24 hours water absorption shall not be more than 20 percent by weight.
- 6.1.5.6 Efflorescence:** The bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) shall have a rating of efflorescence not more than 'slight'.
- 6.1.5.7 Warpage:** The bricks when tested in accordance with the procedure laid down in IS 3495 (Parts 1 to 4) the average warpage shall not exceed 3%.

## **6.2 BRICK WORK**

### **6.2.1 Classification**

The brick work shall be classified according to the class designation of bricks used.

### **6.2.2 Mortar**

The mortar for the brick work shall be as specified and conform to accepted standards. Lime shall not be used where reinforcement is provided in brick work.

### **6.2.3 Soaking of Bricks**

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. Alternatively, bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked, they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note I: The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note II: If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

### **6.2.4 Laying**

- 6.2.4.1** Bricks shall be laid in English Bond (Fig. 6.2, 6.3, 6.4) unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closer where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.

**Note:** Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers.

- 6.2.4.2** All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be



laid on a full bed of mortar, when laying, each brick shall, be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow space are left inside the joints.

- 6.2.4.3** The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jambs and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpends properly aligned within following maximum permissible tolerances:
- (a) Deviation from vertical within a storey shall not exceed 4 mm per 3 m height.
  - (b) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.
  - (c) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.
  - (d) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 4 mm.
  - (e) A set of tools comprising of wooden straight edge, masonic spirit levels, square, 1 meter rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.
- 6.2.4.4** All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other.
- 6.2.4.5** The brick work shall be built in uniform layers. No part of the wall during its construction shall rise more than one meter above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal. Toothing shall not be permitted as an alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.
- 6.2.4.6** All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge.
- 6.2.4.7** Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be properly radiated and keyed into position to form cut (maru) corners as shown in Fig 6.4. Where bricks cannot be cut to the required shape to form cut (maru) corners, cement concrete 1:2:4 (1 cement:2 coarse sand: 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.
- 6.2.4.8** Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.



- 6.2.4.9** In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.
- 6.2.4.10** To facilitate taking service lines later without excessive cutting of completed work, sleeves (to be paid separately) shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.
- 6.2.4.11** Top of the brick work in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throating (to be paid separately) shall be provided where indicated.
- 6.2.4.12** Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer-in-Charge.
- 6.2.4.13** Vertical reinforcement in the form of bars (MS or high strength deformed bars or thermo mechanically treated bars as per direction of Engineer-in-Charge, considered necessary at the corners and junction of walls and jamb opening doors, windows etc. shall be encased with cement mortar not leaner than 1:4 (1 cement: 4 coarse sand), or cement concrete mix as specified. The reinforcement shall be suitably tied, properly embedded in the foundation and at roof level. The dia. of bars shall not be less than 8 mm and concrete grade shall be minimum 1:3:4 (1 cement: 3 coarse sand: 4 graded stone aggregate 20 mm nominal size).
- 6.2.4.14** In retaining walls and the like, where water is likely to accumulate, weep holes, 50 to 75 mm square shall be provided at 2 m vertically and horizontally unless otherwise specified. The lowest weep hole shall be at about 30 cm above the ground level. All weep holes shall be surrounded by loose stones and shall have sufficient fall to drain out the water quickly.

Note: Work of providing loose stone will be payable extra.

- 6.2.4.15** Work of cutting chases, wherever required to be made in the walls for housing G.I. pipe, CI pipe or any other fixtures shall be carried out in various locations as per guidelines given below:
- (a) Cutting of chases in one brick thick and above load bearing walls.
- As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.
  - The depths of vertical chases and horizontal chases shall not exceed one-third and one-sixth of the thickness of the masonry respectively.
  - When narrow stretches of masonry (or short length of walls) such as between doors and windows, cannot be avoided they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration such narrow lengths of walls shall be checked for stresses and high strength bricks in mortar or concrete walls provided, if required.
  - Horizontal chases when unavoidable should be located in the upper or lower one-third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.
  - Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.





- vi. Masonry directly above a recess, if wider than 30 cm horizontal dimension) should be supported on lintel. Holes in masonry may be provided upto 30 cm width and 30 cm height without any lintel. In the case of circular holes in the masonry, no lintel need be provided for holes upto 40 cm in diameter.
- (b) Cutting of chases in half brick load bearing walls.  
No chase shall be permitted in half brick load bearing walls and as such no recessed conduits and concealed pipes shall be provided with half brick thick load bearing walls.
- (c) Cutting of chases in half brick non-load bearing wall:  
Services should be planned with the help of vertical chases. Horizontal chase should be provided only when unavoidable.

### 6.2.5 Joints

The thickness of all types of joints including brick wall joints and cross joints shall be such that four course and three joints taken consecutively shall measure as follows:

- (a) In case of modular bricks conforming to IS 1077 specification for common burnt clay buildings bricks, equal to 39 cm.
- (b) In case of non-modular bricks, it shall be equal to 31 cm.

Note: Specified thickness of joints shall be of 1 cm. Deviation from the specified thickness of all joints shall not exceed one-fifth of specified thickness.

- 6.2.5.1** Finishing of Joints: The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

### 6.2.6 Curing

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

### 6.2.7 Scaffolding

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

- 6.2.7.1 Single Scaffolding:** Where plastering, pointing or any other finishing has been indicated for brick work, single scaffolding may be provided, unless otherwise specified. In single scaffolding, one end of the putlogs/pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each putlog/pole shall be left out. Such holes shall not be allowed in the case of pillars, brick work less than one meter in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls. The holes for putlogs/poles shall be made good with brick work and wall finishing as specified.





**6.2.7.2 Double Scaffolding:** Where the brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.

## **6.2.8 Measurements**

**6.2.8.1** Brick work shall be measured in cubic meters unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 m i.e. 1 cm. Areas shall be calculated to the nearest 0.01 sq mtrs and the cubic contents shall be worked out to the nearest 0.01 cubic meters.

**6.2.8.2** Brick work shall be measured separately in the following stages:

- (a) From foundation to floor one level (Plinth level)
- (b) Plinth (floor one) level to floor two level
- (c) Between two specified floor levels above floor two level

**Note:** Brick work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

**6.2.8.3** No deductions or additions shall be done and no extra payment made for the following:

**Note:** Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

- (a) Ends of dissimilar materials (i.e. joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps, etc.); up to 0.1 m<sup>2</sup> in section
- (b) Opening up to 0.1 m<sup>2</sup> in area (see Note)
- (c) Wall plates, bed plates, and bearing of slabs, Chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall
- (d) Cement concrete blocks as for hold fasts and holding down bolts
- (e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fast for doors and windows
- (f) Chases of section not exceeding 50 cm in girth
- (g) Bearing portion of drip course, bearing of moulding and cornice

**Note:** In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

**6.2.8.4** Walls half brick thick and less shall each be measured separately in square metres stating thickness.

**6.2.8.5** Walls beyond half brick thickness shall be measured in multiples of half brick which shall be deemed to be inclusive of mortar joints. For the sizes of bricks specified in para 6.1.1, half brick thickness shall mean 100 mm for modular and 115 mm for non-modular bricks.

Where fractions of half brick occur due to architectural or other reasons, measurement shall be as follows:

- (a) Up to 1/4th brick-actual measurements and
- (b) exceeding 1/4 brick-full half bricks.

**6.2.8.6** String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running meters stating dimensions of each projection.

**6.2.8.7** Square or rectangular pillars shall be measured separately in cubic meters in multiple of half brick.



- 6.2.8.8** Circular pillars shall be measured separately in cubic meters as per actual dimensions.
- 6.2.8.9** Brick work curved on plan shall be measured like the brick work in straight walls and shall include all cutting and wastage of bricks, tapered vertical joints and use of extra mortar, if any. Brick work curved on plan to a mean radius not exceeding six meters shall be measured separately and extra shall be payable over the rates for brick work in straight walls. Nothing extra shall be payable if the mean radius of the brick work curved in plan exceeds six meters.
- 6.2.8.10** Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for brick work in walls.
- 6.2.8.11** Brick work with brick tiles shall be measured and paid for separately.

**6.2.9 Rate**

The rate shall include the cost of materials and labour required for all the operations described above except the vertical reinforcement and its encasement in cement mortar or cement concrete. The rate shall also include the following:

- (a) Raking out joints or finishing joints flush as the work proceeds.
- (b) Preparing tops of existing walls and the like for raising further new brick work.
- (c) Rough cutting and waste for forming gables, splays at eaves and the like.
- (d) Leaving holes for pipes up to 150 mm dia. and encasing hold fasts etc.
- (e) Rough cutting and waste for brick work curved in plan and for backing to stone or other types of facing.
- (f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.
- (g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items and
- (h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section.
- (i) Brick on edge courses, cut brick corners, splays reveal, cavity walls, brick works curved on plan to a mean radius exceeding six meters.

**6.3 BRICK WORK IN ARCHES**

- 6.3.0** The detailed specifications for brick work mentioned in para 6.2 shall apply, in so far as these are applicable. Arch work shall include masonry for both gauged as well as plain arches. In gauged arches, cut or moulded bricks shall be used. In plain arches, uncut bricks shall be used.

Brick forming skew-backs shall be dressed or cut so as to give proper radial bearing to the end voussoirs. Defects in dressing of bricks shall not be covered by extravagant use of mortar, nor shall the use of chips or bats etc. be permitted.

The bricks of the spandrel wall at their junctions with the extrudes of the arch shall be cut to fit the curvature of the arch. Refer fig 6.5 for brick work in Arches.

**6.3.1 Circular Arches**

These shall be either (a) plain arches and shall be built in half brick concentric rings with break joints, or (b) gauged arches built with bricks cut or moulded to proper shape. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flush with mortar and well pressed into their positions so as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full of mortar and thickness of joints shall not be less than 5 mm nor more than 15 mm.



After the arch is completed, the haunches shall be loaded by filling up the spandrels upto the crown level of the arch. Care shall be taken to load the haunches on two sides of the spandrels.

When the arch face is to be pointed (and not plastered), the face bricks shall be cut to proper shape or moulded, so as to have the joints not more than 5 mm thick. These shall be laid with radial joints to the full depth of the arch. The voussoirs shall break joints to the full depth of the arch.

### **6.3.2 Flat Arches**

These shall be gauged arches of brick cut or moulded to proper shape. The extrados shall be kept horizontal and the intrados shall be given slight camber of 1 in 100 of the span. The centre of the arch from which joints shall radiate, shall be determined by the point of the inter-section of the two lines drawn from the ends of the arch at the springing level and at 40° to horizontal.

In flat arches, bricks shall be laid with radial joints to the full depth of arch and voussoirs breaking joints with each other. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The thickness of the joints shall not exceed 5 mm. Flat arches may be used for the sake of appearance but for purpose of carrying loads of the wall above, these shall be used in conjunction with relieving arches, lintels placed below.

### **6.3.3 Centering and Shuttering**

The centering and shuttering for the arch shall be got approved by the Engineer-in-Charge before the arch work is started. It shall be strong enough to bear the dead load of the arch and the live loads that are likely to come upon it during construction, without any appreciable deflections.

The shuttering shall be tightened with hard wood wedged or sand boxes, so that the same could be eased without jerks being transmitted to the arch. The sequence of easing the shuttering shall be got approved from the Engineer-in-Charge. The shuttering shall be struck within 48 hours of the completion of the arch but not before 24 hours. This shall be done after the spandrel has been filled in and the arch loaded.

### **6.3.4 Measurements**

The length of the arch shall be measured as the mean of the extrados and intrados of the arch correct to a cm. The thickness of the arch shall be measured in multiples of the half brick. The breadth in the direction of the thickness of wall shall be measured as specified. The cubical contents shall be calculated in cubic metre, correct to two places of decimal.

For arches exceeding 4 m in spans extra payment shall be made on the actual area of the soffit for additional cost of centering including all strutting, bolting, wedging, easing, striking and its removal.

### **6.3.5 Rate**

The rate is inclusive of the cost of the materials and labour required for all the operations described above.

## **6.4 HALF BRICK WORK**

Brick work in half brick walls shall be done in the same manner as described above in 6.2.4 except that the bricks shall be laid in stretcher bond. When the half brick work is to be reinforced, 2 Nos. M.S. bars of 4 mm dia., shall be embedded in every third course as given in the item (the dia of bars shall not exceed 8 mm). These shall be securely anchored at their end where the partitions end. The free ends of the reinforcement shall be keyed into the mortar of the main brick work to which the half brick work is joined. Lime mortar shall not be used. Overlaps in reinforcement, if any shall not be less than 30 cm.

The mortar interposed between the reinforcement bars and the brick shall not be less than 5 mm. The mortar covering in the direction of joints shall not be less than 15 mm.



#### **6.4.1 Measurements**

The length and height of the wall shall be measured correct to a cm. The area shall be calculated in sq.m. where half brick wall is joined to the main walls of one brick or greater thickness and measurements for half brick wall shall be taken for its clear length from the face of the thicker wall.

#### **6.4.2 Rate**

The rate includes the cost of the materials and labour involved in all the operations described above except reinforcement which is to be paid for separately.

### **6.5 BRICK TILE WORK**

The work shall be done in the same manner as described in para 6.2.4 except that brick tile shall be used instead of bricks. The measurement and rate shall be same as specified under para 6.2.

### **6.6 HONEYCOMB BRICK WORK**

The honeycomb brick work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

#### **6.6.1 Measurements**

The length and height shall be measured correct to a cm. Area shall be calculated in square metres correct to two places of decimal. Honeycomb openings shall not be deducted.

#### **6.6.2 Rate**

The rate includes the cost of materials and labour involved in all the operations described above.

### **6.7 JOINING OLD BRICK WORK WITH NEW BRICK WORK**

**6.7.1** In case the height of the bricks of old as well as new work is same, the old work shall be toothed to the full width of the new wall and to the depth of a quarter of brick in alternate courses. In case the height of the bricks is unequal, then the height of each course of new work shall be made equal to the height of the old work by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints.

**6.7.2** For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses in height and half a brick in depth shall be cut in the main walls. A space of the three courses shall be left between two consecutive recesses. The new cross wall shall be bonded into the recesses to avoid any settlement.

**6.7.3** Joining of old brick work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

#### **6.7.4 Measurement**

The height and thickness of vertical face in contact with new work shall be measured to the nearest 0.01 m and the area shall be calculated to the nearest 0.01 sqm.

#### **6.7.5 Rate**

The rate includes the cost of labor and material involved in all the operations described above.

### **6.8 MOULDING AND CORNICES**

**6.8.0** The specifications described under para 6.2 shall apply in so far these are applicable. Moldings and cornices shall be made with bricks as specified for brick work. The bricks shall be cut and dressed to the required shape as shown in the architectural drawings.

**6.8.1** Cornices shall not ordinarily project by more than 15 cm to 20 cm and this projection shall be obtained by projecting each brick course by more than one fourth of the length. For cornices projecting more than 20 cm and requiring more than quarter bricks projection, metal cramps shall be used and paid for separately.

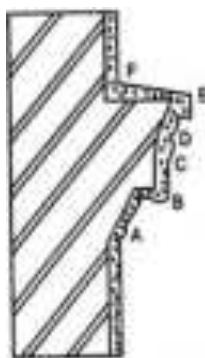
**6.8.2** Corbelling shall be brought roughly to shape by plastering with the specified mortar. When the mortar is still green, the moldings shall be finished straight and true with the help of metal templates.

**6.8.3 Curing and Protection**

The moldings and cornices shall be cured for at least seven days. These shall be protected from the effects of sun and rain by suitable covering and also from damage during the execution of the work.

**6.8.4 Measurements**

For the purpose of measurements, the sectional periphery of moldings and cornices (excluding the portion in contact with wall) shall be measured in centimeters and length in meters (fig. below). The girth and length shall be measured correct to a cm. No deduction shall be made from the masonry of wall for the bearing of the molding and cornices.



Note:

1. The sectional periphery curve ABCDEF.
2. Length FA shall not be measured.

**6.8.5 Rate**

The rate includes the cost of materials and labour involved in all the operations described above.

**6.9 BRICK WORK UNDER WATER OR FOUL CONDITIONS**

Brick Work under following conditions:

- i. Work in or under water/or liquid mud
- ii. Work in or under foul positions



Shall be measured separately for payment of extra rate over and above the quantity measured and paid under para 6.2.8.

## **6.10 EXPOSED BRICK WORK**

### **6.10.1 Facing Bricks**

The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime warpage and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right-angled edges. Facing bricks shall have uniform colour and even texture. Unless otherwise specified, facing bricks shall be machine moulded only. As far as possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and broken corners shall not be used.

### **6.10.2 Dimensions and Tolerances**

The standard sizes of machine moulded facing bricks shall be as specified in para 6.1.1.

#### **6.10.2.1** The permissible tolerances shall be as under:

Dimension mm		Tolerance (For Machine moulded bricks) mm
Length	190 or 225	±3
Width	90 or 111	±1.5
Thickness	40 or 44	±1.5

**Note:** Tolerance and Dimensions for selected hand moulded bricks + 4 mm in length and + 3 mm in width and thickness).

### **6.10.3 Sampling**

As per para 6.1.3 and 6.1.3.2

### **6.10.4 Physical Requirements**

Facing bricks shall be of class designation 75 unless otherwise specified. Average compressive strength shall not be less than 7.5 N/mm, water absorption shall not exceed 20 per cent by weight and efflorescence rating shall be nil when tested in accordance with the procedure laid down and tolerance in dimensions shall be checked as per the procedure laid down in Appendix A-2.

Mortar, Soaking of Bricks and laying shall be as specified in para 6.2.2, 6.2.3 and 6.2.4 respectively.

#### **6.10.5** Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as per para 6.2.5.

#### **6.10.6** Curing and scaffolding shall be as specified in para 6.2.4 and 6.2.7 to 6.2.7.2 respectively.

### **6.10.7 Measurements**

Exposed brick work in face using machine moulded bricks and selected hand moulded bricks shall be measured separately and the measurement shall be as specified in para 6.2.8

### **6.10.8 Rate**

The rates shall be as specified in para 6.2.9 and shall also include the following



- (a) Labour for selecting bricks and wastage of bricks where use of selected hand moulded brick is specified.
- (b) Leaving uniform horizontal and vertical grooves of specified depth and providing joints of required thickness using wooden or steel strips as the work proceeds.

#### **6.11 CAVITY WALL- DELETED**

#### **6.12 GYPSUM PARTITION PANELS**

**6.12.1** The material shall conform to IS:2849.

##### **6.12.2 Dimensions**

As per the item nomenclature.

##### **6.12.3 Laying**

- (a) Panels are stored in a dry place and water should not come in contact with panels during or after construction. If the panels get wet, they should be dried before use.
- (b) The floor should be perfectly level before laying the first course. All panels must be properly aligned to the plumb. Successive layer of panels must be alternatively staggered so that vertical joints are not in the same line.
- (c) The recommended quantity of Gypsum Bonding Plaster must be used for joints and filling the grooves made or conduits, pipelines, etc. Excess Bonding Plaster must be scooped and removed, so that the joints and the places where the grooves are filled in are flush and even.
- (d) The walls should be dry and sanding done properly especially at joints before the primer is applied so that the surface is even and joints will not be visible after painting. Avoid chasing with chisel and hammer. Use electrical saw or grooving tools for conduiting etc.
- (e) The recommended span of walls is maximum 4 meters and maximum height is 4.5 meters.
- (f) Gypsum panel can easily be cut with coarse tooth hand saw, electric jigsaw, etc. The panels can be cut, sawn, drilled, milled or dowelled on the job. For concealed piping and conduit, the depth of groove should not exceed 50 mm. Hammer and chisel techniques to form chases must be avoided.
- (g) Sanding: This application is to make the surface level without undulations. To make the gypsum wall surface level (in particular at joints, where there is excess bonding plaster), do sanding with sand paper at joints and other places, wherever you find uneven surface, otherwise joints will be visible after painting. It is important to sand all joints uniformly.
- (h) Primer Application: The purpose of the primer is to give a better adhesion to the paint and also to reduce consumption of paint on the wall. Water thinable primers shall be used only.

##### **6.12.4 Measurements**

The length and height shall be measured correct to a cm. Area shall be calculated in square meters correct to two places of decimal. No deduction shall be made for ducts, opening made from the standard size of panel.

##### **6.12.5 Rate**

The rate shall include the cost of materials and labor involved in all the operations described above.

#### **6.13 BRICK EDGING**





**6.13.1** The edging shall be of bricks of class specified in the item. The specifications of bricks shall be as described in para 6.1. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the bricks for edging. The bed of trenches shall be compacted to a firm and even surface. The brick shall be laid true to line in cement mortar 1:4 (1 cement: 4 fine sand) with length parallel and butting the plinth protection. The top face of the brick edging shall be in one level to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the brick edging shall project above the adjacent concrete surface. Cement mortar shall conform to the specification described in chapter 3.0.

#### **6.13.2 Measurements**

The brick edging shall be measured in running meter correct a cm.

#### **6.13.3 Rate**

Rate shall include the cost of materials and labour involved in all operations.

### **6.14 AUTOCLAVED AERATED CONCRETE BLOCK MASONRY WORK**

#### **6.14.1 Terminology**

For the purpose of, Autoclave Aerated Concrete Block masonry work, the following definitions shall apply

1. **Autoclaved-** Steam curing of concrete Products, sand lime bricks, asbestos cement products, hydrous calcium silicate insulation Products, or cement in an autoclave at maximum ambient temperatures generally between 170°C to 215°C.
2. **Block-** A concrete masonry unit, any one of the external dimensions of which is greater than the corresponding dimension of a brick as specified in IS: 3952 and of such size and mass as to permit it to be handled by one man. Furthermore, to avoid confusion with slabs and Panels, the height of the block shall not exceed either its length or six times its width.
3. **Block Density-** The density calculated by dividing the mass of a block by the overall volume, including holes or cavities and end recesses.
4. **Drying Shrinkage-** The difference between the length of specimen which has been immersed in water and then subsequently dried to constant length, all under specified conditions; expressed as a percentage of the dry length of the specimen.
5. **Gross Area-** The total area occupied by a block on its loading face, including areas of the cavities and end recesses.
6. **Height-** The vertical dimension of the exposed face of a block, excluding any tongue or other device designed to provide mechanical keying
7. **Length-** The horizontal dimension of the exposed face of a block excluding any tongue or other device designed to provide mechanical keying.
8. **Width-** The external dimension of a block at the bedding plane, measured at right angles to the length and height of the block.

#### **6.14.2 Dimensions & Tolerances**

Autoclave Aerated Concrete Block shall be made in sizes and shapes to fit different concrete needs. They include stretcher, corner, double corner or pier, jamb, header, bull nose, partition block and concrete floor units.





Autoclave Aerated Concrete Block shall be referred to by its normal dimension the term 'normal' means that the dimension includes the thickness of the mortar joints. The actual dimension shall be 10mm short of the normal dimension (or 4mm short in special areas finer joints as specified).

**6.14.2.1** The normal dimension of the concrete block shall be as follows:

Length : 400, 500 or 600 mm  
 Height : 200, 250 or 300 mm  
 Width : 100, 150, 200 or 250 mm

In addition, Autoclave Aerated Concrete Block shall be manufactured in half length of 200, 250 or 300 mm correspond to the full lengths.

**6.14.2.2** The nominal dimensions of the units are so designed that taking account of the thickness of mortar joints, they will produce wall length and heights which will conform to the principles of modular co-ordination.

**6.14.2.3** Block of sizes other than those specified above, may also be used if so specified in the case of special Autoclave Aerated Concrete Block such as jallie or screen wall and ornamental block, the specified size may not necessarily apply.

**6.14.2.4** The maximum variation in the length of the Autoclave Aerated Concrete Block shall not be more than plus/minus 5mm and maximum variation in the height and width of Autoclave Aerated Concrete Block, not more than plus/minus 3mm.

**6.14.2.5** The faces of Autoclave Aerated Concrete Block shall be flat & Rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angle to the face of the Blocks.

**6.14.2.6** The Autoclave Aerated Concrete Block with special faces shall be manufactured and supplied if so specified.

**6.14.3** The autoclaved Autoclave Aerated Concrete Block shall be classified in two grades according to their compressive strength as indicated in table:

S. No.	Density in oven dry (kg/m <sup>3</sup> )	Compressive Strength (min)		Thermal Condition in Air Dry condition (W/m.K)
		Grade-I (N/mm <sup>2</sup> )	Grade-II (N/mm <sup>2</sup> )	
1	451 to 550	2.00	1.50	0.21
2	551 to 650	4.00	3.00	0.24
3	651 to 750	5.00	4.00	0.3
4	751 to 850	4.00	5.00	0.37
5	851 to 1000	7.00	4.00	0.42

#### 6.14.4 Materials

**6.14.4.1** Cement Cement complying with any of the Indian Standard may be used as per the direction of the manufacturer.

**6.14.4.2** Use of Fly ash conforming to IS 3812 may be permitted to a limit of 20% in cement conforming to IS 249.

**6.14.4.3** The lime shall satisfy the requirement for class C lime specified as in IS 712.



**6.14.4.4** The aggregate used for the manufacture of Autoclave Aerated Concrete Block shall conform to the following requirements

- (a) Sand-Conforming to IS 383-1970 except for the grading which may be made to suit the product and silica content shall not be less than 80%.
- (b) Fly ash – Conforming to IS 3812-1981 with loss on ignition not more than 4%.

**6.14.4.5** The water used in the manufacture of Autoclave Aerated Concrete Block shall be free from matter harmful to concrete or reinforcement or matter likely to cause efflorescence in the block and shall meet the requirements of IS 454-2000.

**6.14.4.6** Additives and Admixtures may be added either as additives to the cement during manufacturing or as additive or admixtures to the concrete mix. Additive or admixtures used in the manufacture of concrete block may be

- (a) Accelerating, water reducing and air-entraining admixtures conforming to IS 9103
- (b) Water proofing agent conforming to IS 2445
- (c) Coloring pigments

#### **6.14.5 Physical requirements**

**6.14.5.1** All Autoclave Aerated Concrete Block shall be sound, free of cracks or other defects which interfere with the proper placing of block units, impair the strength or performance of the construction.

**6.14.5.2** Where block units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections except that if not more than 5% of a consignment contains slight cracks or small chippings not larger than 25mm, this shall not be deemed grounds for rejection.

**6.14.5.3** Dimensions- The overall dimension of the block units when measured shall be in accordance with para 6.14.2.1 subjected to the tolerances mentioned in para 6.14.2.4

**6.14.5.4** Block Density - The Block density shall conform to the requirements specified in table of para 6.14.3, when tested accordance with para 6.14.4 (1)

**6.14.5.5** Compressive Strength - The minimum compressive strength being the average of twelve block units shall be as prescribed in table of para 6.14.3, when tested accordance with para 6.14.4(2)

**6.14.5.6** Thermal Conductivity - The thermal conductivity shall not exceed the values specified in table of para 6.14.3 when tested accordance with para 6.14.4(3)

**6.14.5.7** Drying Shrinkage – the drying shrinkage shall be not more than 0.05% for grade-1 block and 0.10% for grade-2 block when tested accordance with para 6.14.4(4)

#### **6.14.6 Tests**

- (a) Block Density- The block density shall be determined in the manner described in IS 4441 (part-1)
- (b) Compressive Strength- The compressive strength of block shall be determined in accordance with IS 4441 (part-5)
- (c) Thermal Conductivity- The thermal conductivity of block shall be determined in accordance with IS 3344
- (d) Drying Shrinkages-The drying shrinkage of block shall be determined in the manner described in IS 4441 (part-2)

#### **6.14.7 Sampling**



- 6.14.7.1** Lot - In any consignment, all the blocks of the same size and from the same batch of manufacture shall be grouped together into a minimum number of groups of 10000 blocks or less. Each such group shall constitute a lot.
- 6.14.7.2** From each lot, a sample of 24 blocks shall be selected at random. The required numbers of Blocks shall be taken at regular intervals during the loading of the vehicle or unloading the vehicles depending on whether sample is taken before delivery or after delivery. When this is not practicable, sample shall be taken from the stack in which case the required number of blocks shall be taken at random from across the top of the stacks, the sides accessible and from the interior of the stacks by opening trenches from the top.
- 6.14.7.3** The sample of blocks shall be marked for future identification of the consignment it represents. The blocks shall be kept under cover and protected from extreme conditions of temperature, relative humidity and wind until they are required for test. The tests shall be undertaken as soon as practicable after the sample has been taken.

#### **6.14.8 Number of tests**

- 6.14.8.1** All the 24 Blocks shall be checked for dimensions and inspected for visual defects.
- 6.14.8.2** Out of the 24 blocks, 12 blocks shall be subjected to the test for compressive strength, 3 blocks to the test for density, 3 blocks to the test for thermal conductivity and 3 blocks to the test for drying shrinkage. The remaining 3 blocks shall be reserved for re-test for drying shrinkage if a need arises.
- 6.14.8.3** The samples of AAC blocks (each sample consisting of 4 specimen) shall be chosen randomly from the lot procured and tested for various parameters specified in para 4 above. One samples shall be tested for every 100 cum or part thereof. However, minimum one sample shall be tested from each lot received at site if the quantity procured in the lot is less than 100 cum. If required, Engineer-in-Charge or his authorized representative shall inspect the factory during production of the material for this work and also collect samples (of materials used for making AAC blocks and precast AAC blocks) from the factory itself. The contractor shall consider this contingency also while placing the order with one of the approved firms. Nothing extra shall be payable on this account.

#### **6.14.9 Criteria for conformity**

- 6.14.9.1** The number of blocks with dimensions outside the tolerance limit and or with visual defects, among those inspected, shall not be more than two.
- 6.14.9.2** For density, the mean value shall be within the range specified in Table of para 3
- 6.14.9.3** For compressive strength, the mean value, say X shall be determined. The test results shall be grouped into groups of 4, individual values of ranges shall be determined, the average range a calculated from these values and shall satisfy the following condition:
- $$X - 0.4 R > \text{minimum value specified in Table of para 3.}$$
- 6.14.9.4** For thermal conductivity, the mean value shall be equal to or less than the value specified in Table of para3.
- 6.14.9.5** For drying shrinkage, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements.

#### **6.14.10 Manufacturer's Certificate**

The manufacturer shall satisfy himself that the masonry units conform to the requirements of this specification and, if requested, shall supply a certificate to this effect to the purchaser or his representative.



#### **6.14.11 Independent Tests**

**6.14.11.1** If the purchaser or his representative requires independent tests, the samples shall be taken before or immediately after delivery, at the option of the purchaser or his representative and the tests shall be carried out in accordance with this specification.

**6.14.11.2** The manufacturer shall supply free of charge the units required for testing.

#### **6.14.12 Storage**

General requirements of storage of autoclaved cellular (aerated) concrete blocks shall be as described in IS: 4082.

#### **6.14.13 Marking**

**6.14.13.1** Each lot of concrete masonry units manufactured in accordance with this specification shall be suitably marked with information-

- (a) The identification of the manufacture
- (b) The grade and block density of the unit
- (c) The month and year of manufacturing

Each block may also be marked with the ISI Certification mark

**6.14.14** The R.C C bend shall be provided on 150mm /230mm/ 300mm thick masonry to increase the strength and compatibility. The RCC bend shall be provided at sill level and at lintel level over throughout the wall. This thickness of the bend shall be approved by the Engineer in charge or as specified in drawing. The payment of RCC bend and reinforcement shall be paid separately.

Autoclave Aerated Concrete Block masonry shall be provided with polymer modified adhesive mortar. The polymer modified adhesive mortar shall be provided @ 30 kg per cum or with cement mortar 1:4 (1 cement: 4 coarse sand).

**6.14.15** Autoclave Aerated Concrete Block with 100 mm thick masonry shall be provided with two number 4mm dia reinforcement steel bar at every third course. The payment of reinforcement shall be paid separately.

**6.14.16** Autoclaved Aerated Concrete Block confirming the IS Code - 2185 (Part-3)

#### **6.14.17 Measurements**

**6.14.17.1** Autoclave Aerated Concrete Block Masonry shall be measured in cubic meters unless otherwise specified.

Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 metre. ie. 1 cm. Areas shall be calculated to the nearest 0.01 sqm and the cubic contents shall be worked out to the nearest 0.01 cubic metres.

Note: (i) Autoclave Aerated Concrete Block work in parapet walls, mumty, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below.

**6.14.17.2** No deductions or additions shall be done and no extra payment made for the following:

Note: Where minimum area is defined for deduction of an opening, void or both, such areas shall refer only to opening or void within the space measured.

- (a) Ends of dissimilar materials (that is, joists, beams, lintels, posts, girders, rafters, purlins, trusses, corbels, steps etc.); up to 0.1 m<sup>2</sup> in section;
- (b) Opening up to 0.1 m<sup>2</sup> in area (see Note);



- (c) Wall plates, bed plates, and bearing of slabs, chajjas and the like, where thickness does not exceed 10 cm and bearing does not extend over the full thickness of wall;
- (d) Cement concrete blocks as for hold fasts and holding down bolts;
- (e) Iron fixtures, such as wall ties, pipes upto 300 mm diameter and hold fasts for doors and windows;
- (f) Chases of section not exceeding 50 cm in girth; and
- (g) Bearing portion of drip course, bearing of moulding and cornice.

Note: In calculating area of an opening, any separate lintel or sills shall be included with the size of the opening but end portions of lintel shall be excluded. Extra width of rebated reveals, if any, shall also be excluded.

**6.14.17.3** String courses, projecting pilasters, aprons, sills and other projections shall be fully described and measured separately in running metres stating dimensions of each projection.

**6.14.17.4** Square or rectangular pillars shall be measured separately in cubic metres

**6.14.17.5** Circular pillars shall be measured separately in cubic metres as per actual dimensions.

**6.14.17.6** Autoclave Aerated Concrete Block work curved on plan shall be measured like the block work in straight walls and shall include all cutting and wastage of blocks, tapered vertical joints and use of extra mortar, if any. Block work curved on plan to a mean radius not exceeding six metres shall be measured separately and extra shall be payable over the rates for block work in straight walls. Nothing extra shall be payable if the mean radius of the block work curved in plan exceeds six metres.

**6.14.17.7** Tapered walls shall be measured net as walls and extra payment shall be allowed for making tapered surface for block work in walls.

#### **6.14.18 Rate**

The rate shall include the cost of materials and labour required for all the operations described. The rate shall also include the following:

- (a) Raking out joints or finishing joints flush as the work proceeds.
- (b) Preparing tops of existing walls and the like for raising further new block work.
- (c) Rough cutting and waste for forming gables, splays at eaves and the like.
- (d) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.
- (e) Rough cutting and waste for block work curved in plan and for backing to stone or other types of facing.
- (f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.
- (g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items
- (h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section; and
- (i) Block on edge courses, cut brick corners, splays reveals, cavity walls, brick works curved on plan to a mean radius exceeding six metres.



## TEST FOR DIMENSIONAL TOLERANCE (Clause 6.1.3.3)

### A -1. Sampling

As per para 6.1.3.1 and 6.1.3.2.

### A -2. Procedure

All the blisters, loose particles of clay and small projections shall be removed from the surface of bricks. Each specimen of 20 bricks shall then be arranged upon a level surface successively as indicated in Fig. A, B and C of para A -4 below in contact with each other and in straight line. The overall length of the assembled bricks (20 Nos) shall be measured with a steel tape sufficiently long to measure the whole row at one stretch.

### A-3. Tolerance

The actual dimensions of bricks when tested as described in A-2 shall be within the following limits per 20 bricks.

#### Modular Bricks

Length	3720 to 3880 mm (3800 $\pm$ 80 mm)
Width	1740 to 1840 mm (1800 $\pm$ 40 mm)
Height	1740 to 1840 mm (1800 $\pm$ 40 mm) for 90 mm high brick
	740 to 840 mm (800 $\pm$ 40 mm) for 40 mm high brick

#### Non-Modular Bricks

For class 10

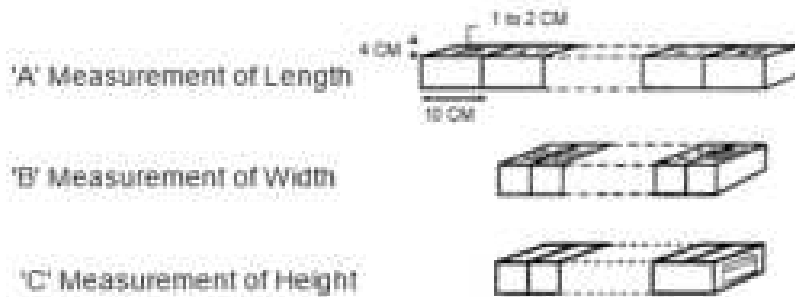
Length	(4520 to 4480) mm (4400 $\pm$ 80 mm)
Width	(2240 to 2140) mm (2200 $\pm$ 40 mm)
Height	(1440 to 1340) mm (1400 $\pm$ 40 mm) for 70 mm high bricks
	(440 to 540) mm (400 $\pm$ 40 mm) for 30 mm high bricks

For other classes

Length	(4320 to 4480) mm
Width	(2130 to 2310) mm
Height	(1340 to 1440) mm for 70 mm high bricks
	(840 to 920) mm for 44 mm high brick

#### A-4. Criteria for Conformity

A lot shall be considered conforming to the requirements of dimensions and tolerances if all the groups of bricks are tested to meet the specified requirements.





## TEST FOR COMPRESSIVE STRENGTH (Clause 6.1.3.4)

### B-1. Specimen

Five whole bricks shall be taken from the samples as specimens for this test. Length and width of each specimen shall be measured correct to 1 mm.

### B-2. Apparatus

The apparatus consists of compression testing machine, the compression plate of which shall have a ball seating in the form of portion of a sphere the centre of which shall coincide with the centre of the plate.

### B-3. Procedure

- a) Pre-conditioning: The specimen shall be immersed in the water for 24 hours at 25° to 29°C. Any surplus moisture shall be allowed to drain at room temperature. The frog of the bricks should be filled flush with mortar 1:3 (1 cement: 3 clean coarse sand of grade 3 mm and down) and shall be kept under damp jute bags for 24 hours, after that these shall be immersed in clean water for three days. After removal from water, the bricks shall be wiped out of any traces of moisture.
- b) Actual Testing: Specimen shall be placed with flat faces horizontal and mortar filled face upward between three plywood sheets each of thickness 3 mm and carefully centered between plates of the testing machine. Plaster of Paris can also be used in place of plywood sheets to ensure a uniform surface. Load shall be applied carefully axially at uniform rate of 14 N/mm<sup>2</sup> per minute till the failure of the specimen occurs.

### B-4. Reporting the Test Results

The compressive strength of each specimen shall be calculated in N/mm<sup>2</sup> as under:

$$\text{Compressive Strength} = \frac{\text{Maximum Load at Failure (in N)}}{\text{Area of Specimen (in sq. mm)}}$$

In case the compressive strength of any individual brick tested exceeds the upper limit of the average compressive strength specified for the corresponding class of brick, the same shall be limited to the upper limit of the class specified in para 6.1.2 for the purpose of calculating the average compressive strength. Compressive strength of all the individual bricks comprising the sample shall be averaged and reported.

### B-5. Criteria for Conformity

A lot shall be considered having satisfied the requirements of average compressive strength if the average compressive strength specified in para 6.1.2 for the corresponding class of brick tested is not below the minimum average compressive strength specified for the corresponding class of bricks by more than 20 per cent.





### TEST FOR WATER ABSORPTION (Clause 6.1.3.5)

#### C-1. No. of Specimen

Five whole bricks shall be taken from samples as specimen for this test.

#### C-2. Apparatus

A balance required for this test shall be sensitive to weigh 0.1 percent of the weight of the specimen.

#### C-3. Procedure

- a) Pre -conditioning: The specimen shall be allowed to dry in a ventilated oven at a 110°C to 115°C till it attains a substantially constant weight. If the specimen is known to be relatively dry, this would be accomplished in 48 hours, if the specimen is wet, several additional hours may be required to attain a constant weight. It shall be allowed to cool at room temperature. In a ventilated room, properly separated bricks will require four hours for cooling, unless electric fan passes air over them continuously in which case two hours may suffice. The cooled specimen shall be weigh ( $W_1$ ) a warm specimen shall not be used for this purpose.
- b) Actual Testing: Specimen shall be completely dried before immersion in the water. It shall be kept in clean water at a temperature of  $27^\circ\text{C} \pm 2^\circ\text{C}$  for 24 hours. Specimen shall be wiped out of the traces of water with a damp cloth after removing from the water and then shall be weighed within three minutes after removing from water ( $W_2$ ).

#### C-4. Reporting the Test Results

The water absorption of each specimen shall be calculated as follows and the average of five tests shall be reported.

$$\text{Water absorption} = \frac{W_2 - W_1}{W_1} \times 100$$

#### C-5. Criteria for Conformity

A lot shall be considered having satisfied the requirements of water absorption if the average water absorption is not more than 20% by weight.

**TEST FOR EFFLORESCENCE**  
**(Clause 4.1.3.4)****D-1. No. of Specimen**

Five whole bricks shall be taken as specimen for this test.

**D-2. Apparatus**

Apparatus required for this test shall be a shallow flat bottom dish containing distilled water.

**D-3. Procedure (actual testing)**

The brick shall be placed vertically in the dish with 2.5 cm immersed in the water. The room shall be warm (18°C to 30° C) and well ventilated. The bricks should not be removed until it absorbs whole water. When the whole water is absorbed and the brick appears to be dry, place a similar quantity of water in that dish and allow it to evaporate as before. The brick shall be examined after the second evaporation.

**D-4. Reporting the Test Results**

The rating to efflorescence in ascending order shall be reported as 'NIL', 'SLIGHT', 'MODERATE', 'HEAVY' or 'SERIOUS' in accordance with the following:

- a) NIL: When there is no perceptible deposit of efflorescence.
- b) SLIGHT: When not more than 10 per cent of the area of the brick is covered with a thin deposit of salts.
- c) MODERATE: When there is heavier deposit and covering upto 50% of the area of the brick surface but unaccompanied by powdering or flaking of the surface.
- d) HEAVY: When there is a heavy deposit of salts covering 50% or more of the brick surface but unaccompanied by powdering or flaking of the surface.
- e) SERIOUS: When there is heavy deposit of salts, accompanied powdering and/or flaking of the surface and tending to increase in the repeated wetting of the specimen.

**D-5. Criteria for Conformity**

A lot be considered having satisfied the requirements of efflorescence if for 4 out of the specimen of 5 bricks, the rating of efflorescence is not beyond "Moderate".



## BRICK PILLARS

Sub Head: Brick Work  
Clause: 6.2.4.1

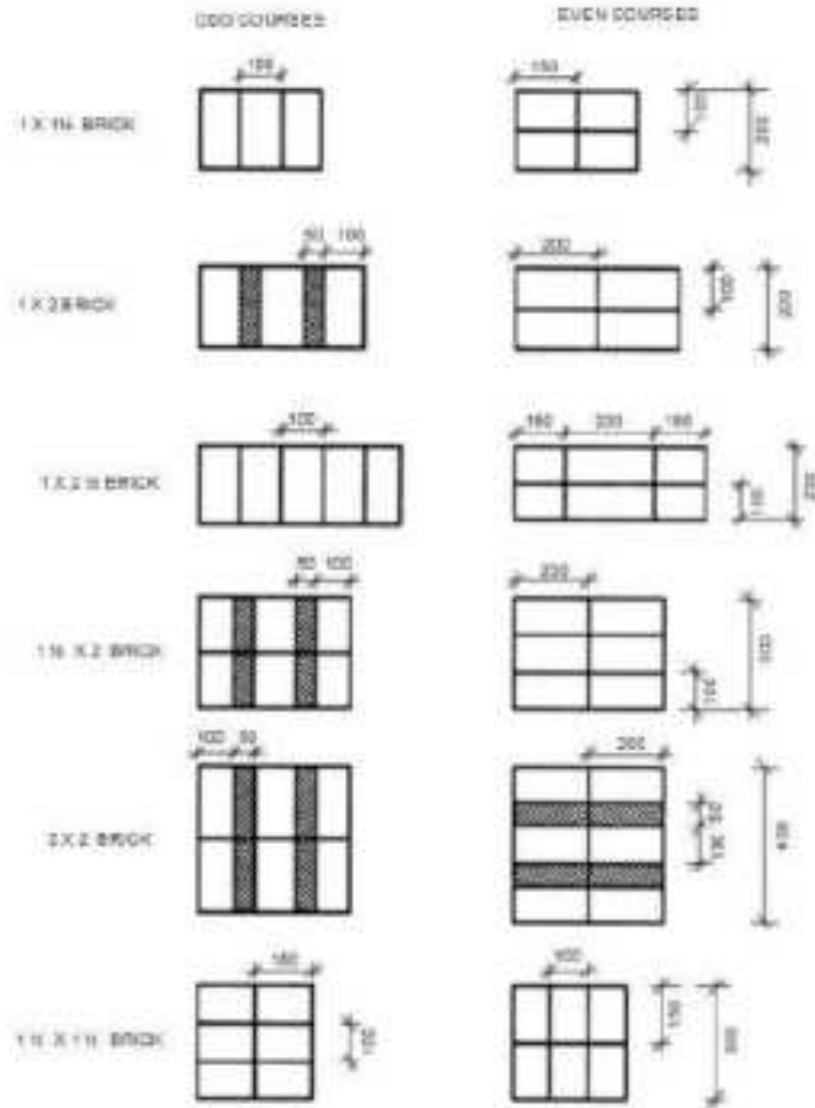


Figure 6.2 : English Bond

Drawing not to scale  
All dimensions are in mm

## BRICK BONDS

Sub Head: Brick Work  
Clause: 6.2.4.1

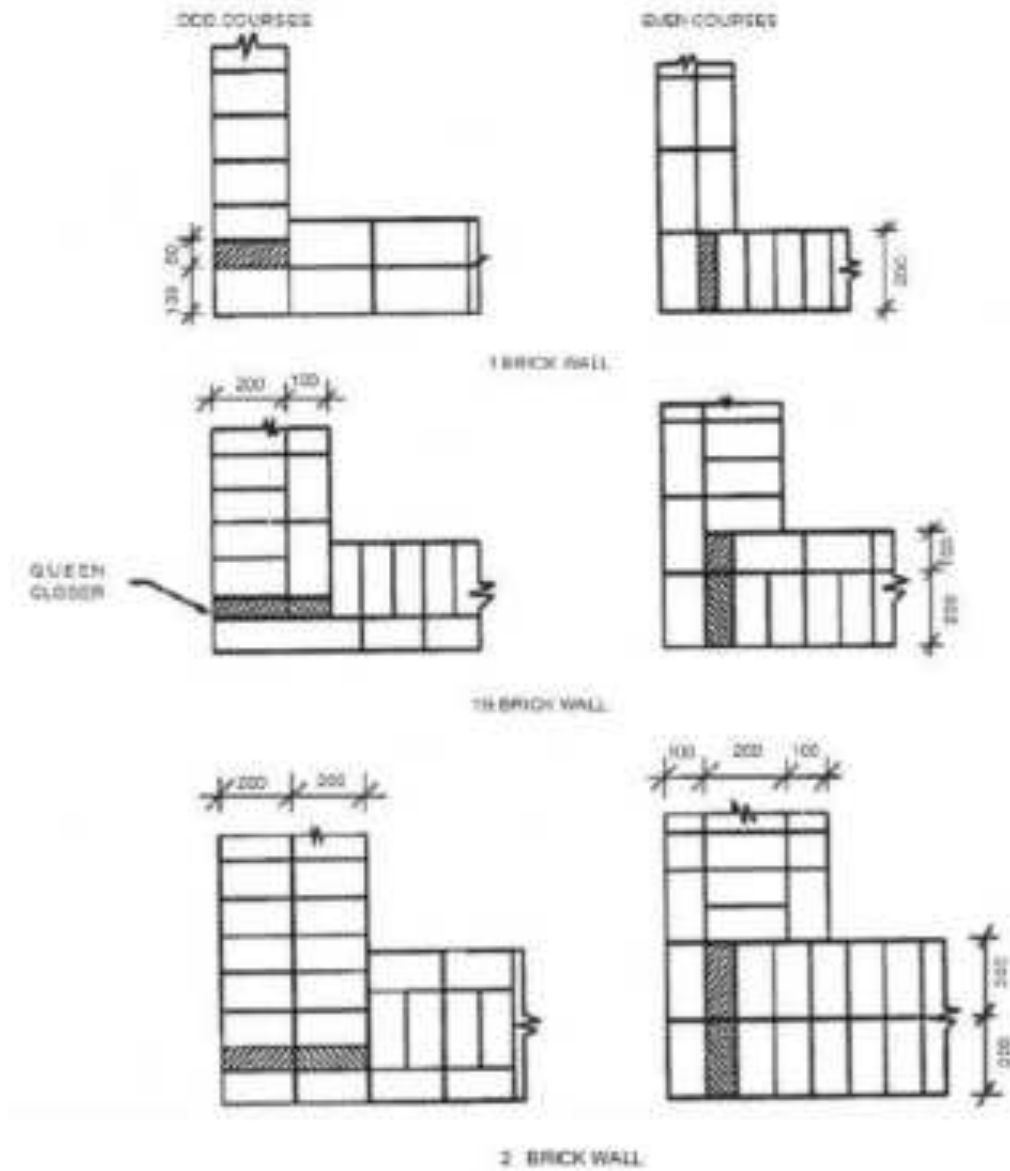


Figure 6.3 : English Bond

Drawing not to scale  
All dimensions are in mm

## BRICK BONDS (Contd.)

Sub Head: Brick Work  
Clause: 6.2.4.1

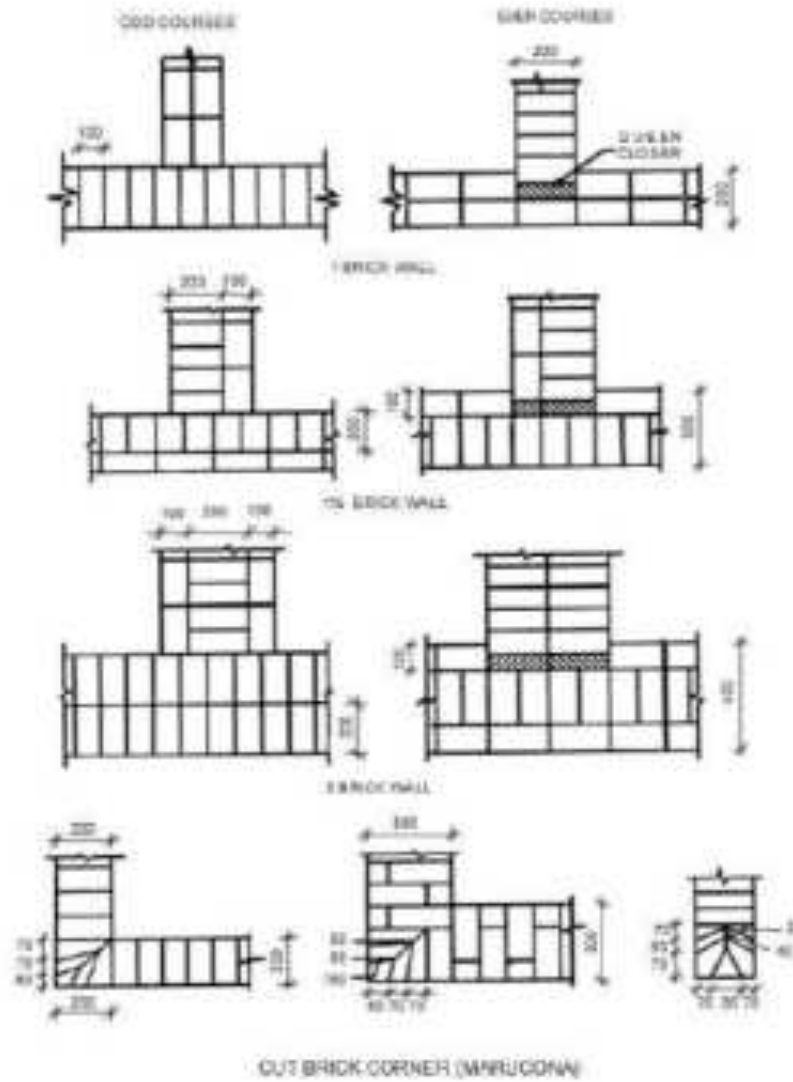


Figure 6.4 : English Bond

Drawing not to scale  
All dimensions are in mm

## BRICK WORK IN ARCHES

Sub Head: Brick Work  
Clause: 6.3

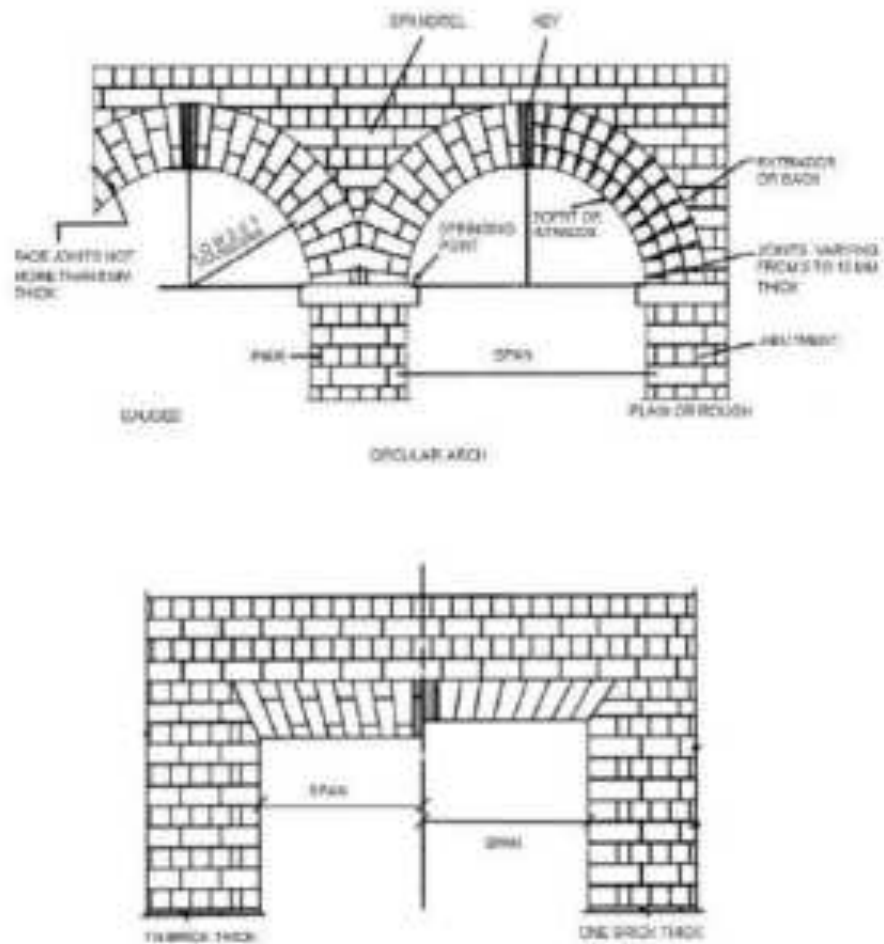


Figure 6.5 : Brick Work in Arches

Drawing not to scale





## STONE WORK



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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work	Material
Stone	7.1.1	(i) Water absorption	Not more than 20% by mass for sandstone and as specified in IS 1123 for other stones.	Lab	IS:1124	One test for 200 sqm/ 40cum or part thereof or change of source as per direction of Engineer-in- Charge <b>(Minimum 50sqm. For slabs and 10 cum in stone masonry).</b>	100 sqm/20 cum or part thereof or change of source as per direction of Engineer-in- Charge <b>(Minimum 50sqm. for slabs and 10 cum in stone masonry)</b>
	7.4	(ii) Transverse Strength	Not less than 7N/mm <sup>2</sup> (70 Kgf/cm <sup>2</sup> ) for sandstone and as specified in IS 1123 for other stone	Lab	IS:1121 Part-2	-do-	-do-
	7.8	(iii) Resistance Of wear	Not greater than 2 mm on the average and 2.5mm for any individual specimen for sandstone and as specified in IS 1123 for other stones	Lab	IS: 1706	-do-	-do-
	7.9	(iv) Durability	Shall not develop of spalling Signs disintegration	Lab	IS: 1126	-do-	-do-



Material	Claus e	Test	Field/ Lab Test	Test Procedure	Frequenc y of testing for construct ion work and EPC Project Work	Frequency of testing for maintenanc e work	Material
			cracks for sandstone and as specified in IS 1123 for other stones.				



### LIST OF BUREAU OF INDIAN STANDARD CODES

S.No.	IS Code	Subject
1.	IS 737	Specifications for wrought aluminium and aluminium alloy, steel and strip for general engineering purpose
2.	IS 1121 - (Pt. I)	Methods of determination of properties and strengths of natural building stones (Part-I compressive strength)
3.	IS 1122	Methods for determination of specific gravity of natural building stone
4.	IS 1123	Methods of identification of natural building stones
5.	IS 1124	Methods of test of determination of water absorption, apparent, specific gravity and porosity of natural building stones
6.	IS 1125	Methods of test of determination of weathering of natural building stone
7.	IS 1126	Methods of test for determination of durability of natural building stone
8.	IS 1128	Specification for Lime stone (Slab & Tiles)
9.	IS 1129	Recommendations for dressing of natural building stones
10.	IS 1200 (Pt. IV)	Methods of measurements of building and Civil engineering works stone Masonry
11.	IS 1197 (Pt. I)	Code of practice for construction of rubble stone masonry
12.	IS 1597 (Pt. II)	Code of practice for construction of ashlar stone masonry
13.	IS 1805	Glossary of terms relating to stones, quarrying and dressing
14.	IS 3620	Specification for laterite stone block for masonry
15.	IS 3622	Sand stone (Slab & Tiles)
16.	IS 4104 (Pt. I)	Code of practice for external facings and veneers (Part I-Stone facing).
17.	IS 4101 (Part II)	Code of practice for external facing and veneers: (Part II-Cement Concrete facing)



## 7 STONE WORK

### 7.0 TERMINOLOGY

#### **Ashlar**

Stone masonry using dressed square stone blocks of given dimensions having faces perpendicular to each other and laid in courses.

#### **Bed Joint**

The joint where one stone presses on another for example, a horizontal joint in a wall or radiating joint between the voussoirs or arch (See Fig. 7.1 and 7.13)

#### **Block**

(a) Hollow (Open and Closed Cavity) Block: A concrete masonry unit with any one of the external dimensions greater than the corresponding dimension of a brick and having one or more large holes or cavities which either pass through the block (open cavity) or do effectively pass through the block (closed cavity) and having the solid material between 50% and 75% of the total volume of the block calculated from the overall dimensions.

(b) Solid Block: A concrete masonry unit with external dimensions greater than corresponding dimension of a brick and having solid material not less than 75% of the total volume of the block calculated from over all dimension.

#### **Bond**

An interlocking arrangement of structural units in a wall to ensure stability.

#### **Bond Stone (through Stone)**

Selected long stone used to hold a wall together transversely (See Fig. 7.8).

#### **Corbel**

Stone bonded well into the wall with part of it projecting out of the face of wall to form a bearing surface.

#### **Cornice**

A horizontal molded projection which crowns or finishes either a wall, any horizontal division of wall, or any architectural feature (See Fig. 7.1C).

#### **Cramp**

A small piece of metal or the hardest or toughest stone procurable, sunk in mortices and fixed across joints as additional ties. The ends of metal cramps are bent at right angles and stone cramps are dovetailed (See Fig. 7.1B).

#### **Course**

A layer of stones in wall including the bed mortar.

#### **Dowels**

Dowels are small sections of metal, stone or pebbles bedded with mortar in corresponding mortice in bed or side joint or adjacent stones (See Fig. 7.1A).

#### **Jamb**

The part of the wall at the side of an opening.

**Joggle**

A key between the stones by providing a groove in one stone to take a corresponding concealed projection in the edges on the other stone (See Fig. 7.1B).

**Natural Bed**

The planes of stratification that occurs in a sedimentary rock.

**Parapet**

A solid or pierced guard wall for flat stone terrace or balcony (or a bridge) or a curb wall at the lower part of a pitched roof which is exposed to atmosphere on face back and top (See Fig. 7.1C).

**Quoin**

A quoin is the external angle of wall or building. The term is also applied to stone specially selected and neatly dressed for forming such angle.

**Random**

Random or irregular size and shapes.

**Reveal**

The part of the jamb between the frame and the arris.

**Rubble Masonry**

Masonry built of stones either irregular in shapes as quarried or squared and only hammer dressed and having comparatively thick joints. As far as possible, stones for rubble masonry shall be angular.

**Skewback**

Sloping surface against which the springing of an arch rests.

**Spandrel**

Space between the haunches below the decking level.

**String Course**

A horizontal band, plain or moulded, usually projecting slightly from the face of wall (See Fig. 7.1C).

**Surfacing or Dressing of Stones**

The stones are dressed to have different surfaces as indicated below.

**Template or Bed Block**

A block of stone or concrete bedded on a wall to distribute the pressure from a concentrated load.

**Self Faced Surfaces**

Surfaces of stone slabs used for roofing, flooring, lintels etc. as obtained from quarry.

**Squared Back Surface**

Means the surface shall be dressed back at right angles to the face of the stone.

**Chisel Drafted Margin**

The dressing done with a drafting chisel in narrow strips of width generally 2 to 5 cm. Chisel drafted margin shall be punch dressed.

**Hammer Dressed Surface**



A hammer dressed stone shall have no sharp and irregular corners and shall have a comparatively even surface so as to fit well in masonry. Hammer dressed stone is also known as hammer faced, quarry faced and rustic faced. The bushing from the general wall face shall not be more than 40 mm on exposed face and 10 mm on faces to be plastered (Fig. 7.2).

#### **Rock Faced Surface**

A rock faced stone shall have a minimum of 25 mm wide chisel drafted margin at the four edges, all the edges being in the same plane (Fig. 7.3).

#### **Rough Tooled Surface**

A rough tooled surface shall have a series of bands, made by means of a plane chisel 4 to 5 cm wide, more or less parallel to tool marks all over the surface. These marks may be either horizontal, vertical or at an angle of 45° as directed (Fig. 7.4). The edges and corners shall be square and true. The depth or gap between the surface and straight edge, held against the surface shall not be more than 3 mm (Rough tooled stones are used where fairly regular plane faces are required for masonry work).

#### **Punched Dressed Surface**

A rough surface is further dressed by means of punch chisel to show series of parallel ridges. The depth of gap between the surface and a straight edge held against the surface shall not exceed 3 mm (Fig. 7.5). Punched dressed stones are used where even surfaces are required.

#### **Close Picked Surface**

A punched stone is further dressed by means of point chisel so as to obtain a finer surface, ridges or chisel marks left over being very tiny. The depth of gap between the surface and a straight edge kept over the surface shall not exceed 1.5 mm (Fig. 7.6).

#### **Fine Tooled Surface**

Close picked surface is further dressed so that all the projections are removed and fairly smooth surface is obtained. The surfaces shall have 3 to 4 lines per centimetre width depending on the degree of hardness of stone and degree of fineness required (Fig. 7.7). This type of dressing is commonly adopted for ashlar work.

#### **Polished Surface**

Surfaces having a high gloss finish. Polishing of stones shall be done by rubbing them with suitable abrasive, wetting the surface where necessary with water. Alternatively polishing of stones shall be done by holding them firmly on the top of revolving table to which some abrasive material like sand or carborundum is fed. The final polishing shall be performed by rubber or felt, using oxide of lime (called by trade name as putty powder) as a polishing medium.

#### **Moulded**

Cut to profile of a moulding with punched dressed surfaces, unless otherwise specified.

### **7.1 RANDOM RUBBLE STONE MASONRY**

#### **7.1.0 Material**

#### **7.1.1 Stone**

The stone shall be of the type specified such as granite, trap, limestone, sand stone, quartzite, etc. and shall be obtained from the quarries, approved by the Engineer-in-Charge. Stone shall be hard, sound, durable and free from weathering decay and defects like cavities, cracks, flaws, sand holes, injurious veins, patches of loose or soft materials and other similar defects that may adversely affect its strength and appearance. As far as possible stones shall be of uniform colour, quality or texture. Generally, stone





shall not contain crypts crystalline silica or chart, mica and other deleterious materials like iron-oxide organic impurities etc. Stones with round surface shall not be used.

The compressive strength of common types of stones shall be as per Table 7.1 and the percentage of water absorption shall generally not exceed 5% for stones other than specified in table 7.1 for laterite this percentage is 12%.

**TABLE 7.1**

Type of stone	Maximum Water Absorption Percentage by weight	Minimum Compressive Strength kg./sq.cm.
Granite	0.5	1000
Basalt	0.5	400
Lime stone (Slab & Tiles)	0.15	200
Sand stone (Slab & Tiles)	2.5	300
Marble	0.40	500
Quartzite	0.40	800
Laterite (Block)	12	35

**Note 1:** Test for compressive strength shall be carried out as laid down in IS 1121 (Part I).

**Note 2:** Test for water absorption shall be carried out as laid down in IS 1124.

#### 7.1.2 Size of Stones

Normally stones used should be small enough to be lifted and placed by hand. Unless otherwise indicated, the length of stones for stone masonry shall not exceed three times the height and the breadth on base shall not be greater than three-fourth of the thickness of wall, or not less than 150 mm. The height of stone for rubble masonry may be up to 300 mm.

The selection and grading of stones for rubble masonry is largely done at site and the smaller stones are used in the hearting of wall.

**7.1.3** Random Rubble Masonry shall be uncoursed or brought to courses as specified (Fig. 7.8 and 7.9). Uncoursed random rubble masonry shall be constructed with stones of sizes as referred to in para 5.0 and shapes picked up random from the stones brought from the approved quarry. Stones having sharp corners or round surfaces shall, however, not be used.

**7.1.4** Random rubble masonry brought to the course is similar to uncoursed random rubble masonry except that the courses are roughly levelled at intervals varying from 300 mm to 900 mm in height according to the size of stones used.

#### 7.1.5 Dressing

Each stone shall be hammer dressed on the face, the sides and the beds. Hammer dressing shall enable the stones to be laid close to neighboring stones such that the bushing in the face shall not project more than 40 mm on the exposed face.

- Face stone:** At least 25% stones shall be headers tailing into the work at least 2/3rd the thickness of wall in super structure masonry. Such stones shall not be less than 200 sq. cm in cross sections.
- Hearting Stones:** The hearting or interior filling of a wall face shall consist of rubble stones not less than 150 mm in any direction, carefully laid, hammered down with a wooden mallet into position and solidly bedded in mortar. The hearting should be laid nearly level with facing and backing.



- iii. **Quoin Stone:** Quoin stone shall be less than 0.03 cum in volume.
- iv. **Jamb stones:** The jambs shall not be made with stones specified for quoins except that the stones which were required to be provided at 1 metre centre to centre on both the exposed faces shall here be provided only on the jamb and the length shall be equal to the thickness of the wall for wall upto 60 cm and a line of headers shall be provided for walls thicker than 60 cm as specified for bond.

#### 7.1.5 (A) Courses

The masonry shall be carried out in regular courses of height not exceeding 50 cm and masonry on any day will not be raised more than 60 cm in height when using mortars having compressive strength less than 20 kg/sq. cm at 28 days and 100 cm when using mortars exceeding this strength.

#### 7.1.5 (B) Thickness of Joints

The joint thickness shall not exceed 30 mm at any point on the face. Chips of the stone and spalls shall be wedged into seating bed of face stones to avoid excessive bed thickness. No pinning shall be allowed to avoid excessive joint thickness.

#### 7.1.6 Mortar

The mortar used for joining shall be as specified.

#### 7.1.7 Laying

Stone shall be laid on their natural bed and shall be solidly bedded full in mortar with close joints, chips of stone spalls be wedged into the work wherever necessary. No dry work or hollow spaces shall be allowed and every stone whether large or small shall be carefully selected to fit snugly the interstices between the large stones. Masonry shall be built breaking joints in all the three directions. Bond stone and headers shall be properly laid into the work and shall be marked by the contractor with white lead paint. The bond stones shall be provided as specified in para 7.1.8.

The masonry work in wall shall be carried up true to plumb or to specified batter.

Random rubble masonry shall be brought to the level courses at plinth, window sills, lintel and roof levels. Levelling shall be done with concrete comprising of one part of the mortar as used for masonry and two parts of graded stone aggregate of 20 mm nominal size.

The masonry in structure shall be carried uniformly. Where the masonry of one part is to be delayed, the work shall be raked back at an angle not steeper than 45°.

#### 7.1.7 (A) Raking out joints

All the joints on the faces to be pointed or plastered shall be raked out with racking tool to a depth of 20mm while the mortar is still green.

#### 7.1.8 Bond Stones

Though bond stones shall be provided in walls up to 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone etc.) the bond stone shall extend about two-third into the wall, as through stones in such walls a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 m<sup>2</sup> of the wall surface and shall be provided at 1.5 m to 1.8 m apart clear in every course.

In case of highly absorbent types of stones (porous lime stone and sand stone etc.) single piece bond stones may give rise to dampness. For all thicknesses of such walls a set of two or more bond stones overlapping each other by at least 15 cm shall be provided. Length of each such bond stone shall not



be less than two-third of the thickness of the wall. Where bond stones of suitable lengths are not available pre-cast cement concrete block of 1:3:6 mix (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) of cross section not less than 225 square centimetres and length equal to the thickness.

At least one bond stone or a set of bond stones shall be provided at 1.5 m to 1.8 m apart clear in every course. (Bond stones shall be marked suitably with paint as directed by the Engineer-in-Charge).

#### **7.1.9 Quoin and Jamb Stones**

The quoin and jamb stones shall be of selected stones neatly dressed with hammer or chisel to form the required angle. Quoin stones shall not be less than 0.01 cum in volume. Height of quoins and jamb stones shall not be less than 15 cm. Quoins shall be laid header and stretcher alternatively.

#### **7.1.10 Joints**

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more than 20 mm thick.

The joints shall be struck flush and finished at the time of laying when plastering or pointing is not to be done. For the surfaces to be plastered or pointed, the joints shall be raked to a minimum depth of 20 mm when the mortar is still green.

#### **7.1.11 Scaffolding**

Single scaffolding having one set of vertical support shall be allowed. The supports shall be sound and strong, tied together by horizontal pieces, over which the scaffolding planks shall be fixed. The inner end of the horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars under one meter in width or near the skew back of arches. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1: 3: 6 (1 cement: 3 coarse sands: 6 stone aggregate 20 mm nominal size).

#### **7.1.12 Curing**

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

#### **7.1.13 Protection**

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

#### **7.1.14 Measurements**

**7.1.14.1** The length, height and thickness shall be measured correct to a cm. The thickness of wall shall be measured at joints excluding the bushing. Only specified dimensions shall be allowed; anything extra shall be ignored. The quantity shall be calculated in cubic meter nearest to two places of decimal.

**7.1.14.2** The work under the following categories shall be measured separately.

- (a) From foundation to plinth level (level one):
  - i. work in or under water and or liquid mud
  - ii. work in or under foul positions.
- (b) Above plinth level and upto floor five level.
- (c) Above floor five level to every floor/floors or part thereof.



- (d) Stone masonry in parapet shall be measured together with the corresponding item in the wall of the storey next below.

**7.1.14.3** No deduction shall be made nor extra payment made for the following:

- (a) Ends of dissimilar materials (that is joists, beams, lintels, posts, girders, rafters purlins, trusses, corbels, steps etc.) up to 0.1 sqm in section.
- (b) Openings each up to 0.1 sqm in area. In calculating the area of openings, any separate lintels or sills shall be included along with the size of opening but the end portions of the lintels shall be excluded and the extra width of rebated reveals, if any, shall also be excluded.
- (c) Wall plates and bed plates, and bearing of chajjas and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

**Note:** The bearing of floor and roof shall be deducted from wall masonry.

- (d) Drain holes and recesses for cement concrete blocks to embed hold fasts for doors, windows etc.
- (e) Building in masonry, iron fixture, pipes up to 300 mm dia, hold fasts of doors and windows etc.
- (f) Forming chases in masonry each up to section of 350 sq cm.

Masonry (excluding fixing brick work) in chimney breasts with smoke or air flues not exceeding 20 sq dm (0.20 sqm) in sectional area shall be measured as solid and no extra payment shall be made for pargetting and coring such flues. Where flues exceed 20 sq dm (0.20 sqm) sectional area, deduction shall be made for the same and pargetting and coring flues shall be measured in running metres stating size of flues and paid for separately. Aperture for fire place shall not be deducted and no extra payment made for splaying of jambs and throating.

**7.1.14.4** Apertures for fire places shall not be deducted and extra labor shall not be measured for splaying of jambs, throating and making arch to support the opening.

**7.1.14.5** Square or Rectangular Pillars: These shall be measured as walls, but extra payment shall be allowed for stone work in square or rectangular pillars over the rate for stone work in walls. Rectangular pillar shall mean a detached masonry support rectangular in section, such that its breadth does not exceed two and a half times the thickness.

**7.1.14.6** Circular Pillars (Columns): These shall be measured as per actual dimensions, but extra payment shall be allowed for stone work in circular pillars over the rate for stone work in walls. The diameter as well as length shall be measured correct to a cm.

**7.1.14.7** Tapered walls shall be measured net, as per actual dimensions and paid for as other walls.

**7.1.14.8** Curved Masonry: Stone masonry curved on plan to a mean radius exceeding 6 meters shall be measured and included with general stone work. Stone work circular on plan to a mean radius not exceeding 6 meters shall be measured separately and shall include all cuttings and waste and templates. It shall be measured as the mean length of the wall.

**7.1.15 Rate**

The rate shall include the cost of materials and labor required for all the operations described above and shall include the following:

- (a) Raking out joints for plastering or pointing done as a separate item or finishing flush as the work proceeds.
- (b) Preparing tops and sides of existing walls for raising and extending.



- (c) Rough cutting and waste for forming gables cores, skew backs or spandrels of arches, splays at eaves and all rough cutting in the body of walling unless otherwise specified.
- (d) Bond stones or cement concrete bond blocks.
- (e) Leading and making holes for pipes etc.
- (f) Bedding and pointing wall plates, lintels, sills etc. in or on walls, bedding roof tiles and corrugated sheets in or on walls.
- (g) Building in ends of joists, beams, lintels etc.

## **7.2 COURSED RUBBLE MASONRY - FIRST SORT (FIG. 7.9)**

**7.2.1 Stone:** Shall be as specified in para 7.1.1.

**7.2.2 Size of Stone:** Shall be as specified in para 7.1.2.

### **7.2.3 Dressing**

Face stones shall be hammer dressed on all beds, and joints so as to give them approximately rectangular block shape. These shall be squared on all joints and beds. The bed joint shall be rough chisel dressed for at least 80 mm back from the face, and side joints for at least 40 mm such that no portion of the dressed surface is more than 6 mm from a straight edge placed on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joint. The bushing on the face shall not project more than 40 mm as an exposed face and 10 mm on a face to be plastered. The hammer dressed stone shall also have a rough tooling for minimum width of 25 mm along the four edges of the face of the stone, when stone work is exposed.

### **7.2.4 Mortar**

The mortar for jointing shall be as specified.

### **7.2.5 Laying**

All stones shall be wetted before use. The walls shall be carried up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 15 cm nor more than 30 cm.

Face stones shall be laid alternate headers and stretchers. No pinning shall be allowed on the face. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar; chips and spalls of stone being used where necessary to avoid thick beds of joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the quantity of stone masonry.

The masonry in a structure shall be carried up uniformly but where breaks are unavoidable, the joints shall be raked back at angle not steeper than 45°. Tothing shall not be allowed.

### **7.2.6 Bond Stones**

Shall be as specified in 7.1.8 except that a bond stone or a set of bond stones shall be inserted 1.5 to 1.8 meters apart, in every course.

### **7.2.7 Quoins**



The quoins shall be of the same height as the course in which these occur. These shall be at least 450 mm long and shall be laid stretchers and headers alternatively. These shall be laid square on the beds, which shall be rough-chisel dressed to a depth of at least 100 mm. In case of exposed work, these stones shall have a minimum of 25 mm wide chisel drafts at four edges, all the edges being in the same plane.

#### **7.2.8 Joints**

All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar, face joints shall not be more than one cm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

**7.2.9 Curing, Scaffolding, Measurements and Rates:** Shall be as specified under para 7.1.

### **7.3 COURSED RUBBLE MASONRY - SECOND SORT (FIG. 7.9)**

**7.3.1 Stone:** Shall be as specified in para 7.1.1.

**7.3.2 Size of Stone:** Shall be as specified in para 7.1.2.

**7.3.3 Dressing:** Shall be as specified in para 7.2.3 except that no portion of dressed surface of joints shall show a depth of gap more than 10 mm from a straight edge placed on it and use of chips shall not exceed 15 per cent of the quantity of stone masonry.

**7.3.4 Mortar:** The mortar for jointing shall be as specified.

**7.3.5 Laying:** Shall be as specified in para 7.2.5 except that the use of chips shall not exceed 15% of the quantity of stone masonry and stone, in each course need not be of the same height but not more than two stones shall be used in the height of a course.

**7.3.6 Bond Stone, Quoins:** Shall be as specified in para 7.2.6 and 7.2.7 respectively.

**7.3.7 Joints:** All bed joints shall be horizontal and all side vertical. All joints shall be fully packed with mortar, face joints shall not be more than 20 mm thick.

When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20 mm by raking tool during progress of work, where the mortar is still green.

**7.3.8 Curing, Scaffolding, Measurement and Rates:** Shall be as specified under para 7.1.

### **7.4 PLAIN ASHLAR MASONRY (FIG. 7.10)**

**7.4.1 (A)** Stone shall be of the type specified. It shall be hard, sound, durable and tough, free from cracks, decay and weathering and defects like cavities, cracks, flaws, sand holes, veins, patches of soft or loose materials etc. before starting the work, the contractor shall get the stones approved by Engineer-in-Charge.

#### **7.4.1 (B) Kota Stone for Veneering**

Kota stone shall be of selected quality, hard, sound, dense & homogeneous in texture free from cracks, decay, weathering and flaws. They shall be machine cut to requisite size and thickness. They shall have colour indicated in the drawings or as instructed by the Engineer-in-Charge. The stone shall have the top (exposed) face polished before being brought to site unless otherwise specified. Before starting the work, the contractor shall get the samples of kota stone approved from the Engineer-in-Charge.



**Dressing:** Every stone shall be cut to the required size and shape and fine machine dressed to the full depth so that a straight edge laid along the side of stone shall be in full contact with it. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the item. Tolerance of  $\pm 2$  mm shall be allowed for the thickness.

#### **7.4.1 (C) Red Sand Stone & White Sand Stone Ashlar Masonry**

The stone shall be red or white as specified in the description of item. The stone shall be hard, sound, tough and free from cracks, decay & weathering. In case of red sand stone, white patches or streaks shall not be allowed. However scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of stone approved by the Engineer-in-Charge.

#### **7.4.2 Size of Stone**

Normally stones used should be small enough to be lifted and placed by hand. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three fourth of the thickness of wall nor less than 15 cm. The height of stone may be up to 30 cm.

#### **7.4.3 Dressing**

Every stone shall be cut to the required size and shape chisel dressed on all beds and joints so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be the fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1 mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straight edge does not exceed 6 mm. Any vertical face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10 mm. All angles and edges that are to remain exposed in the final position shall be true, square and free from chippings.

A sample of dressed stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the work site as a sample after being approved.

#### **7.4.4 Mortar**

The mortar for jointing shall be as specified.

#### **7.4.5 Laying**

All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort.

The walls and pillars shall be carried up truly plumb or battered as shown in drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

In case of ashlar work without backing of brick work or coursed rubble masonry, face stone shall be laid headers and stretchers alternately unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 30 cm in height and all the courses shall be of same height, unless otherwise specified.

For ashlar facing with backing of brick work or coursed rubble masonry (See Fig. 5.11) face stone shall be laid in alternate courses of headers and stretchers unless otherwise directed. Face stone and bond stone course shall be maintained throughout. All connected masonry in a structure shall be carried up nearly at one uniform level throughout, but where breaks are avoidable, the joint shall be made in good long steps so as to prevent cracks developing between new and old work. Bond stone provided in the masonry shall be payable in the item of Ashlar masonry. Neither any deduction will be made from the





brick masonry for embedding the bond stone in the backing nor any extra payment shall be made for any extra labour involved in making holes in brick masonry backing.

When necessary, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these into correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before tying chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work.

**7.4.6 Bond Stones:** Shall be as specified in para 7.1.8.

#### **7.4.7 Joints**

All joints shall be full of mortar. These shall be not more than 6 mm thick. Face joints shall be uniform throughout and a uniform recess of 20 mm depth from face shall be left with the help of the steel plate during the progress of work.

#### **7.4.8 Pointing**

All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15 mm.

#### **7.4.9 Curing**

Masonry work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

#### **7.4.10 Protections**

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

#### **7.4.11 Scaffolding**

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

#### **7.4.12 Measurements**

The finished work shall be measured correct to a centimeter in respect of length, breadth and height. The cubical contents shall be calculated in cubic meter nearest to two places of decimal.

##### **7.4.12.1** No deduction nor any extra payment shall be made for the following:

- i. Ends of dissimilar materials (that is joists, beams, posts, girders, rafters, purlins, trusses, corbels, steps etc.) upto 0.1 sqm in section.
- ii. Openings upto 0.1 sqm in area. In calculating the area of opening, any separate lintels or sills shall be included along with the size of the opening but the end portion of the lintels shall be excluded and extra width of rebated reveals, if any, shall also be excluded.
- iii. Wall plates and bed plates and bearing of chajja and the like, where the thickness does not exceed 10 cm and the bearing does not extend over the full thickness of the wall.

**Note:** The bearing of floor and roof slabs shall be deducted from wall masonry.

- iv. Drainage holes and recesses left for cement concrete blocks to embed hold-fasts for doors and windows, building in the masonry iron fixture and pipes upto 300 mm diameter.





- v. Stone walling in chimney breasts, chimney stacks, smoke or air flues not exceeding 0.20 sqm in sectional area shall be measured as solid and no extra measurement shall be made for pargetting and coring such flues. Where flues exceed 0.20 sqm in sectional area, deduction shall be made for the same and pargetting and coring flues paid for separately.

**7.4.12.2 Square, Rectangular or Circular Pillars:** Shall be measured and paid for as walls, but extra payment shall be allowed for such pillars and columns over the rate for stone work in walls. Rectangular pillars shall mean a detached masonry support, rectangular in section, such that its breadth shall not exceed two and half times the thickness.

**7.4.12.3 Curved Stone Work:** Stone work curved on a plan to a mean radius exceeding six meters shall be measured net and included with general stone work. Stone work circular on a plan to a mean radius not exceeding six meters shall be measured separately and extra payment shall be allowed and shall include all cutting and waste and templates. It shall be measured as the mean length of wall.

#### **7.4.13 Rate**

The rate shall include the cost of materials and labor required for all the operations described above. Stone facing or wall lining up to and not exceeding 8 cm thickness shall be paid for under "Stone work for wall lining etc. (Veneer work)". The stone work of thickness exceeding 8 cm shall be paid under relevant items of work.

### **7.5 PUNCHED ASHLAR (ORDINARY) MASONRY (FIG. 7.10)**

**7.5.1 Stone:** Shall be as specified in para 7.4.1. In case of red or white sand stone, stone shall be red or white as specified in the item. In red sand stone, white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted.

**7.5.2 Size of Stone:** Shall be as specified in para 7.4.2.

**7.5.3 Dressing:** Shall be as specified in para 7.4.3 except that the faces exposed in view shall have a fine dressed chisel draft 2.5 cm wide all-round the edges and shall be rough tooled between the drafts, such that the dressed surface shall not be more than 3 mm from a straight edge placed over it.

#### **7.5.4 Other Details**

The specifications for mortars, laying and fixing, bond stone, joints, pointing, curing, protections, scaffolding, measurements and rates shall be same as specified in para 7.4.

### **7.6 MOULDED, SUNK, CARVED ASHLAR MASONRY (FIG. 7.12)**

**7.6.1 Stone:** Shall be as specified in para 7.4.1.

#### **7.6.2 Dressing**

Every stone shall be cut to the required size and shape and chisel dressed on all beds and joints so as to be free from any waviness and to give perfectly vertical, horizontal, radial or circular joints with adjoining stones as the case may be. The dressed surface shall not be more than 3 mm from a straight edge placed on it. The face shall be gauged, cut, chamfered, grooved, riveted sunk or plain moulded and fine tooled as shown in the working drawings. The joints 6 mm from the face shall also be fine tooled so that straight edge laid along it is in contact with every point. It shall be finest surface which can be given to a stone with the chisel and without rubbing.

In case of sunk or moulded masonry, the corner stone shall be dressed at true right angles or true to the shape as specified. The corners being straight and vertical.

For arch (See Fig. 7.13), dome or circular work (See Fig. 7.12) the stone shall be dressed to require wedge shape so that joints shall be truly radial.



### 7.6.3 Sample

The full-size layout of the molding etc. shall be prepared on platform from which sheet templates shall be cut and the stone dressed to templates to a uniform and fine finish. All visible angles and edge shall be true square and free from chippings. A sample of dressed stone shall be prepared for approval and it shall be kept as sample after being approved by Engineer-in-Charge.

In case of ashlar moulded and carved columns a full-size model of the required moulding, carving etc. shall be prepared in plaster of paris and kept at site of work as sample work after being approved by the Engineer-in-Charge. The stones shall be moulded and carved in accordance with the approved model to a uniform and fine finish.

**7.6.4 Other Details:** Shall be as specified in para 7.4.4, 7.4.5 and 7.4.5 to 7.4.11.

### 7.6.5 Centering and Shuttering

Centering and shuttering required for arch dome or circular moulded work shall be constructed as directed by the Engineer-in-Charge.

### 7.6.6 Measurements

The dimensions of the circumscribing rectangles of the dressed stone used in the work shall be measured correct to a cm and cubical contents shall be calculated in cubic metres, nearest to two places of decimal.

**7.6.6.1** In case of sunk or moulded work the measurements for the work shall be taken course by course. The plain stone used in conjunction with sunk or moulded stone shall be measured and paid for under the relevant item of stone work.

**7.6.6.2** Sunk or moulded work in rectangular, square and circular pillars, moulded cornices and string courses shall be measured under stone work sunk or moulded but extra payment shall be allowed over the general work in each case. No such extra payment shall be allowed for moulded string and plinth courses.

**7.6.6.3** In case of arch dome or circular moulded work for arches exceeding six metres in clear span extra payment for additional cost of centering shall be made on the actual area of soffit including strutting, bolting, wedging, easing, striping and removal.

### 7.6.7 Rate

The rate includes the cost of all materials and labour involved in all the operations described above, including centering and shuttering for arch, dome or circular moulded work.

## 7.7 STONE VENEERING WORK: (Shifted to 8.8)

Clause Shifted to Sub Head 7 (Cladding Work) as Clause No 8.8

## 7.8 STONE CHAJJA (FIG. 7.13)

**7.8.1** Stone slabs shall be hard, sound and durable. These shall be chisel dressed on all faces which are exposed to view and rough dressed at other surface. Angles shall be true and edge lines straight. The finished thickness shall be as stipulated with permissible tolerance of  $\pm 2$  mm. The length of stone slabs in chajja shall not be less than 60 cm unless otherwise specified.

**7.8.2** In case of sloping chajja the stone shall be sloped as specified. It shall have minimum bearing of 20 cm measured horizontally on the wall and the bearing shall also be similarly sloped. Each slab shall have a hole in the centre of the bearing area through which the anchoring M.S. holding down bolt shall pass. The holding down bolts shall be 12 mm diameter and shall be bent at right angles at its lowest end and



buried horizontally for at least 5 cm in a joint 30 cm below the bearing surface. Each holding down bolt shall be secured at top by suitable washer and nut.

- 7.8.3** The stone chajja shall be provided with red sand stone bracket supports in both ends. The stone chajja shall be supported on red sand stone brackets which shall be provided with minimum bearing 15 cm in the brick masonry. The bearing of the stone chajja shall be done by making a recess in brick masonry upto 15 cm width and size of the recess shall be 40 mm large than the thickness of the red sand stone. The red sand stone chajja & support brackets shall be fixed with cement mortar 1:4 (1 Cement : 4 Coarse sand). The stone shall be fixed horizontally with straight outer shape of about 30 mm or 40 mm thickness. It shall be minimum bearing 15 cm on the wall. The stone chajja shall be provided with single pieces of red or white sand stone and supported on the red or white sand stone bracket at ends.

The Chajjas shall be provided with cove supports, where cove is in brick masonry, it shall project out from the wall as under.

45 cm wide Chajjas, cove projection 15 cm, depth of cove 3 courses.

60 cm wide Chajjas, cove projection 20 cm, depth of cove 4 courses.

55 cm wide Chajjas, cove projection 25 cm, depth of cove 5 courses.

90 cm wide Chajjas, cove projection 30 cm, depth of cove 6 courses.

- 7.8.4** In case of horizontal Chajjas, the stone shall be fixed horizontally with a slight outer slope of about 1 cm. It shall have minimum bearing of 15 cm on the wall. Holding down bolts shall be provided, only where so specified.

#### **7.8.5 Pointing**

The joints shall be pointed with 1: 2 cement mortar (1 cement: 2 stone dust) with an admixture of pigment to match the stone shade, and properly cured.

#### **7.8.6 Other Details**

##### **7.8.6.1 Dressing**

Every stone shall be cut to the required size and shape chisel dressed on all beds. All angles and edges that one to remain exposed in the final. Position shall be true; square and true from chipping. A sample of dressed stone shall be prepared for approval of Engineer-in-charge. It shall be kept at the work site as a sample after being approval. No piece which has been damaged shall be used in work.

##### **7.8.6.2 Curing**

Stone chajja work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of stone chajja with fat lime mortar, curing shall commence two days after laying of stone chajja and shall continue for at least seven days thereafter.

##### **7.8.6.3 Protections**

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

##### **7.8.6.4 Scaffolding**

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

#### **7.8.7 Measurements**

- 7.8.7.1** The length and breadth of the finished work shall be measured correct to a cm. The area of Chajjas projecting beyond the wall shall be calculated in sq m correct to two places of decimal.



In case of sloping Chajjas, the sloping breadth shall be measured correct to a cm and the area of Chajjas projecting beyond the wall shall be calculated in sqm correct to two places of decimal.

#### **7.8.8 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above. Anchoring the coves shall be deemed to be included in the rate.

### **7.9 SHELVES, COPING, PLAIN, CORNICES, STRING COURSES ETC.**

#### **7.9.1 Stone**

Stone shall be of uniform colour and texture and of the kind as stipulated.

#### **7.9.2 Dressing**

The exposed faces and sides of shelves shall be chisel dressed such that the dressed surface shall not be more than 3 mm from a straight edge placed on it. All visible angles and edges shall be free from chippings. The surfaces to be buried in the masonry shall be rough dressed.

#### **7.9.3 Laying**

These shall be laid in mortar of specified mix and fixed as shown in drawing or as directed by the Engineer-in-Charge.

#### **7.9.4 Other Details**

Specifications for pointing, curing, protections and scaffolding shall be as specified under para 7.4.

#### **7.9.5 Measurements**

**7.9.5.1 Shelves:** The length and breadth shall be measured inclusive of bearings correct of a cm. The thickness shall be as specified with permissible tolerance of  $\pm 2$  mm. The area shall be calculated in sqm correct to two places of decimal.

**7.9.5.2 Copings:** The dimensions of the circumscribing rectangles of the dressed stones as used in work shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cum.

**7.9.5.3 Plain Cornices, String Courses and Plinth Courses:** The length, breadth and depth of the stone including bearing shall be measured correct to a cm. The cubical contents shall be calculated correct to two places of decimal in cu. m.

**7.9.5.4** No deduction shall be made from the masonry of wall for the bearing of stone shelves, cornices, string courses.

#### **7.9.6 Rate**

The rate shall include the cost of all materials and labour required in all the operations described above.

### **7.10 STONE JALI**

**7.10.1** Stone shall be as specified in para 7.4.1.

#### **7.10.2 Dressing and Fixing**

The stone shall be cut into slabs of required thickness so as to make jali of the specified thickness. The jali shall be cut as per pattern shown on the drawings. All exposed faces shall be fine tooled to a uniform and smooth finish. Fixing shall be done with the adjoining work in grooves, rebates etc., as shown in the drawing or as directed by the Engineer-in-Charge. A tolerance of  $\pm 2$  mm shall be allowed in the specified thickness of the jali.



**7.10.3** Stone jalis shall be fixed in grooves/rebates etc. to adjoining Stone work/Brick work/RCC as shown in the drawing or as directed by Engineer-in-Charge. Necessary sample for the same shall be got approved from the Engineer-in-Charge before execution. The breakage of stone jali during fixing shall be the responsibilities of the contractor and replacement shall be provided at his risk and cost.

#### **7.10.4 Measurements**

The length and breadth of the stone forming the jali including its borders shall be measured correct to a cm and the area shall be calculated in square meters nearest to two places of decimal.

#### **7.10.5 Rate**

It includes the cost of labour and materials required for all the operations described above. It also includes the cost of making grooves or rebates in the adjoining work for fixing jali.

### **7.10A STONE WORK IN OR UNDER WATER AND/OR IN LIQUID MUD & UNDER FOUL POSITION**

**7.10A.1** All water that may accumulate during the progress of work springs; tidal or river seepage from subsoil aquifer shall be bailed, pumped out or otherwise removed. The contractor shall take adequate measures for bailing and pumping out water from site during the progress of work. Pumping shall be done directly from the site in such a manner as to preclude the possibility of movement of water through and fresh work during laying of stone work and for a period of at least 24 hours thereafter, pumping shall be done from a suitable sump separated from the stone work by effective means.

**7.10A.2** Capacity and number of pumps; location at which the pumps are to be installed; pumping hours shall be decided from time to time in consultation with the Engineer-in-charge.

**7.10A.3** Pumping shall be done in such a way as not to cause damage to the work or adjoining property by subsidence etc. Disposal of water shall not cause inconvenience or nuisance in the area or cause damage to the property and structure nearby.

#### **7.10A.4 Classifications**

The stone work shall be categorised as under:

- (a) Work in or under and/or liquid Mud: Stone work where water is met with from any of the sources specified above shall fall in this category. Steady water level in the trial pits before the commencement of bailing or pumping operations shall be the subsoil water level in that one.
- (b) Work in or under foul position: Stone work, where sewage, sewage gases or foul conditions are met with from any source, shall fall in this category. Decision of the Engineer-in-Charge whether the work is in foul position or not shall be final.

#### **7.10A.5 DE-WATERING**

**7.10A.5.1** De-watering shall be done conforming to BIS Code IS: 9559 (guide lines for dewatering during construction) and / or as per the specifications approved by the Engineer-in-Charge. Design of an appropriate and suitable dewatering system shall be the Contractor's responsibility. Such scheme shall be modified / augmented as the work proceeds based on fresh information discovered during the progress of work, at no extra cost. At all times during the construction work, efficient drainage of the site shall be carried out by the Contractor and especially during the laying of plain cement concrete, taking levels, installing rock anchors etc. The Contractor shall also ensure that there is no danger to the nearby properties and installations on account of such lowering of water table. If needed, suitable precautionary measures shall be taken by the Contractor. Also the scheme of dewatering adopted shall have adequate built in arrangement to serve as stand-by to attend, to repair of pumps etc. and disruption of power / fuel supply. Nothing extra shall be payable on this account.



**7.10A.5.2** De-watering shall be carried out by suitable means with adequate stand-by arrangements of pumps etc. and it shall be ensured that its disposal is carried out as per the regulations of the local bodies. The water / slush / muck etc. shall not be disposed off into the public drainage system of sewer manhole or storm water drain but shall be pumped off into the creek close to the plot or disposed by any other manner, subject to the approval of the local bodies in this regard. The agencies are, therefore, advised to inspect and acquaint themselves of the site and location of disposal point(s) of water / slush and satisfy themselves as regards method of pumping and disposal required to be adopted. Any default or failure on the part of the Contractor to acquaint him with the aforesaid aspect of work shall not absolve him from his responsibility for the execution / performance of the contract. Also, all permissions in this regard, to be taken from local authorities, shall be obtained by the Contractor. Nothing extra shall be payable on these accounts.

**7.10A.5.3** In trenches where surface water is likely to get into cut / trench during monsoons, a ring bund of puddle clay or by any other means shall be formed outside, to the required height, and maintained by the Contractor. Also, suitable steps shall be taken by the Contractor to prevent back flow of pumped water into the trench. Nothing extra shall be payable on this account.

**7.10A.5.4** Unless otherwise provided in the item of schedule of quantity, the cost of dewatering or working under water and / or liquid mud for execution of all the items for the work is deemed to be included in quoted rates of the respective items and shall not be measured separately for payment. Nothing extra shall be payable for de-watering in this work, irrespective of whether specified or not, in the item descriptions or in the specifications / conditions in the contract agreement.

**7.10A.6 Measurement:** - The unit, namely, metre depth shall be the depth measured from the level of foul position/ subsoil water level and up to the centre of gravity of the cross-sectional area of excavation actually done for stone work. Metre depth shall be reckoned correct to 0.1 m, 0.05 m or more shall be taken as 0.1 m and less than 0.05m ignored.

In case stone work in or under foul position is also in or under water and/or liquid mud; extra payment shall be admissible only for the stone work actually executed in or under foul position. Pumping or bailing out water met within excavations from source and specifically ordered in writing by the Engineer-in-charge shall be measured separately and paid.

**7.11 DRY STONE CLADDING: (Shifted to 8.12)**

Clause Shifted to Sub Head 8 (Cladding Work) as Clause No 8.12

**7.12 STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING: (Shifted to 8.13)**

Clause Shifted to Sub Head 8 (Cladding Work) as Clause No 8.13

**7.13 ADJUSTABLE STAINLESS STEEL CRAMPS: (Shifted to 8.14)**

Clause Shifted to Sub Head 8 (Cladding Work) as Clause No 8.14

## STONE WORK

Sub Head : Stone Work  
Clause : 7.0

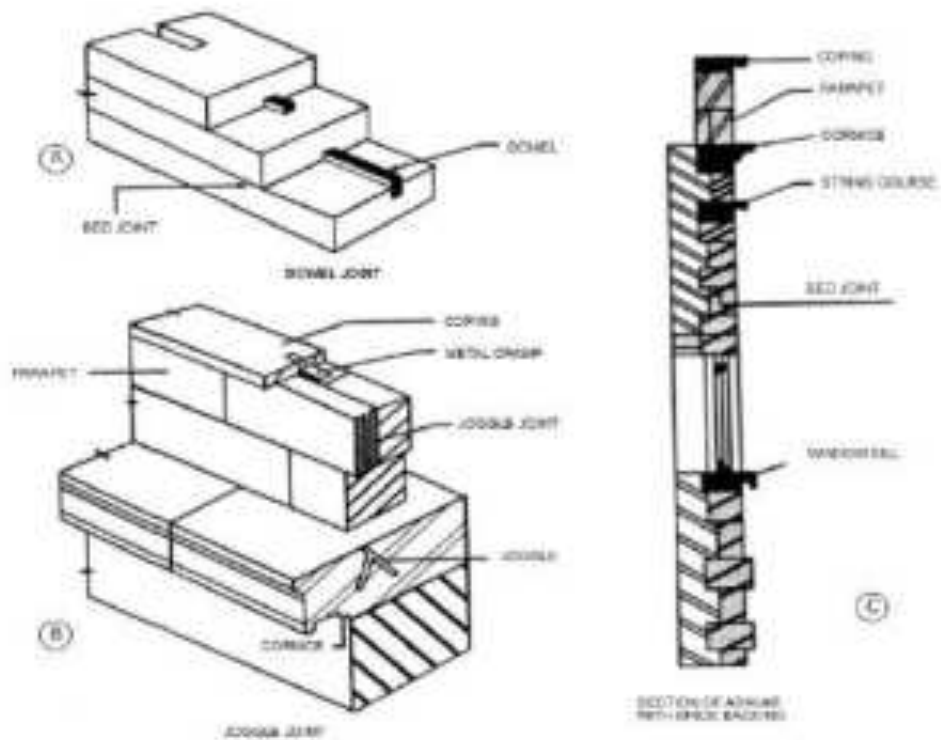


Figure 7.1 : Stone Work

Drawing not to scale





## STONE WORK (Terminology)

Sub Head : Stone Work  
Clause : 7.0



Figure 7.2 : Hammer Dressed Stone Surface



Figure 7.3 : Rock Faced Stone Surface

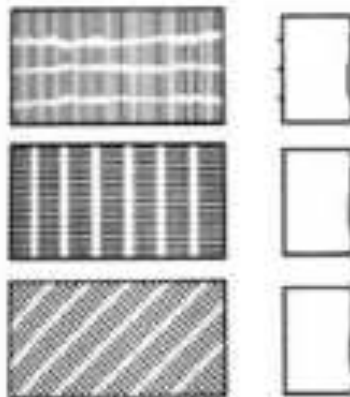


Figure 7.4 : Rough Tooled Stone Surface

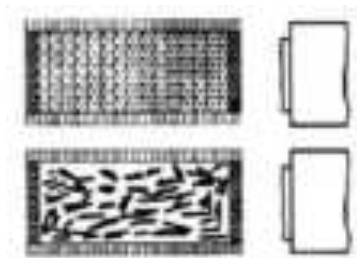


Figure 7.5 : Punched Stone Face Surface (Chisel Drafted)



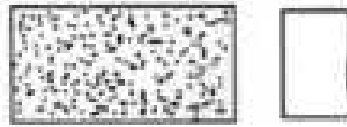


Figure 7.6 : Closed Picked Stone Surface

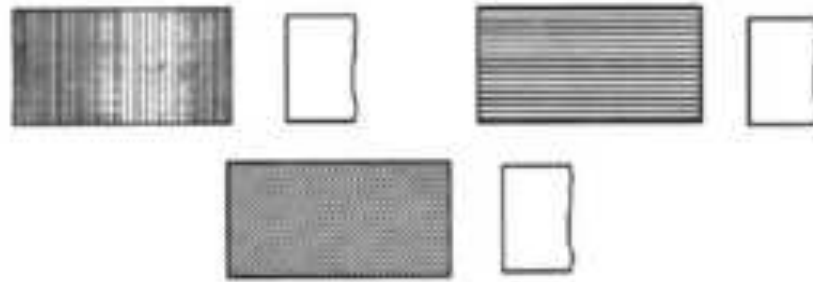


Figure 7.7 : Fine Tooled Stone Surface

Drawing not to scale

## RANDOM RUBBLE MASONRY

Sub Head : Stone Work  
Clause : 7.1

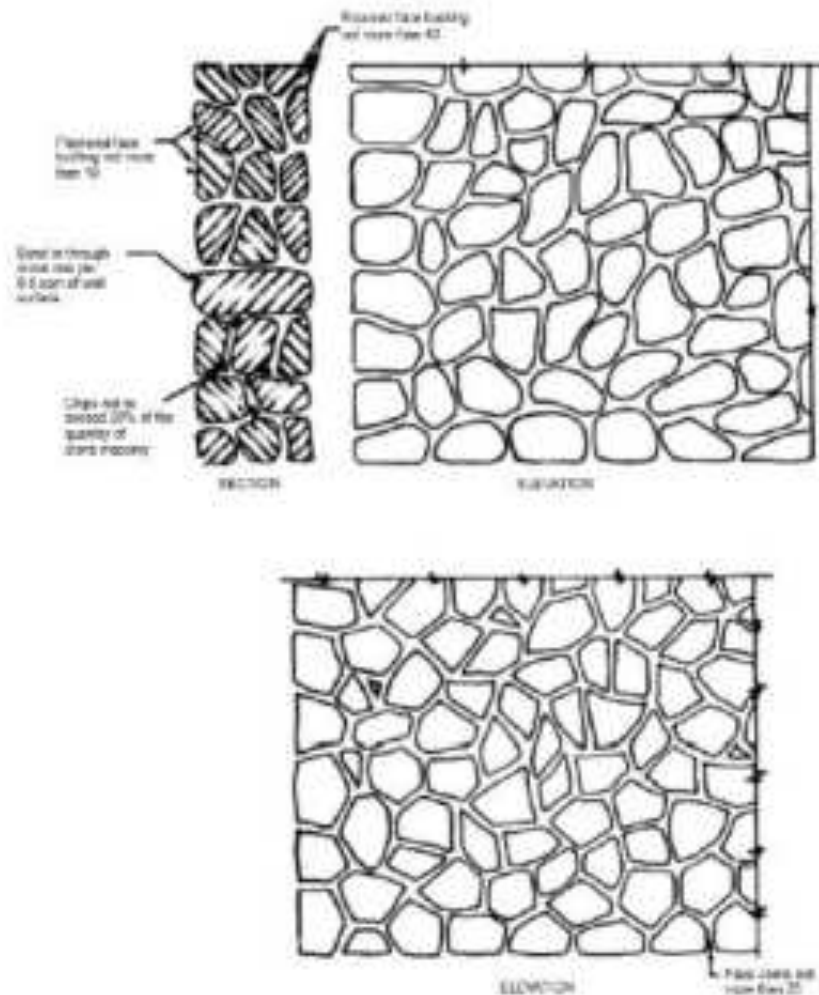


Figure 7.8 : Random Rubble Masonry

Drawing not to scale  
All dimensions are in mm

## RUBBLE STONE MASONRY - COURSED

Sub Head : Stone Work  
Clause : 7.2 & 7.3

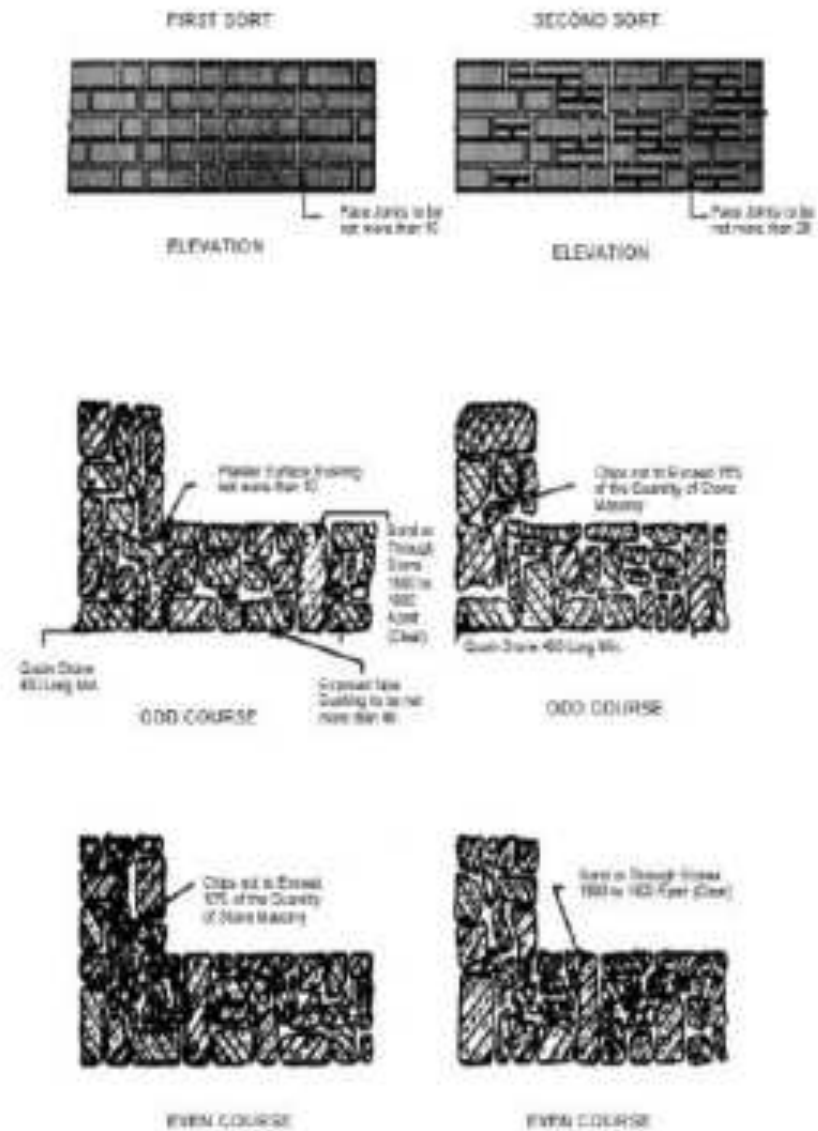


Figure 7.9 : Random Stone Masonry - Coursed

Drawing not to Scale  
All dimensions are in mm

## ASHLAR STONE MASONRY

Sub Head : Stone Work  
Clause : 7.4 & 7.5

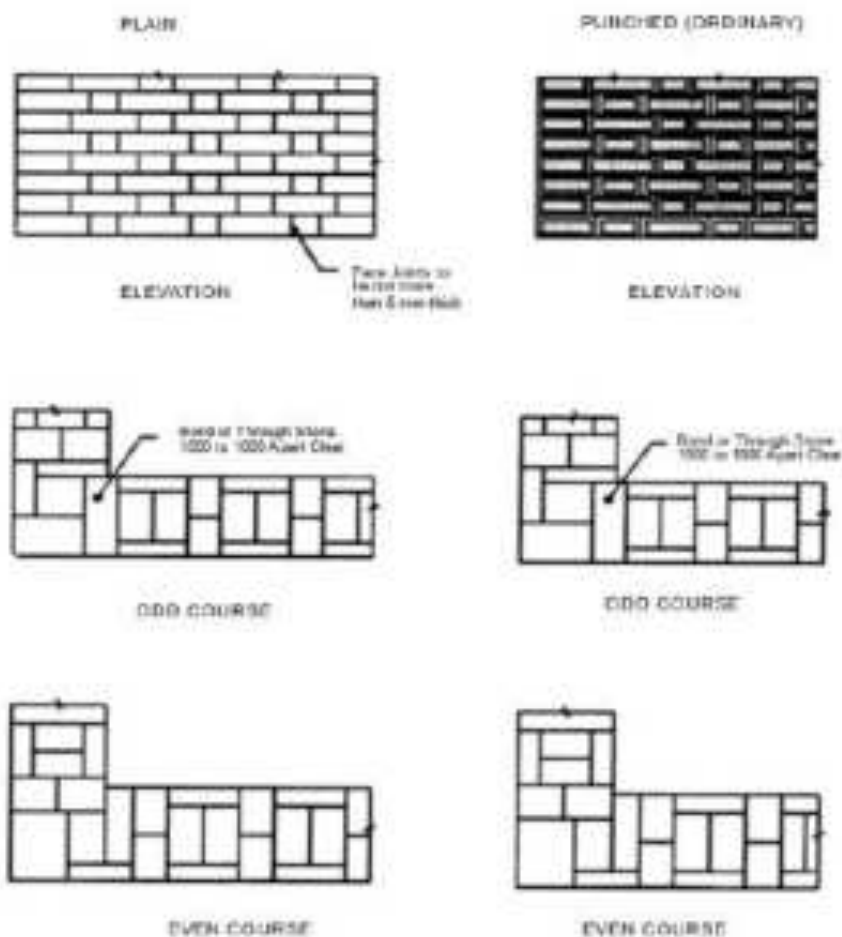


Figure 7.10 : Ashlar Stone Masonry

Drawing not to scale  
All dimensions are in mm

## ASHLAR STONE MASONRY (WITH BRICK BACKING)

Sub Head : Stone Work  
Clause : 7.4.5

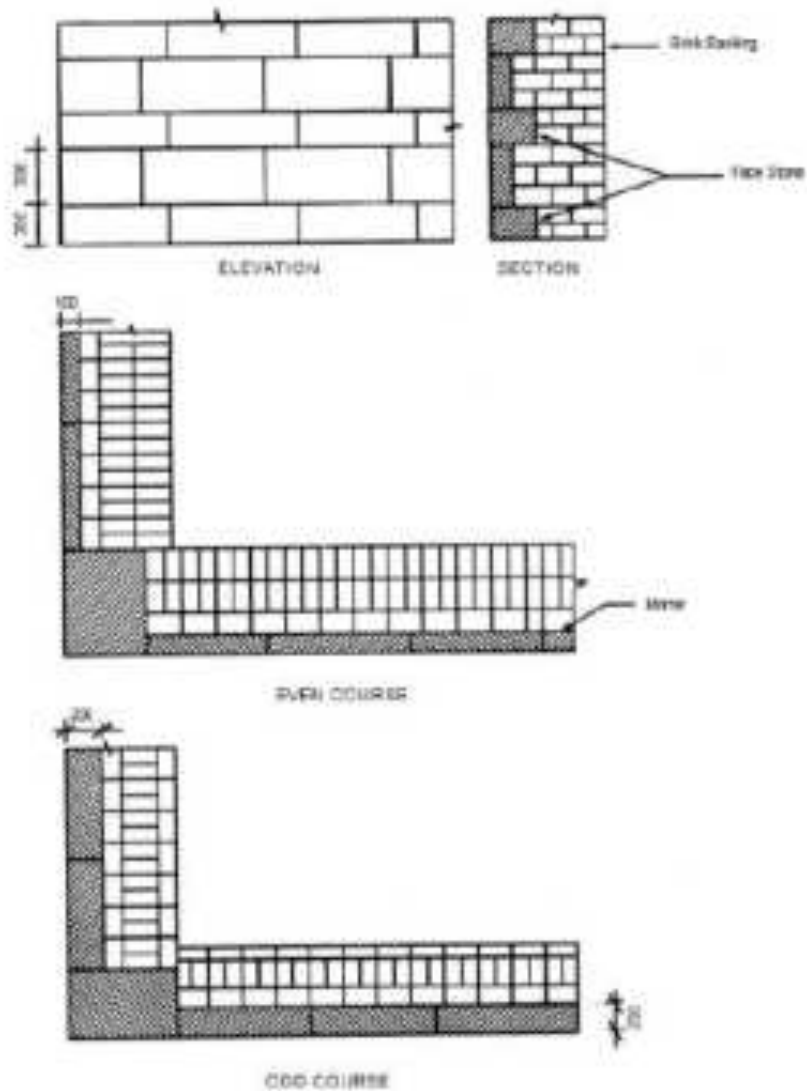


Figure 7.11 : Ashlar Stone Masonry (with Brick Backing)

Drawing not to scale  
All dimensions are in mm

## MOULDED, SUNK, CARVED – STONE WORK

Sub Head : Stone Work  
Clause : 7.6

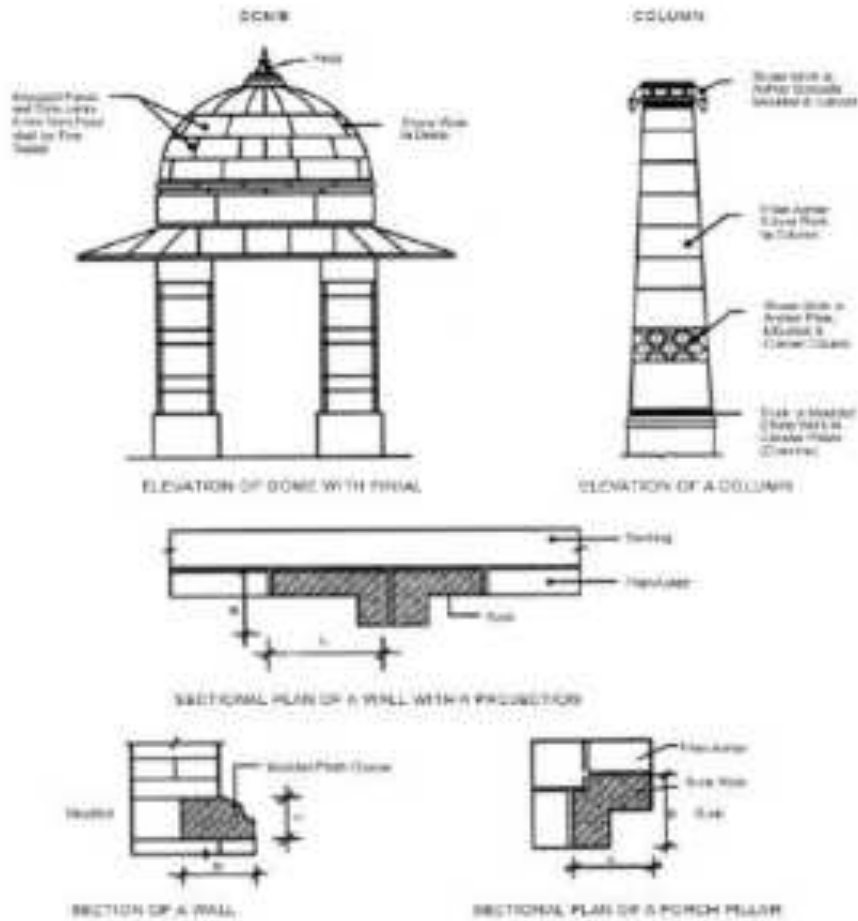


Figure 7.12 : Moulded, Sunk, Carved – Stone Work

Note : Sunk or Moulded Stone Work shown Shaded, to be measured as  $l \times b \times h$

Drawing not to scale

## STONE WORK IN ARCHES & CHAJJAS

Sub Head : Stone Work  
Clause : 7.6 & 7.8

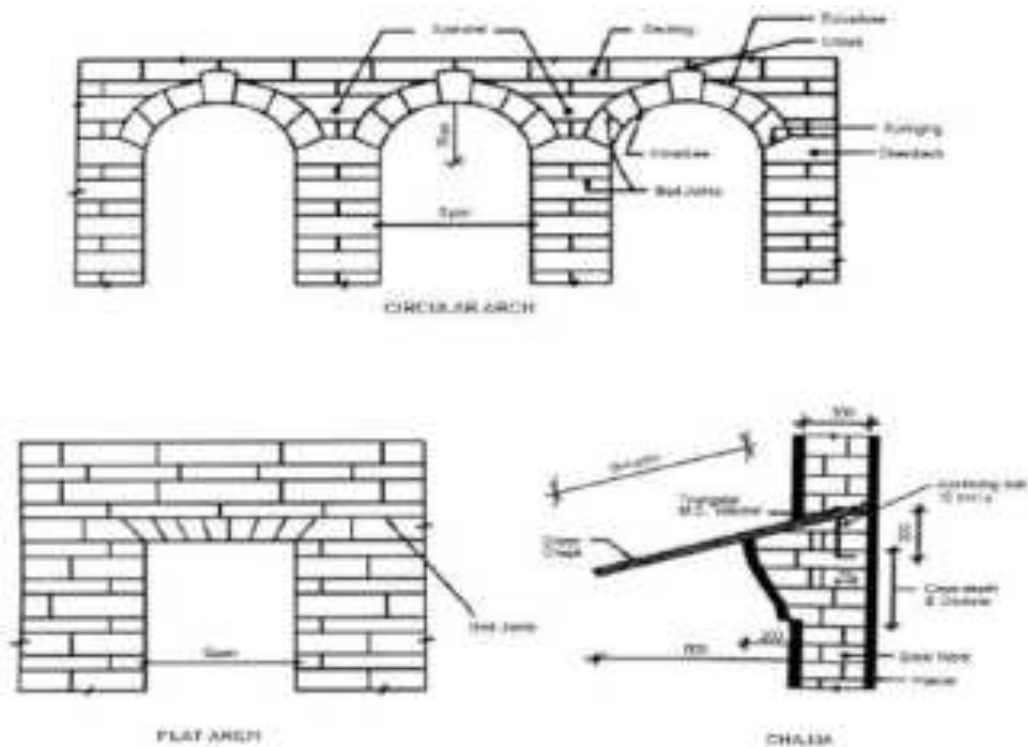


Figure 7.13 : Stone Work in Arches & Chajjas

Drawing not to scale  
All dimensions are in mm

Note: Fig. 7.14, 7.15 & 7.16 shifted to Fig 8.5, 8.6 & 8.5.





## CLADDING WORK



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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
Marble	83 (Table 82)	(i) Moisture Absorption	Lab	IS:112	One test for 500 sqm. or part thereof. (Minimum quantity: 100 sqm)	100 sqm or part thereof (Minimum quantity: 100 sqm)
		(ii) Hardness Test	Lab	Mohs Scale	-do-	-do-
		(iii) Specific Gravity	Lab	IS: 1122	-do-	-do-
Granite		(i) Moisture	Lab	IS: 1124	-do-	-do-
		(ii) Specific Gravity	Lab	IS: 1122	-do-	-do-



## LIST OF BUREAU OF INDIAN STANDARD CODES

S.No.	IS Code No.	Subject
1.	IS 848	Specification for synthetic resin adhesives for plywood (Phenolic and Aminoplastic
2.	IS 1122	Method of test for determination of true specific gravity of natural building stones.
3.	IS 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.
4.	IS 1130	Marble (blocks, slabs and tiles).
5.	IS 1328	Specification for Veneered decorative plywood
6.	IS 1734 (Part-1)	Methods of test for plywood
7.	IS 2380	Methods of test for wood particle boards and boards from other lignocellulosic
8.	IS 3316	Specifications for structural granite
9.	IS 3734 (Part-1)	Rubber – Tolerance for products
10.	IS 4101 (Part 1)	Code of practice for external facing and veneers: Stone facing.
11.	IS 7638	Wood/Lignocellulosic based panel products – Methods of sampling
12.	IS 12049	Dimensions and tolerances relating to wood based panel materials
13.	IS 12823	Wood products – Prelaminated particle boards - Specification
14.	IS 14223 (Part 1)	Polished Building Stones (Part-1) Granite
15.	IS 14842	Coir Veneer board for general purposes – Specification



## 8 CLADDING WORK

### 8.0 GENERAL

Marble shall be hard, sound, dense and homogeneous in texture with crystalline texture as far as possible. It shall generally be uniform in color and free from stains, cracks, decay and weathering.

- 8.0.1** Marbles are metamorphic rocks capable of taking polish, formed from the re-crystallization of lime stones or dolomitic lime stones and are distinguished from lime stone by even visibly crystalline nature and no flaggy stratification.

**Note:** Marble is a product of nature hence it is difficult to guarantee uniformity of colour, veining or other characteristics that may be represented in any sample submitted. A sample will indicate only an average of colour, veining and other general texture and specified finish.

### 8.1 CLASSIFICATION

The marble blocks, slabs and tiles shall be classified broadly in the following two categories:

#### 8.1.1 White Marble

Raj Nagar (plain white) Marble:

It shall be plain white marble with coarse grains predominantly showing mica particles giving reflection in light.

#### 8.1.2 Coloured Marble

i. Plain Black Marble

Black marble sawn along veins locally known as 'Peta Pasu sawing' available at Bhainslana.

ii. Black Zebra Marble/ Cuddapa Black

- (a) Bhainslana Black Zebra Marble: Black marble having grey or white veins available at Bhainslana.
- (b) Kishangarh Black Zebra Marble: Black marble with grey and/or white veins available at Kishangarh.
- (c) Abu Black Zebra Marble: Black marble having white patches and streaks available at Abu.
- (d) Narnaul Black Zebra Marbles: Black marble with thin white veins available at Narnaul.
- (e) Cuddapa Black Marbles: Black Marble from Cuddapa

iii. Green Marble

- (a) Baroda Green Marble: Dark green marble with flowery pattern available at Baroda.
- (b) Abu Green Marble: Light green marble with green and/or brown streaks on white ground available at Ambaji.
- (c) Falna Green Marble: Green marble with prominent yellowish pattern available at Falna.
- (d) Bundi Green Marble: Green marble with pinkish shades available at Umar, (Bundi)

iv. Grey Marble

- (a) Kumari Grey Marble: Grey marble having light blue shades available at Makrana.
- (b) Bundi Grey Marble: Grey Marble with pink or green or black streaks available at Umar (Bundi).



v. Brown Marble

(a) Bar Brown Marble/Brown Marble with light and dark brown shades available at bar.

(b) Narnaul Brown Marble

Brown marble having teak wood shades available at Narnaul.

### 8.1.3 Granite Stone

It shall be of any colour and size as directed by Engineer-in-Charge. Granite shall be plain machine cut and mirror polished. The stone shall be smooth and of even surface without holes or pits.

## 8.2 SIZES AND TOLERANCES

The size of marble blocks, slabs and tiles shall be as mentioned in Table 8.1.

**TABLE 8.1**

Sl. No	Type	Length	Width	Thickness
1.	Blocks	30 to 250	30 to 100	30 to 90
2.	Slabs	70 to 250	30 to 100	2 to 15
3.	Tiles	10 to 60	10 to 60	0.6 to 2.4

1. All dimensions are in centimetre.
2. The length and width, of the blocks shall be in multiple of 30 cm.
3. Length and width of slab shall be in multiple of 10 cm. and thickness in multiple of 1 cm.
4. Tiles shall be square cut and linear dimensions in multiple of 10 cm.
5. Only slabs and tiles shall be machine cut and factory made.
6. For 6 mm thick tiles, special precautions will be required for fixing them like using special adhesive as per manufacturer's specifications. Such tiles are not suitable for outside veneering work exposed to rains/sun if used in large areas in continuous stretches. For tiles of thickness 20 mm and above cramps may be provided if approved by Engineer-in-Charge.

### Tolerance

The following tolerances shall be allowed in the dimension of blocks, slabs and tiles:

Type	Tolerance
Blocks	
(a) Length	+ 2 per cent
(b) Width	+ 2 per cent
(c) Thickness	+ 2 per cent
Slabs	
(a) Length	+ 2 per cent



(b) Width	+ 2 per cent
(c) Thickness	+ 3 per cent
Tiles	
(a) Linear Dimension	+ 3 per cent
(b) Thickness	+ 1 per cent

The sizes other than those mentioned above may be provided as directed by the Engineer-in-Charge and nothing extra shall be payable on this account.

### 8.3 PHYSICAL PROPERTIES

8.3.1 The physical properties of marble for blocks, slabs and tiles and method of tests are mentioned in Table 8.2.

**TABLE 8.2**

**Physical Properties of Marble & Granite**

Characteristic	Marble		Granite	
	Marble Requirements	Method of test	Granite Requirement	Method of test
1. Moisture absorption after 24 hrs immersion in cold water	Max. 0.4%	IS 1124	Max. 0.50% by weight	IS 1124
2. Hardness	Min. 3	Mhos scale		
3. Specific Gravity	Min. 2.5	IS 1122	Min. 2.6	IS 1122

#### 8.3.2 Approval of Sample

Before starting the work, the contractor shall get samples of marble approved by the Engineer-in-Charge. Approved samples shall be kept in the custody of the Engineer-in-Charge and the marble supplied and used on the work shall conform to samples with regard to soundness, colour, veining and general texture.

### 8.4 SAMPLING

In any consignment all the blocks/slabs/tiles of the same group, size and finish shall be grouped together to constitute a lot. Sample shall be selected and tested separately for each lot for determining its conformity or otherwise to the requirements of the specification. The number of blocks/slabs/tiles to be selected for the samples shall depend upon the size of the lot and shall be in accordance with the Table 8.3.

**TABLE 8.3**

**Sample Size and Criteria for Conformity**

Number of Blocks slabs /Tiles in the lot	Number of blocks slabs/ Tiles to be selected in sample	Permissible number defectives	Sub sample Size in no
(1)	(2)	(3)	(4)
Up to 50	As per site Engineer	0	2
50 to 200	5	0	2
201 to 500	6	0	3
501 to 1000	20	1	4

**Note:** The blocks/slabs/tiles in the sample shall be taken at random and in order to ensure to randomness of selection, random tables may be used.

**Explanation 1:** All the blocks/slabs/tiles, selected in the sample, shall be examined for dimensions workmanship and general requirements.

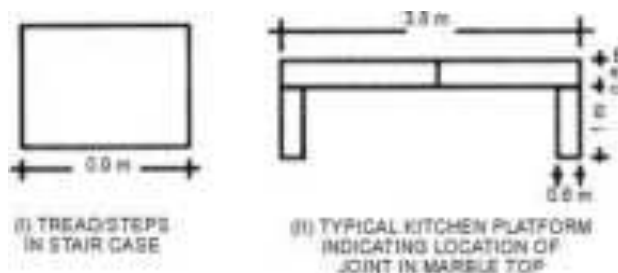
Any block/slab/tile failing in any one or more of the above requirements shall be considered as defective. A lot shall be considered as conforming to these requirements if the number of defectives obtained is not more than permissible no. of defectives given in Col. 3 of table 6.3

**Explanation 2:** The lot having been found satisfactory with respect to dimensions, workmanship and general requirement shall be tested for physical properties of the marble. For this purpose, a sub sample of the size given in Col. 4 of table 6. 3 shall be selected at random. These blocks/slabs/tiles in the sub sample shall be tested for moisture absorption, hardness and specified gravity. The lot shall be considered having satisfied the requirements of the physical properties if none of the blocks/slabs/tiles tested for the requirements fails in any of these tests.

## 8.5 MARBLE WORK - TABLE RUBBED AND POLISHED (PLAIN WORK)

Marble work in steps, jambs, columns and other plain work shall be as specified below:

Joints in staircase treads, kitchen platforms shall be permitted only at curvature or when width/length is more than 0.6/2 mtrs. respectively. Number of joints in each direction shall not be more than one number for every 2 mtrs. length beyond the initial 2.00 m length. Additional joints due to curvature or for providing fixture shall be provide judiciously as given in sketch 'A' below.



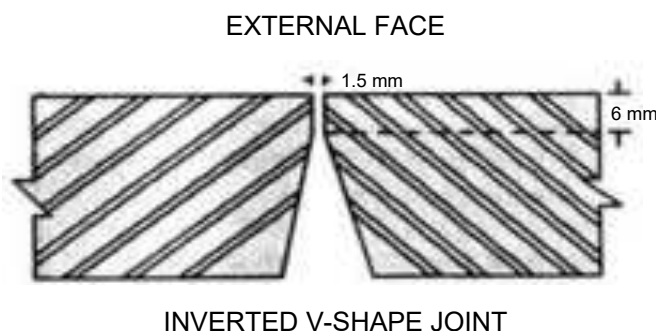
SKETCH (A)

### 8.5.1 Dressing, Cutting and Rubbing

Every marble stone shall be gang saw/machine cut to the required size and shape, chisel dressed machine finished on all beds and joints, so as to be free from any waviness and to give truly vertical, horizontal, radial or circular joints as required. The exposed faces and sides of stones forming joints upto 6mm. from the face shall be fine tooled machine cut such that a straight edge laid along the face



of the stone is in contact with every point on it. All window sills, tread of steps, counters vanities moulding edges etc. shall be machine cut & polished to give high gloss mirror finish as per direction of Engineer-in-Charge. These surfaces shall then be rubbed smooth. All visible angles and edges shall be true, square and free from chipping. Beyond the depth of 6 mm from face, the joints shall be dressed with a slight splay so that the thickness of joint increases, in an inverted V shape as shown in Fig. below. The surfaces of the stones coming in contact with backing need not be chisel dressed.



A sample of dressed and rubbed stone shall be prepared for approval and it shall be kept on worksite after being approved by the Engineer-in Charge.

#### 8.5.2 Mortar

The mortar used for jointing shall be as specified.

#### 8.5.3 Laying

All marble stones shall be wetted before placing in position. These shall then be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort. The walls and pillars shall be carried up truly in plumb or battered as shown in the drawings. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical.

In case of work without backing of brick work or coursed rubble masonry, face stone shall be laid in headers and stretchers alternatively unless otherwise directed. The headers shall be arranged to come as nearly as possible in the middle of stretchers above and below. Stone shall be laid in regular courses of not less than 15 cm in height and all courses shall be of the same height unless otherwise specified. For work facing with backing of brick work or coursed rubble masonry, face stone shall be laid in alternate courses of header and stretchers unless otherwise directed. Face stone and bond stone courses shall have break joint on the face of at least half the height of the standard course and the bond shall be carefully maintained throughout. All the connected masonry in a structure shall be carried up nearly at one uniform level throughout but where breaks are unavoidable the joints shall be made in good long steps so as to prevent cracks developing between new and old work. When necessary, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stones and place these in to correct positions, care being taken that the corners of the stone are not damaged. Stone shall be covered with gunny bags, before putting chain or rope is passed over it, and it shall be handled carefully. No piece which has been damaged shall be used in work. The matching of grains shall be carried out as directed by the Engineer-in-Charge.

#### 8.5.4 Bond Stone

Bond or through stones running right through the thickness of walls, shall be provided in walls upto 60 cm thick and in case of wall above 60 cm thickness a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from face to back. At least one bond stone or a set of



bond stones shall be provided for every 0.5 sqm of the wall surface. All bond stones shall be marked suitably as directed by the Engineer-in-Charge.

#### **8.5.5 Joints**

The depth of joints 6 mm from the face shall be uniform and as fine as possible but shall be not more than 1.5 mm thick on the exposed face. Beyond the depth of 6 mm from face, the thickness of joints shall increase in an inverted V shape so as to give good mortar bond between two stones. The inverted portion of the joints shall be filled with bedding mortar and the face 6 mm portion with pointing mortar.

#### **8.5.6 Curing**

The work shall be kept constantly moist on all faces for a period of at least seven days.

#### **8.5.7 Finishing**

After the marble work is cured, it shall be rubbed with carborundum stone of different grades no. 60, 120 and 320 in succession or with electrical rubbing machines rubbed with carborandum items 0 to 6 nos. in succession, so as to give a plane true and highly smooth surface. It shall then be cleaned with a solution of oxalic acid, washed and finished clean.

#### **8.5.8 Protection**

Green work shall be protected from rain by suitable coverings. The work shall also be suitably protected from damage during construction.

#### **8.5.9 Scaffolding**

Double scaffolding having two sets of vertical supports shall be provided where necessary. The supports shall be sound and strong, tied together by horizontal pieces over which the scaffolding plank shall be fixed.

#### **8.5.10 Tolerances**

As per para 8.2

Note: The above Para 8.5. also applies to the Ashlar masonry referred in Chapter No. 7.0 - Stone Work.

#### **8.5.11 Measurements**

For plain work: Measurements shall be taken correct to a cm in length and breadth and correct to 0.5 cm in thickness.

##### **8.5.11.1**

In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimetre and thickness, correct to 0.5 cm.

The cubical contents shall be calculated in cubic decimetre nearest to two places of decimal.

##### **8.5.11.2**

The marble work in arches and domes shall be measured as for plain work, but extra shall be allowed for such work over the rate for plain work.

##### **8.5.11.3**

Sunk or moulded work in marble shall be measured by volume as per plain marble work or work in arches or domes as the case may be on the basis of circumscribed rectangular block of the finished work but extra shall be paid for such work over the rate for plain work for work in arches and domes. For the purpose of extra payment, volume of every stone sunk or moulded shall be considered.

#### **8.5.12 Rate**

The rate includes the cost of materials and labour required for all the operations i/c cutting of recesses in wall cutting moulding corners edge rounding finishing & polishing as specified.



- 8.5.13** Use of Finished Marble Slabs and Tiles - In case such finished tiles are used, these shall be measured and paid for separately.

## **8.6 WALL LINING/VENEER WORK**

- 8.6.1** Unless and otherwise specified in the nomenclature of the item, the marble slabs used for wall lining/veneer work shall be gang saw cut (polished & machine cut) and conform to dimensions given in Table 8.1 above.

Back shall not be polished/ cut in order to ensure a good grip with the hearting of backing. The cut slabs shall be of the thickness as specified with a tolerance permissible under para 8.2 above. The tolerance in wall lining when straight edge of 3 m length is placed should not be more than 2 mm.

### **8.6.2 Laying**

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or under pinning of any sort. Care shall be taken to match the grains of veneer work as directed by the Engineer-in-Charge. For purpose of matching the grains, the marble slabs shall be selected judiciously having uniform pattern of veins/streaks. Preferably the slabs shall be those got out of the same block from the quarry. The area to be veneered shall be reproduced on the ground and the marble slabs laid in position and arranged in the manner to give the desired matching of grains. Any adjustment needed for achieving the best results shall be then carried out by replacing or interchanging the particular slabs. Special care shall be taken to achieve the continuity of grains between the two slabs one above the other along the horizontal joints. This shall then be got approved by the Engineer-in-Charge and each marble slabs numbered properly and the same number shall be marked on a separate drawing as well as on the surface to be actually veneered, so as to ensure the fixing of the particular slabs in the correct location.

For the facing of the columns also the same procedure as mentioned above shall be followed.

- 8.6.2.1** Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.
- 8.6.2.2** The stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 × 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members cramps shall be of 25 × 6 mm and length as per requirement made out of gun metal or any other metal specified in para 8.6.2.6. Generally, the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape & details of cramps for such backing are as indicated in Fig. 8.2 for general guidance. This can be modified as directed by the Engineer-in-Charge if so, required at site. Cramps shall be spaced not more 60 cm apart horizontally. Alternatively, the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 8.1.

- 8.6.2.3** The adjoining stones shall be secured to each other by means of gun metal cramps or copper pins of the specified size. Cramps may be attached to its sides (see Fig. 8.3A, 8.3B) or top and bottom (See Fig. 8.3C, D, E, F) or sides, top and bottom (see Fig. 8.3G, 8.3H). The general arrangement of cramps required for fixing facing unit to the wall are illustrated in Fig 8.3. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.
- 8.6.2.4** Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal



angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facing below to thick facings above.

**8.6.2.5** Alternatively, cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramps should be properly designed as per IS 4101 (Part 1).

**8.6.2.6** The cramps may be of copper alloyed with zinc, tin, nickel, lead or stainless steel.

The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.

### **8.6.3 Joints**

All joints shall be full of mortar. Special care shall be taken to see that groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and relaid. The thickness of the face joints shall be uniform, straight and as fine as possible, not more than 1.5 mm and in the face joint, the top 6 mm depth shall be filled with mortar specified for the pointing.

### **8.6.4 Mortar**

The mortar used for jointing slabs shall be as specified.

### **8.6.5 Curing, Finishing, Protection and Scaffolding**

It shall be as specified under para 8.5.6, 8.5.7, 8.5.6 and 8.5.9.

### **8.6.6 Measurements**

The length and breadth shall be measured correct to a cm. In case of radially dressed or circular slabs used in the work, the dimensions of the circumscribing rectangles of the dressed stone used in the work, shall be measured & paid for. The area shall be calculated in sqm nearest to two places of decimal. Marble work in lining up to 4 cm thickness shall be paid by area under veneer work and lining of greater thickness paid by volume under plain marble work.

### **8.6.7 Rate**

The rate includes the cost of materials and labour required for all the operations described above except for the cost of providing and fixing of dowel and cramps which shall be paid for separately, unless otherwise stipulated in the item of work. When factory made finished slabs and tiles are used, no further finishing as mentioned in para 8.5.7 shall be required nor anything extra shall be payable.

## **8.7 MARBLE STONE FLOORING AND MARBLE STONE IN RISERS OF STEPS AND SKIRTING**

Refer to relevant clause in subhead 11.0 of flooring of Specifications.

### **8.7.0 Marble Slab Urinal Partitions**

The partitions shall be of marble slab embedded in the wall. The size and shape of the marbles slab shall be as per direction of Engineer-in-Charge. The finished thickness shall be 16 mm. The specifications for marble/granite stone work, in general, shall be as specified. The marble granite stone shall be cut into slabs of required thickness and shall be one piece. (Fig. 8.4).

#### **8.7.1 Finishing**

The partition of the slab to be embedded in the masonry shall be rough dressed. Dressing and rubbing of the exposed portion of the slab shall be as described. The dressed slab shall be of the thickness as specified with a tolerance of + 1.5mm. The s lab shall be got approved from the Engineer-in- Charge before fixing.



### 8.7.2 Fixing

Fixing shall be as specified except that the recess shall be 7.5 cm wide. Fixing shall be done by cutting chase with chase cutter/fine tools in a recess of 7.5 cm X 7.5 cm filled with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 6mm nominal size). Fixing can also be done by epoxy grout in a chase of 2.0 X 7.5 cm as per direction of Engineer-in-Charge.

### 8.7.3 Measurement shall be as per para 8.6.6.

8.7.4 Rate shall include the cost of labour and materials involved in all the operations described above including the leaving/cutting of recess in the wall, moulding, curves, edge rounding, finishing and polishing as specified.

## 8.8 STONE VENEERING WORK (FIG. 8.5, 8.6 & 8.7)

Stone lining up to 6 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

8.8.1 **Stone:** Shall be as specified in para 7.4.1.

The stone shall be gang saw cut into slabs of required thickness along the planes parallel to the natural bed of stone.

8.8.2 **Dressing:** Shall be as specified in 7.4.3 except that dressing at the back shall not be done, so as to ensure better grip with the hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of  $\pm 2$  mm.

8.8.3 **Mortar:** Mortar for fixing shall be as specified.

### 8.8.4 Laying

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

8.8.4.1 Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

8.8.4.2 Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of stainless steel or any other metal specified in para 7.7.4.6. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape and details of cramps for such backing are indicated in Fig. 8.6 for general guidance. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally. Alternatively, the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 8.5 and the adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

8.8.4.3 Cramps may be attached to its sides (see Fig. 8.7A, 8.7B) or top and bottom (see Fig. 8.7C to F) or sides, top and bottom (see Fig. 8.7G & H). The minimum number of cramps required for fixing facing unit to the wall are illustrated in Fig. 8.7. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.



- 8.8.4.4** Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.
- 8.8.4.5** Alternatively cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).
- 8.8.4.6** The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 304.
- 8.8.4.7** The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.
- 8.8.4.8** The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.
- 8.8.4.9** As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

#### **8.8.5 Joints**

The joints shall be done with cement mortar 1: 3 (1 cement: 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow groundings are detected by taping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout.

Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement: 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

#### **8.8.6 Other Details**

Specifications for pointing, curing, protections and scaffolding shall be specified under para 7.4.

#### **8.8.7 Measurements**

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal.

The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

#### **8.8.8 Rate**





The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

**Note:** Clause 8.8 brought from Sub Head 7 (Stone Work) clause 7.7.

## 8.9 WALL LINING BUTCH WORK WITH DHOLPUR STONE

**8.9.0** Stone lining upto 6 cm shall be treated as veneering work and lining of greater thickness as plain Ashlar Masonry.

**8.9.1 Stone:** The stone shall be red or white as specified in the description of item. The stone shall be hard, sound, tough, free from cracks, decay & weathering. In case of red sand stone, white patches or streaks shall not be allowed. However scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of stone approved by the Engineer-in-Charge.

The stone shall be gang saw cut into slabs of required thickness along the planes parallel to the natural bed of stone.

**8.9.2 Dressing:** Every stone shall be cut to the required size and shape chisel dressed on all beds and joints so as to be free from waviness and to give truly vertical and horizontal joints. In exposed masonry, the faces that are to remain exposed in the final position and the adjoining faces to a depth of 6 mm shall be the fine chisel dressed so that when checked with 60 cm straight edge, no point varies from it by more than 1 mm. The top and bottom faces that are to form the bed joints shall be chisel dressed so that variation from 60 cm straight edge at no point exceeds 3 mm. Faces which are to form the vertical joints should be chisel dressed so that variation at any point with 60 cm straightedge does not exceed 6 mm. Any vertical face that is to come against backing of masonry shall be dressed such that variation from straight edge does not exceed 10 mm. All angles and edges that are to remain exposed in the final position shall be true, square and free from chippings. A sample of dressed stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved except that dressing at the back shall not be done, so as to ensure better grip with the hearting or backing. The dressed slabs shall be of the thickness as specified, with permissible tolerance of  $\pm 2$  mm.

**8.9.3 Mortar:** Mortar for fixing shall be as specified.

**8.9.4 Laying:** The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

**8.9.4.1** Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

**8.9.4.2** Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.

Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of copper alloyed with zinc or nickel or of stainless steel of grade 304. Generally the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. Typical shape and details of cramps for such backing are indicated in Fig. 8.6 for general guidance. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally. Alternatively the stone may be secured to the backing by means of stone dowels 10 x 5 x 2.5 cm as per shape indicated in Fig. 8.5 and the adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.



- 8.9.4.3** Cramps may be attached to its sides (see Fig. 8.7A, 8.7B) or top and bottom (see Fig. 8.7C to 8.7F) or sides, top and bottom (see Fig. 8.7G & H). The minimum number of cramps required for fixing facing unit to the wall is illustrated in Fig. 8.7. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.
- 8.9.4.4** Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.
- 8.9.4.5** Alternatively, cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).
- 8.9.4.6** The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 304.
- 8.9.4.7** The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.
- 8.9.4.8** The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.
- 8.9.4.9** As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

### **8.9.5 Joints**

The joints shall be done with cement mortar 1: 3 (1 cement: 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow groundings are detected by tapping the face stones, these shall be taken out and re-laid. The thickness of joints shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout. Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement: 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

### **8.9.6 Other Details**

#### **8.9.6.1 Pointing**

All exposed joints shall be pointed with mortar as specified. The pointing when finished shall be sunk from stone face by 5 mm or as specified. The depth of mortar in pointing work shall not be less than 15mm.

#### **8.9.6.2 Curing**





Stone work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

#### **8.9.6.3 Protections**

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

#### **8.9.6.4 Scaffolding**

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

#### **8.9.7 Measurements**

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal. The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

#### **8.9.8 Rate**

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

### **8.10 KOTA STONE VENEERING WORK**

**8.10.1** Kota stone shall be of selected quality, hard, sound, dense & homogeneous in texture free from cracks, decay, weathering and flaws. They shall be machine cut to requisite size and thickness. They shall be of colour indicated in the drawings or as instructed by the Engineer-in-Charge. The stone shall have the top (exposed) face polished/rough chiselled before being brought to site unless otherwise specified. Before starting the work, the contractor shall get the samples of kota stone approved from the Engineer-in-Charge.

#### **8.10.2 Dressing:**

Every stone shall be cut to the required size and shape and fine machine dressed to the full depth so that a straight edge laid along the side of stone shall be in full contact with it. The thickness of the slab after it is dressed shall be 20, 25, 30 or 40 mm as specified in the item. Tolerance of  $\pm 2$  mm shall be allowed for the thickness. A sample of dressed kota stone shall be prepared for approval of Engineer-in-Charge. It shall be kept at the worksite as a sample after being approved.

#### **8.10.3 Mortar:**

Mortar for fixing shall be as specified.

#### **8.10.4 Laying:**

The stone shall be wetted before laying. They shall then be fixed with mortar in position without the use of chips or underpinning of any sort.

**8.10.4.1** Where so desired, the adjoining stones shall be secured to each other by means of copper pins 75 mm long and 6 mm diameter or as specified.

**8.10.4.2** Further the stones shall be secured to the backing by means of cramps. The material for cramps shall have high resistance to corrosion under conditions of dampness and against the chemical action of mortar or concrete in which cramps are usually embedded.



Cramps shall be of 25 mm x 6 mm and 30 cm long in case of backing of stone masonry walls and brick masonry walls thicker than 230 mm. In case of backing with brick masonry walls 230 mm or less thick or RCC members, cramps shall be of 25 x 6 mm and length as per requirement made out of copper alloyed with zinc or nickel or of stainless steel of grade 316. Generally, the outer length of cramp in half brick work backing shall be 115 mm and in one brick work backing it shall be 150 mm. typical shape and details of cramps for such backing are indicated. This can be modified as directed by the Engineer-in-Charge, if so required at site. Cramps shall be spaced not more than 60 cm apart horizontally. The adjoining stone secured to each other by means of stainless steel cramps or copper pins of the specified size. Minimum one cramp/stone dowel shall be used to secure one slab to the backing.

- 8.10.4.3** The minimum number of cramps required for fixing facing unit to the wall. The actual number of cramps and their sections, however, shall be as per requirements of design to carry the loads.
- 8.10.4.4** Where cramps are used to hold the unit in position only, the facings shall be provided with a continuous support on which the stones rest at the ground level and other storey levels, the support being in the form of projection from or recess into the concrete floor slab, or a beam between the columns or a metal angle attached to the floor slab or beams. These supports shall preferably be at vertical intervals not more than 3.5 m apart and also over the heads of all openings. Such supports shall also be provided where there is transition from thin facings below to thick facings above.
- 8.10.4.5** Alternatively, cramps may be used to hold the units in position and in addition to support the units thus transferring the weight of the units to the backing. Such cramp should be properly designed as per IS 4101 (Part 1).
- 8.10.4.6** The cramps shall be of copper alloyed with zinc or nickel or of stainless steel of grade 316.
- 8.10.4.7** The pins, cramps and dowels shall be laid in cement mortar 1:2 (1 cement: 2 fine sand) and their samples got approved by the Engineer-in-Charge and kept at site.
- 8.10.4.8** The walls shall be carried up truly plumb. All courses shall be laid truly horizontal and all vertical joints truly vertical. The stone shall break joints on the face for at least half the height of the course, unless otherwise shown in the drawings. The stone shall be laid in regular courses not less than 20 cm height and all the stones shall be of the same height unless otherwise specified. No stone shall be less in length than one and a half times its height unless otherwise specified.
- 8.10.4.9** As far as possible the backing shall be carried up simultaneously with the face work. In case of reinforced cement concrete backing, the lining shall be secured to the backing after it has set and got cured. The cramps shall be fixed in concrete at the required positions, while laying.

#### **8.10.5 Joints**

The joints shall be done with cement mortar 1: 3 (1 cement : 3 coarse sand). All joints shall be full of mortar. Special care shall be taken to see that the groundings for veneer work are full of mortar. If any hollow grounding are detected by taping the face stones, these shall be taken out and re-laid. The thickness of points shall be as small as possible, not exceeding 5 mm. For a close butt jointed facing the thickness shall not exceed 1.5 mm. The face joints shall be uniform throughout. Where joint filler or compound is to be used, the joints shall be raked out to a depth of at least 25 mm after the mortar in the joints has set sufficiently and the filler or compound applied. The joints may be subsequently finished with a mortar suited to the appearance of the work. It is preferable to use joint sealing compounds where the facings are exposed to heavy rainfall and winds and their selections would depend upon local experience and availability of joint sealing compounds. In their absence only masonry mortars 1:3 (1 cement : 3 coarse sand) which are proved to be successful from local exposure conditions shall be used.

#### **8.10.6 Laying**



All stones shall be wetted before placing in position. These shall be floated on mortar and bedded properly in position with wooden mallets without the use of chips or under pinning of any sort. The walls and pillars shall be carried up truly plumb or battered as shown in drawings. All Kota Stone shall be laid truly horizontal and all vertical joints shall be truly vertical. It shall be handled carefully. No piece which has been damaged shall be used in work.

#### **8.10.7 Curing**

Stone work in cement or composite mortar shall be kept constantly moist on all faces for a minimum period of seven days. In case of masonry with fat lime mortar, curing shall commence two days after laying of masonry and shall continue for at least seven days thereafter.

#### **8.10.8 Protections**

Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

#### **8.10.9 Scaffolding**

Double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

#### **8.10.10 Measurements**

The length and breadth of the finished work shall be measured in metre correct to cm. The area should be calculated in sq. metre correct to two places of decimal. The veneering work curved on plan shall be measured as plain work, but extra payment shall be allowed for radii not exceeding six metres on external face. For radius beyond six metres the work shall be measured as plain work only, even the face may have to be dressed to curve.

#### **8.10.11 Rate**

The rate includes the cost of materials and labour involved in all the operations described above, except for the cost of providing and fixing pins, dowels and metal cramps and ledges and supports, which shall be paid for separately unless otherwise stipulated in the item of work.

### **8.11 EXTRA FOR STONE WORK FOR WALL LINING**

**8.11.1** The stone lining work shall be executed at site as per the relevant item. All the specification shall be follows as per relevant items. The exterior stone work at height greater than 10.0 m from average ground level shall be measured separately.

#### **8.11.2 Scaffolding**

For all exposed stone work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

#### **8.11.3 Measurement**

The Exterior stone work at a height greater than 10 .0 meter from ground level shall be measured separately for every additional story height 3.0 meter or part thereof.

The Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres upto two places of decimal. The area of stone work at every additional height of 3.0 m shall be added with the consequent lower story height of 3.0 m means after stone work height at greater than 10.0 m. first area of 3.0 m height (at 13.00 meter) shall be measured one times and second area of next 3.0 m height (16.0 m) shall be measured two times and third area of next 3.0 m height (19.00 meter) shall be measured three times and so on.



## 8.12 DRY STONE CLADDING

### 8.12.1 Material

Stone shall be of the type as specified in the item. it shall be hard, sound durable and tough free from cracks, decay and weathering and defects like cavities cracks, flaws, holes, veins, patches of soft or loose materials etc. Thickness of stone shall be as specified

Stone shall be cut with the gang saw to the required size and shape on all beds and joints so as to free from any waviness and to give truly vertical horizontal surface as required. The exposed face and sides of stones forming joints shall be such that the straight edge laid along the face of the stone is in contact with every point on it. All the visible angle and edges shall be square and free from chipping. The dressed stone shall be of the thickness specified with permissible tolerance of  $\pm 2$  mm.

Before starting the work, the contractor shall get the samples of stone approved by Engineer-In-charge. Approved sample shall be kept in custody of Engineer-in-Charge and stones supplied and used on the work shall conform to sample with regard to soundness, colour, veining and general texture. The stone shall be cut by gang saw into slabs of required thickness along the places parallel to the natural bed. When necessary double scaffolding for fixing the stone at greater heights, jib crane or other mechanical appliances shall be used to hoist the heavy pieces of stone and placed them into correct positions. Care shall have to be taken that corners of the stone are not damaged. Stone shall be covered with gunny bags before tying chain or rope is passed over and it shall be handled carefully. No pieces which has been damaged shall be used that work

### 8.12.2 Stacking and Storing

Stone slabs are thin and brittle and should never be stacked flat across timber supports. They should therefore, be stacked on edge on timber or like runners. Packing pieces inserted between the slabs may be rope or timber. Slabs shall be well covered with plastic sheeting to protect them from any possible staining.

### 8.12.3 Scaffolding

As specified in 7.4.11.

### 8.12.4 Fixing

The size & shape of the cramps shall be as per drawing and as per directions of Engineer-in-Charge. The samples of steel cramps should be approved in advance before starting the stone cladding work. The cramp shall be attached to top and bottom of the stone. The cramps shall have inbuilt adjustment for vertical and horizontal alignment. The cramps used to hold support and transfer the load of stone unit to the supporting structured steel shall be designed by the manufacturer and approval of the same shall be obtained from the Engineer-in-Charge.

The minimum number of cramps required shall be as per requirement of design to carry the load of individual stone slabs. The cramps shall be spaced not more than 60 cm horizontally and vertically along the stone side for insertion of pins / bolt attached with the steel cramps. Adequate cutting in stone shall be made with precision instrument to hold the cramps pins at the joints.

Stone shall be secured with cramps with high quality workmanship. The walls shall be carried up truly plumb. All the courses shall be laid truly horizontal and all the vertical joints truly vertical. The sequence of execution for cladding work shall be approved by the Engineer-in-Charge.

*Jointing:* Joints horizontal and vertical shall be filled with weather sealant of make as approved by Engineer-in-Charge with the help of pouring gun for filling the sealant. Before filling the joint with sealant, masking tape are required to be fixed on stones surface on both edges of joints of the stones, so that



sealant may not spoil the surface of the stone. When all the joints are filled and sealant has dried, the masking tape may be removed.

Protection: Work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage and rain during construction.

Measurement: The length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Any opening of area 0.01 sqm. or less shall not be deducted.

Rate: The rate includes the cost of materials and labour involved in all operations described above including cost of support scaffolding staging, sealant, pouring guns but excluding the cost of steel cramps drilling holes / making recesses in stones which shall be paid for separately.

**Note: Clause 8.12 brought from Sub Head 7 (Stone Work) clause 7.11.**

### **8.13 STRUCTURAL STEEL FRAME WORK FOR DRY STONE CLADDING**

Specification for structural frame work for dry stone cladding are same specifications as for steel work in built up sections (welded or bolted).

#### **8.13.1 Fixing of Frame**

The properly designed structural frame for withstanding the weight of stone slab are fixed/supported on wall surface with the help of M.S. brackets/lugs of angle iron/flat etc. which is welded at each junctions of member of frame and also embedded in cement concrete block 1: 2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) of size 300 x 230 x 300 mm. The concrete block can be made by cutting the hole of size as mentioned in brick wall and filling the hole with cement concrete including provision of necessary centering/shuttering for holding of concrete. The frame can also be supported on RCC surface with the help of approved expansion hold fastener by drilling the holes in RCC surface. Steel cramps are either welded or bolted to the frame (by making necessary holes in frame work) for holding of stone.

**8.13.2 Measurement:** The mode of measurement shall be the same, as specified for steel work in built up section except that the weight of welding material shall not be added in weight of members for payment and nothing extra shall be paid for making holes for temporary fastening of members during erection before welding, which also includes cost of cement concrete block, centering and shuttering and making holes in walls, but excluding the cost of expansion fastener, steel clamps which shall be paid for separately.

**8.13.3 Rate:** The rate shall include the cost of all labour and material involved in all the operation described above.

**Note: Clause 8.13 brought from Sub Head 7 (Stone Work) clause 7.12.**

### **8.14 ADJUSTABLE STAINLESS STEEL CLAMPS**

The clamps shall be stainless steel of make approved by the Engineer-in-charge.

**8.14.1** The weight of the stainless steel clamp (including weight of nut and washer) shall not be less than 260 gms.

**8.14.2** Necessary holes at suitable locations are to be done on steel frame work for dry stone cladding to be fixed.

**8.14.3** Necessary recessed are required to be done in stone slab which is required to be supported by clamps.

**8.14.4** The one end of steel clamp is fixed on frame with nut and bolt and other end is inserted into recesses/hole for fixing the dry cladding stone on frame.



**8.14.5** The rate includes cost of materials and other operations mentioned as above.

**Note: Clause 8.14 brought from Sub Head 7 (Stone Work) clause 7.13.**

## **8.15 WALL LINING**

Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patchings or plugging of, any kind shall not be permitted except as provided.

### **8.15.1 Grounds**

Grounds shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 × 50 mm and top 35 × 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement: 3 fine sand) and batten of first class hard wood or as specified of size 50 × 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimetres centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

### **8.15.2 Panelling**

**8.15.2.1 Material:** This panelling shall be decorative or non-decorative (Paintable) type as per design and thickness specified by the Engineer-in-Charge, of 2nd class teak wood, FPT-1 or graded wood prelaminated particle board or as specified in item.

**8.15.2.2 Ornamental Work:** The ornamental wood work shall be painted on the back with priming coat of approved wood primer before fixing the same to the grounds with screws, which shall be sunk into the wood work and their tops covered with putty. The ornamental work shall be made true and accurate to the dimensions shown in the working drawings. The fixing shall be done true to lines and levels. The planks for wall lining shall be tongued and grooved, unless otherwise specified.

**8.15.2.3 Measurements:** Length and breadth shall be measured correct to a cm. Wall panelling such as teakwood panelling and block panelling, plain lining, and plain skirting each shall be measured separately in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm.

The measurements for ground shall be taken on the basis of cubical contents of battens and paid for separately, unless otherwise specified.

Where only plugs are required to be fixed for the ornamental work, the cost for the same shall be deemed to be included in the rate of ornamental work and no separate payment shall be made for plugs.

**8.15.2.4 Rate:** The rate includes the cost of materials and labour required for all the operation described above.

**Note: Clause 8.15 brought from Sub Head 9 (Wood Work and PVC Work) clause 9.9.**

## **8.16 VENEERED DECORATIVE PLYWOOD**

**8.16.1** Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall be of two types. Type I and type 2 and shall conform to IS 1326.

**8.16.1.1** Requirement of Type-I Veneered decorative plywood shall be as under:

- (a) Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin





adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.

- (b) The decorative veneered surface shall be free from torn grain, dead knots decolourisation and sapwood.
- (c) The decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects except to the Engineer-in-charge permitted under para 8.16.1.1(a). All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.

**8.16.2 Adhesive:** The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 646 for MR and BWR grade veneered decorative plywood respectively.

**8.16.3 Dimensions and Tolerances:**

**8.16.3.1** The dimensions of plywood boards shall be as follows:

2400 mm x 1200 mm	2100 mm x 900 mm
2100 mm x 1200 mm	1600 mm x 900 mm
1600 mm x 1200 mm	

**8.16.3.2 Thickness:** The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 9 mm, 12 mm, 19 mm and 25 mm.

**Note:** Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

**8.16.3.3 Tolerances:** Tolerances on the nominal sizes of finished boards shall be as follows:

Dimension	Tolerance
Length	+6 mm-0 mm
Width	+3 mm-0 mm
Thickness	+ 10 per cent
i. Less than 6 mm	
ii. 6 mm and above	+ 5 per cent
Edge straightness	2 mm per 1000 mm Or 0.2 per cent
Squareness	2 mm per 1000 mm Or 0.2 per cent

Note: Edge straightness and squareness shall be tested as per Appendix I of the specifications.

**8.16.4 Finish:** The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested as per Appendix I shall be within the tolerance specified in para 8.16.3.3.

**8.16.5 Sampling and Criteria for Conformity:** The method for drawing representative samples and criteria for conformity shall be as per IS 7636.

**8.16.6 Tests: Boards shall be subjected to following tests:**



- i. Moisture content: Decorative veneered plywood of either type when tested in accordance with IS1734 (Pt. I) shall have moisture content not less than 5 per cent and not more than 15 percent.
- ii. (ii) Water Resistance Test: Three test specimen of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at 62 +20C for a period of 3 hours and dried for 6 hours at a temperature of 65 + 20C and then followed by two more cycles of soaking and drying under same conditions described above. Decorative Veneered plywood of either type shall not show delamination or blister formation.

**8.16.7 Marking:** Each plywood board shall be legibly and indelibly marked or stamped with the following on the face of board near one corner.

- (a) Indication of the source of manufacture
- (b) Year of manufacture
- (c) Batch no.
- (d) Type of plywood
- (e) Criteria for which the plywood has been labelled as ECO mark

The decorative veneered plywood may also be marked with standard BIS certification mark.

**8.16.8 Measurement:** Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

**8.16.9 Rates:** The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which shall be paid separately.

## **8.17 COIR VENEER BOARD FOR GENERAL PURPOSES**

**8.17.1** Coir veneer board is manufactured with a combination of coconut fibre needled felt, veneer and jute fibres with craft paper coconut fibre. Needled felt can be used as core cross bands or as outer skin formed with jute fibres and craft paper. However, the composite ply should be a balanced construction on either side of central ply. The blended mass of glued fibres is laid to form a mat which is pre needed.

**8.17.2** Coir veneer board generally shall conform to IS 14642.

### **Grades**

Coir veneer board for general purposes shall be of two grades:

- (a) Boiling water resistant (BWR) grade
- (b) Moisture resistant (MR) grade

### **8.17.3 Material**

- (a) Coconut Fibre: Coconut fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 600 gm/m<sup>2</sup>.
- (b) Jute: Jute fibre layer used in the manufacture of coir veneer board shall be uniform with minimum of 60 gm/m<sup>2</sup>.
- (c) Adhesive: Adhesive for manufacture of coir veneer board shall be conform to BWR/MR of IS 848 for BWR/MR grade boards respectively.
- (d) Veneer: Any species of timber may be used for the manufacture of veneers.
- (e) Kraft Paper: Kraft paper used in manufacture of coir veneer board shall be uniform with minimum of 40 gm/m<sup>2</sup>.





**8.17.4 Permissible Defects:** Gap in cores and cross band shall not be permitted. Splits in cores and cross bands may be permitted to an extent of 2 per core or cross band and overlap shall be permitted in core/cross bands only.

**8.17.5 Dimensions and Tolerances:** The dimensions and tolerances of coir veneer board shall be quoted in following order. The first dimension shall represent the length, the second dimension the width and the third dimension the thickness. The dimensions and tolerances shall be as per IS 12049.

Thickness of coir veneer board shall be 3 mm, 4 mm, 5 mm, 6 mm, 9 mm, 12 mm, 16 mm, 16 mm, 20 mm and 25 mm.

The following tolerance on nominal thickness shall be permissible.

- |                    |       |
|--------------------|-------|
| (a) Less than 6 mm | + 10% |
| (b) 6 mm and above | + 5%  |

**8.17.6 Workmanship and Finish:** Coir veneer board shall be of uniform thickness and density throughout the length and width of board. The squareness and edge straightness of the board shall be as per para 9 of IS 12642 and Appendix J.

**8.17.7 Sampling:** The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7636.

**8.17.8 Tests:** The tests shall be carried out as specified in IS 14642 – Appendix K.

**8.17.9 Moisture Content:** Coir veneer board when tested in accordance with IS 3734 (Part-I) shall have a moisture content not less than 5 percent and not more than 15 percent.

**8.17.10 Marking:** Each coir veneer board shall be legibly and indelibly marked or stamped with the following near one corner.

- (a) Identification of source
- (b) Year of manufacturing
- (c) Batch no.
- (d) The grade and type as follow
- (e) Boiling water resistant (BWR) and
- (f) Moisture resistant (MR)

**8.17.11 BIS Certification Marking:** Coir veneer board may also be marked with the standard mark governed by the BIS Act, 1966.

**8.17.12 Measurement:** Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

**8.17.13 Rates:** The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

## **8.18 PRELAMINATED PARTICLE BOARDS**

**8.18.1** Pre-laminated particle boards are available in two grades namely Grade I and II as per IS 12623. Each grade is further classified in four types; namely Type –I, II, III, IV.

### **8.18.2 Material**



- 8.18.2.1** Particle Board Pre-laminated particle board Grade-1 (FPT-I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and pre-laminated conforming to IS 12623 Grade-I, type II or I shall be used.
- 8.18.2.2** Impregnated Base Paper: Printed or plain coloured absorbent base paper having a weight of 60-140 g/m<sup>2</sup> impregnated in a suitable synthetic resin and dried to a volatile content of 4-6 per cent shall be used for pre-lamination on both surfaces of particle board.
- 8.18.2.3** Impregnant Overlay: An absorbent tissue paper having a weight of 16-40 gm/m<sup>2</sup> impregnated in a suitable synthetic resin and dried to volatile content of 4-6 per cent.

### 8.18.3 Dimension and Tolerances

- 8.18.3.1** Dimensions of pre-laminated particle boards shall be as follows:

**Length:** The length of pre-laminated particle boards shall be 4.6, 3.6, 3.0, 2.7, 2.4, 2.1, 1.6, 1.5, 1.2, 1.0 and 0.9 metres.

**Width:** The width of pre-laminated particle boards shall be 1.6, 1.5, 1.2, 1.0, 0.9, 0.6 and 0.45 metres.

**Thickness:** The thickness of pre-laminated particle boards shall be 6, 9, 12, 15, 20, 25, 30, 35, 40 and 45 mm.

- 8.18.3.2 Tolerances:** Tolerances on the nominal sizes of finished boards shall be as given below:

**Note:** Edge straightness and squareness shall be tested as per IS 12623.

Dimension	Tolerance
Length	+6 mm-0
Width	+3 mm-0 mm
Thickness	+ 5 per cent
Edge straightness	2 mm per 1000 mm Or 0.2 per cent
Squareness	2 mm per 1000 mm Or 0.2 per cent

- 8.18.4 Sampling and Inspection:** The number of pre-laminated particle board to be selected from a lot shall be in accordance with the Table 8.4 given below:

Lot size	Number of pre-laminated boards to be selected
Upto 50	2
51-100	3
101-200	4
201-300	5
301-500	7
501 and above	10

- 8.18.4.1** The pre-laminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the pre-laminated particle boards in the lot may be arranged in a serial order and every pre-laminated particle board may be selected till the required number is obtained, 'r' being the integral part of  $N/n$ , where N is the lot size and n is the sample size.



**8.18.4.2** All board selected as given in para 6.16.4.1 shall be tested as specified in IS 2360 (part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 6.16.3.2.

**8.18.4.3 Testing and Number of Tests:** For each of particle board selected as per para 6.16.4 Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12623.

**8.18.4.4 Criteria for Conformity:** A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 6.16.4 & 6.16.4.3 of this specification.

In case of a failure, double sample shall be taken from the lot for testing. The lot shall be considered as passed, if all these samples conform to the specified requirement.

**8.18.4.5 Marking:** Each pre-laminated particle board shall be legibly and indelibly marked on any of its edges with following:

- (a) Indication of source of manufacturer
- (b) Grade and type of pre-laminated particle board
- (c) Thickness
- (d) Batch number and year of manufacture

**8.18.5 Measurement:** Length and width of the decorative veneer shall be measured in square metres to nearest two places of decimal.

**8.18.6 Rates:** The rate includes the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

## **8.19 PRESSED CERAMIC/VITRIFIED TILES IN SKIRTING AND DADO**

**8.19.1** The tiles shall be of approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze, however, any glaze if unavoidable shall be permissible on only upto 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawlings or other imperfections detracting from the appearance when viewed from a distance of one metre. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of coloured tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

### **Dimensions and Tolerances**

Glazed pressed ceramic tiles shall be made square or rectangular in sizes Table 1, 3, 5 & 7 of IS 15622 give the modular sizes and table 2, 4, 6 & 6 of IS 15622 gives the sizes of non modular tiles. The tiles shall conform to IS 15622 for dimensional tolerance, physical and chemical properties.

Half tiles for use as full tiles shall have dimensions which shall be such as to make the half tiles when jointed together (with 1 mm joint) match with dimensions of full tiles. Tiles may be manufactured in sizes other than those specified above.

The thickness of the tiles shall be 5 mm or 6 mm or as specified. The dimensions of fittings associated with the glazed tiles namely cover base, round edge tile, angles corner cups, ridge and legs, cornices



and capping beads shall be of the shape and dimensions as required and the thickness of fittings shall be the same as the thickness of tiles given above.

#### **8.19.2 Preparation of Surfaces**

The joints shall be raked out to a depth of at least 15 mm in masonry walls. In case of concrete walls, the surface shall be hacked and roughened with wire brushes. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

#### **8.19.3 Laying**

12 mm thick plaster of cement mortar 1: 3 (1 cement: 3 coarse sand) mix of as specified shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal at closed intervals. The tiles should be soaked in water, washed clean, and a coat of cement slurry applied liberally at the back of tiles and set in the bedding mortar. The tiles shall be tamped and corrected to proper plane and lines. The tiles shall be set in the required pattern and jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal and joints truly vertical except where otherwise indicated. Odd size/cut size of tile shall be adjusted at bottom to take care of slope of the flooring. Skirting and dado shall rest on the top of the flooring. Where full size tiles cannot be fixed these shall be cut (sawn) to the required size and their edges rubbed smooth. Skirting / dado shall not project from the finished "surface of wall" by more than the tile thickness, undulations if any shall be adjusted in wall.

#### **8.19.4 Curing and Finishing**

The joints shall be cleaned off the grey cement grout with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigments if required to match the colour of tiles. The work shall then be kept wet for 7 days.

After curing, the surface shall be washed and finished clean. The finished work shall not sound hollow when tapped with a wooden mallet.

#### **8.19.5 Measurements**

Length shall be measured correct to a cm. Height shall be measured correct to a cm in the case of dado and 5 mm in the case of riser and skirting. The area shall be calculated in square metre, correct to two places of decimal. Length and height shall be measured along the finished face of the skirting or dado including curves where specials such as coves, internal and external angles and beads are used. Where cornices are used the area of dado shall be measured excluding the cornices. Nothing extra will be paid for cutting (sawn) the tiles to sizes.

#### **8.19.6 Rates**

The rate shall include the cost of all material and labour involved in all the operations described above. The rate shall not include cost of cornices which shall be measured and paid for in running meters separately.

**Note: Clause 8.19 brought from Sub Head 11 (Flooring) clause 11.16**

### **8.20 CURTAIN WALL WITH ALUMINIUM COMPOSITE PANELS (ACP) CLADDING**

#### **8.20.1 General**

1. All composite aluminum panels shall have a thickness of 4.00 mm.
2. The composite cladding panels shall be of cassette type, framed with an extrude aluminum profile.



3. All fasteners shall be concealed within the panel joints. All fixing and joint details shall be designed to provide for the expected thermal expansion and contraction. The fixing of these panels shall accommodate the expected structural movements in the building.
4. With a gloss of 30% according to Gardner Scale, the installed composite panel surface shall not have irregularities such as oil canning, waves, buckles, and other irregularities when viewed at any position not less than 15 degrees to the true plane of the panel.
5. All fasteners, anchors, brackets and similar attachments used for the fixing and erection of these panels shall be of aluminum, non-magnetic stainless steel, or hot dip galvanized steel.

### 8.20.2 Materials

Aluminium Composite Panel (ACP) cladding in pan shape in metallic colour of approved shade, made of Aluminium Composite Material (ACM), made out of 4 mm thick aluminium composite panel consisting of 3 mm thick fire retardant (FR) grade mineral filled thermoplastic inorganic core of grade B1 sandwiched between two thin coil coated aluminium sheets (Top i.e. face # 1 & rear i.e. face # 2) of alloy, Grade 3003 and H-16 temper and minimum thickness of 0.5 mm each as specified in the nomenclature of item. The ACPs are used for the external cladding surface like column, wall, jambs, sills, projected area, ceiling, decorative cladding on any surface to any profile and shape (pan shape) at horizontally / vertically / sloped / curved / circular etc. (linear as well as curvilinear shape).

The ACP fire retardant core of B1 grade contain 70% of Non-Combustible Inorganic compound & 30% of virgin LDPE. The main ingredient of the non-combustible compound are Aluminum Oxide (AlO) and Magnesium Oxide (MgO), when this ACP are put on fire at self-ignition temperature of 460°C, it can be caught on fire after 5 minutes and when the fire leaves the panels, the fire on the wall extinguish after 10 seconds.

The ACP top face (exposed surface) coil should have Kynar 500 PVDF (Polyvinylidene fluoride) / Lumiflon based fluoropolymer resin (high surface energy) coating of approved colour and shade of 30 microns to ensure corrosion resistance and weather proof and thus shall confirm to relevant ASTM or DIN or EN or BS code. The back face (rear side) of the cladding panel surface facing to the wall shall have polyester based wash (service) coating of 7 microns preferably grey in colour to protect against possible corrosion problems. The finished surface (Top face) shall be protected with a self adhesive peel off film with two layers of white & black tested to with stand local weather conditions without losing the original peel off characteristic or causing stains or other damages.

The weight of the Aluminum Composite Panel (ACP) should not be less than 7.50 Kg/Sqm. The ACP shall confirm to ASTM E64-06 or EN13501-1 or DIN4102 resulting in fire resistant properties.

The complete system shall be designed to with stand the design wind pressure as per relevant IS code or international code (Test pressure shall be 1.5 times of the design wind pressure).

Necessary pull out test of anchor fastener shall be carried out on the masonry wall /RCC structure to check the load carrying capacity of the bolt designed under suction pressure for designing the supporting and anchoring system.

### 8.20.3 Movement

System shall be designed to accommodate movement due to any force including the movement resulting from the exterior skin temperature ranging from 15°C to 65°C and also to accommodate the horizontal building movement of 10 mm per panel & vertical movement of 20 mm between floors on the aluminium framing system with support brackets, glass, gaskets and fastening devices. System shall be designed to accommodate the size and shape of the Laminated sandwiched composite panel as per the approved drawings including approved modifications as may be required during execution as well as all other incidental forces and stresses likely to be experienced under service conditions, i.e. Lateral



force, Dead weight and Thermal expansion due to building movement both vertical and horizontal etc. Grooves shall be designed in such a way to accommodate weather silicon sealant/ Non staining sealant of approved make.

#### 8.20.4 Testing

The mechanical properties of 4mm thick ACP or ACM with core and aluminium coil/sheet shall confirm to the requirement as given in table 8.5 below.

**Table 8.5**

#### **Specification for Aluminium Composite Material (ACM)**

S. No.	Description	Specification for 4mm	
A	Physical Test	Standard Test	Acceptable Value/Results
1	Overall thickness of ACM	Measurement	4mm (Tolerance + 0.2mm)
2	Aluminium Skin thickness (each side)	Measurement	0.5mm (Tolerance +/- 0.03mm)
3	Panel weight (ACM)	Measurement	7.5 Kg/m <sup>2</sup> (+ 5%)
B	Mechanical Properties of ACM		
1	Peel off strength (Drum Peel Test)	ASTM D903	Min. 4 N/mm
2	Tensile strength	ASTM E6	Min. 40 N/mm <sup>2</sup>
3	Yield strength	ASTM E6	Min. 40 N/mm <sup>2</sup>
4	Elongation	ASTM E6	Min. 6%
5	Flexural strength	ASTM C393	Min. 130 N/mm <sup>2</sup>
6	Shear strength with punch shear test	ASSTM D732	Min. 18 N/mm <sup>2</sup>
C	Properties of Aluminium skin		
1	Tensile strength (Rm)	ASTM E6	Min. 150 N/mm <sup>2</sup>
2	Modules of elasticity	ASTM E6	Min 70000 N/mm <sup>2</sup>
3	Elongation	ASTM E6	Min. 2%
4	0.2% proof stress	ASTM E6	Min. 110 N/mm <sup>2</sup>
5	Yield strength	ASTM E6	Min. 124 N/mm <sup>2</sup>
6	Sound Transmission loss	ASTM E413	Max. 26 dB

#### 8.20.5 Performance Certificate

Requisite performance certificate from the manufacturer of ACM stating compliance with ACM technical specification as per Table 5 above shall be submitted by the contractor to the Engineer-in-Charge before fixing at site of work.

The contractor shall provide curtain wall with aluminum composite panel cladding, having all the performance characteristics all complete as per the Architectural drawings, as per items description, as specified, as per the approved shop drawings and as directed by the Engineer-in-charge.

#### 8.20.6 Marking



The ACP sheet should have a following laser marking and should be at repeated interval at the rear face of ACP sheet.

1. Total thickness with coil and core materials.
2. Size of ACP sheet.
3. Fire Retardant (FR) grade.
4. Date of manufacturing.
5. Batch number.
6. Make of manufacturer.

#### 8.20.7 Installation

The installation system of ACP as external cladding with tray type (rout and return) panels and sealing joint is one of the most common method and it is available for a wide range of new buildings and renovation projects. The ACP sheet under this system is first fixed on the substructure i.e. of steel members/RCC structures/brick walls with the help of base aluminium member frame work using necessary clamps, brackets, anchor fasteners, stainless screws, nuts and bolts, weather silicon sealant backer rods etc. as per approved design & drawing at all height and elevation which include all labours, materials, equipment's, handling, transportation, workmanship, design & preparation of working drawings, staging, scaffolding etc. all complete as per specification, drawings and instructions of the Engineer-in-Charge.

**8.20.7.1 Frames:** Providing and fixing Aluminium extruded members (Box Tube) designed to with stand design wind pressure and movement as specified as continuous member for cladding the Aluminium Composite Panel. Aluminium member shall be fixed into masonry wall / RCC member /steel structures with brackets /clamps and it shall be of chromicised finish aluminium. All fastening straps, nuts & bolts, rivets, washers/other fastening materials shall be of nonmagnetic stainless steel and aluminium brackets shall be considered for ACP cladding with standard dimension and after the site survey if any undulation is observed intern that doesn't allow to fix the aluminium bracket only in these areas the additional support with locally fabricated hot dip galvanized bracket can be considered. The bidder shall include the provision for these brackets also with in the quoted rate for ACP cladding works. Aluminium shim shall be used for level adjustment of bracket but more than 20 mm is not acceptable. If more than 20 mm, bracket shall be designed according to site condition.

Aluminium brackets / clamps shall be fixed with chemical injection technique threaded anchor rods of approved make to the base structure in the case of masonry wall / RCC members and SS anchor bolts in the case of steel structure. Extruded member shall be designed to accommodate laminated sandwiched composite panel as per the approved shop drawings and extruded aluminium member shall be 6063 T6 or 63400 (H9) grade conforming to BS 1467 or IS 6147, finished with transparent electrolytic colour anodic coating AC15 grade conforming to IS 1666.

**8.20.7.2 Composite Panel:** Aluminium composite panel cladding of approved make as specified in BOQ to be fixed on the framing system described above. Lamination process of Aluminium panel shall only be glue technology and the source of complete composite panel shall only be accepted.

The Laminated sandwiched composite panel suitably stiffened internally on the back side for preventing deformation due to design wind pressure beyond permissible limits by using aluminium flat 25 mm wide, 4 mm thick gloved with double adhesive tape in order to maintain panel flatness and to avoid permanent deformation over a period. Stiffener shall be provided at 600 mm c/c behind ACP panel irrespective of structural check of the panel against stability and deflection. Aluminium flat of size 25 mm wide and 3 mm thick shall be provided to a length 100 mm bent to shape, wherever the inner skin is cut to bend the





ACP at the corners and as per approved shop drawing. Methodology of fixing the stiffener/flat in the corner panel shall be established in the drawing or to be glued to ACP on the backside of the panel in such a way the fixing mechanism of stiffener / flat shall not be visible on the elevation of the panel / outside.

**8.20.7.3 Sealing:** After fixing the ACP on the sub structure, then a suitable sealing material i.e. Non structural weather silicon sealant/Non staining sealant filled to the joints of panel with baker rod of approved make to ensure water tightness to the panel. Sealing shall be carried out with Non-structural (weather) sealant / Non staining sealant with PE baker rods, wherever the system is interfacing with glazing, cladding groove and any other groove.

**8.20.7.4 Flashing:** Fixing flashing at terrace level as part of the system made to profile as shown in the approved shop drawings and the profile shall be made out of hot dip galvanized sheet 1.2 mm thick and galvanizing coating thickness shall be in accordance with IS 2629 & 4759. In general, the flashing shall be provided to the entire length of cladding horizontally at terrace level with necessary anchoring system with SS fastening devices of approved make. Also, the flashing shall be provided at parapet top below the coping to drain the water during any seepage through the sealant joints with overlap of 100 to 125 mm in plan with sealant at joints to make sure that no water leakage through coping / flashing joints.

**8.20.7.5 Field Test:** Conduct field test at site on the installed system as per the criteria set out in the particular specification in the presence of Engineer in charge. Methodology for carrying out the test shall be submitted to Engineer-in Charge for approval prior to testing. Record the results and submit the report to the Engineer-in Charge for approval. If Field test fails, correct the defects revealed to the satisfaction of the performance data as set out in the technical specification with the prior approval of Engineer-in Charge on defects rectification methodology.

**8.20.7.6 General Guideline:** System design in total, including Aluminium extruded member, type & thickness of Aluminium composite panel, Aluminium sleeves at connections, inserts, Sealant, Supporting system/bracket including fastening and anchoring system & materials specified in the schedule and the system details as shown in the tender drawing are only tentative and is meant to set out a general outline of the proprietary system. Since the cladding system in terms of design, materials, all fixing details, methodology of execution are proprietary in nature, the onus of the design and performance requirements, shop drawing, execution etc. satisfying the design intent, particular specification and site conditions lies solely with the Contractor.

#### **8.20.8 Precautions**

- (a) Do unpacking and repacking of ACP sheet work in a clean place.
- (b) Remove dust and chips from ACP sheet and the packing paper.
- (c) Handle ACP sheet on a worktable. Do not handle it on the floor.
- (d) ACP sheets should always be handled by two people with external face upward to avoid possible rubbing of the ACP surface during handling.
- (e) Prior to fabrication, clean off the worktable, temporary stand and both side of ACP sheet.
- (f) Ensure that cutting chips generated from saws, routers and drills are completely removed from the interface between ACP sheet and tools.
- (g) The arrow should be followed as marked on the rear (back) face coil/ sheet to avoid the variation in colour.
- (h) Protective film of 75 microns should be removed within 45 days after the installation.





- (i) Do not use adhesive tapes made of PVC (Polyvinyl Chloride) on the surface of protective film or any time during storage, fabrication or installation.
- (j) Aluminum composite material (ACM) manufacturer shall provide warranty of ten years for any manufacturing defects.

#### **8.20.9 Measurements**

For the purpose of payment, only the actual area on the external face of the curtain wall with Aluminum Composite Panel cladding (including width of groove) shall be measured in square meters upto two places of decimal.

#### **8.20.10 Rate**

The rate includes the cost of all materials, labour, equipment's, design, shop drawing, fabricating, installation and fixing in position the curtain wall with Aluminum composite panels cladding for all height and all level etc. in all the operation described above and any other stipulations in the specification and agreement. Also, includes the cost of scaffolding, infrastructure facility and all other consumables to execute the work as specified above.

The cost of all mockups at site, testing charges, cost of all sample of the individual components for testing in an approved laboratory, field test on the assembled working curtain wall with aluminum composite panels claddings, cleaning and protection of the curtain wall with aluminum composite panel claddings till the handing over of the building for occupation. Base aluminum members frame work for ACP cladding is payable under the relevant aluminum items.





## GENERAL ARRANGEMENTS OF CRAMPS

Sub Head : Marble Work  
Clause : 8.6.2.3

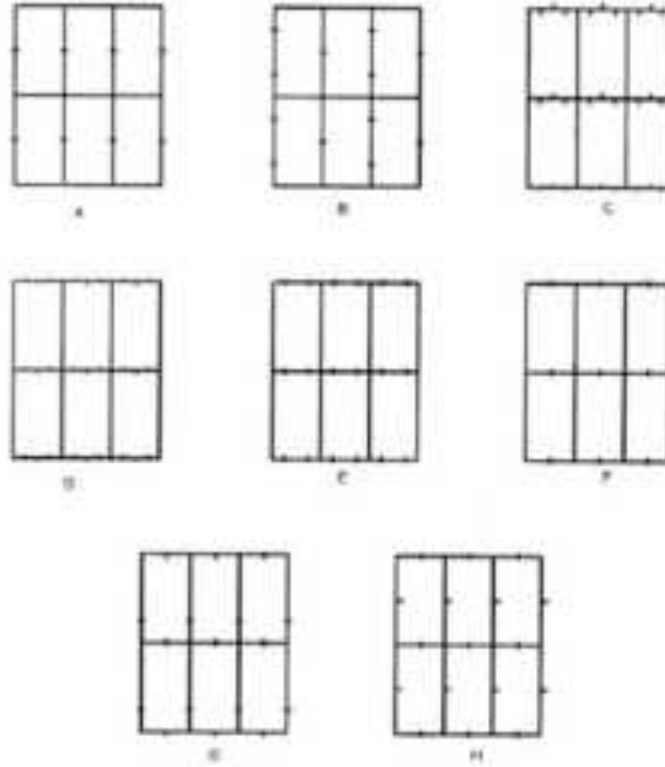


Figure 8.3 : General Arrangements of Cramps

Drawing not to scale  
All dimensions are in mm

Note: Cramps arrangements is shown above for veneering with longer sides vertical. For veneering having the longer sides horizontal cramps would be arranged to suit the altered positions.

## MARBLE SLAB URINAL PARTITION

Sub Head : Marble Work  
Clause : 8.7

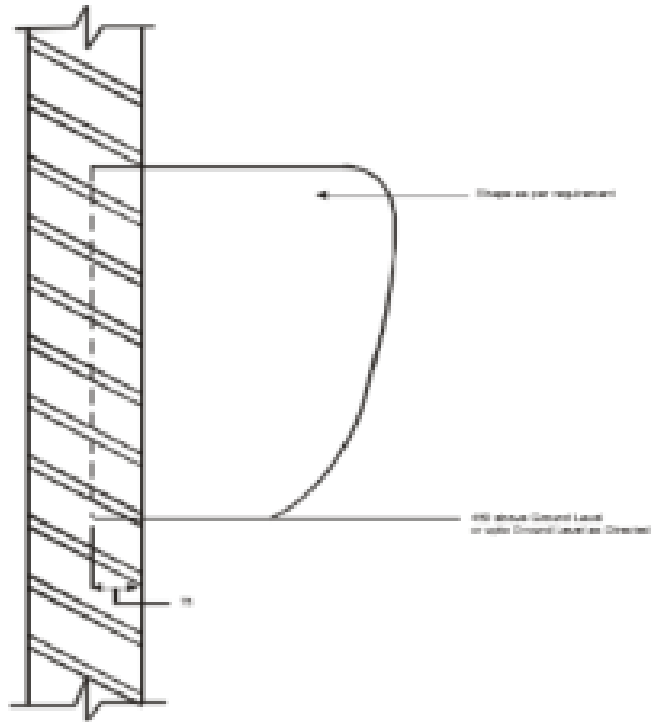


Figure 8.4 : Marble Slab Urinal Partition

Drawing not to scale  
All dimensions are in mm



## STONE VENEERING (Typical Fixing Arrangement)

Sub Head : Stone Work  
Clause : 8.8.4.2 & 8.8.4.6

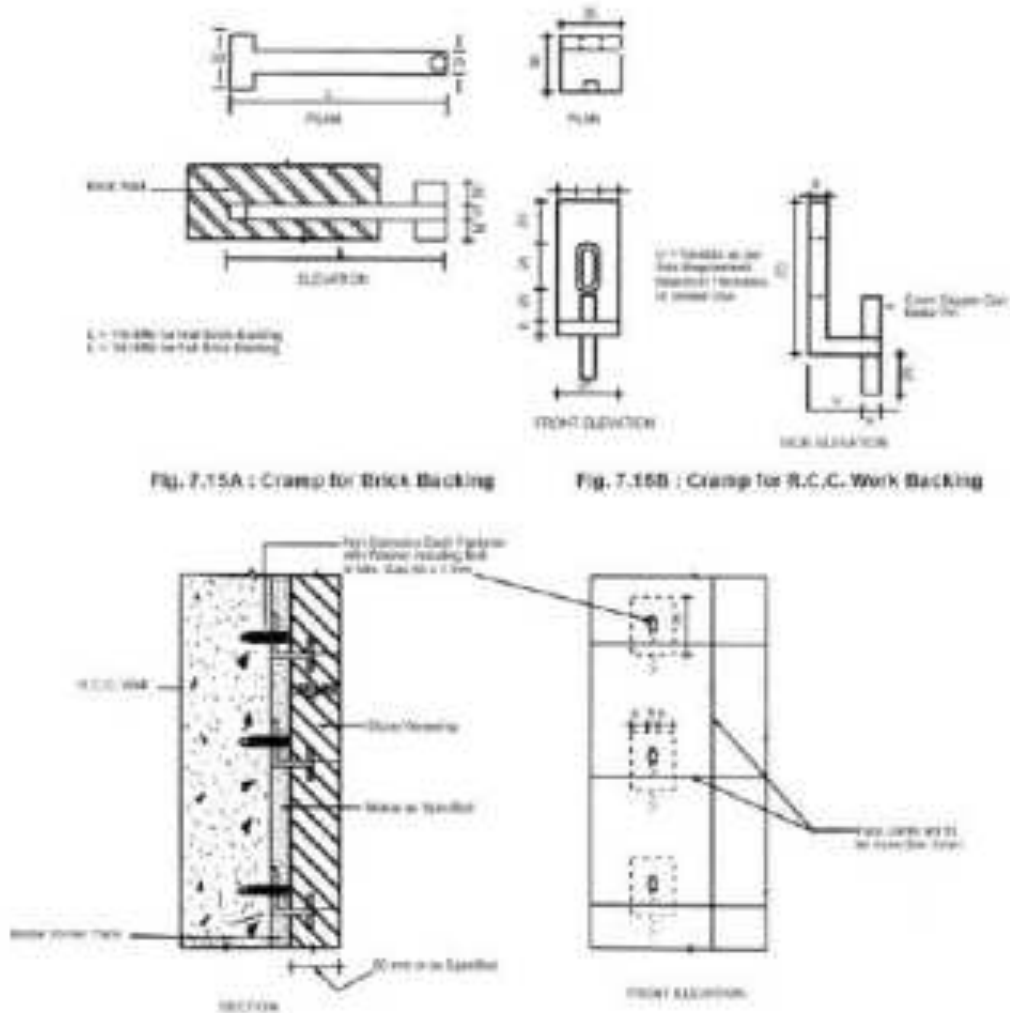


Figure 8.6 : Stone Veneering (Typical Fixing Arrangement)

Drawing not to scale  
All dimensions are in mm

## GENERAL ARRANGEMENT OF CRAMPS

Sub Head : Stone Work  
Clause : 8.8.4.3

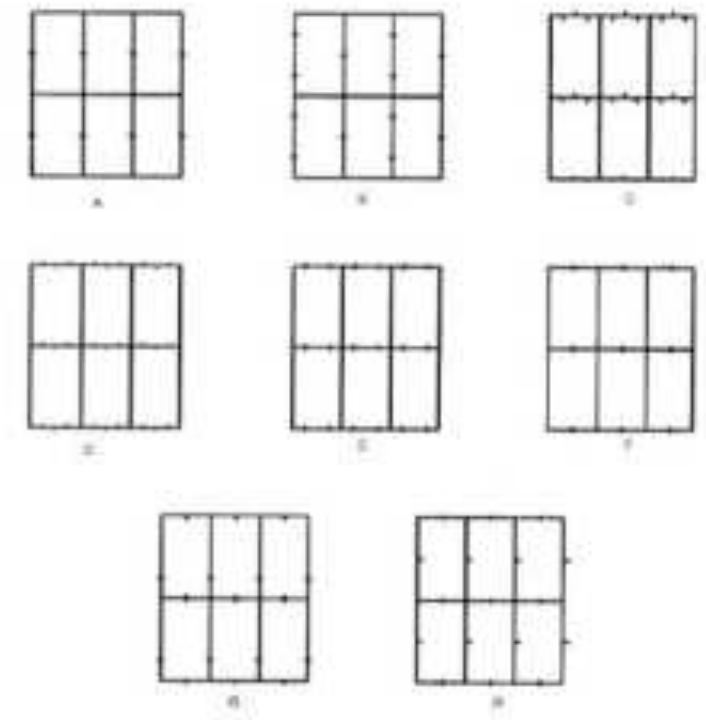


Figure 8.7 : General Arrangements of Cramps

Drawing not to scale  
All dimensions are in mm

**Note:** Fig. 8.5, 8.6 & 8.7 brought form Fig. 7.14, 7.15 & 7.16





## WOOD WORK & PVC WORK



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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
1	2	3	4	5	6	7
<b>Timber</b>	916	Moisture content	Field (by Moisture meter) laboratory test required Engineer-in-Charge	IS: 17088 Part-1	One test for one cum or part thereof (Minimum quantity for Testing: 1 cum)	Everyone cum or part thereof (Minimum quantity for Testing: 1 cum)
<b>Flush door</b>	97 10	End immersion Test, Knife test, Adhesion Test, Screw withdrawal Resistance Testing: 26 shutters) Test	Lab	IS: 4020 Part-13 Part-14 Part-15, Part-16	As per sampling and testing and specified in clause 9.7.11 (Minimum quantity for Testing: 26 shutters)	As per sampling and testing specified in clause 9.7.11 (Minimum quantity for Testing: 26 shutters)
<b>Wooden Paneled Door Shutter/ Flush door shutter /Laminated Veneer Lumber (LVL) door shutter/ PVC door shutter s/FRP door shutter</b>		TYPE TEST (as applicable for a particular type of door as per relevant IS code) (i) Dimension Squareness Test and (ii) General Flatness Test (iii) Local Planeness Test	Lab	IS:4020 Part-2 Part-3 Part-4 Part-5 Part-7 Part-8 Part-9 Part-10 Part-11 Part-16 Part-13 Part-1 Part-15	Manufacturer type test report for at least 3 nos. door obtained from contractor after supply of 5000 nos or part thereof or once in 12 month whichever is earlier.  (Manufacturer Type test Report is not mandatory in case total	As prescribed specification in Shutter/ Flush relevant for the door shutters. (Minimum Quantity: 50 nos)



Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
		(iv) Impact Indentation Test (v) Edge Loading Test (vi) Shock Resistance Test (vii) Buckling Test (viii) Slamming Test (ix) Misuse Test (x) Screw Holding Test (xi) End immersion Test (xii) Knife Test (xiii) Glue Adhesion Test			quantity of shutters to be supplied in the work is less than 50 nos.)	
<b>Mortice Locks</b>	9.15.13	Testing of spring	Lab	IS: 2209	100 or part thereof (Minimum Quantity: 50 Nos.)	100 or part thereof (Minimum Quantity- 50 Nos.)



### LIST OF BUREAU OF INDIAN STANDARD CODES

S. No.	IS No.	Subject
1.	IS 204 (Part I)	Specification for tower bolts (ferrous bolt)
2.	IS 204 (Part II)	Specification for tower bolts (non ferrous metals)
3.	IS 205	Specification for non ferrous metal butt hinges
4.	IS 206	Specification for Tee and strap hinges
5.	IS 207	Specification for Gate and shutter hook and eye
6.	IS 208	Specification for door handles
7.	IS 277	Galvanized steel sheets (Plain and Corrugated)
8.	IS 281	Specification for mild steel door bolts for use with pad locks
9.	IS 287	Recommendations for maximum permissible moisture contents of timber used for different purpose
10.	IS 303	Specification for plywood for general purposes
11.	IS 362	Specification for parliament hinges
12.	IS 363	Specification for hasps and staple
13.	IS 364	Specification for fan light catch
14.	IS 401	Code of practice for preservation of timber
15.	IS 419	Putty for use on window frames
16.	IS 451	Technical supply condition for wood screws
17.	IS 452	Specification for door spring rat tail type
18.	IS 453	Specification for double acting spring hinge
19.	IS 707	Glossary of terms applicable to timber technology and utilization
20.	IS 710	Specifications for Marine Plywood
21.	IS 723	Specification for steel counter sunk head wire nails.
22.	IS 729	Specification for drawer lock, cupboard lock and box locks
23.	IS 848	Specification for synthetic resin adhesive for plywood (phenolic and amino plastic)
24.	IS 851	Specification for synthetic resin adhesive for const. work (non structural in wood)
25.	IS 852	Specification for animal glue for general wood work purpose
26.	IS 875 (Part-3)	Code for practice for design loads (other than Earthquake) for building and structures
27.	IS 1003 (Part I)	Specification for timber panelled and glazed shutter Part I (door shutters)
28.	IS 1003 (Part II)	Specification for timber panelled and glazed shutter Part II (window and ventilator shutter)
29.	IS 1079	Hot rolled carbon steel sheet and strip
30.	IS 1141	Specification for code of practice for seasoning of timber





S. No.	IS No.	Subject
31.	IS 1200 Part XIV	Method of measurement of building and civil engg work glazing.
32.	IS 1200 Part XII	Wood work and joinery
33.	IS 1328	Specification for veneered decorative plywood
34.	IS 1341	Specification for steel butt hinges
35.	IS 1378	Specification for oxidized copper finishes
36.	IS 1566	Specification for hard drawn steel wire fabric
37.	IS 1568	Specification for wire cloth for general purpose
38.	IS 1658	Specification for hard drawn steel wire fabric
39.	IS 1659	Specification for block boards
40.	IS 1708 (Part 1 to 18)	Testing of small clear specimen for timber
41.	IS 1734	Determination of density and moisture content.
42.	IS 1823	Specification for floor door stopper
43.	IS 1868	Specification for anodic coating on aluminium and its alloy
44.	IS 2046	-do- Decorative thermosetting synthetic resin bonded laminated sheet
45.	IS 2095	Specification for gypsum plaster board
46.	IS 2096	Specification for asbestos cement flat sheet.
47.	IS 2202 (Pt I)	Specification for wooden flush door shutter, solid core type (plywood face panels)
48.	IS 2202 (Part II)	-do- (Particle boards and hard board face panels)
49.	IS 2209	Specification for mortice lock (Vertical Type)
50.	IS 2380	Method of test for wood particle board and board for lignocelluloses material
51.	IS 2547	Specification for gypsum plaster
52.	IS 2753	Method for estimation of preservatives in treated timber and in treating solutions
53.	IS 2681	Specification for non-ferrous metal sliding door bolts use with pad locks
54.	IS 3087	Specification for wood particle boards (Medium density) for general purpose
55.	IS 3097	Specification for veneered particle board
56.	IS 3828	Specification for ventilator chain
57.	IS 3400 (Part II)	Method of test for Vulcanized rubber (hardness)
58.	IS 3400 (Part IV)	Accelerated aging
59.	IS 3400 (Part IX)	Density
60.	IS 3564	Specification for door closer (hydraulically regulated)
61.	IS 3618	Phosphate treatment of iron and steel for protection against corrosion
62.	IS 3813	"C" hooks for use with swivels
63.	IS 3818	Specification for continuous (Piano) hinges



S. No.	IS No.	Subject
64.	IS 3847	Specification for mortice night latch
65.	IS 4351	Steel Door Frames - Specification
66.	IS 4835	Specification for polyvinyl acetate dispersion based adhesive for wood
67.	IS 4948	Specification for welded steel wire fabric for general use
68.	IS 4985:2000	uPVC pipes for potable water supplies
69.	IS 4992	Specification for rebated mortice lock
70.	IS 5187	Specification for flush bolts
71.	IS 5509	Specification for Fire Retardant Plywood
72.	IS 5930	Specification for mortice latch
73.	IS 6318	Specification for plastic wire window fasteners
74.	IS 6607	Specification for rebated mortice lock (Vertical type)
75.	IS 6760	Specification for slotted counter sunk head wood screws.
76.	IS 7196	Specification for hold fast
77.	IS 7534	Specification for sliding locking bolts for use with pad lock
78.	IS 7638	Wood/lignocellulosic based panel products - Method for sampling
79.	IS 8756	Specification for mortice ball catch for use in wooden almirah
80.	IS 9308 (Part II)	Specification for mechanically extracted coir fibres. (Mattress coir fibres)
81.	IS 9308 (Part III)	-do- Decorated coir fibre
82.	IS 11215	Moisture content of timber and timber products method of determination
83.	IS 12049	Dimensions and tolerance relating to wood based panel materials
84.	IS 12406	Specification for medium density fibre board
85.	IS 12817	Specification for stainless steel Butt Hinges
86.	IS 12823	Specification for wood products -Prelaminated particle Boards
87.	IS 14276	Cement Bonded Particle Boards - Specificaion
88.	IS 14616	Specifications for laminated veneer lumber
89.	IS 14842	Specification for coir veneer board for general purposes
90.	IS 14856	Specification for glass fibre reinforced plastic (FRP) panel type door
91.	IS 14862	Fibre Cement Flat Sheets - Specification
92.	IS 14900	Specifications for transparent float glass



## 9 WOOD WORK & PVC WORK

### 9.0 TERMINOLOGY

#### **Ballies**

Thin round poles usually without bark.

#### **Beam**

A structural timber generally long in proportion to its width and thickness and used for supporting load primarily by its internal resistance to bending.

#### **Block Board**

A Board having a core made up of strips of wood, each not exceeding 25 mm in width, laid separately or glued or otherwise joined to form a slab which is glued between two or more outer veneers with the direction of the grain of the core blocks running at right angles to that of the adjacent outer veneers.

#### **Core**

The inner layers of a composite wood product.

#### **Cross B**

A general term indicating a transverse layer of veneer or veneers in composite wood products.

#### **Decorative Veneers**

Veneers having attractive appearance due to figure, colour, grain, lusture, etc.

#### **Hard Wood**

A conventional term used to denote the wood obtained from broad-leaved trees. It has no relationship to the physical properties of hardness or strength. On account of the confusion this word might cause, its use is discouraged.

#### **Freeze Rail**

Horizontal member, mortised or otherwise secured to the stiles of a door, provided just below the freeze panel usually provided for decorative purposes in the uppermost portion of the door.

#### **Joint**

A prepared connection for joining adjacent pieces of wood, veneer, etc.

#### **Dovetail Joint**

A joint at the corner of two pieces in such a way that the notches made to one are fitted exactly into projections of corresponding size and shape made in the other. There are various kinds of dovetail joints for instance, lapped dovetail joint, wedge shaped dovetail joint, etc. joined in a way which will resist withdrawal except in the direction in which it was assembled (Fig. 9.1C).

#### **Mitred Joint**

A joint, between two members at an angle which bisects the joining angle usually the joining faces are cut at 45° to form a right angle (Fig. 9.1B).

#### **Mortise and Tenon Joint**

A joint in which the reduced end (tenon) of one member fits into the corresponding slot (mortise) in another member (Fig. 9.1D).

**Tongue and Groove Joint**

A joint in which a tongue is provided on edge of one member to fit into a corresponding groove on the other (Fig. 9.1A).

**Knot**

Base of a branch or limb embedded in the tree which becomes visible when it is cut.

**Diameter of a Knot**

The maximum distance between two points farthest apart on the periphery of a round knot, on the face where it becomes visible. In the case of a spike or splay knot, the maximum width of the knot visible on the face on which it appears shall be taken as its diameter.

**Muntin**

Small horizontal or vertical dividing bars within basic framework of a window, or door subdividing and supporting the glass panes or panels of doors.

**Particle Board**

A board manufactured from particles of wood or other lignocellulose material, for example, flakes, granules, shavings, slivers, splinter agglomerated, formed and pressed together by use of an organic binder together with one or more of the agents, such as heat, pressure, moisture and a catalyst.

**Particle**

Distinct particle or fraction of wood, or other lignocellulose material produced mechanically for use as the aggregate for making a particle board. This may be in the form of flake, granule, shaving, splinter and sliver.

**Plywood**

A board formed of three or more layers of veneers cemented or glued together, usually with the grain of adjacent veneers running at right angles to each other.

**Rebate**

A recess along the edge of a piece of timber to receive another piece or a door, sash or a frame.

**Sapwood**

The outer layers of the log, which in the growing tree contain living cells and feed material. The sapwood is usually lighter in colour and is readily attacked by insects and fungi.

**Seasoning**

A process involving the reduction of moisture content in timber under more or less controlled conditions towards or to an amount suitable for the purpose for which it is to be used.

**Seasoned Timber**

Timber whose moisture content has been reduced to the specified minimum, under more or less controlled processes of drying.

**Structural Timber**

Timber used in framing and load bearing structures or timber used or intended for use in buildings where strength is the primary consideration.

**First Class Wood**



Individual hard and sound knots shall not be more than 25 mm in diameter and the aggregate area of all the knots shall not exceed one per cent of the area of the piece.

### **Second Class Wood**

Individual hard and sound knot shall not be more than 40 mm in diameter and aggregate of all the knots shall not exceed one and half per cent of the area of the piece. Wood shall be generally free from sapwood, but traces of sapwood may be allowed.

## **9.1 TIMBER**

- (a) Timber is classified as under:
- (b) Teak wood
- (c) Deodar wood
- (d) Non-coniferous timbers other than teak
- (e) Coniferous timber other than deodar

The timber shall be free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, splits and cracks. The timber shall be graded as first grade and second grade on the basis of the permissible defects in the timber as given in Appendix 'A' of Chapter 9.0. For both the grades, knots should be avoided over a specified limit.

### **9.1.1 Teak Wood (Tectona Grandis)**

It is of outstanding merit in retention of shape and durability. The heart wood is one of the most naturally durable woods of the world. It usually remains immune to white ant attack and insect attack for very long periods. It is, however, not always immune from fungus attack (rot). Taken as a whole, good quality teak is very durable, it is relatively easy to saw and work. It can be furnished to a fair surface and takes polish well. It is generally used for making furniture and all important timber construction.

- 9.1.1.1 Superior Class Teak Wood such as Balarsha, Malabar and Dandeli:** Individual hard and sound knot shall not be more than 12 mm in diameter and the aggregate area of all the knots shall not exceed one half per cent of the area of the piece. It shall be close grained.

### **9.1.2 Deodar Wood (Cedrus Deodars)**

It is the strongest of the Indian conifers. Its weight and strength is 20% per cent less than teak. It is easy to saw and works to a smooth finish. It is not, however, a suitable wood for polish or paint work as the oil in the wood and especially near knots, always seeps through such finishes and discolours them.

It is used for house building, furniture and other construction work. It is also suitable for beams, floors, boards, posts, window frames and light furniture etc.

### **9.1.3 Sal Wood (Shoera Robusta)**

Sal is about 30 percent heavier than teak, 50 percent harder, and about 20 to 30 percent stronger. In shock resistance it is about 45 percent above teak. Its heart wood is a naturally durable wood, and usually remains immune to attack by white ants and fungi for a long period, while its sapwood is very perishable and should not be used. Well dried sal is not a really easy wood to saw and work. It is a rough constructional wood than a carpentry timber. No individual hard and sound knot shall exceed 25 mm in diameter and the aggregate area of all the knots shall not exceed 1% of the area of the piece.

It can be used for a variety of purposes, such as for beams, rafters, flooring, piles, bridging, tool handles, picker arms and tent pegs, etc.

### **9.1.4 Kail Wood (Pinus Roxburghie)**



Kail Wood is not a very durable wood. But it is easy to saw and work and usually very popular in workshops. It can be brought to a fine smooth surface but is more suitable for paint and enamel finishes than for polish work. It is useful for joinery works, constructional work, light furniture and house fittings.

### 9.1.5 Other Species

The other species of timber as given in Table 9.1 of chapter 9.0 can also be used for various activities of building construction.

**TABLE 9.1**

**Species of Timber**

Sl No	Botanical Name	Availability						
		Trade Name	Avg Unit weight in kg/m <sup>3</sup>	North Zone	East Zone	Central Zone	West Zone	South Zone
1	Tectone grandis linnf	Teak	640	—	Y	X	X	X
2	Acacia Catechiu Willd	Khair	1010	X	X	X	Y	Y
3	Acacia Arabica Willd	Babul	785	X	X	X	Y	Z
4	Adina Cordifolia Roxb HK. f	Haldu	675	X	—	—	—	X
5	Cedrus Deodara D Don	Deodar	545	X	—	Y	Y	—
6	Magnifera Indica Linn	Mango	670	X	X	Y		X
7	Pinus Roxburghie	Chir	575	X	—	—	—	—
8	Pinus Excelsa Wall	Kail	515	X	—	—	—	—
7	Shorea Robusta Gaertn.	Sal (U.P.)	881	X	X	—	—	—
10	Terminalia Myrioecarpa Heurcket Muell Arg.	Hollock	610	-	X	—	—	—
11	Lagerstroemia Lanceolata Wall	Benteak	675	—	—	—	Y	X
12	Gamelinc Arborea Ronb.	Gamari	515	Y	Y	Y	Z	Y
13	Terminalia Bellirica Roxb.	Bahora	801	X	X	X	Y	X
14	Pterocarpus Marsupium Roxb	Bijasal	800	—	X	X	Y	Y

Note: The Average unit wt. is at 12% moisture content.

**NORTH ZONE** : Jammu and Kashmir, Punjab, Himachal Pradesh, Delhi, Uttar Pradesh and Rajasthan.

**EAST ZONE** : Assam, Manipur, Tripura, West Bengal, Bihar, Orissa, Sikkim, Andamans, Northeast Frontier Agency and Nagaland.

**CENTRAL ZONE** : Madhya Pradesh, Vidharbha areas of Maharashtra State and the Northeast Part of Andhra Pradesh (Godavari delta area).

**WEST ZONE** : Maharashtra State (Except Vidharbha areas), Gujarat and North West part of Karnataka. Tamil Nadu, Andhra Pradesh (except the Godawari Delta area) Kerala and karnataka (except North West port)



**SOUTH ZONE** : Tamil Nadu, Andhra Pradesh (Except the Godawari delta area) Kerala and Karnataka (except North West part)

The availability of timbers is categorised under three classes as indicated below:

X - Most common, 1415 m<sup>3</sup> (1000 tonnes) and more per year.

Y - Common, 355 m<sup>3</sup> (250 tonnes) to 1415 m<sup>3</sup> (1000 tonnes) per year

Z- Less common, below 355 m<sup>3</sup> (250 tonnes) per year.

### 9.1.6 Moisture Content

Control on moisture content of timber is necessary to ensure its proper utility in various climatic conditions. For specifying the permissible limit of moisture content in the timber the country has been divided into four climatic zones as per Appendix B of Chapter 9. In each of the zones, maximum permissible limit of moisture content of timber for different uses, when determined in accordance with the procedure laid down in Appendix C shall be as per Table 9.2 of Chapter 9.

**TABLE 9.2**

**Maximum Permissible Moisture Content of Timber**

Sl.No.	Use	Max Moisture Content Percent			
		Zone I	Zone II	Zone III	Zone IV
1.	Beams, Rafters & Posts	12	14	17	20
2.	Doors and windows				
	(a) 50 mm and above thickness	10	12	14	16
	(b) Thinner than 50 mm	8	10	12	14
3.	Flooring strips	8	10	10	12
4.	Furniture & Cabinet making	10	12	14	15

**9.1.6.1 Tolerance on Moisture Content:** Average Moisture content of all the samples from a lot shall be within + 3 per cent and moisture content of individual samples within + 5 per cent of maximum permissible moisture content specified in table 9.2. These tolerances are the absolute values over the percentage moisture content for Sl. No. 1 & 2 of Table 9.2 No tolerance on moisture content is permitted for Sl. No. 3 & 4 of Table 9.2.

### 9.1.7 Seasoning of Timber

The process of drying timber under controlled conditions is called seasoning of timber. Timber shall be either air seasoned or kiln seasoned and in both cases moisture content of the seasoned timber shall be as specified in Table 9.2 of Chapter 9 unless otherwise specified, air seasoned timber shall be used. Kiln seasoning of timber, where specified, shall be done as per IS 1141 in a plant approved by Engineer-in-Charge.

### 9.1.8 Preservation of Timber

Preservative treatment does not improve basic properties of timber but gives varying degree of protection against deterioration due to attacks by fungi, termites, borers and marine organisms.



Preservative treatment, where specified, shall be done using Oil type, Organic solvent type or Water-soluble type preservative. Oil type preservatives shall be used if the timber is not required to be polished or painted. Before preservative treatment, the timber shall be sawn and seasoned. All surfaces exposed after treatment, except due to planing, shall be thoroughly brushed with the preservation before jointing. Preservative treatment of timber shall be done as per IS 401 in a plant approved by the Engineer-in-Charge.

## 9.2 PANELLING MATERIAL

### 9.2.1 Timber

Timber panels shall be preferably made of timber of larger width. The minimum width and thickness of a panel shall be 150 mm and 15 mm respectively. When made from more than one piece, the pieces shall be joined with a continuous tongue and groove joint, glued together and reinforced with metal dowels. The grains of timber panels shall run along the longer dimensions of the panels. The panels shall be designed such that no single panel exceeds 0.5 square metre in area.

### 9.2.2 Plywood Boards

**9.2.2.1** Plywood shall be of BWP grade or BWR grade as per IS 303.

**9.2.2.2** Marine plywood confirming to IS 710.

**9.2.2.3** Fire resistant plywood confirming to IS 5507.

**9.2.2.4** Thickness: Plywood boards are available in thickness ranging from 3 to 25 mm. Tolerance in thickness shall be  $\pm 10\%$  for boards upto and including 5 mm;  $\pm 7\%$  for boards from 6 to 7 mm and  $\pm 5\%$  for boards above 7 mm thickness. The boards shall be of uniform thickness and the surfaces of the boards shall be sanded to a smooth finish. Number of plys in plywood boards shall be as per Table 9.3.

**TABLE 9.3**

Thickness in mm	No. of ply	Thickness in mm	No. of ply
3,4,5,6	3	12,15,16,17	7
5,6,8,7	5	17,22,25	11
7,12,15,16	7		(Above 11 Ply as ordered)

**Note:** Plywood of 7 mm thick of 5 or 7 ply may be used generally.

**9.2.2.5** Moisture content of the plywood boards when tested in accordance with IS 1734 (Part 1) shall not be less than 5 per cent and not more than 15 per cent.

**9.2.2.6** Testing: One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 303. However, testing may not be done if the total requirement of plywood boards is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of plywood boards specified in Appendix D of Chapter 7.

### 9.2.3 Particle Boards

**9.2.3.1** Particle boards shall be of medium density and manufactured from particles of agro waste, wood or lignocellulose i.e. material blended with adhesive and formed into solid panels under the influence of heat, moisture, pressure etc. The particle boards shall be flat pressed three layered or graded and of Grade-I as per Table 1 of IS 3087. Both surfaces of the boards shall be sanded to obtain a smooth finish and shall conform to IS 3087.

**9.2.3.2 Adhesives:** Adhesives used for bonding shall be BWP type synthetic resin conforming to IS 848.





**9.2.3.3 Thickness and Tolerance:** Thickness of particle boards shall be as specified. Tolerance in thickness shall be  $\pm 5\%$  for boards upto and including 25 mm thick and  $\pm 2.5$  per cent for boards above 25 mm thickness. Each board shall be of uniform thickness.

**9.2.3.4 Testing:** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3087. However, testing may not be done if the total requirement of particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirement of physical and mechanical properties of particle boards specified in Appendix E of Chapter 9.0.

#### 9.2.4 Veneered Particle Boards

Veneered Particle Boards with core of FPT-1 or graded board Grade-I particle board (IS 3087) with commercial or general-purpose veneer (Type-1) or decorative veneers on both faces or with decorative veneer on one face and commercial /general purpose veneers on the other Type-2. Face veneers are bonded using adhesives under the influence of heat and pressure.

**9.2.4.1 Adhesives:** The adhesive used for bonding veneers shall be BWP or BWR type conforming to IS 848 for grade I veneered particle board.

**9.2.4.2 Thickness & Tolerance:** Veneered particle boards are available in various thickness 6, 10, 12, 20, 25, 30, 35, 40, 45 & 50 mm.

Tolerance in thickness shall be  $\pm 5\%$ .

**9.2.4.3 Testing:** One sample for every 100 sqm or part thereof shall be taken and testing done as per IS 3077. However, testing may not be done if the total requirement of veneered particle boards in a work is less than 30 sqm. All the samples tested shall meet the requirements of physical and mechanical properties of veneered particle boards as under:

1.	Moisture Content	5-15%
2.	Water Absorption	
	(a) 2 hrs. soaking	Not more than 25%
	(b) 24 hrs. soaking	Not more than 50%
3.	Water Resistance	No sign of disintegration or delamination after 3 hrs. boiling in water.
4.	Swelling in Water	
	(a) General absorption for 2 hrs. immersion	Not more than 7%
	(b) Surface absorption for 2 hrs.	Not more than 5%
5.	Adhesion of piles	Knife test

**9.2.4.4** Type of face veneers, thickness of veneered particle boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade veneered particle boards with BWP type synthetic resin adhesive shall be used.

#### 9.2.5 Non-Asbestos Fibre Boards

**9.2.5.1** Fibre boards shall be of medium density cement board reinforced with wood fibre, produced by fiberizing steamed wood under pressure, blended with adhesive and wax and formed into solid pan else under controlled conditions of heat and pressure as per IS 14862.



**9.2.5.2 Adhesives:** The adhesive used for bonding shall be BWP type synthetic resin conforming to IS 848.

**9.2.5.3 Thickness:** Fibre boards are available in thickness 6, 7, 12, 15, 18, 22, 25, 30, 35 & 40 mm. The tolerance in thickness shall be  $\pm 0.3$  mm. Thickness of fibre boards and adhesive used for bonding shall be as specified. Unless otherwise stated, exterior grade fibre boards bonded with BWP type synthetic resin adhesive shall be used.

#### **9.2.6 Float Glass, Frosted Glass**

Float glass used shall be as specified in sub-head 21.0 of these specifications. For panel exceeding 0.5 sqm in area, the nominal thickness of the glass to be used shall be as specified.

#### **9.2.7 Wire Cloth (Wire Gauze)**

Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanized mild steel wires in both warp and weft directions. The wire cloth shall be properly selvaged by one or more wires in each edge.

**Mesh:** Average width of aperture and the nominal diameter of the wire shall be as under:

<i>Average width of Aperture mm</i>	<i>Nominal dia. of wire mm</i>
1.40	0.63
1.18	0.56
1.00	0.50

**9.2.7.1** Width of aperture and dia of wire cloth shall be as specified. Unless otherwise stated, wire cloth of 1.40 mm average aperture width woven with 0.63 mm nominal dia galvanised mild steel wire shall be used.

**9.2.7.2** Fly-proof wire cloth (aperture 1.40 mm) is generally provided in Kitchen and dining areas while wire cloth of smaller aperture is used in mosquito proof shutters.

#### **9.2.8 Veneered Decorative Plywood**

Decorative plywood shall be of two grades namely BWR and MR Decorative Plywood shall be of two types. Type I and Type 2 and shall conform to IS 1328.

**9.2.8.1** Requirement of Type-I Veneered decorative plywood shall be as under:

- Open slits checks or open joints not more than 150 mm in length and 0.5 mm in width shall be permissible provided the same are rectified with a veneer insert bounded with synthetic resin adhesive, as the case may be and further provided that the insert matches with the surrounding veneer in colour as well as figure.
- The decorative veneered surface shall be free from torn grain, dead knots discolourisation and sapwood.
- The decorative veneered surface shall be selected for figure, texture, colour and grain etc. It shall be free from all manufacturing and wood defects except to the Engineer-in-Charge permitted under para 9.2.8.1(a). All veneers shall be matched or mismatched to achieve a decorative effect in colour figure and grain.

**9.2.8.2 Adhesive:** The adhesive for bonding veneers shall be MR and BWR type synthetic resin adhesive conforming to IS 848 for MR and BWR grade veneered decorative plywood respectively.

#### **9.2.8.3 Dimensions and Tolerances:**

**9.2.8.3.1** The dimensions of plywood boards shall be as follows:



2400 mm x 1200 mm    2100 mm x 700 mm

2100 mm x 1200 mm    1800 mm x 700 mm

1800 mm x 1200 mm

**9.2.8.3.2 Thickness:** The thickness of plywood board shall be 3 mm, 4 mm, 6 mm, 7 mm, 12 mm, 17 mm and 25 mm.

**Note:** Any other dimensions (length, width and thickness) as agreed to between the manufacturer and the purchaser may also be used.

**9.2.8.3.3 Tolerances:** Tolerances on the nominal sizes of finished boards shall be as follows:

<i>Dimension</i>	<i>Tolerance</i>
Length	+6 mm - 0
Width	+3 mm -0 mm
Thickness:	
(i) Less than 6 mm	±10 per cent
(ii) 6 mm and above	+ 5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

**Note:** Edge straightness and squareness shall be tested as per Appendix I.

**9.2.8.4 Finish:** The decorative plywood shall be uniform in thickness within the tolerances limits specified. The ends shall be trimmed straight and square edge straightness and squareness when tested as per Appendix I shall be within the tolerance specified in 9.2.8.3.3.

**9.2.8.5 Sampling and Criteria for Conformity:** The method for drawing representative samples and criteria for conformity shall be as per IS 7638.

**9.2.8.6 Tests:** Boards shall be subjected to following tests:

- Moisture content: Decorative veneered plywood of either type when tested in accordance with IS 1734 (Pt. I) shall have a moisture content not less than 5 per cent and not more than 15 per cent.
- Water Resistance Test: Three test specimen of size 250 mm x 100 mm shall be prepared for each of the boards selected and submerged in water at  $62 \pm 2^\circ\text{C}$  for a period of 3 hours and dried for 8 hours at a temperature of  $65 \pm 2^\circ\text{C}$  and then followed by two more cycles of soaking and drying under same conditions described above. Decorative Veneered plywood of either type shall not show delamination or blister formation.

**9.2.8.7 Marking:** Each plywood bound shall be legibly and indelibly marked or stamped with the following on the face of board near one corner.

- Indication of the source of manufacture
- Year of manufacture
- Batch no.



d. Type of plywood

The decorative veneered plywood may also be marked with standard BIS certification mark.

### 9.2.9 Prelaminated Particle Boards

**9.2.9.1** Prelaminated particle boards are available in two grades namely Grade I and II as per IS 12823. Each grade is further classified in four types; namely Type - I, II, III, IV.

#### 9.2.9.2 Material

9.2.9.2.1 Particle Board Prelaminated particle board Grade-1 (FPT-I or graded wood particle board FPT-I) bonded with BWP type synthetic resin and Prelaminated conforming to IS 12823 Grade-I, type II or I shall be used.

9.2.9.2.2 Impregnated Base Paper: Printed or plain coloured absorbent base paper having a weight of 60-140 g/m<sup>2</sup> impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for prelamination on both surfaces of particle board.

9.2.9.2.3 Impregnant Overlay: An absorbent tissue paper having a weight of 18-40 g/m<sup>2</sup> impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

#### 9.2.9.3 Dimension and Tolerances

9.2.9.3.1 Dimensions of Prelaminated particle boards shall be as follows:

Length	: The length of Prelaminated particle boards shall be 4.8, 3.6, 3.0, 2.7, 2.4, 2.1, 1.8, 1.5, 1.2, 1.0 and 0.7 metres.
Width	: The width of Prelaminated particle boards shall 1.8, 1.5, 1.2, 1.0, 0.7, 0.6 and 0.45 metres.
Thickness	: The thickness of Prelaminated particle boards shall be 6, 7, 12, 15, 20, 25, 30, 35, 40 and 45 mm.

Tolerances: Tolerances on the nominal sizes of finished boards shall be as given below:

Dimension	Tolerance
Length	+ 6 mm - 0
Width	+ 3 mm - 0
Thickness	5 per cent
Edge straightness	2 mm per 1000 mm or 0.2 per cent
Squareness	2 mm per 1000 mm or 0.2 per cent

Note: Edge straightness and squareness shall be tested as per IS 12823.

**9.2.9.4 Sampling and Inspection:** The number of prelaminate particle board to be selected from a lot shall be in accordance with the Table 9.4 given below:

**Table 9.4**

Lot Size	Number of prelaminate boards to be selected
Upto 50	2



51 to 100	3
101 to 200	4
201 to 300	5
301 to 500	7
501 and above	10

9.2.9.4.1 The prelaminated particle boards shall be selected at random (ref. IS 4903). In order to ensure randomness of selection, all the prelaminated particle boards in the lot may be arranged in a serial order and every  $r$ th prelaminated particle board may be selected till the required number is obtained, 'r' being the integral part of  $N/n$ , where  $N$  is the lot size and  $n$  is the sample size.

9.2.9.4.2 All board selected as given in para 9.2.9.4.1 shall be tested as specified in IS 2380 (Part-2) for length, width, thickness, edge straightness and squareness shall comply with the requirements specified under para 9.2.9.3.2.

**9.2.9.5 Testing and Number of Tests:** For each of particle board selected as per para 9.2.9.4 Test specimens shall be cut out from portion 150 mm away from the edges for tests and tests shall be carried out as per IS 12823.

**9.2.9.6 Criteria for Conformity:** A lot shall be considered as in conformity to the requirements of the specification if no group of specimens for any of the characteristics fails to meet the conditions as prescribed in para 9.2.9.3 & 9.2.9.5 of this specification.

In case of a failure, double sample shall be taken from the lot for testing. The lot shall be considered as passed, if all these samples conform to the specified requirement.

**9.2.9.7 Marking:**

Each prelaminated particle board shall be legibly and indelibly marked on any of its edges with following

- (a) Indication of source of manufacturer
- (b) Grade and type of prelaminated particle board
- (c) Thickness
- (d) Batch number and year of manufacture

**9.2.9A PRE-LAMINATED MEDIUM DENSITY FIBER BOARD**

**9.2.9A.1** Pre-laminated medium density fiber boards are available in two grades namely Grade I and II as per IS 14587:1778. Each grade is further classified in four types; namely Type –I, II, III, IV.

**9.2.9A.2 Material**

**9.2.9A.2.1** A medium density fiber board laminated on both surfaces by synthetic resin impregnated base papers conforming to IS 14587:1778 Grade-I, type II or I shall be used.

**9.2.9A.2.2** Impregnated Base Paper: Printed or plain colored absorbent base paper having a weight of 60-140 g/m<sup>2</sup> impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of medium density fiber board.

**9.2.9A.2.3** Impregnated Overlay: An absorbent tissue paper having a weight of 18-40 g/m<sup>2</sup> impregnated in a suitable synthetic resin and dried to volatile content of 4-8 per cent.

**9.2.9A.3 Dimension and Tolerances**

**9.2.A.3.1** Dimensions of pre-laminated medium density fiber boards shall be as follows:



Thickness: The thickness of pre-laminated medium density fiber boards shall be 6, 7, 12, 15, 18, 22, 25, 30, 35 and 40 mm.

**9.2.9A.3.2 Tolerances:** Tolerances on the nominal sizes of finished boards shall be as given below:

Dimension	Tolerance
Length	± 3 mm/metre
Width	± 3 mm/metre
Thickness	± 0.3 mm
Edge straightness	2 mm/metre
Squareness	2 mm/metre

**9.2.9A.4 Sampling and Inspection:** The number of prelaminated particle board to be selected from a lot shall be in accordance with the Table 9.4 given below:

**Table 9.4A**

Lot Size	Number of prelaminated boards to be selected
Upto 50	2
51 to 100	3
101 to 200	4
201 to 300	5
301 to 500	7
501 and above	10

**9.2.9A.5 Marking:**

Each prelaminated particle board shall be legibly and indelibly marked on any of its edges with following

- (a) Indication of source of manufacturer
- (b) Grade and type of prelaminated particle board
- (c) Thickness
- (d) Batch number and year of manufacture

**9.2.10 Coir Veneer Board for General Purposes: DELETED**

**9.2.11 Marine Plywood**

**9.2.11.1** Marine plywood shall be generally conforming to IS 710. Selection of timber species for manufacture of plywood shall be as prescribed in IS 710 and as far as possible a single species of timber shall be used.

**9.2.11.2 Adhesive:** The adhesive used for bonding the veneer shall be of the hot press synthetic resin, phenol formaldehyde type (BWP) and shall conform to IS 848. Extender shall not be added to the adhesive by the plywood manufactures. Fillers, if used, shall not exceed 10 percent by mass of solid content of the glue.

**9.2.11.3 Dimensions**



9.2.11.3.1 The dimensions of plywood boards shall be quoted in following order. The first dimension shall represent the length, the second dimension the width and the third dimension the thickness. The dimensions and tolerances shall be as per IS 12047.

Thickness of coir veneer board shall be 3 mm, 4 mm, 5 mm, 6 mm, 7 mm, 12 mm, 16 mm, 18 mm, 20 mm and 25 mm. The following tolerance on nominal thickness shall be permissible.

- (a) Less than 6 mm  $\pm 10\%$
- (b) 6 mm and above  $\pm 5\%$

9.2.11.3.2 The thickness of any board shall not exceed the number of pieces multiplied by 2.5 mm. The two face veneers in finished board shall be of the same nominal thickness.

**9.2.11.4 Tolerances:** The following tolerances in the nominal size of finished boards shall be permitted.

Dimension	Nominal Size	Tolerance
Length	Upto 120 cm	+ 3 mm
	Above 120 cm	+ 6 mm
Width	Upto 70 cm	+ 3 mm
	Above 70 cm	+ 6 mm
Thickness	Upto 4 mm	$\pm 10$ per cent
	Above 4 mm	$\pm 5$ per cent

**9.2.11.5 Sampling:** The method of drawing representative samples and criteria for conformity shall be as prescribed in IS 7638.

**9.2.11.6 Tests:** Test pieces cut from each of board as specified at para 9.2.11.5 shall be subjected to following tests.

- (a) Moisture content
- (b) Glue adhesive in dry state
- (c) Water resistance test.
- (d) Tensile strength
- (e) Mycological test
- (f) Retention of preservative.

These tests shall be carried out as specified in IS 710.

**9.2.11.7 Marking:** Each plywood board shall be legibly and indelibly marked or stamped with following particulars along with such other marks as the purchaser may stipulate at the time of placing order.

- (a) Manufacturer's name, initials or recognized trade mark, if any.
- (b) Year of manufacturing.
- (c) Abbreviation indicating the species of timber used in each ply as indicated in col. 3 of Table – 1 and 2 of IS 710.
- (d) Batch number



**9.2.11.8 BIS Certification Marking:** The plywood board may also be marked with the standard mark, governed by the BIS Act, 1786.

#### **9.2.12 Fire Retardant Plywood**

**9.2.12.1** Fire retardant plywood shall generally conform to IS 5507. The plywood to be given fire retardant treatment shall conform to BWR grade of IS 303 to be able to stand pressure impregnation. Plywood for treatment shall be clean, free from oil or dirt patches on the surface and at a moisture content not exceeding 15 percent. In case of veneered decorative plywood care shall be taken that colour of the solution does not spoil to decorative surface.

For Eco-mark the plywood shall conform to the requirements of Eco-mark specified in IS 303.

**9.2.12.2 Fire Retardant Treatment:** This shall be either pressure impregnation or soaking treatment as per IS 5507.

**9.2.12.3 Choice of Treatment:** The choice of treatment may be left to the manufacturer of plywood as per fire resistant requirements prescribed in IS 5507. The purchaser should, however, specify whether plywood is to be treated with fire retardants only or with fire retardants and preservatives.

The recommended retention of fire-retardant chemicals for different hazards like interior or exterior use not subject to leaching by rain and water is of the order of 50 kg/m<sup>3</sup>.

**9.2.12.4 Conditioning after Treatment:** The plywood after treatment shall be conditioned to suitable equilibrium moisture content of not more than 20 per cent.

**9.2.12.5 Dimension and Tolerances** shall conform to IS 2047. The tolerance of thickness shall conform to IS 303.

**9.2.12.6 Sampling:** The method of drawing representative sample and the criteria of conformity shall be as prescribed in IS 7638.

**9.2.12.7 Test Specimen and Number of Tests:** From each of fire-retardant plywood selected as above para 9.2.12.6, following test specimens shall be cut from portions 150 mm away from the edges for tests specified as under:

- (a) For Flammability: Six test specimens 125 mm x 125 mm in full thickness of material from each sample.
- (b) For Flame Penetration: Three test specimens 125 mm x 125 mm in full thickness of material from each sample.
- (c) For Rate of Burning: Three test specimen 100 mm x 12.5 mm in full thickness of material from each sample.

#### **9.2.12.8 Test Requirements and Other Tests**

- (a) Moisture Content: Shall not exceed 20%.
- (b) Flammability: When tested as per IS 1734, time taken for second ignition shall not be less than 30 minutes.
- (c) Flame Penetration: When tested as per IS 1734, time taken for flame penetration shall not be less than 15 minutes for every 6 mm thickness.
- (d) Rate of Burning: When tested as per IS 1734, the time taken to lose weight from 30 per cent to 70 per cent shall not be less than 20 minutes.

**9.2.12.9 Marking:** Each board shall be legibly and indelibly marked near the edge with the following:

- (a) Manufacturer's name, his initials or his recognized trade mark, if any.





- (b) Year of manufacture
- (c) Type of treatment
- (d) Criteria for which the plywood has been labeled as ECO mark.

**9.2.12.10 BIS Marking:** Each board may also be marked with standard mark governed by the BIS Act, 1786.

#### **9.2.13 Decorative Thermosetting Synthetic Resin Bonded Laminated Sheets**

**9.2.13.1 Scope:** Decorative thermosetting synthetic resin bonded laminated sheets shall generally conform to IS 2046. This material is intended for interior use and is not intended for load bearing applications.

**9.2.13.2 Terminology:** For the purpose of this standard, the definition given under para 2 of IS 1778 shall apply.

**9.2.13.3 Types:** The material shall be of two types namely:

Type 1 - Having only one side bearing decorative surface the other side being roughened or given an appropriate treatment to promote adhesion to the base. This type shall generally be used, unless specified otherwise.

Type 2 - Having both sides bearing the decorative surface, the two sides may be different in colour or pattern or both.

#### **9.2.13.4 Requirements**

- (a) Appearance: The types of surface finish of decorative and reverse side, edge finish, colour and pattern shall be as agreed to between the purchaser and the supplier. The sheets shall be reasonably free from local deformation.
- (b) Note: Since sheets may vary slightly in colour and appearance, it is recommended that sheets for any one scheme may be matched.
- (c) Flatness: For nominal thickness 1.5 mm - when a sheet is tested for flatness in accordance with the method given in Appendix -C of IS 2046, the height above the flat surface at the edge of full manufactured and trimmed width shall nowhere exceed 150 mm.
- (d) Tolerance to nominal thickness: The departure from nominal thickness of sheet at any point, shall not exceed the value given below:

Nominal Thickness	Tolerance
Upto 1.5 mm	$\pm 0.25$ mm

- (e) Straightness of edges of rectangular finished panels, resistance to dry heat, resistance to boiling water, resistance to staining, gross breaking strength, packing and marking, sampling and criteria for conformity etc. shall be as per IS 2046.

### **9.3 DOOR, WINDOW AND VENTILATOR FRAMES**

**9.3.1** Timber for door, window and ventilators frames shall be as specified. Timber shall be sawn in the direction of the grains. All members of a frame shall be of the same species of timber and shall be straight without any warp or bow. Frames shall have smooth, well-planed (wrought) surfaces except the surfaces touching the walls, lintels, sill etc., which may be left clean sawn. Rebates, rounding or moulding shall be done before the members are jointed into frames. The depth of the rebate for housing the shutters shall be 15 mm, and the width of the rebates shall be equal to the thickness of the shutters. A tolerance of  $\pm 2$  mm shall be permitted in the specified finished dimensions of timber sections in frames.

#### **9.3.2 Joints**



The Jamb posts shall be through tenoned into the mortise of the transoms to the full thickness of the transoms and the thickness of the tenon shall be not less than 2.5 cm. The tenons shall closely fit into the mortise without any wedging or filling. The contact surface of tenon and mortise before putting together shall be glued with polyvinyl acetate dispersion based adhesive conforming to IS 4835 or adhesive conforming IS 851 and pinned with 10 mm dia hard wood dowels, or bamboo pins or star shaped metal pins. The joints shall be at right angles when checked from the inside surfaces of the respective members. The joints shall be pressed in position. Each assembled doorframe shall be fitted with a temporary stretcher and a temporary diagonal brace on the rebated faces.

### **9.3.3 Fixing of Frames**

The frames shall be got approved by the Engineer-in-Charge before being painted, oiled or otherwise treated and before fixing in position. The surface of the frames abutting masonry or concrete and the portions of the frames embedded in floors shall be given a coating of coal tar. Frames shall be fixed to the abutting masonry or concrete with holdfasts or metallic fasteners as specified. After fixing, the jamb posts of the frames shall be plugged suitably and finished neat. Vertical members of the door frames shall be embedded in the floor for the full thickness of the floor finish and shall be suitably strutted and wedged in order to prevent warping during construction. A minimum of three hold fasts shall be fixed on each side of door and window frames one at centre point and other two at 30 cm from the top and bottom of the frames. In case of window and ventilator frames of less than 1 m in height two hold fasts shall be fixed on each side at quarter point of the frames. Hold fasts and metallic fasteners shall be measured and paid for separately.

### **9.3.4 Measurements**

Wood work wrought, framed and fixed shall be measured for finished dimension without any allowance for the wastage or for dimensions beyond specified dimension. However, in case of members having mouldings, roundings or rebates and members of circular or varying sections, finished dimensions shall be taken as the sides of the smallest square or rectangle from which such a section can be cut. Length of each member shall be measured over all to the nearest cm so as to include projection for tenons. Width and thickness shall be measured to the nearest mm and the quantity shall be worked out in unit of upto three places of decimal.

### **9.3.5 Rate**

The rate shall include the cost of material and labour involved in all the operations described above except the hold fasts or metallic fasteners which will be paid for separately.

## **9.4 FALSE CEILING AND PARTITION FRAMES**

This work shall be done as specified in 7.3 except that the scantlings need not be planed unless otherwise specified.

**9.4.1** All screws shall be of stainless-steel minimum grade 304 of required size.

**9.4.2 Rate:** The rate shall include cost of all materials including SS screws involved in all operations described above except the holdfast or metallic fastness which shall be paid for separately.

## **9.5 TRUSSES**

**9.5.0** The work shall be carried out as per detailed drawings and as directed by the Engineer-in-Charge specified timber shall be used. Sawing shall be truly straight and square, and in the direction of the grains. The scantlings shall be accurately planed smooth to the full dimensions and rebate roundings and mouldings shown in the drawings, before the same are framed. Patching or plugging of any kind shall not be permitted. A tolerance of +3 mm and -2 mm shall be allowed in the finished cross sectional dimension.



### **9.5.1 Joints**

Joints shall be simple, neat and strong. All mortise and tenon joints, mitred joints, scarfs etc. shall fit in fully and accurately without wedging or fillings. The joints shall be as per detailed drawings. Holes of correct sizes shall be drilled before inserting screws/bolts. Driving in screws with hammer is prohibited. Holes for bolts shall be of uniform diameter. The screws, bolts and nails shall be dipped in oil before using. The heads of nails and screws shall be sunk and puttied or dealt with as instructed by Engineer-in-Charge. The gauge and length of nails, screws and bolts shall be approved by the Engineer-in-Charge before using on works.

### **9.5.2 Shaping Form and Cutting**

The wood sections, as specified or required, shall be straightened, cut square and to correct lengths. A fine accuracy shall be ensured in the fabrication of various member so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true to shape and free from twist, kinks, buckles or open joints.

### **9.5.3 Fabrication**

As per drawing, a full-size truss diagram shall first be drawn on a levelled platform. From this full-size diagram, templates of all joints as for tenons, mortises, scarves etc. shall be made for use in the fabrication. The template shall be made to correspond to each member and plate holes for screws and bolts shall be marked accurately on them and drilled. The templates shall be laid on wooden members and the holes for screwing and bolting marked on them. The ends of the wooden members shall also be marked for cutting. The base of columns and the position of anchor bolts shall be carefully set out. Before fabrication of the truss individual members shall be assembled together to ensure close abutting or lapping of the surfaces of the different members and fitted close together as per drawing.

### **9.5.4 Hoisting and Placing in Position**

The trusses shall be hoisted and placed in position carefully, without any damage to itself and other building work and injury to workman. The trusses shall be secured to walls by means of holding down bolts or as directed by the Engineer-in-Charge. The necessary mechanical appliances such as lifting tackle, winch etc. for hoisting the truss shall be used. The trusses shall be stayed temporarily till they are permanently secured in position and connected with each other by means of purlins. Holding down bolts cleats used for purlins and bottom plates used for tie and rafter member shall be paid for separately.

### **9.5.5 Surface Treatment**

Wood work shall not be painted, oiled or otherwise treated before it has been approved by the Engineer-in-Charge. All portions of timber built into or against or close to masonry or concrete or buried in ground shall be given two coats of boiling coal tar. All junctions of rafters, purlins, beams and wall plates shall be painted with approved wood primer.

### **9.5.6 Measurements**

Wood work shall be measured for finished dimensions. No allowance shall be made for dimensions supplied beyond those specified. Length of each piece shall be measured over all nearest to a cm, so as to include projections for tenons, scarves or mitres. Width and thickness shall be measured to the nearest mm. Cubical contents can be worked out in units' cubic meters up to 3 places of decimal in whole numbers.

### **9.5.7 Rate**



The rate includes the cost of materials and labour involved in all the operations described above. Unless otherwise specified, iron fixtures such as bolts and nuts, M.S. steel plates, holding down bolts and staining, priming, painting or polishing of the work shall be paid for separately.

## 9.6 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS (FIG. 9.2)

**9.6.0** Panelled or glazed shutters for doors, windows, ventilators and cupboards shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, fibre board wire gauze or float glass. The shutters may be single or multipanelled, as shown in the drawings or as directed by the Engineer-in-Charge. Timber for framework, material for panel inserts and thickness of shutters shall be as specified. All members of the shutters shall be straight without any warp or bow and shall have smooth well planed face at right angles to each other.

Any warp or bow shall not exceed 1.5 mm for door shutter and 1 mm for window and ventilator shutters. The right angle for the shutter shall be checked by measuring the diagonals and the difference between the two diagonals should not be more than 3 mm. Generally panelled glazed or panelled and glazed shutter shall conform to IS 1003 (Pt. 1 & 2).

### 9.6.1 Frame Work

**9.6.1.1** Timber for stiles and rails shall be of the same species and shall be sawn in the directions of grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the required dimensions. The stiles and rails shall be joined to each other by plain or haunched mortise and tenon joints and the rails shall be inserted 25 mm short of the width of the stiles. The bottom rails shall have double tenon joints and for other rails single tenon joints shall be provided. The lock rails of door shutter shall have its centre line at a height of 800 mm from the bottom of the shutters unless otherwise specified. The thickness of each tenon shall be approximately one-third the finished thickness of the members and the width of each tenon shall not exceed three times its thickness.

**9.6.1.2** Gluing of Joints: The contact surfaces of tenon and mortise shall be treated, before putting together, with bulk type synthetic resin adhesive conforming to IS 851 suitable for construction in wood or synthetic resin adhesive (Phenolic and aminoplastic) conforming to IS 848 or polyvinyl acetate dispersion based adhesive conforming to IS 4835 and pinned with 8-10 mm dia hardwood dowels or bamboopins or star shaped metal pins; after the frames are put together and pressed in position by means of press.

**9.6.1.3** Stiles and bottom rail shall be made out of one piece of timber only. Intermediate rail exceeding 200 mm in width may be of one or more pieces of timber. The width of each piece shall be not less than 75 mm. Where more than one piece of timber is used for rails, they shall be joined with a continuous tongued and grooved joint glued together and reinforced with metal dowels at regular intervals not exceeding 200 mm.

**9.6.1.4** Door Shutters - Finished dimensions and tolerances of components of door shutters has been given in Table 9.5 below.

**TABLE 9.5**

**Dimensions and Tolerances of Components of Door Shutters**

Sl. no.	Description	Width (mm)	Thickness (mm)
a.	Vertical Stile, top and freeze rail	100 ± 3	35 ± 1 OR 40 ± 1
b.	Lock rail	150 ± 3	35 ± 1 OR 40 ± 1
c.	Bottom rail	200 ± 3	35 ± 1 OR 40 ± 1



d.	Muntin	100 ± 3	35 ± 1 OR 40 ± 1
e.	Glazing bar	40 + 3	35 + 1 OR 40 + 1

Size and Types: Size and types of the timber panels and glazed shutters shall generally conform to modular sizes specified in Table 9.6 below.

**TABLE 9.6**

**Dimension of Door Shutters**

Sl. No	Designation of Doors	Width (mm)	Height (mm)
i.	8DS 20	700	1705 (1745)
ii.	8DS 21	700	2005 (2045)
lii	7DS 20	800	1705 (1745)
iv.	7DS 21	800	2005 (2045)
v.	10 DS 20	700	1705 (1745)
vi.	10 DS 21	700	2005 (2045)
vii.	12 DT 20	1100	1705 (1745)
viii.	12 DT 21	1100	2005 (2045)

Notes:

- The designation refers to modular sizes of door openings. First number stands for width and the last for height in modules (M = 100 mm). Alphabet D refers to doors, 'S' to single and 'T' to double leaf shutter.
- Standard sizes of door frames are covered in IS 4021 and IS 4351.
- The standard widths and heights for panel doors are arrived at as shown in Fig. 6 of IS 1003 (Part 1). In case the modular height is taken from the finished floor level, the height of the door shall be the one given in bracket. In the case of double leave shutters, the rebate in the shutter shall be as given in 6.15 of IS 1003 (Part 1).

**9.6.1.5 Window and Ventilator Shutters:** Window and ventilator shutters shall conform to IS 1003 (Part 2).

**9.6.1.5.1 Dimensional Sizes and Tolerances:** The finished dimensions and tolerances of different component shall be as given in Table 9.7.

**TABLE 9.7**

**Dimensions and Tolerances of Components of Window and Ventilator Shutters**

Description of components	Window Shutters		Ventilator Shutters	
	Width mm	Thickness mm	Width mm	Thickness mm
Stiles and rails	80 ± 3	25 ± 1	80 ± 3	20 ± 1
		30 ± 1		22.5 ± 1
				25 ± 1



				27.5 ± 1
				30 ± 1
Munting	60 ± 3	25 ± 1	60 ± 3	-do-
		30 ± 1		
Glazing bars	40 ± 1	25 ± 1	40 ± 1	-do-
		30 ± 1		

9.6.1.5.2 **Designation:** Window and ventilator shutters shall be designated by symbols denoting the width, type and height of window and ventilators in following manner.

- (a) Width: It shall be indicated by the number of modules in the width of opening
- (b) It shall be indicated by the following letters of alphabet:  
W-window, V- Ventilator, S- Single shutter, T- Double shutter
- (c) Height: It shall be indicted by the number of modules in the height of opening.

**Example:** 10 WT 12 would mean a window shutter suitable for a double shutter window of 10 modules width and 12 modules height.

12 V 6 would mean ventilator shutter suitable for ventilator of 12 modules width and 6 modules height.

9.6.1.5.3 **Sizes:** Sizes of window and ventilator shutters shall generally conform to the modular sizes specified in Tables 9.8 and 9.7 respectively. These sizes are derived after allowing the thickness of the frame and a margin of 5 mm all round based on 100 mm module.

9.6.1.5.4 Tolerances on the overall dimensions of window and ventilator shutter shall be  $\pm 3$  mm.

**TABLE 9.8**

**Dimensions of Timber Window Shutters**

Designation	Width mm	Height mm
(1)	(2)	(3)
6 WS 12	500	1100
10WT 12	460	1100
12 WT 12	560	1100
6 WS 13	500	1200
10 WT 13	460	1200
12 WT 13	560	1200

**TABLE 9.9**

**Dimensions of Timber Ventilator Shutters**

Designation	Width mm	Height mm
(1)	(2)	(3)
6 V 6	500	500
10 V 6	700	500



12 V 6	1100	500
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**9.6.2** Mounting and glazing bars where required shall be stub tenoned to the maximum depth which the size of the member would permit or to a depth of 25 mm whichever is less. Unless otherwise specified the finished dimensions of the components of frame work of shutters shall be as given in Table 7.7. The tolerance on width of styles and rail shall be  $\pm 3$  mm. The tolerance in thickness will be  $\pm 1$  mm. The thickness of all components of frame work shall be the same as the thickness of the shutter. Tolerance on over all dimensions of the shutter shall be  $\pm 3$  mm.

### **9.6.3 Rebating**

The shutters shall be single-leaf or double leaved as shown in the drawings or as directed by the Engineer-in-Charge. In case of double leaved shutters, the meeting of the stiles shall be rebated by on e- third the thickness of the shutter. The rebating shall be either splayed or square type as shown in Fig. 9.2.

### **9.6.4 Panelling**

The panel inserts shall be either framed into the grooves or housed in the rebate of stiles and rails. Timber, plywood, and particle board panels as given in para 9.2 of this sub head and shall be fixed only with grooves. The depth of the groove shall be 12 mm and its width shall accommodate the panel inserts such that the faces are closely fitted to the sides of the groove. Panel inserts shall be framed into the grooves of stiles and rails to the full depth of the groove leaving space of 1.5 mm. Width and depth of the rebate shall be equal to half the thickness of stiles and rails. Glass panels, asbestos panels wire gauze panels and panel inserts of cupboard shutters shall be housed in the rebates of stiles and rails.

**9.6.4.1 Timber Panels:** Timber panels shall be preferably made of timber of large width; the minimum width and thickness of the panel shall be 100 mm, and 15 mm respectively. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint glued together and reinforced with headless nails at regular intervals not exceeding 100 mm. Depth and thickness of such joint shall be equal to one-third of thickness of panel. The panels shall be designed such that no single panel exceeds 0.5 square metre in area. The grains of timber panels shall run along the longer dimensions of the panels. All panels shall be of the same species of timber unless otherwise specified.

**9.6.4.2 Plywood Panels:** Plywood boards used for paneling of shutters shall be BWP type or grade as specified in 9.2.2. Each panels shall be a single piece of thickness, 9 mm for two or more panel construction and 12 mm thickness for single panel construction unless otherwise specified.

**9.6.4.3 Veneered Particle Board Panels:** Veneered Particle board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive as specified in 9.2.4.2. Each panel shall be a single piece of thickness 12 mm unless otherwise specified.

**9.6.4.4 Fiber Board Panels:** Fiber board used for paneling of shutters shall be Exterior Grade bonded with BWP type synthetic resin adhesive and each fibre board panel shall be a single piece unless otherwise specified.

**9.6.4.5 Wire Gauze Panels:** Wire Gauze used for paneling of shutters shall be woven with 0.63 mm dia galvanized mild steel wire to form average aperture size of 1.40 mm as specified in 9.2.7. Wire gauze shall be securely housed into the rebates of stiles and rails by giving right angles bend turned back and fixed by means of suitable staples at intervals of 75 mm and over this wooden beading shall be fixed. The space between the rebate and the beading shall be fixed with putty to give a neat finish. Each wire gauze panel shall be a single piece, and the panels shall be so designed that no single panels exceed 0.5 sqm in area. However, care shall be taken to prevent sagging of wire gauge, of panel by providing and fixing 20 x 20 mm square or equivalent beading to the external face to the required patterns as decided by the Engineer-in-Charge.





**9.6.4.6 Glass Panels:** Glass paneling (Glazing) shall be done as specified in 9.2.6. Glazing in the shutters of doors, windows and ventilators of bath, WC and Lavatories shall be provided with frosted glass the weight of which shall be not less than 10 kg/sqm. For making the glass of frosted look, suitable fill as per direction of the Engineer-in-Charge shall also be accepted and nothing shall be paid extra. Frosted/Filmed glass panes shall be fixed with frosted face on the inside. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 417 applied between glass pane and all along the length of the rebate and also between glass panes and wooden beading.

**9.6.4.7** Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been primed and prepared for painting, so that wood may not draw oil out of putty.

**9.6.4.8 Finish:** Panels of shutters shall be flat and well sanded to a smooth and level surface.

#### **9.6.5 Beading**

Beadings in panelled shutter shall be provided. Each length of beading shall be single piece. Joints at the corners shall be mitred and exposed edges shall be rounded. Beading shall be fixed with headless nails at 75 mm intervals. For external shutters, the beading shall be fixed on the outside face.

#### **9.6.6 Machine/Factory made Shutters**

Machine made shutters, where specified, shall be procured from an approved factory. For machine made shutters, operations like sawing, planning, making tongue and tenons, cutting grooves, mortises and rebates, drilling holes and pressing of joints shall be done by suitable machines. Machines made shutters shall be brought to the site fully assembled but without any priming coat. Panel inserts of sheet glass and wire gauze may, however, be fixed at site.

#### **9.6.7 Fixing of Shutters**

For side hung shutters of height upto 1.2 m and width up to 0.7 m each leaf shall be hung on two hinges at quarter points and for shutter of height more than 1.2 m and width up to 0.7 m each leaf shall be hung on three hinges one at the centre and the other two at 200 mm from the top and bottom of the shutters. One additional hinge shall be provided for width exceeding 0.7m for 0.3 m or part thereof. Top hung and bottom hung shutters shall be hung on two hinges fixed at quarter points of top rail or bottom rail. Centre hung shutter shall be suspended on a suitable pivot in the centre of the frame. Size and type of hinges and pivots shall be as specified. Flap of hinges shall be neatly counter sunk into the recesses cut to the exact dimensions of flap. Screws for fixing the hinges shall be screwed in with screw driver and not hammered in. Unless otherwise specified, shutters of height more than 1.2 mm shall be hung on butt hinges of size 100 mm and for all other shutters of lesser height butt hinges of size 75 mm shall be used. For shutter of more than 40 mm thickness butt hinges of size 125 × 70 × 4 mm shall be used. Continuous (piano) hinges shall be used for fixing cup-board shutters where specified.

#### **9.6.8 Fittings**

Fittings shall be provided as per schedule of fittings as shown in drawings or as decided by Engineer-in-Charge. The schedule of fittings and screws for door & windows contained in Appendix H is for guidance only. All fittings shall be paid for separately. The fittings shall conform to specifications laid down in 9.15. All screws shall be of stainless steel of minimum grade 304.

#### **9.6.9 Wooden Cleats and Blocks**

Wooden cleats and blocks shall be fixed to doors and windows as directed by Engineer-in-Charge, as per size and shape approved by him. These are included in the cost of providing and fixing the shutters.





#### 9.6.10 Measurements

Framework and panelling shall be measured separately.

**9.6.10.1 Framework of Shutters:** The overall length and width of the framework of the shutters shall be measured nearest to a cm in fixed position (overlaps not to be measured in case of double leaved shutters) and the area calculated in square metres correct to two places of decimal. No deduction shall be made to form panel openings or louvers. No extra payments shall be made for shape, joints and labour involved in all operations described above.

**9.6.10.2** For panelling of each type or for glazed panel length and width of opening for panels inserts or glazed panels shall be measured correct to a cm before fixing the beading and the area shall be calculated to the nearest 0.01 sq.m. The portions of the panel inserts or glazed panel inside the grooves or rebates shall not be measured for payment.

#### 9.6.11 Rate

Rate includes the cost of materials and labour involved in all the operations described above. The framework and panelling of each type or glazed panels shall be paid separately. The rate for framework includes the cost of butt hinges and necessary screws as specified in 9.6.7. However, extra shall be paid for providing moulded beading where specified. Nothing extra shall be paid for plain beading as stated in 9.6.5.

### 9.7 FLUSH DOOR SHUTTERS (Fig. 9.3)

**9.7.0** Flush door shutters shall have a solid core and may be of the decorative or non-decorative (Paintable type as per IS 2202 (Part I). Nominal thickness of shutters may be 25, 30 or 35 mm. Thickness and type of shutters shall be as specified.

**9.7.1** Width and height of the shutters shall be as shown in the drawings or as indicated by the Engineer-in-Charge. All four edges of the shutters shall be square. The shutter shall be free from twist or warp in its plane. The moisture content in timbers used in the manufacture of flush door shutters shall be not more than 12 per cent when tested according to IS 1708.

#### 9.7.2 Core

The core of the flush door shutters shall be a block board having wooden strips held in a frame constructed of stiles and rails. Each stile and rail shall be a single piece without any joint. The width of the stiles and rails including lipping, where provided shall not be less than 45 mm and not more than 75 mm. The width of each wooden strip shall not exceed 30 mm. Stiles, rails and wooden strips forming the core of a shutter shall be of equal and uniform thickness. Wooden strips shall be parallel to the stiles. End joints of the pieces of wooden strips of small lengths shall be staggered. In a shutter, stiles and rails shall be of one species of timber. Wooden strips shall also be of one species only but it may or may not be of the same species as that of the stiles and rails. Any species of timber may be used for core of flush door. However, any non-coniferous (Hard wood) timber shall be used for stiles, rails and lipping.

#### 9.7.3 Face Panel

The face panel shall be formed by gluing, by the hot-press process on both faces of the core, either plywood or cross-bands and face veneers. The thickness of the cross bands as such or in the plywood shall be between 1.0 mm and 3.0 mm. The thickness of the face veneers as such or in the plywood shall be between 0.5 mm and 1.5 mm for commercial veneers and between 0.4 mm and 1.0 mm for decorative veneers, provided that the combined thickness of both is not less than 2.2 mm. The direction of the veneers adjacent to the core shall be at right angles to the direction of the wooden strips. Finished



faces shall be sanded to smooth even texture. Commercial face veneers shall conform to marine grade plywood and decorative face veneers shall conform to type I decorative plywood in IS 1328.

#### **9.7.4 Lipping**

Lipping, where specified, shall be provided internally on all edges of the shutters. Lipping shall be done with battens of first-class hardwood or as specified of depth not less than 25 mm. For double leaved shutters, depth of the lipping at meeting of stiles shall be not less than 35 mm. Joints shall not be permitted in the lipping.

#### **9.7.5 Rebating**

In the case of double leaves shutters the meeting of stiles shall be rebated by 8 mm to 10 mm. The rebating shall be either splayed or square type as shown in drawing where lipping is provided. The depth of lipping at the meeting of stiles shall not be less than 30 mm.

#### **9.7.6 Opening for Glazing**

When required by the purchaser opening for glazing shall be provided and unless otherwise specified the opening for glazing shall be 250 mm in height and 150 mm or 200 mm in width unless directed otherwise. The bottom of the opening shall be at a height of 1.4 m from the bottom of the shutter. Opening for glazing shall be lipped internally with wooden batten of width not less than 25 mm. Opening for glazing shall be provided where specified or shown in the drawing.

#### **9.7.7 Venetian Opening**

Where specified the height of the venetian opening shall be 350 mm from the bottom of the shutter. The width of the opening shall be as directed but shall provide for a clear space of 75 mm between the edge of the door and venetian opening but in no case the opening shall extend beyond the stiles of the shutter. The top edge of the opening shall be lipped internally with wooden battens of width not less than 25 mm. Venetian opening shall be provided where specified or shown in the drawing.

#### **9.7.8 Tolerance**

Tolerance on width and height shall be + 3 mm and tolerance on nominal thickness shall be  $\pm 1.2$  mm. The thickness of the door shutter shall be uniform throughout with a permissible variation of not more than 0.8 mm when measured at any two points.

#### **9.7.9 Adhesive**

Adhesive used for bonding various components of flush door shutters namely, core, core frame, lipping, cross-bands, face veneers, plywood etc. and for bonding plywood shall conform to BWP type, phenol formaldehyde synthetic resin adhesive conforming to IS 848.

#### **9.7.10 Tests**

Samples of flush door shutters shall be subjected to the following tests:

- (a) End Immersion Test
- (b) Knife Test
- (c) Glue Adhesion Test

One end of each sample shutter shall be tested for End Immersion Test. Two specimens of 150 x 150 mm size shall be cut from the two corners at the other end of each sample shutter for carrying out Glue Adhesion Test. Knife Test shall be done on the remaining portion of each sample shutter. Test shall be done as laid down in Appendix F of Chapter 9.

#### **9.7.11 Sample Size**



Shutters of decorative and non-decorative type from each manufacturer, irrespective of their thickness, shall be grouped separately and each group shall constitute a lot. The number of shutters (sample size) to be selected at random from each lot for testing shall be as specified in Table 8.10. If the total number of shutters of each type in a work (and not the lot) is less than twenty-five, testing may be done at the discretion of the Engineer-in-Charge and in such cases extra payment shall be made for the sample shutter provided the sample does not fail in any of the test specified in 9.7.10.

For knife test, glue adhesive test, slamming test, the end immersion test, the number of shutters shall be as per col. 4 of Table 9.10.

**TABLE 9.10**

**Sample Size and Criteria for Conformity**

Lot Size	Sample Size	Permissible no. of defective	Sub. Sample size
(1)	(2)	(3)	(4)
Upto 50	As per site Engineer	0	1
51 - 300	13	1	2
300 and above	20	1	2

#### **9.7.12 Criteria for Conformity**

All the sample shutters when tested shall satisfy the requirements of the tests laid down in Appendix F of Chapter 9. The lot shall be declared as conforming to the requirements when numbers of defective sample does not exceed the permissible number given in col. 3 of Table 9.10. If the number of sample shutters found unsatisfactory for a test is one, twice the number of samples initially tested shall be selected and tested for the test. All sample shutters so tested shall satisfy the requirement of the test. If the number of samples found unsatisfactory for a test is two or more, the entire lot shall be considered unsatisfactory.

#### **9.7.13 Fixing**

This shall be as specified in 9.6.7.

#### **9.7.14 Measurements**

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Overlap of two shutters shall not be measured. All work shall be measured net as fixed and area calculated in square metres to nearest two places of decimal. No deduction shall be made for providing venetian opening and opening for glazing.

#### **9.7.15 Rates**

The rate includes the cost of material and labour involved in all the operations described above. Extra rate shall be payable for providing rebates in double leaved shutters. Glazing when provided shall be measured & paid for separately as specified in 9.6.10.2.

### **9.8 WIRE GAUZE FLY PROOF SHUTTERS**

- 9.8.0** Specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted except as provided.



#### **9.8.1 Stile and Rails**

The Specifications shall be as described under 9.6.1.3. The stiles and rails shall be given a rebate to receive the wire gauze which shall form the panels.

#### **9.8.2 Wire Gauze**

This shall be unless specified otherwise conform to para 9.2.7 and 9.6.4.5. The wire gauze shall be bent at right angles in the rebates of stiles and rails, turned back and fixed tight with blue tacks at about 75 mm centres, fixed alternately in the two faces of the rebates. Over this, wooden beading shall be fixed with brads or small screws at about 75 mm centres. The space between the beading and rebates, where the wire gauze is bent, shall be neatly finished with putty, so that the end of the wire gauze may not be visible.

#### **9.8.3 Fixing Fittings, Wooden cleats, blocks and Measurement shall be as specified under 9.6.**

#### **9.8.4 Rate**

This includes the cost of materials and labour involved in all the operations described above, and as specified under 9.6.

### **9.9 WALL LINING: (Shifted to 8.15)**

Clause shifted to Sub Head 8 (Cladding work) as clause no 8.15

### **9.10 SHELVES**

#### **9.10.1 Shelves and vertical partitions of cupboards shall be of timber planks fibre board, particle board, block board or veneered particle board as specified. Thickness and type of planks or boards shall be as specified. Each shelf shall be a single piece and vertical partitions between two consecutive shelves shall be without any joint. Exposed edges of boards having particle board core shall be sealed with 3 mm thick single piece teak wood strips of width equal to the thickness of board with headless pins. The arrangement of shelves and vertical partitions shall be as per drawings or as directed by the Engineer-in-Charge.**

#### **9.10.2 Fixing**

Planks for shelves shall be planed on all faces and edges. In case of boards they shall be sawn to the required size truly straight and square. Timber battens 25 x 40 mm unless otherwise specified shall be planed smooth and fixed inside the cupboard with wooden plugs and screws. Shelves shall be fixed to the battens and vertical portions shall be held in position by fixing them to the battens and shelves using screws. Teakwood strips for edge sealing of the boards shall be planed smooth and fixed with headless nails. Tolerance in width shall be  $\pm 1.5$  mm and in thickness 1 mm.

#### **9.10.3 Measurements**

Length and width of shelves and vertical partitions shall be measured correct to a cm. separately for each type of board stating its thickness. Area shall be calculated correct to 0.01 sqm.

#### **9.10.4 Rate**

It includes the cost of materials and labour required for all the operations described above.

#### **9.10.5 A Lipping in pelmet**

Lipping shall be provided on all edges of the pelmets. The timber shall be as specified.

### **9.11 TRELLIS (JAFFRI) WORK: DELETED**

### **9.12 PELMETS**



**9.12.1** Planks and curtain rods of specified timber shall be used, and it shall be sawn in the direction of the grains. Sawing shall be truly straight and square. The timber shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patching or plugging of any kind shall not be permitted.

**9.12.2** Sides, front and top of the pelmets shall be of 12 mm planks or boards of specified quality and width unless otherwise stated. These shall project from the wall face by 15 cm or as specified and shall be securely fixed to walls with wood screws by means of wooden plugs and 10 cm long 25 × 3 mm M.S. flat bent in the form of angle or by any other device approved by the Engineer-in-Charge. The pelmets shall be provided with curtain rods and brackets or curtain rails with rollers, stop ends and brackets wooden, brass or chromium plated brass as specified. Intermediate wooden brackets shall be provided, if the front length of pelmet exceeds 1.5 metres.

#### **9.12.3 Measurements**

The pelmets box shall be measured along the sides and front planking correct to a centimetre.

#### **9.12.4 Rate**

The rate includes the cost of sides, front and top planking curtain rods with brackets or curtain rails with rollers labour and materials required for all the operations described above.

### **9.13 HOLD FASTS**

**9.13.1** These shall be made from mild steel flat 40 × 5 mm size conforming to IS 7176 without any burns or dents. 5 cm length of M. S. flat at one end shall be bent at right angle and one hole 11 mm dia shall be made in it for fixing to wooden frame with 10 mm dia nut bolt. The bolt head shall be sunk into the wooden frame, 10 mm deep and plugged with wooden plug. At the other end 10 cm length of the hold fast flat shall be forked and bent of length as specified at right angle in opposite direction and embedded in cement concrete block of size 30 x 10 x 15 cm of mix 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate, 20 mm nominal size) or as specified (see Fig. 9.4).

**9.13.2 Measurements:** Measurements for the hold fasts shall be in number.

**9.13.3 Rate:** It includes the cost of labour and material involved in all the operations described above including fixing bolt and cement concrete blocks.

### **9.14 EXPANDED METAL, HARD DRAWN STEEL WIRE FABRIC AND WIRE GAUZE IN WOODEN FRAMES**

**9.14.0** Expanded metal, hard drawn steel wire fabric or wire gauge or weld mesh as described in the item of work shall be fixed to the window frames on the outside or inside as per detailed drawings or as directed by the Engineer-in-Charge. These shall be free from rust and other defects.

**Expanded Metal** - This shall be in the form of rhombus with its opening diagonals 20 × 60 mm and strands 3.25 mm wide and 1.6 mm thick weighing 3.633 kg/m<sup>2</sup> unless otherwise specified.

**Welded Steel Drawn Wire Fabric** - This shall conform to IS 4748 and shall have rectangular mesh of 75 × 25 mm size with wires of diameter not less than 5 mm longitudinally and 3.15 mm transversely. Its weight shall be not less than 7.75 kg/m<sup>2</sup> unless otherwise specified.

**Wire-Gauze** - This shall be as per clause 9.2.7.

#### **9.14.1 Fixing**

Expanded metal, hard drawn steel wire fabric and wire gauze shall be cut in one piece to the size of the frame (out to out). Expanded metal and hard drawn steel wire fabric shall be fixed on to the frame with staples, over which wooden beading 60 x 20 mm shall be fixed with wood screws.

#### **9.14.2 Measurements**



The length and breadth shall be measured correct to a cm, the area from outside to outside of beading shall be calculated in square metre nearest to two places of decimal.

#### 9.14.3 Rate

It includes the cost of labour and materials required for all the operations described above.

### 9.15 FITTINGS

**9.15.0** Fitting shall be of mild steel, brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

- (a) **Mild Steel Fittings:** These shall be bright finish black stone enamelled or copper oxidised (black finish), nickel chromium plated or as specified.
- (b) **Brass Fittings:** These shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.
- (c) **Aluminium Fittings:** These shall be anodised to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in Appendix H attached. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-in-Charge.

Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings. These shall be of the size as indicated in respective figures.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sinking of hinges.

#### 9.15.1 Butt Hinges (Fig. 9.5A)

These shall be of the following types according to the material used.

- (a) Mild steel butt hinges (Medium).
- (b) Cast brass butt hinges light/ordinary or heavy.
- (c) Extruded aluminium alloy butt hinges.

**9.15.1.1 Mild Steel (Medium) (Fig. 9.5A):** These shall be medium type manufactured from M.S. sheet. These shall be well made and shall be free from flaws and defects of all kinds. All hinges shall be cut clean and square and all sharp edges and corners shall be removed. These shall generally conform to IS 1341.

**Hinge Pin:** Hinge pin shall be made of mild steel wire. It shall fit inside the knuckles firmly and riveted head shall be well formed so as not to allow any play or shake, and shall allow easy movement of the hinge, but shall not cause looseness.

**Knuckles:** The number of knuckles in the hinges of different sizes shall be as per IS 1341. The size of knuckles shall be straight and at right angle to the flap. The movement of the hinges shall be free and easy and working shall not have any play or shake.



**Screw Holes:** The screw holes shall be clean and counter sunk. These shall be suitable for counter sunk head wood screws and of the specified size for different types and sizes of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of the wood screws. The nos. of screw holes shall as specified in IS 1341.

- 9.15.1.2 Cast Brass:** These shall be light/ordinary or heavy as specified. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright or chromium plated or oxidised or as specified. These shall generally conform to IS 205.

**Hinge Pin:** Hinge pin shall be made of brass or of stainless steel. The hinge pins shall be firmly riveted and shall be properly finished. The movement of the hinge pin shall be free, easy and square and shall not have any play or shake.

**Knuckles:** The number of knuckles in each hinge shall not be less than five. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

**Screw Holes:** The screw holes shall be clean and counter sunk and of the specified size for different types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

- 9.15.1.3 Extruded Aluminium Alloy:** These shall be manufactured from extruded sections. These shall be well made and free from flaws and defects of all kinds. These shall generally conform to IS 205.

**Hinge Pin:** Hinge pin shall be made of mild steel (galvanised or aluminium alloy). The aluminium alloy hinge pin shall be anodised. The hinge pin shall be finally riveted and shall be properly finished. The movement of hinges shall be free easy and square and shall not have any play or shake.

**Knuckles:** Number of knuckles in each hinge pin shall not be less than 5. The number of knuckles in case of sizes less than 40 mm be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

**Screw Holes:** The screw holes shall be suitable for counter sunk head wood screws, and of specified sizes for different type of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

## **9.15.2 Parliament Hinges (Fig. 9.5B)**

- 9.15.2.1** These shall be of mild steel cast brass or as specified, and shall generally conform to IS 362. The size of parliament hinges shall be taken as the width between open flanges. Mild steel parliament hinges shall be copper oxidised (thick finish) or as specified. The brass parliament hinges shall be finished bright, chromium plated or oxidised or as specified.

- 9.15.2.2** The hinge pin shall be made of mild steel in the case of brass hinges. The hinge pin shall be mild steel (galvanised) in the case of aluminium alloy hinges. The hinge pin shall be firmly riveted and shall be properly finished. The movement of the hinges shall be free, easy and square, and shall not have any play or shake.

All screw holes shall be clean and counter sunk to suit the counter sunk head of wood screws specified.

## **9.15.3 Spring Hinges (Single or double acting)**

- 9.15.3.1** These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and shall generally conform to IS 453.





Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

- (a) When the door is pushed through 70° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.
- (b) The door shall require a force of  $2.0 \pm 0.5$  kg for 100 mm hinges and  $3.0 \pm 0.5$  kg for 125 mm and 150 mm hinges at a distance of 45 cm from the hinge pin to move the door through 70°.

The size of spring hinge shall be taken as the length of the plate.

#### 9.15.3.2 These shall be of the following type:

- (a) **Mild Steel:** The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and riveted, or from solid drawn tube of thickness not less than 1.60 mm; or from mild sheet of 1.60 mm thickness pressed to form the two casing and the distance piece. It shall be stove enamelled black or copper oxidized or as specified.
- (b) **Cast Brass:** The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. It shall be satin, bright nickel plated or copper oxidized or as specified.

#### 9.15.4 Rising Hinges

These shall be made of brass, finished bright or chromium plated or oxidised or as specified. Its shape and pattern shall be approved by the Engineer-in-Charge. The size of the rising hinge shall be taken as the length of its plate.

#### 9.15.5 Continuous Piano Hinges (Fig. 9.6B)

**9.15.5.1** These shall be made from mild steel or aluminium alloy sheet, these shall generally conform to IS 3818. All screw holes shall be clean and counter sunk. Piano hinges shall be fixed in the entire length of the cupboard shutters. Its size will be the width of the two flaps when open.

**9.15.5.2** M.S. Piano Hinges: These shall be made from 1 mm or 0.80 mm thick M.S. sheets and shall be protected with anti-corrosive treatment, such as bright polished, chromium plated or oxidised finish.

Hinge pin shall be of galvanised mild steel. It shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy and working shall not have any play and shake.

**9.15.5.3** Aluminium Piano Hinges: These shall be made of aluminium alloy sheet and shall be anodised. The anodic coating shall not be less than the grade AC 15 of IS 1868.

Hinge pin shall be made of aluminium alloy with anodic coating not less than the grade of AC-15 of IS 1868. The hinge pin shall fit in the knuckle firmly so as not to allow any play or shake and shall allow easy movement of hinge but shall not cause looseness.

The sides of the knuckles shall be straight and at right angles to the flap. The movement of the hinge shall be free and easy, and working shall not have any play and shake.

#### 9.15.6 Tee Hinges (Fig. 9.6A)

These shall be made from M.S. sheets and shall be either bright finished or stove enamelled black or as specified. These shall generally conform to IS 206 (Tee hinges shall be well made, free from burrs,





flaws, and defects of any kind. The movement shall be square, and the working shall be free and easy without any play or shake. The hole for the hinge shall be central to the bore and shall be square.

The hinge pin shall be firm and riveted over, so that the heads are well formed. All screw holes shall be clear and counter sunk and shall be suitable for the counter sunk head of wood screws.

#### **9.15.7 Sliding Door Bolts (Aldrops) (Fig. 9.7)**

**9.15.7.1** These shall be of mild steel, cast brass, aluminium or as specified, and shall be capable of smooth sliding action.

**9.15.7.2** M.S. Sliding Door Bolts: These shall be made of M.S. sheets and M.S. rods and shall generally conform to IS 281. M.S. sliding door bolts shall be copper oxidised (black finish) or as specified.

**9.15.7.3** Cast Brass Sliding Door Bolts: These shall be made from rolled brass and shall generally conform to IS 2681. The hasp shall be of cast brass and secured to the bolt as shown in Fig. 9.7. Alternatively, the hasp and the bolt may be cast in one piece. The fixing and staple bolts shall be cast with 6 mm studs. Bolts shall be finished to shape and have threaded ends and provided with robs washers and nuts of square or hexagon type. All components shall be finished smooth and polished before assembly. Cast brass sliding bolts shall be finished bright or chromium plated or oxidised or as specified.

**9.15.7.4** Aluminium Sliding Door Bolts: These shall be made of aluminium alloy and shall generally conform to IS 2681. Aluminium sliding door bolts shall be anodized. All screw holes shall be counter sunk to suit the counter sunk head of screws of specified sizes. All edges and corners shall be finished smooth. In case of single leaf door, when iron socket plate or a brass or aluminium fixing bolts (or sliding door bolt) cannot be fixed, hole of suitable size shall be drilled in the door frame and an iron or brass plate cut to shape shall be fixed at the face of the hole. The leading dimensions of the sliding door bolts are illustrated.

#### **9.15.8 Tower Bolts (Fig. 9.8)**

**9.15.8.0** These shall generally conform to IS 204 (Part. I) & IS 204 (Part. II). Tower bolts shall be well made and shall be free from defects. The bolts shall be finished to the correct shape and shall have a smooth action. All tower bolts made with sheet of 1.2 mm thickness and above shall have counter sunk screw holes to suit counter sunk head of wood screws. All sharp edges and corners shall be removed and finished smooth.

The height of knob of tower bolt when the door, window etc. is in closed position from the floor level shall be not more than 1.7 metre.

**9.15.8.1** Tower bolts shall be of the following types:

(a) Aluminium barrel tower bolts with barrel and bolt of extruded sections of aluminium alloy. The knob shall be properly screwed to the bolt and riveted at the back.

(b) Brass tower bolts with cast brass barrel and rolled or cast brass bolt.

or

Brass tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt.

The knobs of brass tower bolts shall be cast and the bolt fixed with knob, steel spring and ball shall be provided between the bolt and the barrel.

(c) Mild steel barrel tower bolts with mild steel barrel and mild steel bolt.

or

(d) Mild steel tower bolts with mild steel barrel and cast iron bolts.



The plates and straps after assembly shall be firmly riveted or spot welded. The rivet head shall be properly formed and the rivet back shall be flush with the plate. These shall be made in one piece.

**9.15.8.2** Unless otherwise specified bolt shall have finish as given below:

- (a) Mild steel tower bolts (Types 1 and 2) Bolts bright finished or plated as specified and barrel and socket stove enamelled black.
- (b) Brass tower bolts (type 3 to 5) Bolt and barrel polished or plated as specified.
- (c) Aluminium alloy tower bolts (type 6) Bolt and barrel anodized.

The anodic film may be either transparent or dyed as specified. The quality of anodized finish shall not be less than grade AC-10 of IS 1868.

#### **9.15.9 M.S. Locking Bolt with Holes for Pad Locks**

**9.15.9.1** This shall conform to IS 7534.

**9.15.9.2** This shall be of mild steel polished bright or copper oxidised batch electrogalvanised or stove enamelled. In case of stove enamelled locking bolts, the bolt may be finished bright.

#### **9.15.10 Pull Bolt Locks (Fig. 9.7)**

**9.15.10.1** These shall be of M.S. cast brass or aluminium as specified. M.S. pull bolt locks shall be copper oxidized (black finish) or as specified.

**9.15.10.2** Brass pull bolt locks shall be finished bright, chromium plated or oxidised as specified. Aluminium pull bolt locks shall be anodised and the anodic coating shall not be less than grade. A.C. 10 of IS 1868. The bolt shall be 10 mm in diameter and the fixing plate 3 mm thick. The stop block shall be screwed to the fixing plate by a small ball and spring over which the bolt shall slide.

**9.15.10.3** The fixing plate shall have four holes for fixing it to the door leaf, two of which shall be square to receive 6 mm dia. bolts with round heads, the remaining two shall receive machine screwed with lock nuts. The receiving plate shall be of the same width and thickness as the fixing plate and shall have 3 counter sunk holes.

Where the bolt slides into wooden members, like the chowkhat, which have a rebate, the receiving plate shall also be correspondingly shaped so as to fit into the rebate. The screws and bolts shall have the same finish as the main bolt. The leading dimensions of pull bolt locks are given in the drawing. The denominating size of the pull bolt locks shall be length of the fixing plate between guides plus the thickness of the guides.

#### **9.15.11 Door Latch**

**9.15.11.1** This shall be of mild steel, cast brass, or as specified and shall be capable of smooth sliding action. In case, of mild steel latch, it shall be copper oxidized (black finish) or as specified and in case of brass, it shall be finished bright, chromium plated or oxidized or as specified. The size of door latch shall be taken as the length of the latch.

#### **9.15.12 Indicating Bolt (Vacant/Engaged)**

These shall be of cast brass finished bright chromium plated or oxidized or as specified. The shape and pattern shall be approved by the Engineer-in-Charge.

#### **9.15.13 Mortice Lock and Latch (Fig. 9.10)**

**9.15.13.1** This should generally conform to IS 2207.



**9.15.13.2** The size of the mortice lock shall be denoted by the length of the body towards the face and it shall be 65 mm, 75 mm and 100 mm as specified. The measured length shall not vary more than 3 mm from the length specified.

**9.15.13.3 Non-interchangeable Keys:** Testing of non-interchangeable keys shall be as per IS 2207.

**9.15.13.4** The clear depth of the body shall not be more than 15 mm. The fore end shall be firmly fitted to the body suitably by counter sunk head screw. The latch bolt shall be of specified material and of section not less than 12 x 16 mm for all sizes of locks. If made of two piece construction both parts shall be riveted. Ordinary lever mechanism with not less than two levers shall be provided. False levers shall not be used. Lever shall be fitted with one spring of phosphor bronze or steel wire and shall withstand the tests as provided in IS 2207.

**9.15.13.5** Locking bolts, spring and strike plate shall conform to IS 2207.

**9.15.13.6** Handles: These shall conform to IS 4772.

**9.15.13.7** Keys: Each lock shall be provided with two keys.

**9.15.13.8** Sampling, Criteria for Conformity: It shall be the same as specified in clause 9.15.1.4.

**9.15.13.9** Tests: The finally assembled locks shall be tested as prescribed in Appendix G of Chapter 9.

#### **9.15.14 Mortice Latch (with Locking Bolt)**

**9.15.14.1** These are generally used in doors of bath rooms, WC's and private rooms.

**9.15.14.2** Mortice latch shall, in respect of shape, design and mechanism of the latch and its components parts, generally conform to IS 5730. The material used for the different component parts of the latch shall comply with Tables 1 and 2 of IS 5730, unless otherwise specified.

**9.15.14.3** The size of the latch shall be denoted by the length of the body towards the face and shall be 65 mm, 75 mm or 100 mm as specified. The depth of the body shall not be more than 15 mm.

**9.15.14.4** The latch shall be of size 10 × 18 mm of shape as shown in Fig. 1 of IS 5730. The locking bolt shall be of section not less than 8 x 25 mm for all size of locks. The mechanism of the latch bolt, its spring, striking plate etc. shall be as described in IS 5730.

**9.15.14.5** The handles provided shall conform to IS 4772.

**9.15.14.6** Sampling, criteria for conformity shall be same as per clause 9.15.1.4.

#### **9.15.15 Mortice Lock and Latch (Rebated)**

These are slightly different from mortice lock described in 9.15.14 and are designed for use in double leaved doors. These should generally conform to IS 6607. Handles, Keys, Sampling, Criteria for Conformity and Test: These shall be same as specified in clause 9.15.14.

#### **9.15.16 Mortice Night Latch (Fig. 9.11)**

**9.15.16.1** This is a mortice lock having a single spring bolt withdrawn from the outside by using the key and from inside by turning the knob and with an arrangement whereby the lock can be prevented from being opened by its key from outside while the night latch is used from inside the room.

**9.15.16.2** This should generally conform to IS 3847.

**9.15.16.3** It shall be cast or sheet brass, cast or sheet aluminum alloy or Mild steel as specified and of best quality of approved make. These shall be bright finished or copper oxidized (black) finish as specified. Nominal size of the latch shall be denoted by the length of the face over the body in millimeters. These shall have not less than two levers. False (Dummy) levers shall not be allowed.



**9.15.16.4 Keys:** Each latch shall be provided with two keys which should work smoothly and without any appreciable friction in the lock.

#### **9.15.17 Cupboard or Wardrobe Lock**

This should generally conform to IS 727. The size of the cupboard lock shall be 40, 50, 65 & 75 mm. This shall be made of cast brass and shall be of the best make of approved quality. These shall be finished bright or chromium plated or oxidised or as specified. The size of the lock shall be denoted by the length of the face across the body in mm. These locks shall be fitted with four, five or six levers as specified. False (dummy) levers shall not be used.

#### **9.15.18 Kicking Plates**

**9.15.18.1** This shall be of brass (finished bright or chromium plated or oxidised) bronze, stainless steel, aluminium or as specified. Aluminium kicking plates shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. It shall be made from a plate of minimum thickness 3.0 mm & 1.5 mm in case of stainless steel. Shape of the plate shall be as specified. This shall have bevelled or straight edges and shall be fixed by means of counter sunk or rounded screws of the same material and finish as that of the plate. The shape and pattern shall be according to the drawings and as approved by the Engineer-in-Charge.

#### **9.15.19 Door Handles (Doors and Windows) (Fig. 9.12)**

**9.15.19.1** These should generally conform to IS 208. The door handles shall be well made and free from defects. These shall be finished correct to shape and dimensions. All edges and corners shall be removed and finished smooth so as to facilitate easy handling. Cast handle shall be free from casting defects. Where the grip portion of the handle is joined with the base piece by mechanical means, the arrangement shall be such that the assembled handle shall have adequate strength comparable to that of integrally cast type handles.

**9.15.19.2** Door handles shall be of the following types according to the material used:

- (a) **Cast or Sheet Aluminium Alloy Handles:** These shall be of aluminium of specified size, and of shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size unless, otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6. Aluminium handles shall be anodized and the anodic coating shall not be less than grade AC 15 - IS 1868 as specified. The finish can be bright natural, matt or satin or dyed as specified.
- (b) **Cast Brass Handles:** These shall be of cast brass of specified size and of the shape and pattern as approved by the Engineer-in-Charge. The size of the handle shall be determined by the inside grip of the handle. Door handles shall be of 100 mm size and window handles of 75 mm size, unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No 6. Brass handles shall be finished bright satin or nickel chromium plated or copper oxidised or as specified.
- (c) **Mild Steel Handles:** These shall be of mild steel sheet, pressed into oval section. The size of the handles will be determined by the inside grip of the handle. Door handles shall be 10 mm size and window handles of 75 mm size unless otherwise specified. These shall be fixed with 25 mm long wood screws of designation No. 6., Iron handles shall be copper oxidised (black finish) or stove enamelled black or as specified.
- (d) **Stainless Steel Handles:** These shall be of stainless steel of specified size, shape and pattern as approved by Engineer-in-Charge for using in doors, windows and kitchen cabinets. Doors handles shall be of 125 mm or 100 mm size and window handles of 75 mm size unless, otherwise specified. Kitchen cabinet handles shall of 125 mm, 100 mm or 75 mm as specified. These shall be fixed with stainless



steel screws 20 mm long. Stainless steel handles shall not be less than grade 304. The finish can be bright or matt finish as specified.

Lot size	Sample size	Acceptance no.	Rejection no.
(1)	(2)	(3)	(4)
Upto 50	8	0	1
51-70	13	1	2
71-150	20	1	2
151-280	32	2	3
281-500	50	3	4
501-1200	80	5	6
1201 and above	125	7	8

#### 9.15.20 Floor Door Stopper (Fig. 9.13)

**9.15.20.1** The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pat tern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified.

The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body for housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodised and anodic film shall not be less than grade AC-10 of IS 1868.

**9.15.20.2 Sampling and Criteria for Conformity:** The number of floor door stoppers to be selected from each lot shall depend on the size of the lot and shall be in accordance with col. 1 and 2 of Table 9.17. These stoppers shall be selected at random from at least 10 percent of the randomly selected packages subject to a maximum of three equal number of stoppers being selected from each such package.

All the floor stoppers selected shall be checked for dimensional requirement, material, manufacture and finish. Any of door stopper which fails to satisfy any one or more of these requirements shall be considered as defective door stopper.

A lot shall be considered as conforming to the requirements of this specifications if the number of defective floor door stoppers among these tested does not exceed the corresponding number given in col. 3 of Table 9.17. Otherwise it shall be considered as not conformity to the requirements of this specification.

**TABLE 9.17**

#### Requirements for Rubber for Use in Floor Door Stoppers

Lot Size	Sample Size	Permissible number of Decorative sliding door bolts
(1)	(2)	(3)



Upto 100	5	0
101 to 300	20	1
301 to 500	32	2
501 to 1000	50	3
1001 and above	80	5

**TABLE 9.18**

**Requirements for Rubber for Use in Floor Door Stoppers**

Particulars	Requirements	Testing Procedure
Relative density Max.	1.3	IS 3400 (Part IX)
Hardness	60 ± 5	IS 3400 (Part II)
Ageing for 24 hours at 100o ± 1°C	Change in initial hardness Shall not develop brittleness + 5, – 0	IS 3400 (Part II)

**9.15.21 Hanging Rubber Door Stopper**

**9.15.21.1** These shall be of cast brass, finished bright, chromium plated or as specified. Aluminum stopper shall be anodized and the anodic coating shall not be less than grade AC-10 of IS 1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

**9.15.22 Universal Hydraulic Door Closer (Exposed Type)**

**9.15.22.1** These shall be made of cast iron/aluminum alloy/zinc alloy and of shape and pattern as approved by the Engineer-in-Charge.

**9.15.22.2** These shall generally conform to IS Specifications for door closers (Hydraulically regulated) IS 3564.

**9.15.22.3** The door closers may be polished or painted and finished with lacquer to desired color. Aluminum alloy door closer shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868. All dents, burrs and sharp edges shall be removed from various components and they shall be pickled, scrubbed and rinsed to remove grease, rust, scale or any other foreign elements. After pickling, all the M.S. parts shall be given phosphating treatment in accordance with IS 3618.

**9.15.22.4** The nominal size of door closers in relation to the weight and the width of the door size to which it is intended to be fitted shall be given in Table 9.19.

**TABLE 9.19**

**Type and Designation of Door Closers**

Designat ion of closers	Mass of the door (kg)	Width of the door (mm)	Remarks
1.	Upto 35	Upto 700	For light doors such as double leaved and toilet doors.
2.	36 to 60	701 to 850	Interior doors, such as of bedrooms, kitchen and store



3.	61 to 80	851 to 1000	Main doors in a building, such as entrance doors
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**9.15.22.5 Sampling and Criteria for Conformity:** All the door closer of the same nominal size and shape and from the same batch of manufacture, in one consignment shall constitute a lot. The number of door closers to be taken at random from a lot shall depend upon the size of the lot. (Table 9.20). The sample shall be tested for construction, finish, dimensions, interchangeability of parts and performance in accordance of Table 9.20. Any door closer failing in any one or more of these characteristics shall be considered as defective. If in the first sample, the number of defective door closer is less than or equal to corresponding acceptance number, the lot shall be declared as conforming to the requirement of these characteristics. If the number of defective door closer is greater than or equal to the rejection number, the acceptance number but less than the rejection number, lot shall be deemed as not meeting with requirements of these characteristics. If the number of defectives is greater than the acceptance number, but less than the rejection number, a second sample of the size equivalent to that of the first shall be taken to determine the conformity or otherwise of the lot. The number of defective door closers found in the first and the second sample shall be combined and if the combined number of defective thus obtained is less than or equal to the corresponding acceptance number, the lot shall be declared as conforming to the requirements of these characteristics.

**Endurance Test-** Two door closer in case of lot size 280 or less and five door closers in case of lot size more than 280 shall be selected from those already found satisfactory. These door closers shall be tested for the endurance test.

If all the door closers tested for endurance test satisfy the requirement of this standard, the lot shall be deemed as having satisfied the requirements of endurance test, otherwise not.

**TABLE 9.20**

No. of door closers in the lot	Sample	Sample size	Cumulative sample size	Acceptance Number	Rejection Number
Upto 50	First	8	8	0	2
	Second	8	16	1	2
51 to 90	First	13	13	0	2
		13	26	1	2
91 to 150	Second	20	20	0	3
		20	40	3	4
151 to 280	First	32	32	1	4
		32	64	4	5
281 to 500	Second	50	50	2	5
		50	100	6	7
501 to 1200	First	80	80	3	7
		80	160	8	9
1201 to 3200	Second	125	125	5	9
		125	250	12	13
3201 and above	First	200	200	7	11
		200	400	18	19





**9.15.22.6** Performance Requirements: After being fitted in its position when the door is opened through 90°, the same should swing back to angle of 20° ± 5° with nominal speed but thereafter, the speed should get automatically retarded and in case of doors with latches, it should be so regulated that in its final position the door smoothly negotiates with the latch.

#### **9.15.23 Casement Brass Stays (Straight Peg Type) (Fig. 9.14)**

**9.15.23.1** These shall be made of mild steel, cast brass, aluminium (extruded section) or plastic (Polypropylene) as specified. Mild steel casement stays shall be a copper oxidised (black finish) or as specified. Cast brass stays shall be finished bright or chromium plated or as specified. Aluminium stays shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. Aluminium and

M.S. stays shall be made from channel section. The stays shall not weigh less than that indicated below:

200 mm	0.24 kg each
250 mm	0.28 kg each
300 mm	0.33 kg each

**9.15.23.2** The shape and pattern of the stays shall be approved by the Engineer-in-Charge. The size of stays shall be determined by its length as shown in the plate. The plastic (Polypropylene) stays shall conform to IS 6318.

#### **9.15.24 Quadrant Stays 300 mm**

These shall be made of cast brass and finished bright or chromium plated or as specified. The shape and pattern shall be approved by the Engineer-in-Charge. It shall not weigh less than 0.20 kg each.

#### **9.15.25 Hasp and Staple Safety Type (Fig. 9.15)**

**9.15.25.1** This shall be made of mild steel, cast brass or aluminium as specified. This shall generally conform to IS 363. M.S. Hasp and staples shall be finished black enamelled, or copper oxidised (black finish) or as specified. Brass hasp and staples shall be finished bright chromium plated or oxidised or as specified. Aluminium hasp and staples shall be anodized and the anodic coating shall not be less than grade AC 15 of IS 1868.

**9.15.25.2** M.S. hasp and staples shall be manufactured from M.S. sheet and brass hasp and staples by casting and Aluminium hasp and staples shall be made from dye section. The hinge pin which in all cases shall be of mild steel, shall be firm and its riveted heads well formed. The movement of hasp shall be free, easy and square and shall not have any play or shake.

The hasp shall fit, in the staple correctly. The size shall be determined by the length of the bigger of the hasp.

**9.15.25.3** The staple except in the case of cast one, shall be riveted properly to its plate. The ends of the hinge pin for the safety type hasp shall be riveted and properly finished. All screw holes shall be clean and counter sunk to suit counter sunk wood screw. All edges and corners shall be rounded.

#### **9.15.26 P.T.M.T (Polytetra Methylene Tetraphthalate) Fittings**

### **9.16 LAMINATED VENEER LUMBER (LVL): DELETED**

### **9.17 PARTITIONS**

#### **9.17.1 Materials**

- i. Gypsum plaster Board conforming to IS 2075 (Pt.-I) (Board with BIS Certification mark)
- ii. Glass Reinforced Gypsum (GRG) plaster board confirming to IS 2075 (Pt.-3) (Board with BIS certification mark)





- iii. Fibre cement flat sheet conforming to IS 14862
- iv. Cement bonded particle board conforming to IS 14276

Tapered Edge Calcium Silicate Board are manufactured from Siliceous and Calcareous materials reinforced with fibres. The boards are made in a laminar process and then autoclaved to give a stable crystalline structure. It is lightweight and can be fixed to either side of timber, aluminum or lightweight galvanized metal sections. The partitions are non-load bearing and can easily be assembled at site.

#### **9.17.2 Installation**

The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of Engineer-in-Charge. (Fig. 9.17).

#### **9.17.3 Jointing & Finishing**

Joints of the boards are finished with specially formulated Jointing compound and fibre tape to provide seamless finish. Board surface can be decorated with any type of paint, wall paper, wood veneer & hard laminates. Services should be incorporated before commencement of board fixing.

#### **9.17.4 Fitting and Fixtures**

It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing.

#### **9.17.5 Tolerance**

Tolerance in dimensions shall be  $\pm 5$  mm.

#### **9.17.6 Measurements**

**9.17.6.1** Length and breadth of superficial area of the finished work shall be measured correct to a cm. Area shall be calculated in square meter correct to two places of decimal. No deduction will be made of openings of areas upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.

**9.17.6.2** For openings exceeding 0.40 sqm. in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such openings.

#### **9.17.7 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above including all scaffolding, staging etc.

### **9.18 PVC DOOR FRAMES:**

#### **9.18.0 Material:**

Polyvinyl chloride Resin suspension grade is the basic raw material for forming PVC compound. PVC resin then is mixed with chemicals like Calcium, Stearate, Hydrocarbon Wax, Titanium Dioxide, Calcium Carbonate, Acrylic processing aids. Further, additives like impact modifiers, pigments, epoxy plasticizer, UV stabilizer, lubricants, chemical blowing agent etc. are added. The purpose of adding the chemicals and additives is to impart cellular structure, strength, surface finish, colour and resistance to fading by light rays. These chemicals are mixed in the desired proportion and shall be used in the formulation of PVC material and for free and smooth extrusion of PVC profiles.

#### **9.18.1 PVC Door Frame**



PVC door frame shall be made of PVC material conforming to IS 10151. The door frame shall be made from extruded PVC section having overall dimensions of 48 x 40 mm or 42 x 50 mm having wall thickness of 2.0 mm + 0.2 mm. Corners of the door frame to be jointed by M.S. galvanized brackets. Joints mitred and plastic welded. The hinge side vertical outer frames shall be reinforced by galvanized M.S. Tube of size 19 x 19 mm of wall thickness 1 mm + 0.1 mm and a tie rod shall be provided at the bottom of the frame. The frame shall be fabricated in factory as per nomenclature of the item and directions of Engineer-in-Charge. (Fig. 9.18).

#### **9.18.2 Fixing of Frames**

The frames are to be fixed in prepared openings in the walls. All civil work and tiling should be completed before the fixing of the frames. The frames are to be fixed directly on the plastered wall. In case tiling is to be done in the place the frames are to be fitted, a 50 mm strip should be left untilled at the location where the frames are to be fitted. The frames are erected in the prepared opening such that the vertical members of the door frame are embedded 50 mm in the floor. The frame shall be fitted truly in plumb. A minimum of three anchor bolts or screws of size 65/100 shall be used to fix each vertical member. One bolt shall be fixed at 200 mm from the top member and one bolt shall be fixed at 200 mm from the floor. The third anchor bolt shall be fixed in the center. The top horizontal member shall be fixed using two 65/100 size anchor bolts or screws at a distance of 200 mm from both the corners.

#### **9.18.3 Measurements**

The outer length of the vertical and horizontal members of PVC door frame shall be measured in running metres including embedded length in floor corrected upto a cm.

#### **9.18.4 Rate**

The rate includes the cost of the materials and labour involved in all the operations described above. The cost of anchor bolts or screws for joining the frame is included in the rate. Any other hardware, which may be required, shall be paid for separately.

#### **9.19 PVC DOOR SHUTTERS: DELETED**

#### **9.20 PVC DOOR FRAME: DELETED**

#### **9.21 PANEL PVC DOOR SHUTTER: DELETED**

#### **9.22 FIBRE GLASS REINFORCED PLASTIC (FRP) DOOR FRAMES: DELETED**

#### **9.23 FIBRE GLASS REINFORCED PLASTIC (F.R.P.) SHUTTERS: DELETED**

#### **9.24 SOLID PVC FOAM PROFILE DOOR: DELETED**

#### **9.25 SOLID PVC FOAM SHUTTERS: DELETED**

#### **9.26 FACTORY MADE FIBRE GLASS REINFORCED PLASTIC CHAJJA**

**9.26.1** F.R.P. chajja shall be 4 mm thick of required colour/size, design and drawing as approved. The chajja shall have smooth gradual slope curvature for easy drainage of water & shall be factory manufactured as per nomenclature of item & directions of Engineer-in-Charge. (Fig. 9.27).

#### **9.26.2 Material**

1. Glass Fibre (chopped strand mat) shall be as per IS 11551
2. Unsaturated Polyester Resin shall be as per IS 6746
3. Surface Burning Characteristics of Building Material – ASTM E 84-77a
4. Unsaturated Polyester Resin Gel coat shall be as per IS 6746



5. Curing Agents – Cobalt Napthanate and MEKP
6. Test of products – IS 14425
7. Glass Fiber Roving – IS 11320

The F.R.P. chajja laminate shall be water and chemical resistant and shall have very high transit strength to weight ratio and high modulus of elasticity, good textile processing and excellent fiber reinforcement properties. The laminate shall have low coefficient of thermal expansion and a high thermal conductivity and high dielectric constants. The F.R.P. laminate shall be diversionally stable, shall have moisture and corrosion resistance.

#### **9.26.3 Tolerance**

Tolerance of + 10 mm in overall size of FRP chajja is permissible.

#### **9.26.4 Finish**

The F.R.P. laminate to be finished with polyurathene based or equivalent paint as final coat or gloss or mat followed by clear lacquer coat to get the shine of required shade.

#### **9.26.5 Tests**

Frequency of tests as per direction of Engineer-in-Charge & tests to be conducted as per para 9.19.4.

#### **9.26.6 Measurement and Rate**

The width and length to be measured in centimetres and area to be calculated as square metre correct upto two places of decimal. The rate includes cost of all the materials, labour scaffolding, fittings & fixing upto all heights etc. involved in operations described above but excludes the cost of paint.

#### **9.26.7 WALL PANELLING (Fig. 9.28)**

All specification same as per clauses 9.17.1 to 9.17.7.

#### **9.27 WALL PANELLING (Fig. 9.28)**

All specification same as per clauses 9.17.1 to 9.17.7.

### **9.28 uPVC CASEMENT/SLIDING WINDOW & DOOR**

#### **9.28.1 Material**

uPVC (un-plasticized polyvinyl chloride) is PVC resin blended with acrylic modifier, titanium dioxide and other chemicals. Then it is processed through machine and mould to produce required uPVC multi-chambered profiles.

The factory-made uPVC white colour doors and windows shall be comprising of approved uPVC make multi-chambered frames, sash and mullion duly reinforced with appropriate thickness of galvanised iron section of required length, an appropriate dimension of uPVC glazing beads, EPDM gasket according to frame/sash profile and specified hardware and fittings of approved make having dimensions as per nomenclature of items. There are two type of uPVC extruded profile series which are used depending upon the size and design of window/door and wind load consideration and the agency shall also provide wind load calculation sheet duly approved by the Engineer-in-Charge as per IS 875 (Part-3) namely Small Series (small depth dimension) having wall thickness of  $1.7 \pm 0.2$  mm and Big Series (big depth dimension) having wall thickness of  $2.3 \pm 0.2$  mm of uPVC main profile i.e frame. Depth and width of the profile mentioned in the nomenclature of the item is as following.

- i. Depth of a profile (D)- Dimension which is measured at right angles to the glazing plane, between the front and back face surfaces of a profile.



- ii. Width of a profile (W)-Dimension, measured in the direction of the glazing plane, and perpendicular to the longitudinal axis of the profile.

Note:

- i. Profile size mentioned in the Delhi Schedule of Rate are in Depth (Base of Frame) x width format (visible elevation)
- ii. For building it is a must to use big series above 5th floor.
- iii. All uPVC profiles should be got approved by Engineer-in-charge before fixing at site of work.

#### 9.28.1.1 Tolerance in profile dimension

For uPVC frame, sash and mullion extruded profile minus 5 % tolerance in dimension. i.e in depth and width of profile shall be accepted. Variation in profile dimension in higher side shall be accepted but no extra payment on this account shall be made.

#### 9.28.2 Terminology

##### (a) Frame

Non movable or fixed portion of the window/door attached to the wall and to which the sash is assembled.

##### (b) Sash

Movable part in a window/door.

##### (c) Glazing Bead

Profile which holds the glass or any other partition materials.

##### (d) Transom (or Mullion)

Profile used within the frame, vertically or horizontally in a frame and/ or sash.

#### 9.28.3 Marking

uPVC profiles shall be legibly and visibly marked in an unobtrusive position not visible when the window is closed at least once every one meter along the length of the profile and it should be visible when the window is open as well as shall contain the following minimum information on the main profile such as frame, sash and mullion/transom.

- (a) The name of the trade mark or brand name of the manufacturer
- (b) Date of manufacturing and profile code

#### 9.28.4 Testing (Criteria for conformity)

The uPVC extruded hollow profiles use in window and doors shall conform to the specification as per EN 12608 and other standards as mentioned below:

S.No.	Name of the test	Test Method	Specified Parameter
1	Vicat Softening Temperature	EN ISO – 306	Shall not be < 75°C
2	Charpy Impact Strength	EN ISO – 177-2	Shall not be < 20KJ/m <sup>2</sup>
3	Flexural Modulus Elasticity	EN ISO – 178	Shall not be < 2200 N/mm <sup>2</sup>
4	Tensile Impact Strength	EN ISO – 8256	Shall not be < 600 KJ/m <sup>2</sup>



5	Mean Breaking Stress for welded corner		
	(a) For the tensile bending test	EN – 514	Shall not be < 25 N/mm <sup>2</sup>
	(b) For the compression bending test		Shall not be < 30N/mm <sup>2</sup>
6	Heat Reversion Test	IS:4785-2000	Shall not be > 2.0 %
7	Surface Spread of flame	BS: 476 - Part 7	Classification 1
8	Ignitability Evaluation	BS: 476 - Part 5	'P' Not easily ignitable
7	Tensile modulus	ASTM D 638	Shall not be < 35 MPa
10	Shear Modulus	ASTM D 732	Shall not be < 220 MPa
11	Tensile Strength	EN ISO 527	Shall not be < 30 MPa

For the determination of the weld ability of profiles, welded corners shall be tested for tests as mentioned above. The sample subjected to weld test shall not be finished by grooving and knifing etc. except for the outside edge of 70-degree angle, which shall be cleaned to permit the sample to sit fully on to the support.

Minimum percentage of titanium dioxide content in uPVC profiles shall not be less than 7.00 percent and calcium carbonate content shall not be more than 10.00 percent.

The uPVC casement / fixed / sliding windows and doors shall be factory fabricated by the approved manufacturer and installation work shall be carried out by them or their authorized vendor duly approved by the Engineer - in -charge.

#### 9.28.5 Configuration

Indicative size and configuration of window& door (Casement/ sliding) are given in figure 7.27 to 7.38. In case a new configuration is to be provided, same shall be specified in the item and figure included in the tender document.

#### 9.28.6 Fabrication

- According to the drawing, the required dimension and length of uPVC frame, sash and mullion profiles shall be mitred cut and reinforced with galvanized iron section of required length and thickness.
- All frame and sash profiles of door and window shall be fusion welded at all corners. Mullion and Transom profiles shall also be fusion welded as per window / door design so as to prevent any ingress of water or air in the reinforcement chamber.
- Each corner and joints shall be neatly cleaned by removing all excess material. The weld shall be finished by grooving, knifing etc. at exposed welded portion only.
- The minimum overlap of 6 mm shall be provided on frame and mullion to ensure effective seal between the sash and frame.
- The window / door shall be designed and provided water drainage/ventilation slots in profile of frame, sash, transom or mullion in order to permit the escape of entrapped water, moisture from the system. A minimum of 2 nos slots shall be provided at least at every 500 mm. The drainage shall be so designed as not to puncture the reinforcement chamber and prevent water running through the



reinforcement chamber. The holes and slots shall offset between the inner and outer walls so as to prevent any back flow.

#### 9.28.7 Reinforcement

- i. The reinforcement material should be non-hygroscopic and should have no adverse effect of the performance of the window/door and it shall confirm to any grade of IS 1077 or IS 513.
- ii. Mild steel section reinforcement made from Roll forming process and shall be hot dip zinc galvanized in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.
- iii. The thickness of reinforcement shall be as such that the uPVC window and doors meet the design wind pressure in accordance with IS 875 (Part-3) and design of the reinforcement should be as per uPVC profile manufacturer recommendation and fix to ensure adequate fastener retention.
- iv. Galvanized mild steel reinforcement section is to be inserted in uPVC frame, sash and mullion profile of required length with in 6 to 15 mm distance from the face of the weld and then shall be screwed at 150mm from the end at every 400 mm (maximum) pitch to uPVC profile so that it does not move or rattle.
- v. Galvanized mild steel reinforcement section thickness shall be changed according to floor level keeping in consideration of wind load factor and minimum thickness should be as below:
  - (a) From ground floor upto floor 5th level = 1.60±0.2 mm
  - (b) From floor 5th level onwards = 2.20±0.2 mm

#### 9.28.8 Glazing

- i. After fusion welding and cleaning of the corner of the sash prescribed glass panes shall be placed after fitting EPDM gasket and uPVC beading of approved quality and make.
- ii. Window sash shall be made in such a way that glazing or re-glazing is possible at site without the need to remove the outer frame.
- iii. The plastic spacer shall be used to provide to support the glass in sash/frame.
- iv. The following glass thickness shall be used in uPVC windows and doors but in no case less than 4mm.
  - (a) For single glazing - 4 to 6mm
  - (b) For double glazing - 20 mm or 24mm

Glazing supports shall be provided on frame or sash in order to distribute the load of the glass and to place the glass in the frame or sash. Spacers that would provide supports to the glass in the frame or sash shall be installed after the glazing support are installed. The supports and spacers shall be so placed as not block the drainage holes/slots.

#### 9.28.9 Glazing gasket & Weather pile strip/ Wool pile

- i. Material for glazing gaskets shall be of EPDM (Ethylene propylene diene monomer) and shall be used on both side of glass panes in uPVC sash and glazing bead profiles.
- ii. Weather pile strip / Wool pile shall be used in uPVC sliding door and window to reduce air filtration and water penetration.

#### 9.28.10 Window / Door Hardware and Fittings

Materials for all hardware except for fixing shall have at least the equivalent corrosion resistance of EN 1670- 1788 grade 4 (240 hrs) when subjected to natural salt spray testing in accordance with EN ISO



7227. Testing shall be carried out on complete hardware items and also duly approved by the Engineer - in - charge before use at the site of work.

Hardware like hinges, rollers and locking devices which have been life cycle tested in accordance with EN 177 (Windows and Doors - Resistance to repeated opening and closing - Test method) and have achieved at least 10,000 operating cycles (i.e. opening and closing) without deterioration, failure or excessive wear.

These shall be provided as per nomenclature of item of approved make and duly approved by Engineer-in- Charge before fixing at site of work. Hardware / fittings such as handle, roller, touch lock, multipoint locking, 3D hinges, friction hinges etc. shall be directly screwed not pre-drilled or hammered.

#### **9.28.10.1 For Casement windows**

Approved quality stainless steel friction hinges (SS 304 grade) with SS screws shall be provided as per nomenclature of item and length of friction hinges should cover more than 60 percent width of the shutter and two number friction hinges required for each shutter one at top and one at bottom.

#### **9.28.10.2 For Casement doors**

Minimum three numbers of approved quality 3D hinges with necessary SS screws shall be provided in the casement door shutter up to 0.70 meter in width and 2.10 meter in height, for more than 2.10 metre height minimum four numbers 3D hinges to be used.

#### **9.28.10.3 For Sliding windows/doors**

- i. One pair of zinc alloy body with single nylon roller (weight bearing capacity to be 40 kg) upto 1.50m window height dimension and one pair stainless steel (SS 304 grade) body with adjustable double nylon roller (weight bearing capacity to be 120kg) above 1.50 m window height dimension of approved quality to each shutter of window shall be provided.
- ii. One pair of adjustable double nylon roller of approved quality to each shutter of door shall be provided.
- iii. In case of wire mesh, stainless steel fly proof wire mesh shall be provided as per nomenclature of item of approved make and manufactures duly approved by the Engineer-in-charge before fixing at site of work. SS wire mesh must be in the first track of the three-track frame from the interior field of vision and that SS wire mesh must be fixed with EPDM gasket in a sash profile as the glass sash profile.

#### **9.28.10.4 Tolerance**

The tolerance in dimensions of finished window / door in size shall not be more than  $\pm 5$ mm from the approved drawing dimension.

#### **9.28.11 Installation**

- i. There shall be a maximum gap of 3 to 5mm in between uPVC door / window frame and finished opening and the plastic packers shall be provided to maintain the level.
- ii. To maintain the exact dimension of door or window, the opening shall be checked for dimension and orthogonally using a prefabricated template. Any defect shall be made good by the agency at his own cost before fixing of door or window.
- iii. The uPVC frames are to be fixed in prepared opening in the walls. Window / door frame shall be fixed into the aperture by drilling through the outer frame to the existing structure and shall use 100x8mm fasteners of approved make.





- iv. The gap between uPVC window / door and adjacent RCC/Brick/Stone cladding work shall be filled with weatherproof Silicon sealant of approved make to maximum 5mm depth and 5mm in width to allow expansion/contraction of uPVC profiles. Silicon sealant of matching color of uPVC profile shall be applied over backer rod.

#### **9.28.12 Precautions taken before installation of uPVC Window & Door**

- i. Jambs, sills and soffits of the opening shall be finished with plaster / stone / tiles according to agreement where uPVC window / door to be fixed.
- ii. Aperture shall be smooth in line and level as well as in plumb.
- iii. Flooring (where casement door is to be installed should be complete before installation of door).
- iv. The grill where to be installed in sliding / casement window should be provided after the installation of window.
  - a. For sliding window – The grill shall be provided on the outer face of window.
  - b. For casement window – The grill shall be provided on the inner face of window.
- v. Installation of uPVC door and window should be done before the last coat of the paint on the wall where window jambs, sills and soffits to be finished by paint. At least one coat of paint should be done before installation begins.
- vi. The colour of the profile shall be same and uniform on any surfaces or part of the surfaces which may be visible after installation of the window/door fabricated from the profile, when viewed by the normal vision.
- vii. The uPVC profiles manufacturer shall provide warranty of 10 years for colour fastness and any manufacturing defects in respect of uPVC profiles as well as water and air tightness in case of casement uPVC door/window unit.
- viii. uPVC door/windows hardware and fittings manufacturer shall provide warranty of 10 years for any manufacturing defects.

#### **9.28.13 Mode of Measurement**

The length and width of the window / door shall be measured from outer to outer face of the uPVC frame correct to a centimetre. Area shall be calculated in square meter nearest to 0.01 square metres.

#### **9.28.14 Rate**

The rate includes the cost of all labour, material and T&P involved in all the operations described above at all heights of the building. The cost of glass panes, wire mesh and silicon sealant shall be paid separately.

### **9.28A HARDWARE FITTINGS FOR UPVC DOORS & WINDOWS**

**9.23A.1** Hardware fittings such as zinc alloyed white powder coated casement handles, touch lock, steel roller, steel crescent lock (white powder coated) for uPVC doors/windows shall be of approved brand/make, size and manufacturer as described in nomenclature of item complete as per direction of Engineer-in-Charge.

#### **9.28A.2 Measurement**

uPVC doors & windows hardware fittings shall be measured in numbers.

#### **9.28A.3 Rate**

Rate shall include all the material and operation as described in the nomenclature of item.





## 9.29 FIRE RESISTANT GLAZED DOORS, WINDOWS & PARTITIONS

### 9.29.1 GENERAL

The Fire resistant Glazed Doors (hereinafter termed as FRGD), Fire resistant Glazed windows (hereinafter termed as FRGW) and Fire Resistant Glazed Partition (hereinafter termed as FRGP) shall not collapse during the rated period of fire under the specified fire conditions and shall provide safe access to the escape route.

### 9.29.2 CODES & SPECIFICATIONS

All materials, items, hardware etc. shall be subjected to approval by Engineer-In-Charge. Necessary documentation/ test certificates shall be furnished by the Contractor from the manufacturer before supply of material for approval by Engineer-in-charge. Each Door/Window and Partition shall be provided with a small metal identification plate in suitable location indicating Fire rating, name of the Manufacturer, date of installation and details of approved test house. Each Glazing pane shall carry a permanent stamp of the manufacturer.

The complete assembly of the doors i.e. frame, shutter, vision glass and hardware shall have fire rating as required and shall confirm to:

1.	EN 1634-1	Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware - Part 1: Fire resistance test for door and shutter assemblies and openable windows
2.	EN 1364-1	Fire resistance tests for non-load bearing elements – Part 1: Walls
3.	EN 410	Determination of luminous and solar characteristics of glazing.
4.	EN 12600	Glass in Buildings – Pendulum test – Impact test and classification for flat glass

### 9.29.3 TESTING AND CERTIFICATION

The FRGD, FRGW & FRGP shall be supplemented with appropriate certification by fire test lab, for applicable or higher dimension with complete description of the architectural components and hardware for FRGD, FRGW and FRGP for which the approval is given. Along with the material tests, the complete system along with the framing shall be tested in accordance with the criteria of EN1634- 1 for door/window and EN1364-1 for partition. The installation of the fire rated system shall confirm to requirement of test evidence. The choice of hardware and/or glazed accessories shall be as per test evidence.

### 9.29.4 Fire Resistant Doors/Windows and Partitions

#### 9.29.4.1 Frame for Fire Resistant Glazed Door / Windows

Frame for Door/Window of 120 min fire rating shall be made of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/m<sup>2</sup>) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 76Kg/m<sup>3</sup>. The frame will have a provision of G.I. Anchor fasteners 14 nos (5 each on vertical style & 4 on horizontal style of size M10 x 80) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x87x3mm for fixing of fire rated glazed shutter. The frame shall be finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge. (Cost of SS ball bearing hinges is excluded).

#### 9.29.4.2 Frame for Fire Resistant Glazed Partitions



Frame for non load bearing fixed fire resistant glazed Partition for 120 min Fire Rating shall be made out to a profile of dimension 60mm x 70 mm of 1.6 mm thick galvanised steel sheet as per test evidence suitable for fixing fire rated glass for 120 min of both integrity & radiation control (EW120) & minimum 15 min of insulation (EI15). The profile has to be fixed to the supporting construction by means of anchor fasteners of size M10 x 80, every 150 mm from the edges and every 500 mm (approx) c/c. The frame shall be filled with mineral wool insulation of density min 76kg/m<sup>3</sup>. and finished with an approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer - in- charge.

#### **9.29.4.3 Shutter for Fire Resistant Doors/Windows**

Glazed fire resistant door shutters 60 mm thick of 120 min Fire Rating shall be confirming to IS:3614 (Part II) or EN1634-1:1777, tested and certified as per laboratory approved by Engineer-in- charge, with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m<sup>2</sup>) duly filled mineral wool insulation having density min 76 kg/m<sup>3</sup> and fixing with necessary stainless steel ball bearing hinges of size 100x87x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc all complete as per direction of Engineer-in-charge (panelling to be paid for separately).

#### **9.29.4.4 Fire Resistant Glass for Doors/Windows and Partitions**

Glazing to be fixed in fire resistant doors/window shutters and fixed Partitions with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m<sup>2</sup>) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c , including applying a coat of approved fire resistant primer/powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc complete in all respect as per direction of Engineer-in-charge. The glass should be clear, toughened, interlayered, non-wired fire resistant having 11 mm minimum thickness of approved brand with 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 15 min of insulation (EI15) and having a sound reduction of more than 35dB and LT of 85%. Glass shall be compliant to class 2B2/1B1 category of Impact Resistance as per EN 12600. The glass should be manufactured in UL & TUV audited Facility and including UL-EU Certification. The maximum glazing size cannot be more than 1100 mm x 2200 mm (w x h) or 2.42 sq mts in total area. The test report for the complete system (Glazed Door or Partition) will be considered valid only if it contains the stamp and signature of the authorized signatory from the glass manufacturer. (Actual glass size is to be measured at site for payments).

The complete assembly shall satisfy the given criteria of fire resistance - stability, fire integrity, radiation control and insulation as per above mentioned rating required.

#### **9.29.5 Vision Panel For FRD**

##### **9.29.5.1 Vision Panel for Fire Door**

Specifications for glass for Vision panels for Fire Rated Door shall be as per para C above. Minimum size of glass to be used for vision panels shall not be less than 350 mm x 350 mm.

#### **9.29.6 DELIVERABLES BY THE CONTRACTOR**

Following documentation/ drawings shall be furnished along with the Doors/window/partition.

1. Prototype Test Certificate by national/international test house
2. Shop drawings
3. Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items intended to be used.



4. Certificate indicating that design and installation of Doors and hardware conforms to norm laid down by approved national/international test house.
5. Test report to be attested by Fire rated glass manufacturer.
6. The Fire rated glass applicator has to be approved by Fire rated Glass Manufacturer has to Submit the approved applicator certificate.

#### **9.29.7 Measurements**

##### **9.29.7.1 Measurement of frame for door/window/partition**

The outer length of the vertical and horizontal members of fire rated door/window frame shall be measured in running metres including embedded length in floor upto two decimal places. The outer length of the vertical and horizontal members of fire rated partition frame shall be measured in running metres upto two decimal places.

##### **9.29.7.2 Measurement of shutter for door/window**

Length and width of the shutters shall be measured to the nearest cm in closed position covering the rebates of the frames but excluding the gap between the shutter and the frame. Area is calculated to the nearest 0.01 sqm.

#### **9.29.8 Rate**

The rate of frame includes the cost of the materials and labour involved in all the operations. The cost of SS ball bearing hinges and any other hardware which may be required, shall be paid for separately. The specified rate for door/window shutter include the cost of the door/window shutter and labour involved in fixing of the shutter. Fittings, fixtures and paneling on the door shutter except hinges & screws shall be paid extra as provided.

#### **9.30 NICKEL PLATED M.S. PIPE CURTAIN ROD WITH NICKEL PLATED M.S. BRACKETS: DELETED**

#### **9.31 M.S. GRILLS OF REQUIRED PATTERN IN FRAMES OF WINDOWS ETC. WITH M.S. FLATS, SQUARE OR ROUND BARS ETC. INCLUDING PRIMING COAT: DELETED**

#### **9.32 BAMBOO JAFFERY/ FENCING: DELETED**

#### **9.33 WOODEN MOULDED CORNER BEADING OF TRIANGULAR SHAPE: DELETED**

#### **9.34 MAGNETIC CATCHERS**

Magnetic catchers for kitchen cabinets and cup-boards can be of slightly different sizes by different manufacturers with varied base materials for housing magnetic plates.

Main body can either be of stainless steel or HDGI steel or 1<sup>st</sup> grade virgin ABS plastic in which two or three galvanized steel magnetic strips with magnets placed vertically or horizontally in box type body.

Most commonly used magnetic catcher by standard manufacturers are of 1st grade virgin ABS plastic having two/three magnetic strips housed within box type case as described below.

- (a) Triple strip magnetic catcher for fixing vertically on the door meeting side of the cabinet/cupboard box of size not less than 70x30x15 mm with three nos. galvanized steel M.S. magnetic strips housed within the body and its attraction strip/plate of size not less than 60x15 mm. Both fixing of catcher and the attraction plates are to be fixed with 3-M, 15 mm long fully threaded sunken head screws complete.
- (b) Double strip magnetic catcher for fixing horizontally at top or bottom meeting edge of cabinet/cup board box of size not less than 50x30x12 mm with two nos. galvanized steel M.S. magnetic strips housed within the body and its attraction strip/plate of size not less than 50x12 mm. Both the



catcher and the alteration plates are to fixed with 3-M, 15 mm long fully threaded sunken headed steel screws complete.

#### **9.34.1 Measurements**

It shall be counted in numbers.

#### **9.34.2 Rate**

Rate is inclusive of one set of magnetic catcher including its alteration strip and sunken headed steel screws and labour required for proper positioning and fixing in cabinets or cup boards.

### **9.35 POWDER COATED TELESCOPIC DRAWER CHANNEL 300 MM LONG**

Telescopic drawer channels of standard length comprises of four components:

- i. Outer fixed channel
- ii. Inner fixed channel
- iii. Intermediate movable channel and
- iv. High carbon high strength stainless steel balls in S.S ball cages.

Both outer and inner fixed channels are punched with holes/slots for fixing to cabinet box and drawer respectively.

The size of drawer channel is defined as length of outer fixed channel which is in this item is 300 mm. The inner fixed channel is of even smaller size in web depth and flange (which is detachable) by way of an ABS plastic clip mechanism and fixed to either side of drawer wall and slides in the intermediate channel.

The telescopic drawer channels are always fixed in pair i.e. on either side of drawers and fixing to cabinet box using fully threaded M-4, 20 mm long sunken headed screws.

All the three channels are made of die pressed M.S. strips 1.5 mm thick with necessary holes and slots punched/cut and powder coated (minimum 30 microns) black/brown/chocolate color Virgin ABS plastic stopper cleats and clips are also housed/fixed. The standard weight of a pair (one set) of 300 mm long telescopic drawer channel shall not be less than 800 grams.

#### **9.35.1 Measurements**

It shall be counted in pair i.e. one set.

#### **9.35.2 Rate**

The rate for the item is inclusive of cost of a pair of telescopic drawer channel and sunken headed steel screws and labour for fixing to cabinets/drawer etc complete.

### **9.36 SLIDING ARRANGEMENT IN RACKS/CUP-BOARDS/ CABINET SHUTTER**

This sliding clamp is made of chrome plated (minimum 30 microns) M.S. strips to be pressed, cut and bend to form 'U' shaped clamps and 4 nos. 'V' shaped cuts, holes punched and bent inverse to form S.S. roller bearing axis tracks with two nos. S.S. roller bearings in each clamp.

This sliding clamp (1 pair each shutter panel) can be fixed to glass/plywood shutter panel of the cabinet by making inverse U-shaped cut at the bottom in the said sliding shutter panel and using EPDM piece of required size & thickness push fixed to form firm grip to ply/glass sliding panel.

#### **9.36.1 Measurements**

It shall be counted in numbers.



#### 9.36.2 Rates

The rate for each clamp is inclusive of the cost of clamp and labour charges for making the cuts in shutter panel and fixing of 'C' & E channels etc. all complete as per directions of Engineer-in-Charge.



## APPENDIX A

**TABLE FOR PERMISSIBLE DEFECTS FOR VARIOUS GRADES OF TIMBERS**  
(Clause 9.1)

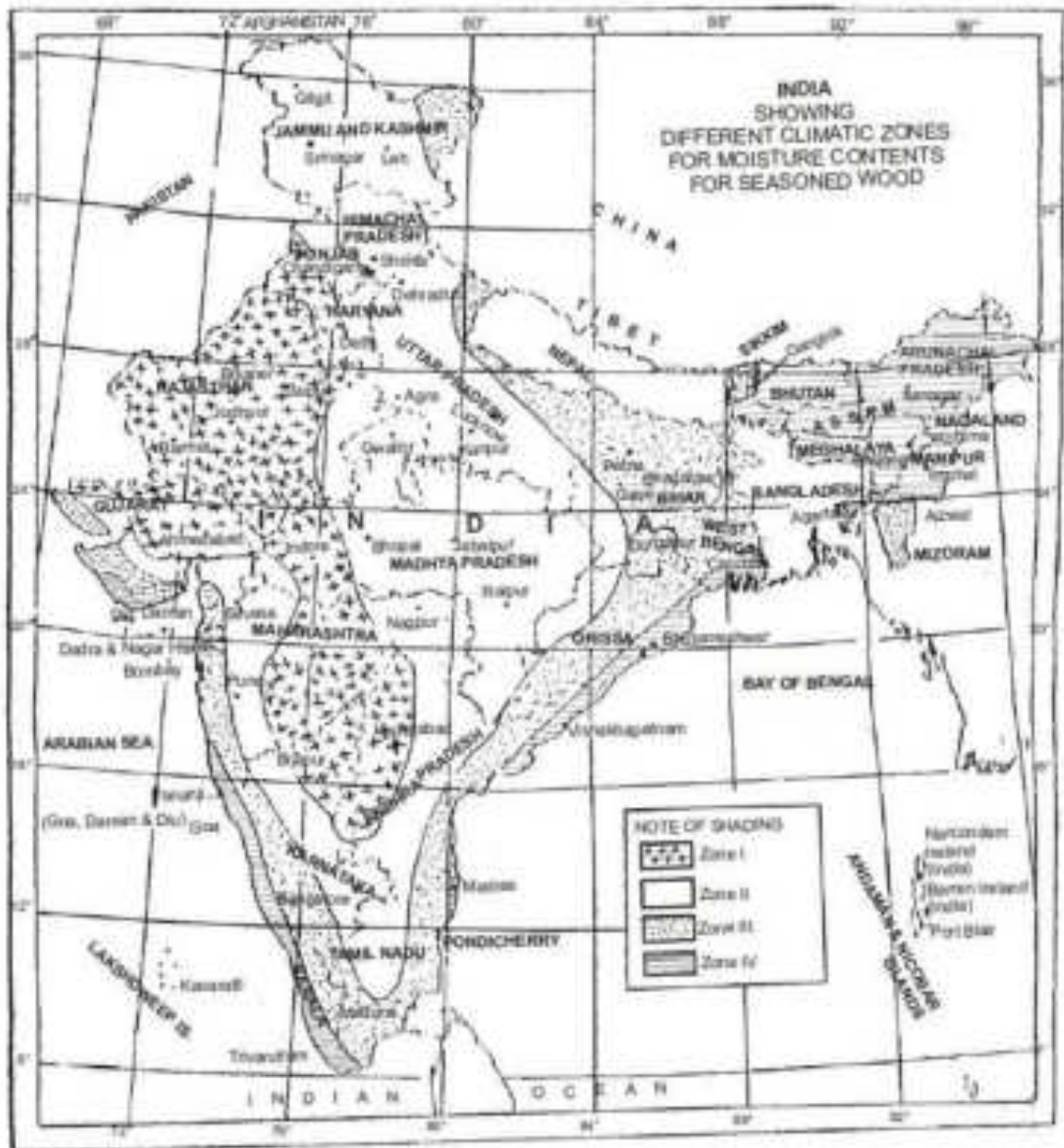
Sl. No.	Defects	First Grade	Second Grade
(1)	(2)	(3)	(4)
(i)	Cross-grain	Not steeper than 1 in 15	Not steeper than 1 in 10
(ii)	Sound knots and live knots	<p>(i) Stiles and Rails</p> <p>(a) Short Exposed Face: Not more than 15 mm size and not more than 1 knot/metre</p> <p>(b) Long Exposed Face- Not more than 15 mm size and not more than 1 knot/m. No knot shall occur within 20 mm of the edges</p> <p>(ii) Panels - Not more than 20 mm size and not more than 2 knots/m<sup>2</sup>. No knot shall occur on edge of any component of a panel.</p>	<p>(i) Stiles and rails</p> <p>(a) Short exposed Face - Not more than 15 mm size and not more than 3 knots per stile and 1 knot per rail</p> <p>(b) Long Exposed Face- Not more than 20 mm size and not more than 3 knots per stile and 1 knot per rail</p> <p>(ii) Panels - Not more than 20 mm size and not more the 4 knot/m<sup>2</sup>. No knots shall occur on edge of any component of a panel.</p>
(iii)	Dead and loose knots (plugged)	<p>(i) Stiles and Rails - Not more than 10 mm size - centrally located and not more than 1 knot / m</p> <p>(ii) Panels - Not more than 15 mm size and not more than 2 knots/m<sup>2</sup>. No knot shall occur on edges of any component of a panel</p>	<p>Stiles and Rails - Not more than 10 mm size, centrally located and not more than 3 knots per stile and 1 knot per rail.</p> <p>Panels - Not more than 15 mm size and not more than 4 knots/m<sup>2</sup>. No knot shall occur on edge of any component of a panel.</p>
(iv)	Pitch pockets or streaks	None	Permissible except on exposed edges provided that they are clean and filled up with suitable putty or filler when pitch pockets or streaks are located on the exposed edges of the core, they shall be cut out and filled with piece of wood of similar species with grain running in the same direction. The piece shall be well glued.



(v)	Sapwood	Total not exceeding 5 mm wide and 150 mm long per metre. (This restriction applies only to super group species).	Total not exceeding 10 mm wide and 300 mm long per metre. (This restriction applies only to super group species).
(vi)	Pin holes	Permitted provided they are not in cluster	Permitted.
(vii)	Worm holes	None	Permitted provided they are not more than 10 mm in diameter and not more than one per metre and provided such worm holes are plugged with similar timber in such a manner that the plugging merges with the surrounding area both as to colour and grain.



DIFFERENT CLIMATIC ZONES FOR MOISTURE CONTENT OF TIMBER  
(Clause 9.1.6)



- Note 1: Based upon Survey of India map with the permission of the Surveyor General of India.
- Note 2: The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.
- Note 3: The boundary of Meghalaya shown on this map is as interpreted from the North Eastern Area (Reorganisation) Act, 1971, but has yet to be verified.
- Note 4: The administrative headquarters of Chandigarh, Haryana and Punjab are at Chandigarh.





### MOISTURE CONTENT OF TIMBER (Clause 9.1.6)

Moisture content of timber shall be checked for every 1 cum or part thereof by electrical moisture meters as per IS 287.

Electrical moisture meters are of resistance type and shall be used when the moisture content is within a range of 8 to 25 per cent. When checking moisture content with electrical moisture meter, it shall be ensured that:

Timber is not hot or surface wet and the moisture gradient is not large due to wet cores. Electrode probes are of adequate depth (not less than one-fifth the thickness of the timber). Sufficient number of reading at different positions are taken on each piece of timber to eliminate localised variations in surface moisture and species corrections are applied for the make of electrical resistance type moisture meter. If for any reason, whatsoever, the result of electrical moisture are not to be relied upon the moisture content shall be checked by the oven drying method.

For checking moisture content by oven drying method, a complete test cross section, 12 to 19 mm long in the direction of timber grain, free from all defects shall be cut from each piece of timber selected for test as follows:

If weighing can be done immediately, the test section shall be cut from a point at least 45 cm from one end of the piece or from its centre.

In case cutting of test section from the piece is not permissible the moisture content in the whole section can also be determined by collecting a boring to a depth of half of the thickness of the piece by means of an auger, in a preweighed weighing bottle which should then be sealed properly.

The test sections obtained above shall be weighed, immediately after cutting, on a balance the sensitivity of which is not less than 10 mg. They shall be dried in a ventilated, and preferably thermostatically controlled, oven at a temperature of 100°C to 105°C until the weight is constant. The weight of the test section shall be deemed to have become constant if successive weighing at intervals of 2 to 5 hours do not differ from one another by more than 50 mg. The test weight shall be taken to be the oven dry weight of the test section.

The percentage moisture content in the test section shall be calculated as follows:

$$\text{Moisture content (Per cent)} = \frac{W1 - W0}{W0} \times 100$$

Where:

W1 = initial weight of test section

W0= oven dry weight of test section

When moisture content of timber is checked by oven drying method, results of electrical moisture meter shall be ignored.



## APPENDIX D

### PHYSICAL AND MECHANICAL PROPERTIES OF PLYWOOD (Clause 9.2.2.6)

Moisture content –  
5 to 15 per cent.

Shear Strength

Parameter	Dry State	Resistance to Moisture
Average	135	100
Individual	110	80



## APPENDIX E

### PHYSICAL AND MECHANICAL PROPERTIES OF FPT OR GRADED PARTICLE BOARD (Clauses 9.2.3.4)

Sl. No.	Properties	Flat pressed Three layer multi layer & graded	
		Grade - I	Grade -II
(i)	Density variation, percent	± 10	± 10
(ii)	Water absorption, percent		
	2 h soaking	10	40
	24 h soaking	20	80
(iii)	Linear expansion (swelling in water). 2 h soaking- percent		
	Length	0.5	0.5
	Width	0.5	0.5
(iv)	Thickness, swelling, percent 2 h soaking	8	12
(v)	Swelling in thickness due to surface absorption, percent	6	9
(vi)	Modulus of rupture, N/mm <sup>2</sup>		
	Average	15	11
	Minimum	13	10
(vii)	Modulus of elasticity, N/mm <sup>2</sup>		
	Average	2500	2000
	Minimum	2250	1800
(viii)	Tensile strength perpendicular to surface, N/mm <sup>2</sup>		
	Upto 20 mm thickness	0.45	0.3
	Above 20 mm thickness	0.40	0.3
(ix)	Tensile strength perpendicular to surface, N/mm <sup>2</sup>		
	After cyclic test	0.2	-
	Accelerated water resistance test <sup>2)</sup>	0.15	-
(x)	Screw withdrawal strength, N		
	Face	1250	1250
	Edge (for thickness >12mm)	850	700



Cyclic Test— Specimen are immersed in water at  $27 \pm 2^{\circ}\text{C}$  for a period of 72 h, followed by drying in air at  $27 \pm 2^{\circ}\text{C}$  for 24 H and then heating in dry air at  $70^{\circ}\text{C}$  for 72 h. Three such cycles are to be followed and then the specimens are tested for tensile strength perpendicular to surface.

Accelerated Water Resistance Test— Specimen are immersed in water at  $27 \pm 2^{\circ}\text{C}$  and water is brought to boiling and kept at boiling temperature for 2 h. Specimen are then cooled in water to  $27 \pm 2^{\circ}\text{C}$  and then tested for tensile strength perpendicular to surface.

## TESTS FOR FLUSH DOOR SHUTTERS (Clause 9.7.1 to 9.7.10)

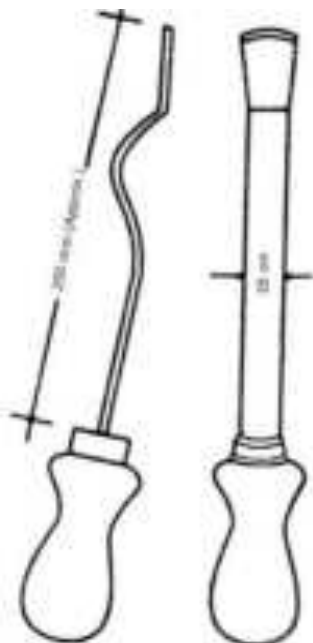
### F-1. END IMMERSION TEST

Door shutters shall be tested for resistance of their base to immersion in water as follows:

The door shutter shall be immersed vertically to a height of 30 cm in water at room temperature for 24 hours and then allowed to dry for 24 hours at  $27 \pm 2$  °C and relative humidity of  $65 \pm 5$  per cent. The cycle shall be repeated eight times. There shall be no delamination at the end of the test.

### F-2. KNIFE TEST

Apparatus: The type of knife required to be used in the test is given in Fig. below. It may be made from a 250 x 25 mm file. The cutting edge should be kept chisel sharp. The test shall be carried out on a stout table to which a wooden batten is screwed against which the edge of test piece is placed.



Drawing not to scale

### KNIFE FOR TESTING PLYWOOD FOR ADHESION OF PLIES

Procedure: The knife is inserted with its cutting edge parallel to the grain of the outer veneer and worked into, or if possible along a glue line and the veneer is prised upwards. A hard and dense specie of plywood requires considerable force to effect entry and to prise and veneer. In a soft timber the knife tends to follow an easy course through the wood and in this case it is essential that the knife be firmly guided along the glue line.



The bond should just pass the requirement, it is judged by the relative amount of wood fibre left on the core veneer, and the area prised off. The grading is assessed chiefly on the appearance of the break. The force needed to effect separation is also an accompanying requirement.

The bond is 'excellent', when it is difficult to find the glue line and impossible to keep the tool within it for more than 6 mm without cutting adjacent wood. On prising upwards, the veneer usually breaks off over a width slightly greater than that of the tool.

The bond is 'poor' when knife meets little opposition in the glue line and the prise results in the easy removal of almost all the veneers from one side of the test piece. The separated veneers are usually almost free from adherent fibre.

Reporting of test results: The results shall be reported as 'pass standard' 'excellent' or 'poor'. **F-3.**

### **GLUE ADHESION TEST**

A specimen shall be considered to have passed the test if no elimination has occurred in the glue lines in the plywood and if no single delamination more than 50 mm in length and more than 3 mm in depth has. Two square section, 150 x 150 mm shall be cut from the corners of the door. These corner section as cut from the door shall be immersed in boiling water at 100°C for 4 hours, then dried at 27 ±2°C and relative humidity of 65 ±5 per cent for 24 hours. At the end of the drying period, the samples shall be examined for delamination. In the case of the glue lines in the plywood, all the four exposed edges of the plywood on both faces of a specimen shall be examined in the assembly glue lines between the plywood faces and the stile rail. Delamination at the corner shall be measured continuously around the corner. Delamination at a knot, knot hole, a pitch pocket and worm hole or other permissible wood defects shall not be considered in assessing the sample. A door shall be deemed to have passed this test if both of the two specimen tested pass the test.

### TEST FOR MORTICE LOCKS (Clause 9.15.13)

The finally assembled lock shall withstand the test given as below:

The locking bolt shall be first locked in the forward position. A load of 40 kg shall be applied without shock in the direction perpendicular to securing face as well as on both the locking faces of protruding bolt in turn. Then the load shall be applied by means of a fixed steel board 3 mm thick by rounded edge held in such a position that the centre line is approximately 3 mm from the fore end. A typical arrangement for the purpose of this test is shown in Fig. below:

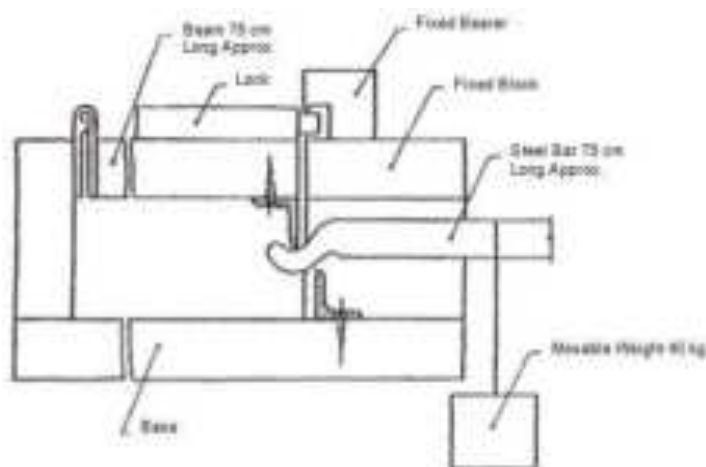


Fig.: Strength Test for Locking Bolt

When the spindle with handle is inserted into hole in the follower and turned, the latch bolt shall draw smoothly into the lock body and shall be within one millimetre from the face of the fore end.

When the latch bolt is pressed into the lock body by pressure, the action shall be smooth and when fully pressed the latch bolt shall not project more than one millimetre from the face of the fore end.

When a key is inserted in key hole from one side of the lock and turned to withdraw the locking bolt the action shall be smooth and without impediment. When the direction of turn is reversed to lock the locking bolt then also the action shall be smooth and without impediment. In the locked position the locking bolt shall project 12 mm from the face of the fore end, although one millimetre free movement is permissible. In the withdrawn position the locking bolt shall not project more than one millimetre from the face of the fore end. The locking bolt shall be worked by turning key in both the direction 6000 times. At the end of the test, the lock shall continue to work smoothly.

The test shall be repeated with the key inserted from the other side of the lock.

**Note:** The clearance for levers while in the operating condition shall not exceed 0.25 mm.

When the key is turned to lock the locking bolt at the same time applying a reasonable pressure by finger on it, after completion of the key rotation the locking bolt shall be positively locked in the forward position. This test shall be repeated with the key inserted from the other side of the lock.



## APPENDIX H

### SCHEDULE OF FITTING FOR DOORS AND WINDOWS (Clause 9.6.8)

Sl. No	Name of Fittings	Double leaf doors shutter s panelled or glazed	Single leaf door shutter s external panelled or glazed	Single leaf door shutter s inter communicating panelled or glazed	Single leaf wire gauze door shutters	Single leaf wardrobe/cupboard shutters	Single leaf window shutter s panelled or glazed	Fan light/clear storey window shutter s	Designation no. of wood screw	Length in mm of wood screws IS 6760	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
1	Butt Hinges 100 mm	6	3	3	3	-	-	-	9	40	
2	Butt Hinges 75 mm	-	-	-	-	-	2	2	8	20	
3	Butt Hinges 50 mm	-	-	-	-	1	1	-	6	20	For fixing wooden cleat
4	Piano Hinges	-	-	-	-	-	-	-	6	20	
5	Tower Bolt 250 mm	3	2	3	2	-	1	-	10	30	
6	Tower Bolt 150 mm	-	-	-	-	-	1	-	8	30	
7	Tower Bolt 100 mm	-	-	-	-	-	-	-	6	30	
8	Sliding door Bolt 300 mm	1	-	-	-	-	-	-	9	35	
9	Sliding door Bolt 250 mm	-	1	-	-	-	-	-	9	35	
10	Floor door stopper	2	1	1	-	1	-	-	9	30	
11	Door handle with plate 100 mm	2	2	2	1	-	-	-	6	25	
12	Window handle with plate 75 mm	-	-	-	-	-	1	-	6	20	
13	Casement stay 300 mm	-	-	-	-	-	1	-	6	30	
14	Helical door spring (Superior quality)	-	-	-	1	-	-	-	6	30	
15	Cupboard /Wardrobe Lock	-	-	-	1	1	-	-	6	20	





16	Fanlight Catch	-	-	-	-	-	-	1	8	30	
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## Notes:

### A: Door Shutters

1. Door of room adjoining the verandah, corridor, lobby or hall, shall be considered as external door.
2. Where the height of the door leaf exceeds 2.15 metres above the floor level, one extra hinge shall be provided for every additional height of 0.50 metre, or part thereof and the length of top bolts shall be increased by the height of the leaf above 2.15 metres from floor level.
3. Single leaf door shutters of more than 0.80 m in width shall be provided with one extra hinge.
4. Fan light shutters of more than 0.80 metre width shall be provided with one extra hinge and extra quadrant stay.
5. In double leaf shutters of doors, two door bolts shall be fixed to the first shutter and one to the closing shutter at the top.
6. In case of single leaf inter communicating, panelled, glazed or panelled door shutter for bath and w.c. one tower bolts will be replaced by a bathroom latch.
7. For shutter exceeding 40 mm thickness, heavy type M.S. butt hinges of 125 x 90 x 4 mm shall be used.
8. In case of external door shutters, instead of sliding door ball mortice lock can be provided where specified.
9. Cupboard and wardrobe shutters will have ball catches where specified.
10. Finger plates shall be provided in case of bath and wc shutters in office buildings.

### B: Window Shutters

1. In case of windows with double shutters, two tower bolts shall be fixed to the closing shutters and one tower bolt to the first shutter at the top.
2. In case of window shutters, hooks and eyes may be provided in lieu of casement stays where specified.
3. Where the height of window shutter exceeds 1.20 metres one extra hinge shall be provided and length of top bolts shall be increased by height of the leaf above 2.15 metres from the floor level.
4. Window shutter with steel frames shall be provided with six hinges in case of double leaf shutters and three hinges in case of single leaf shutters, irrespective of height and width of shutters.

### C: Fanlight and Clerestory Window or Ventilator

5. Centrally hung and bottom hung CS windows and fan lights, will be provided with chain and hook bamboo pole with hook for opening ventilators shall be provided for each residence or for set of 4 rooms in case of office building.
6. Centrally hung clerestory windows or fan lights will have fan light pivots in lieu of hinges.



## APPENDIX I

### METHOD OF TEST FOR EDGE STRAIGHTNESS AND SQUARENESS OF PLYWOOD (Clause No. 9.2.8.3)

#### PROCEDURE FOR EDGE STRAIGHTNESS

The straightness of the edge and ends of plywood shall be verified against a straight edge not less than the full length of the plywood. If the edge on the end of the plywood is convex, it shall be held against the straight edge in such a way as to give approximately equal gap at each end. The largest gap between the straight edge and the edge shall be measured to the nearest millimeter and recorded.

#### PROCEDURE FOR SQUARENESS

The squareness of plywood shall be checked with a 1200 mm x 1200 mm square by applying one arm of the square to the plywood. The maximum width of the gap shall be recorded.

## JOINTS IN TIMBER

Sub Head: Wood Work and PVC Work  
Clause: 9.0

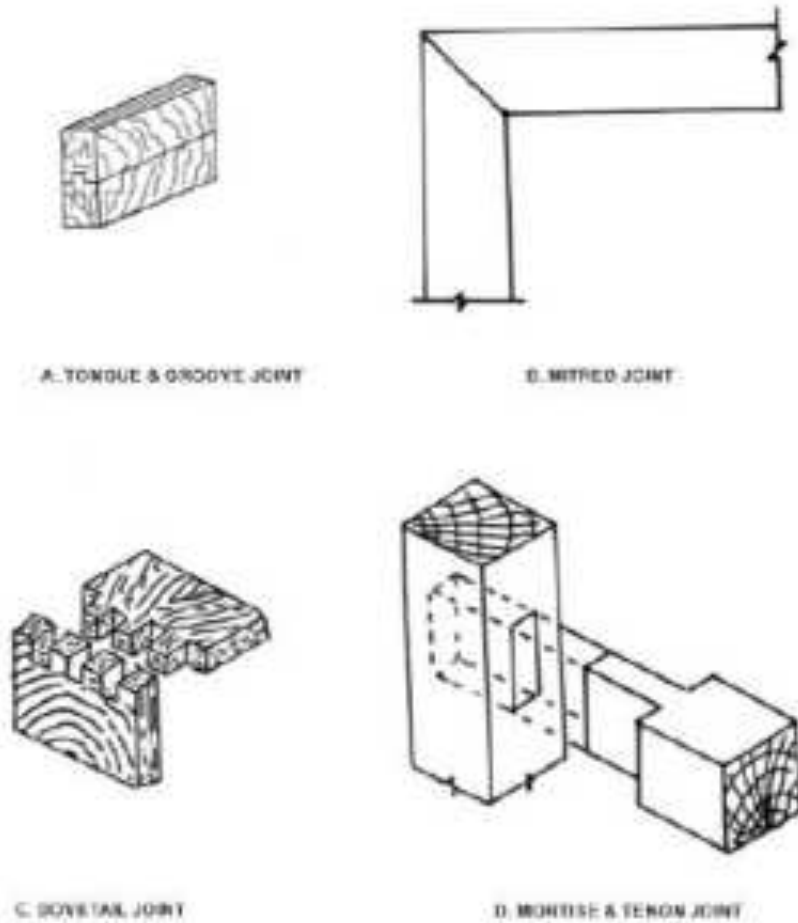


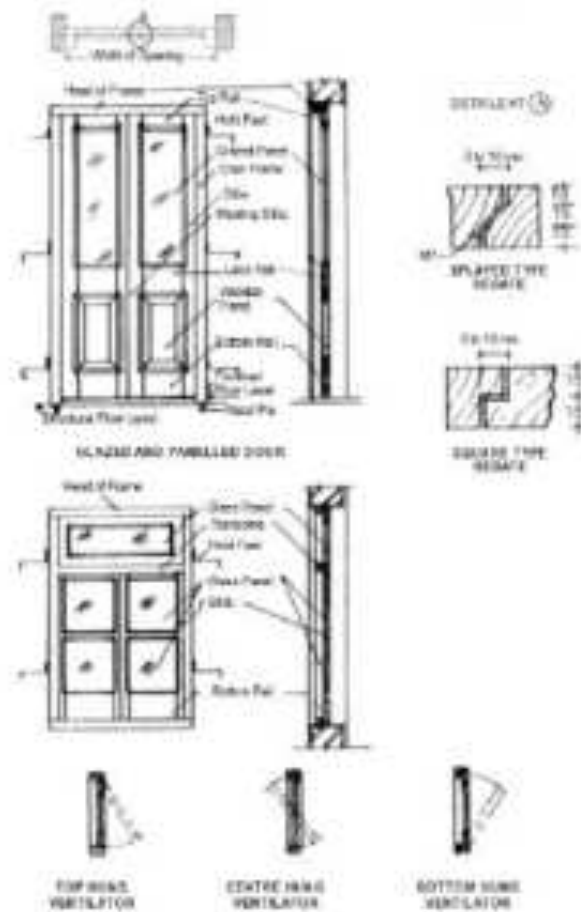
Figure 9.1 : Joints in Timber

Drawing not to Scale

## TERMINOLOGY TIMBER DOOR, WINDOW & VENTILATOR COMPONENTS

Sub Head: Wood Work and PVC Work

Clause: 9.6



## WINDOWS AND VENTILATORS

Figure 9.2 : Terminology Timber Door, Window & Ventilator Components

Drawing not to Scale  
All dimensions are in mm

## WOODEN FLUSH DOORS SHUTTERS

Sub Head: Wood Work and PVC Work  
Clause: 9.7

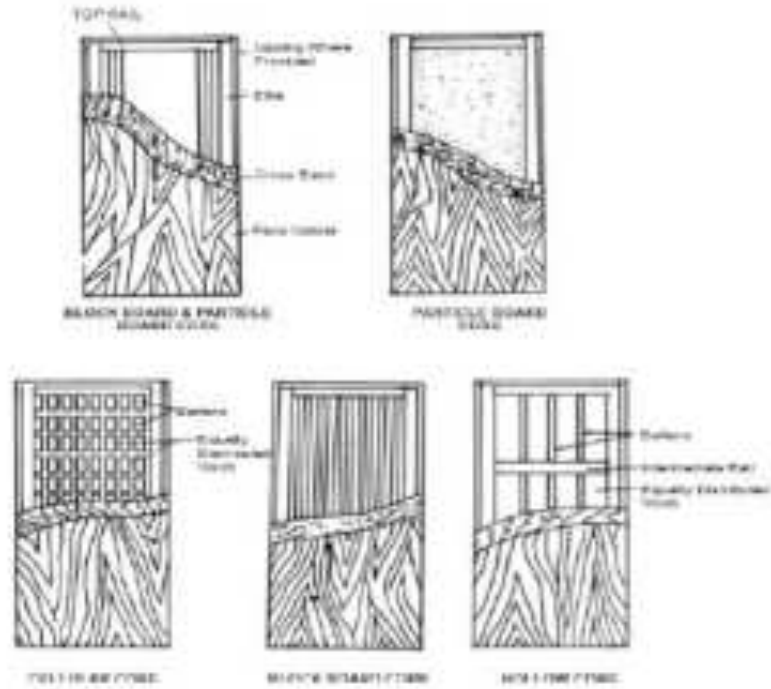


Figure 9.3 : Wooden Flush Doors Shutters

Drawing not to Scale

## HOLD FAST

Sub Head: Wood Work and PVC Work

Clause: 9.13

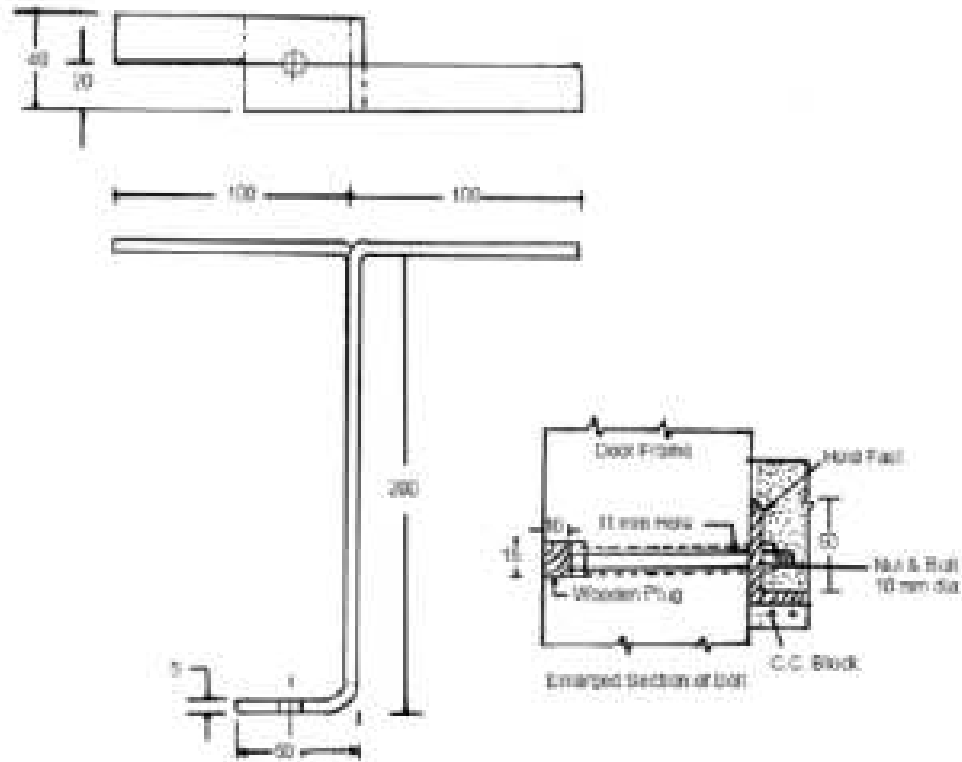


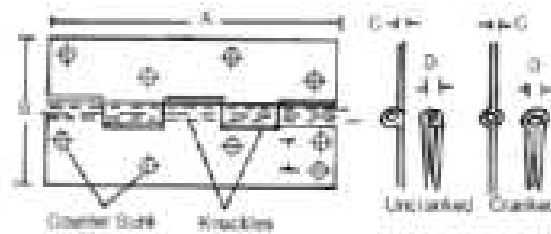
Figure 9.4 : Hold Fast

Drawing not to Scale  
All dimensions are in mm

## HINGES

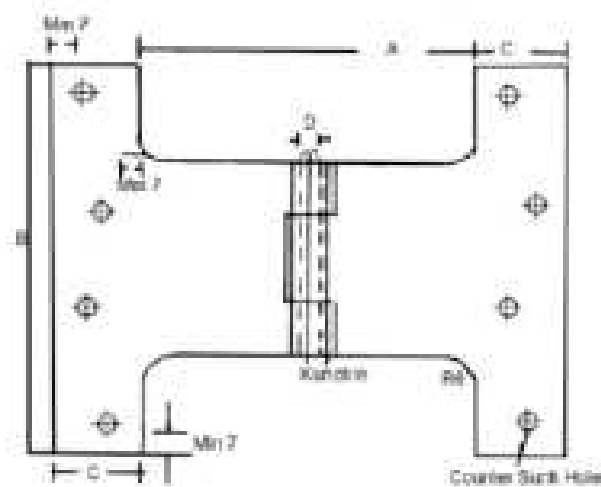
Sub Head: Wood Work and PVC Work

Clause: 9.15.1 to 9.15.2



### A. DIMENSION OF MEDIUM WT. MILD STEEL BUTT HINGES

Size of Hinge	Length (A)	Breadth (B)	Thickness of Flap (C)	Dia of Hinge Pin (D)	No. of Knuckles	No of Screw Holes.	Holes Screw No. for
1	2	3	4	5	6	7	8
50	$50 \pm 0.5$	$37 \pm 1$	$1.50 \pm 0.06$	$3.15 \pm 0.08$	3	4	6
75	$75 \pm 0.5$	$47 \pm 1$	$1.70 \pm 0.06$	$4.00 \pm 0.08$	5	6	8
100	$100 \pm 0.5$	$58 \pm 1$	$1.90 \pm 0.06$	$5.60 \pm 0.08$	5	8	10



### B. PARLIAMENT HINGES

Figure 9.5 : Hinges

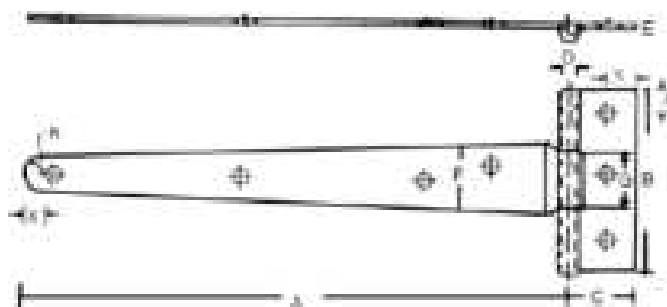
Drawing not to Scale  
All dimensions are in mm



## HINGES

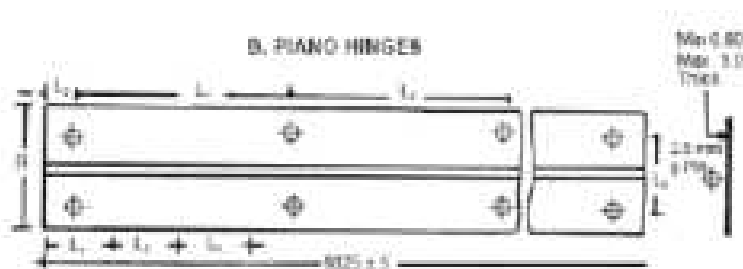
Sub Head: Wood Work and PVC Work  
Clause: 9.15.5, 9.15.6

### A. TEE HINGES



#### DIMENSIONS

Size	A	B	C	D	E	F	G	R	Screw Designation No.	No. of Holes in Strap	No. of Holes in Tee
250	250 $\pm 3$	100 $\pm 2$	30 $\pm 15$	5.6 $\pm 0.10$	2.24 $\pm 0.10$	45 $\pm 2$	40 $\pm 1$	8 $\pm 1$	9	5	3
300	300 $\pm 3$	115 $\pm 2$	30 $\pm 1.5$	6.30 $\pm 0.10$	2.26 $\pm 0.10$	50 $\pm 2$	50 $\pm 1$	8 $\pm 1$	9	5	3



#### DIMENSIONS

Nominal Size	B	L1	L2	L3
40	40 $\pm 1$	25 $\pm 2$	25 $\pm 1$	20 $\pm 1$
30	30 $\pm 1$	75 $\pm 2$	25 $\pm 1$	15 $\pm 1$

Figure 9.6 : Hinges

Drawing not to Scale  
All dimensions are in mm



## SLIDING DOOR BOLTS

Sub Head: Wood Work and PVC Work  
Clause: 9.15.7

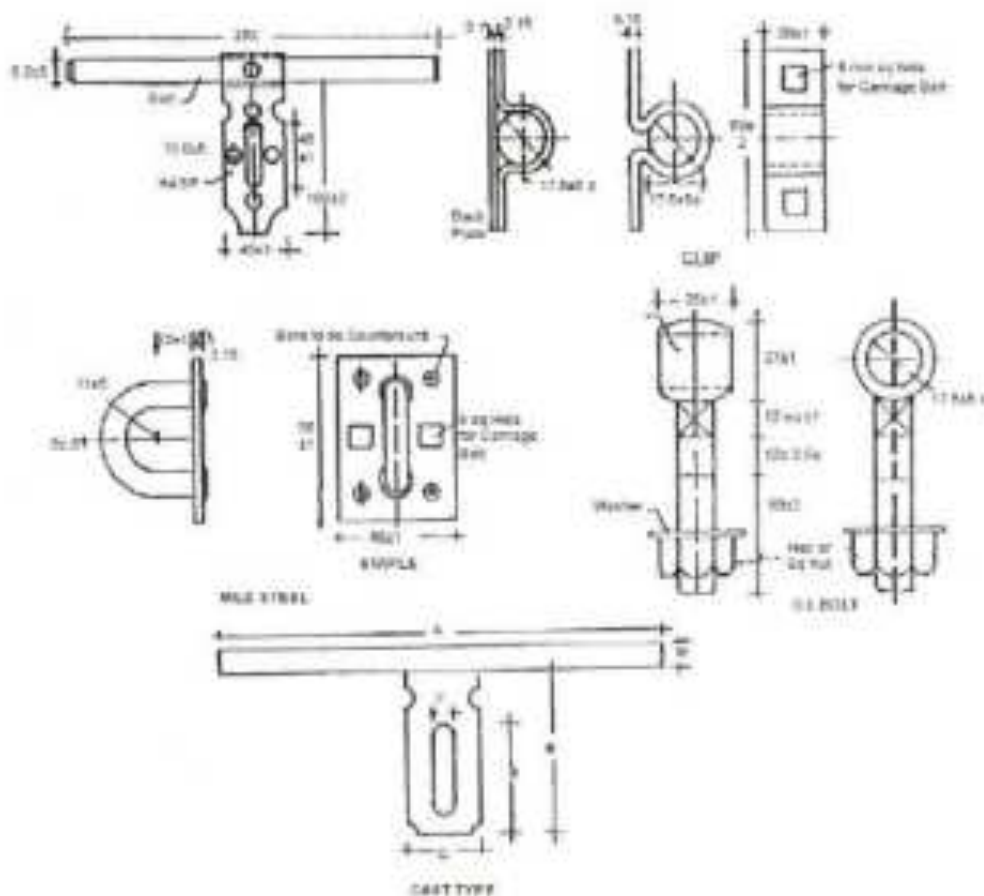


Figure 9.7 : Sliding Door Bolts

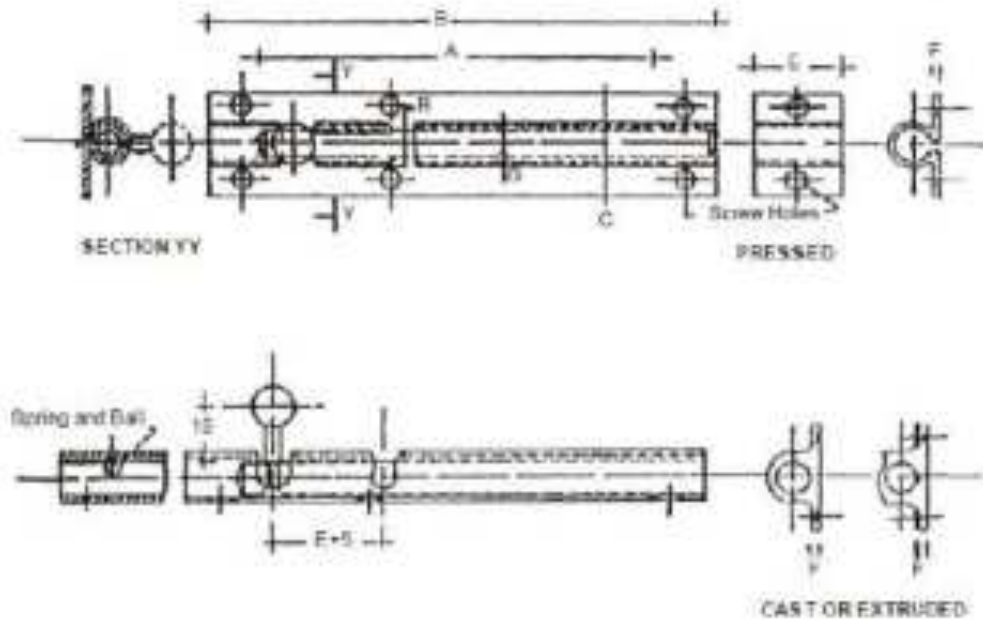
### DIMENSIONS

Size	A	B	C	E	F	M	Screw Designation No.
250	250 ± 2	100 ± 2	45 ± 1	55 ± 1	15 ± 1	16.0 ± 0.5	9
300	300 ± 2	100 ± 2	45 ± 1	55 ± 1	15 ± 1	16.0 ± 0.5	9

Drawing not to Scale  
All dimensions are in mm

## BARREL TOWER BOLTS

Sub Head: Wood Work and PVC Work  
Clause: 9.15.8



### DIMENSIONS

Size	A	B	Width of Barrel		D	E	Thickness of Metal of Barrel Sheet				G	Screw Designation No.	
			C	When D=10.0			When D=12.00	Brass or Zinc Alloy	Aluminum Alloy				Sheet Mild Steel or Brass
									When D=10.0	When D=12.0			
150	150+3 -1	170+3 -1	32+3 -1	38+3 -1	10 or 12 ± 0.5	25±1	2.0 +0.5 -0.2	1.80 ±0.33	2.40 ±0.36	1.25 mm ±0.15	1 to 1.5 more than dia of bolt	8	
200	200+3 -1	220+3 -1	32+3 -1	38+3 -1	10 or 12 ± 0.5	25±1	2.0 +0.5 -0.2	1.80 ±0.33	2.40 ±0.36	1 to 1.25 ±0.15		8	
250	250+3 -1	270+3 -1	32+3 -1	38+3 -1	10 or 12 ± 0.5	25±1	2.0 +0.5 -0.2	1.80 ±0.33	2.40 ±0.36	1 to 1.25 ±0.15		10	

Figure 9.8 : Barrel Tower Bolts

Drawing not to Scale  
All dimensions are in mm

## PULL BOLT LOCKS

Sub Head: Wood Work and PVC Work

Clause: 9.15.10

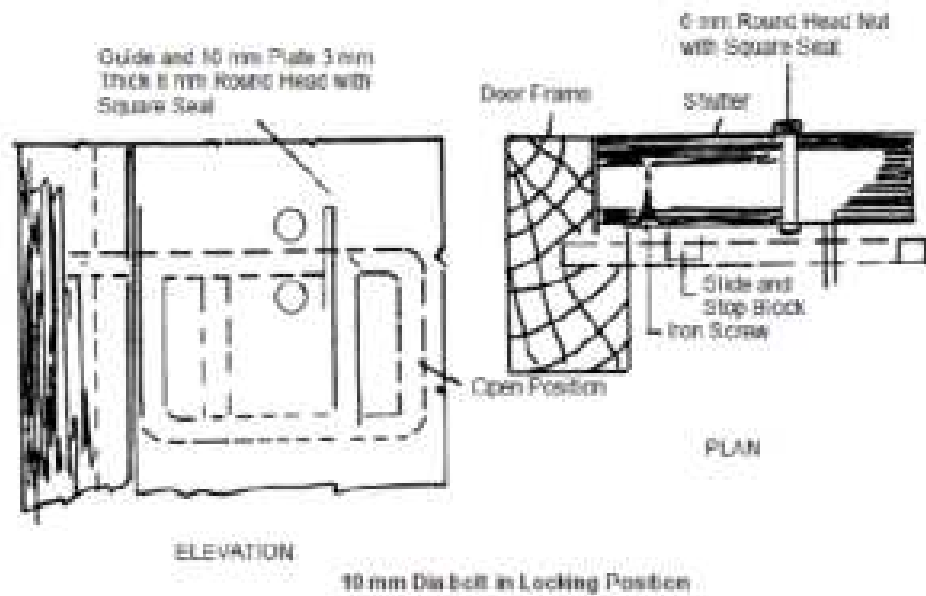


Figure 9.9 : Pull Bolt Locks

Drawing not to Scale

## MORTICE LOCK & LATCH

Sub Head: Wood Work and PVC Work  
Clause: 9.15.13 - Locking Bolt Guide Pin

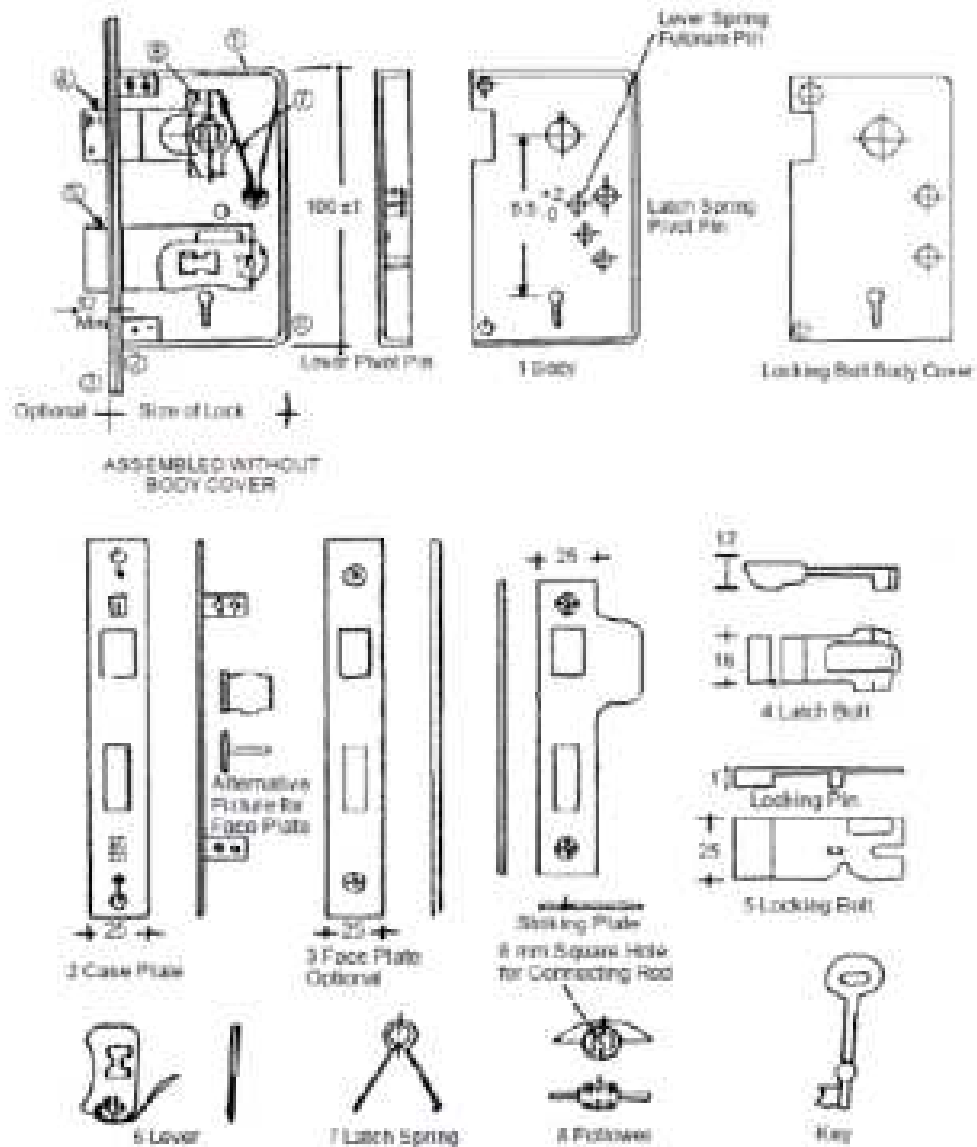


Figure 9.10 : Mortice Lock & Latch

Drawing not to Scale  
All dimensions are in mm



## HANDLES FOR DOORS AND WINDOWS

Sub Head: Wood Work and PVC Work  
Clause: 9.15.19

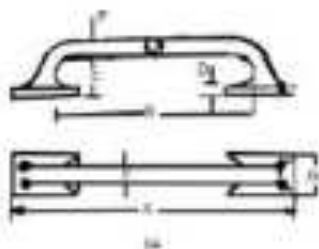


Fig. 9.12.1 : Typical Door Handle (Type 1)

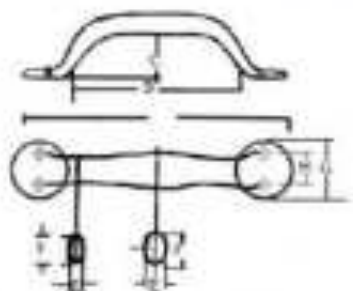


Fig. 9.12.2 : Typical Door Handle (Type 2)

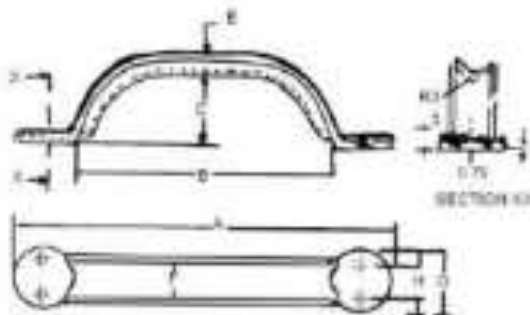
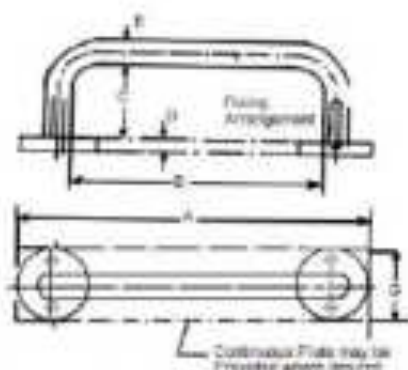


Fig. 9.12.3 : Typical Door Handle (Type 3)



Note: (MS > 20 mm G.I. Coarse thread machine screws or any other suitable fixing arrangement may be used)

Fig. 9.12.4 : Typical Door Handle (Type 4)

Figure 9.12 : Handles for Door and Windows

Drawing not to Scale  
All dimensions are in mm



**TABLE 2 A DIMENSIONS OF DOOR HANDLES**

(Fig. 9.12.1 to 9.12.3)

All dimensions in millimetres

Type of Head	Ref to. Fig.	Sizes	A	B	C	D	E	F	G	H	I	Screw Holes*	
			Min	Min	Min	Min	Min	Min	Min	Min	Min	No. in Each Lug	Size Designation Counter-sunk Head Wood Screw (see IS 6760-1972#)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1.	9.12.1 A	75	125	75	20	2.5	5	8	15	-	-	2	6
		100	150	100	25	3.0	8	10	20	-	-	2	6
		125	190	125	25	4.0	10	12	22	-	-	2	6
		150	215	150	30	1.5	12	15	25	-	-	2	8
	9.12.1 B	75	85	75	20	2.5	5	8	15	-	-	2	6
		100	110	100	25	3.0	5	10	20	-	-	2	6
		125	140	125	25	3.0	7.5	12	22	-	-	2	6
		150	165	150	30	4.0	7.5	15	25	-	-	2	8
2.	9.12.2	75	125	75	20	-	10	16	32	20	1.0	2	6
		100	150	100	25	-	11	19	38	20	1.0	2	6
		115	175	115	28	-	13	22	45	25	1.0	3	8
		135	200	135	30	-	14	25	50	32	1.25	3	8
3	9.12.3	75	100	75	20	-	5	14	16	8	1.25	1	6
		90	125	90	25	-	6	16	20	10	1.25	2	6
		100	150	100	28	-	7	18	25	12	1.60	2	6

**TABLE 2B DIMENSIONS OF DOOR HANDLES**

All dimensions in millimetres.

Type	Ref to Fig	Sizes	A	B	C	D	E	G	Screw Holes		
			Min.		Min.			Dia.	No. in each lug	No. in a plate when a continuous plate is used	Size designation of counter-sunk head wood screws (see IS:6760-1972)
1	2	3	4	5	6	7	8	9	10	11	12
4	9.12.4	75	115	75	25	5+-0.5	10+-0.5	30+-0.5	2	4	6
		100	140	100	30	5+-0.5	10+-0.5	30+-0.5	2	4	6

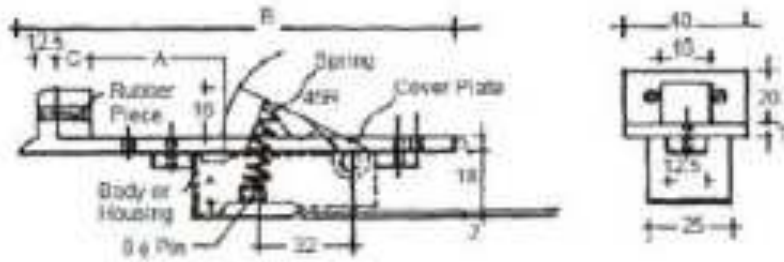


		125	175	125	35	5+- 0.5	10+- 0.5	38+- 0.5	3	6	6
		150	200	150	35	5+- 0.5	10+- 0.5	38+- 0.5	3	6	6



## FLOOR DOOR STOPPER - CAST TYPE

Sub Head: Wood Work and PVC Work  
Clause: 9.15.20



DIMENSION

Thickness of Door Shutter	A	B	C	Casting $T_1$	Screw Designation No.	No. of Holes for $T_1$
30	$35.0 \pm 0.5$	$140.0 \pm 0.5$	13	$4.5 + 0.3$ $-0$	9	4
35	$40.0 \pm 0.5$	$140.0 \pm 0.5$	8	$4.5 + 0.3$ $-0$	9	4
40	$45.0 \pm 0.5$	$150.0 \pm 0.5$	13	$4.5 + 0.3$ $-0$	9	4
45	$50.0 \pm 0.5$	$150.0 \pm 0.5$	8	$4.5 + 0.3$ $-0$	9	4

Figure 9.13 : Floor Door Stopper – Cast Type

Drawing not to Scale

All dimensions are in mm

Fig. 9.13: Floor Door Stopper – Cast Type

## WINDOW STAY

Sub Head : Wood Work and PVC Work  
Clause : 9.15.23

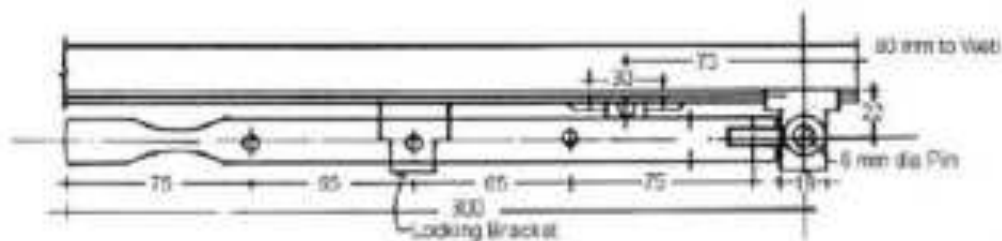


Figure 9.14 : Window Stay

Drawing not to Scale

All dimensions are in mm



## PARTITIONS

Sub Head: Wood Work and PVC Work  
Clause: 9.17.2

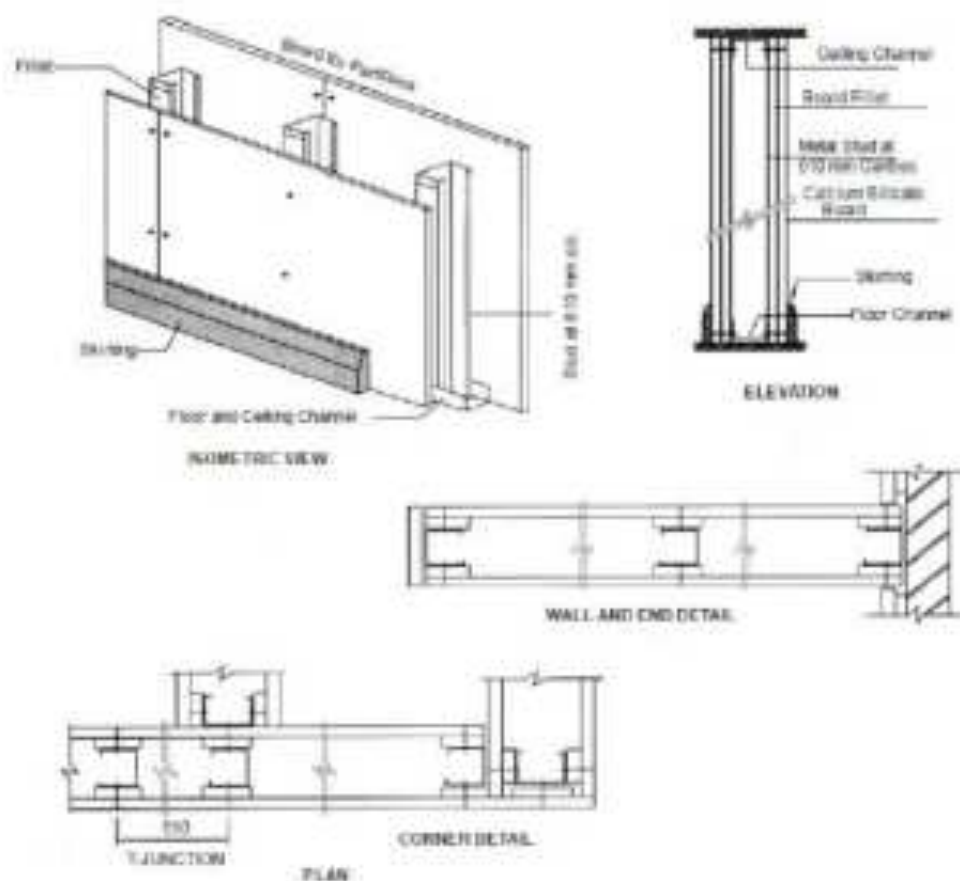


Figure 9.17 : Partitions

DETAILS		
Board	8 / 10 / 12 mm Thick	One layer board on each side of studs
Board Fillets	60 / 100 mm	On each side of all studs and channels
Floor/Ceiling Channel	50 x 32 x 32 x 0.55 mm	Top and bottom perimeter of the partition
Stud	48 x 50 x 48 x 0.55 mm	Vertically at 610 mm c/c
Bracing Member	45 x 15 x 15 x 0.9 mm	At horizontal board joint on both side
Screws (C/S head)	25 & 35 mm long, self drilling with under head cutter	12 mm from the edge & 40 mm from the corner of the board at 200 mm c/c

## FRP CHAJJA

Sub Head : Wood Work and PVC Work  
Clause : 9.26

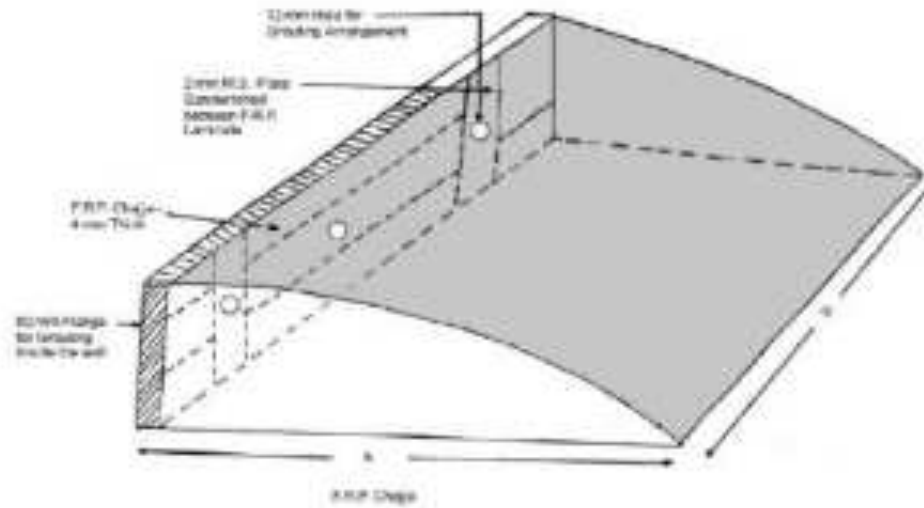


Figure 9.27 : FRP Chajja

## WALL PANELLING

Sub Head : Wood Work and PVC Work  
Clause : 9.27

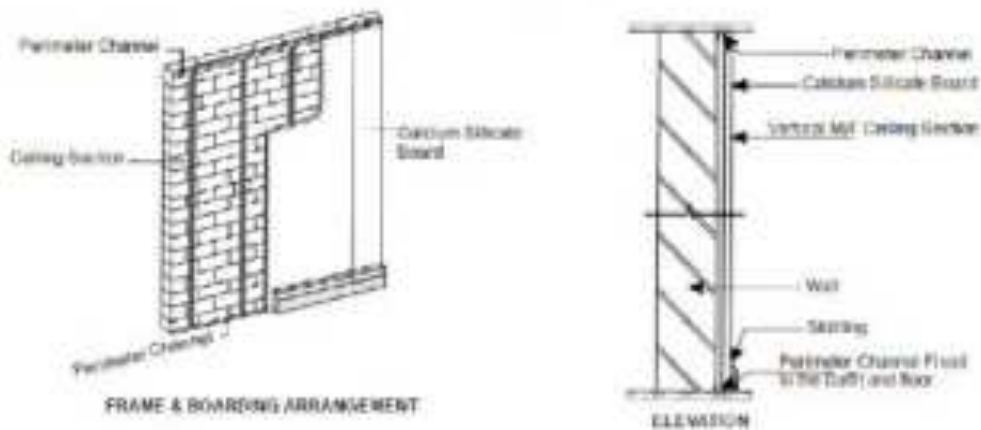


Figure 9.28 : Wall Paneling

## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work

Clause : 9.28

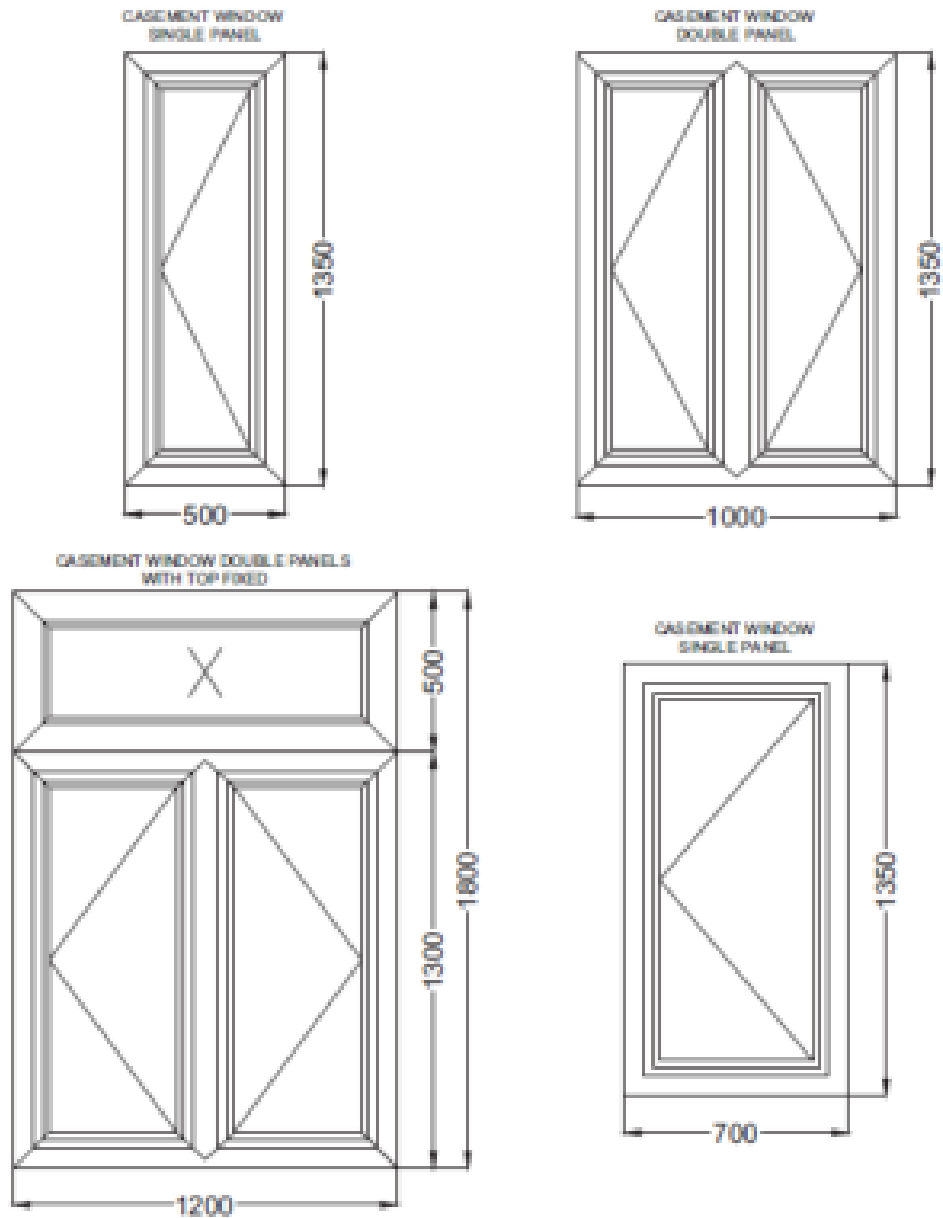


Figure 9.29 : uPVC Doors & Windows

## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work  
Clause : 9.28

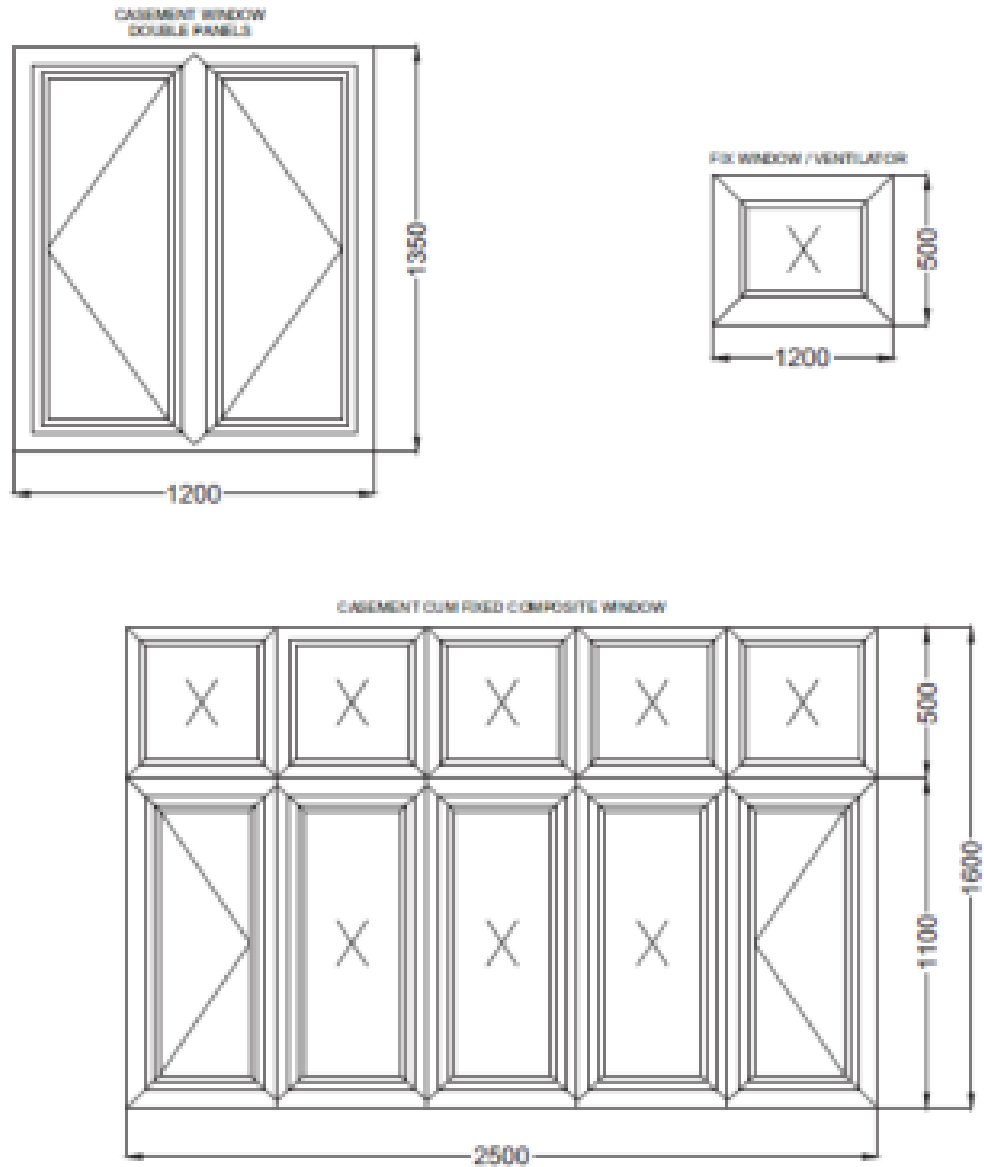


Figure 9.30 : uPVC Doors & Windows

## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work

Clause : 9.28

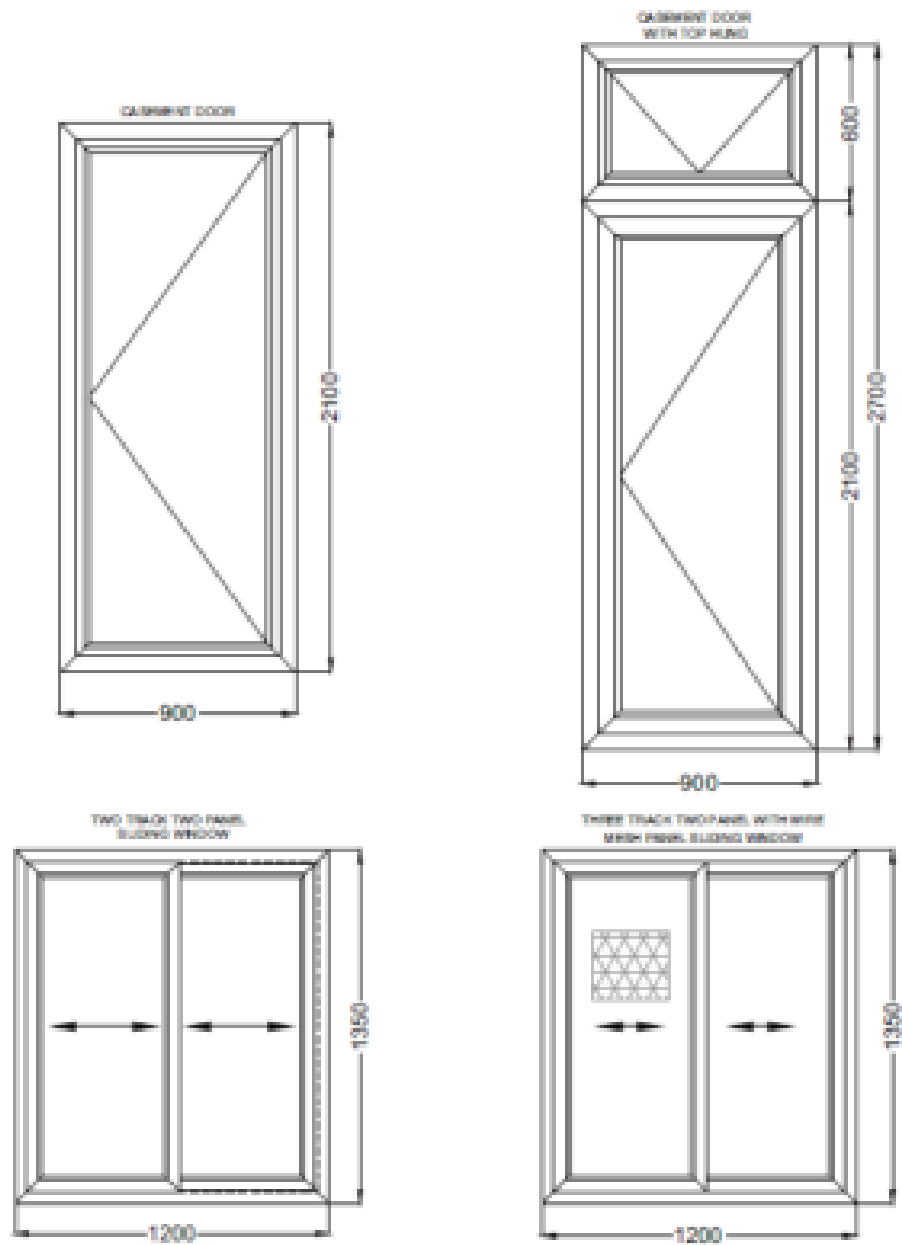


Figure 9.31 : uPVC Doors & Windows

## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work

Clause : 9.28

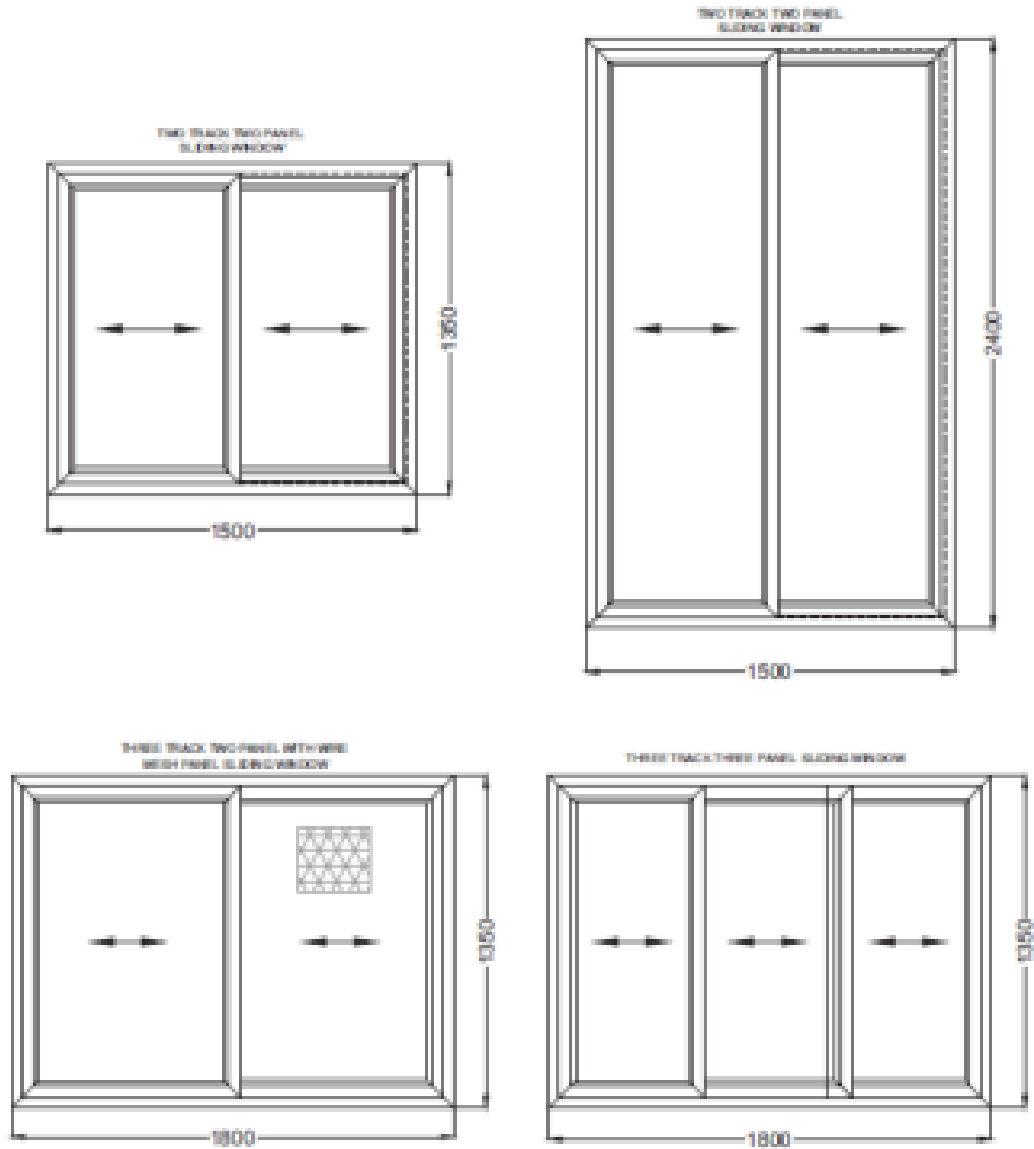


Figure 9.32 : uPVC Doors & Windows



## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work

Clause : 9.28

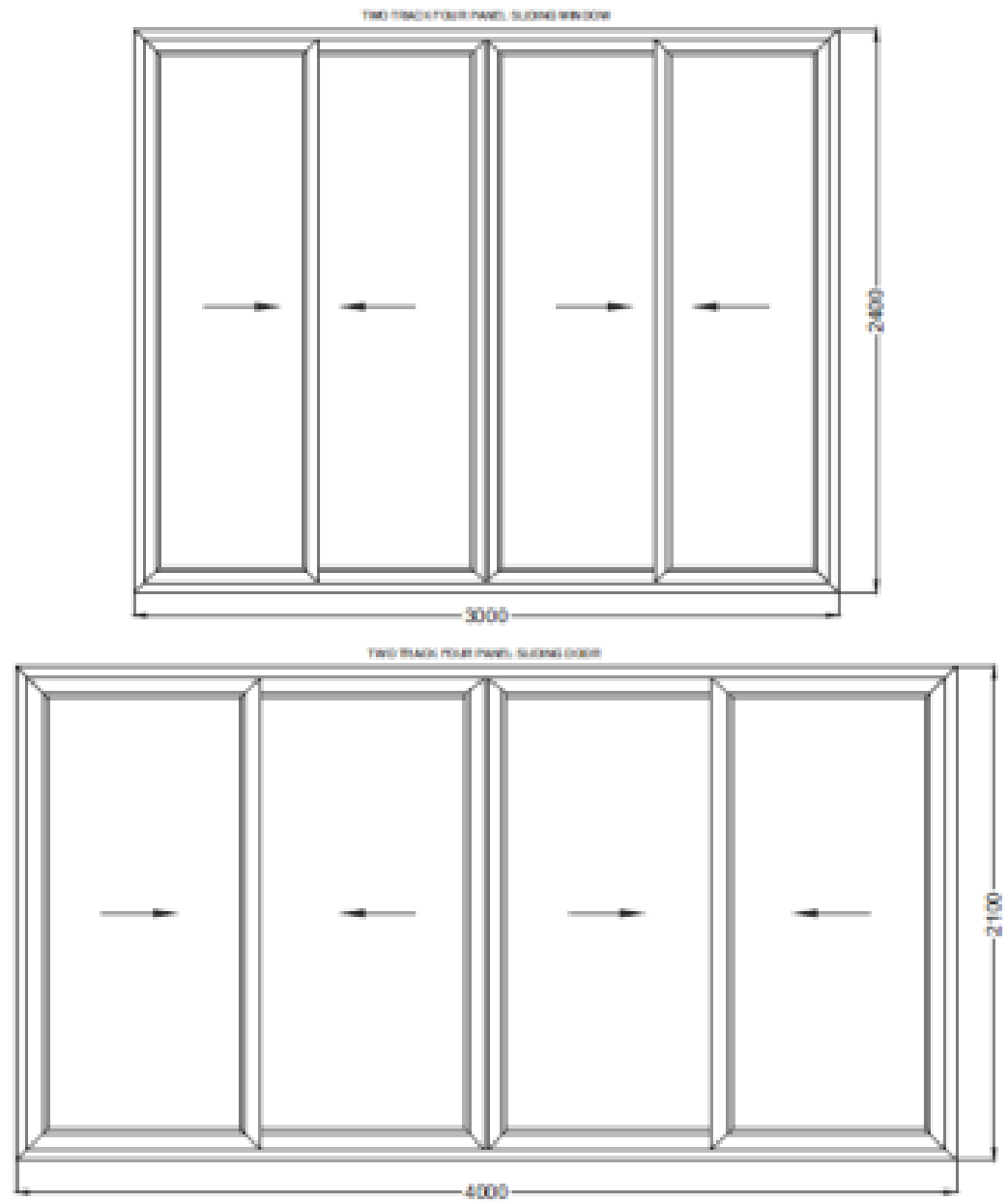


Figure 9.33 : uPVC Doors & Windows

## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work  
Clause : 9.28

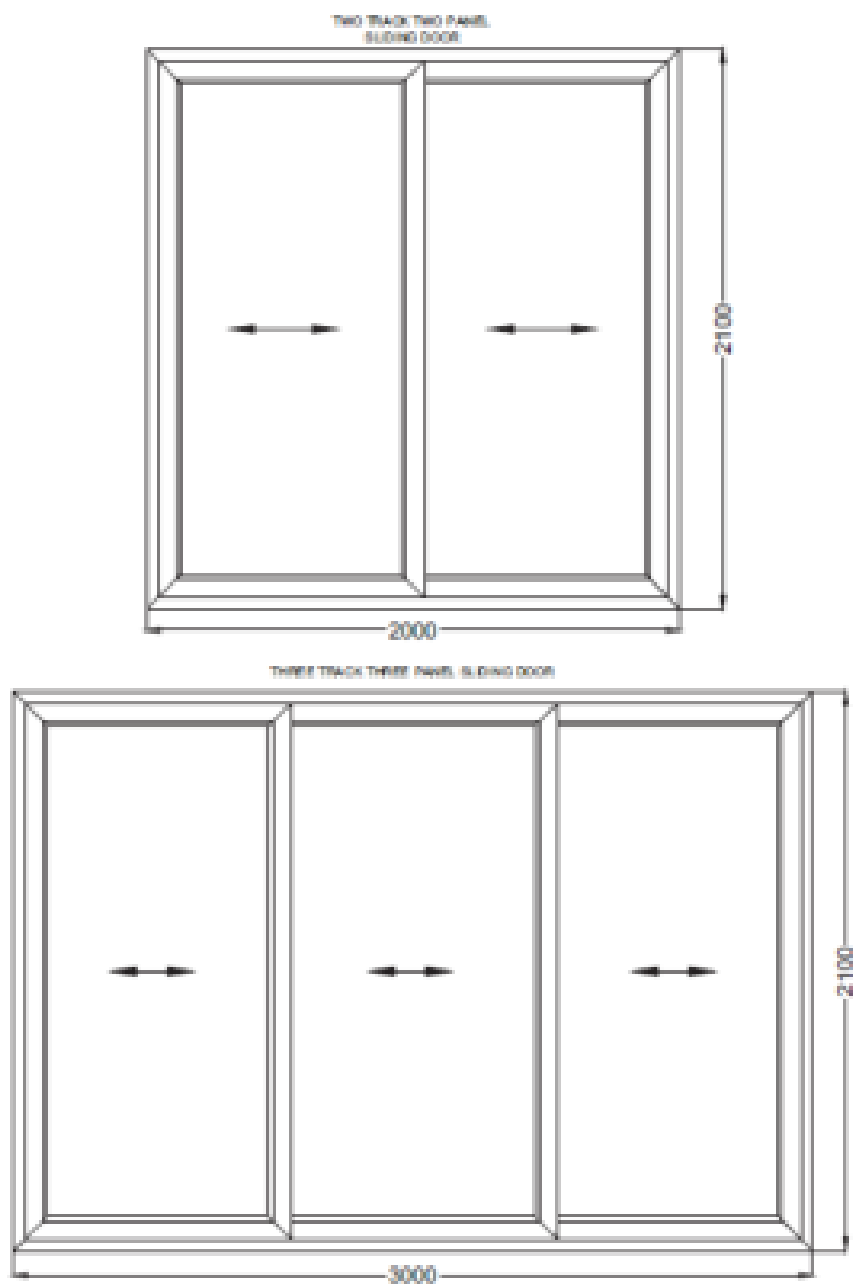


Figure 9.34 : uPVC Doors & Windows



## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work  
Clause : 9.28

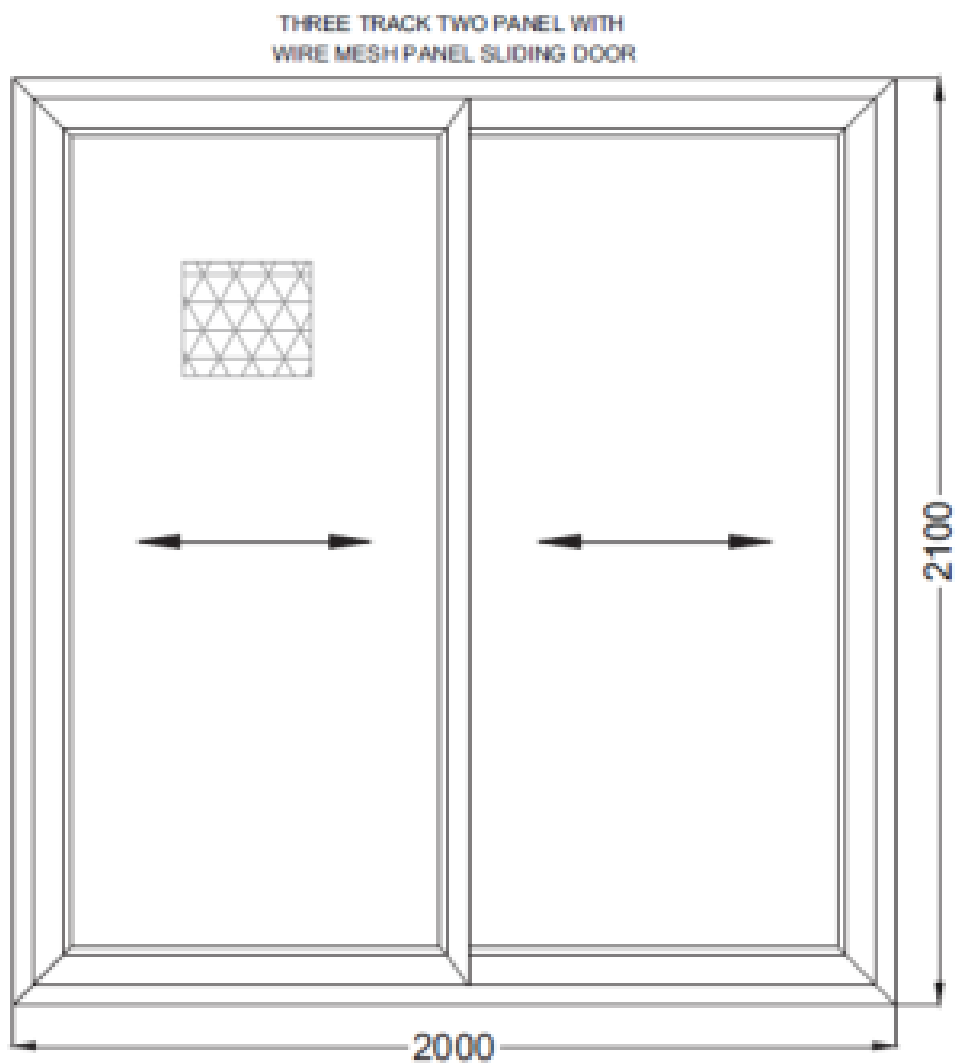


Figure 9.35 : uPVC Doors & Windows

## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work

Clause : 9.28

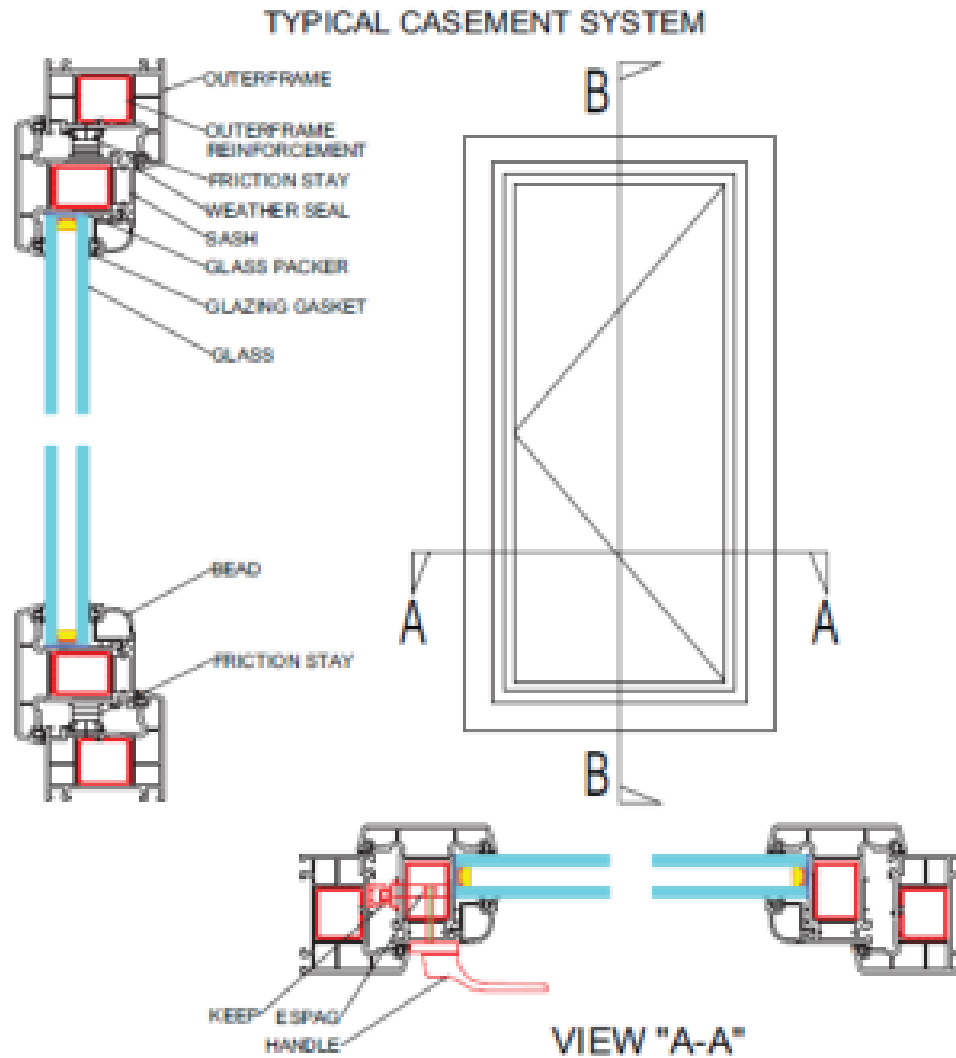


Figure 9.36 : uPVC Doors & Windows (Typical Casement System)



## uPVC DOOR AND WINDOWS

Sub Head : Wood Work & PVC Work

Clause : 9.28

### TYPICAL SLIDER SYSTEM

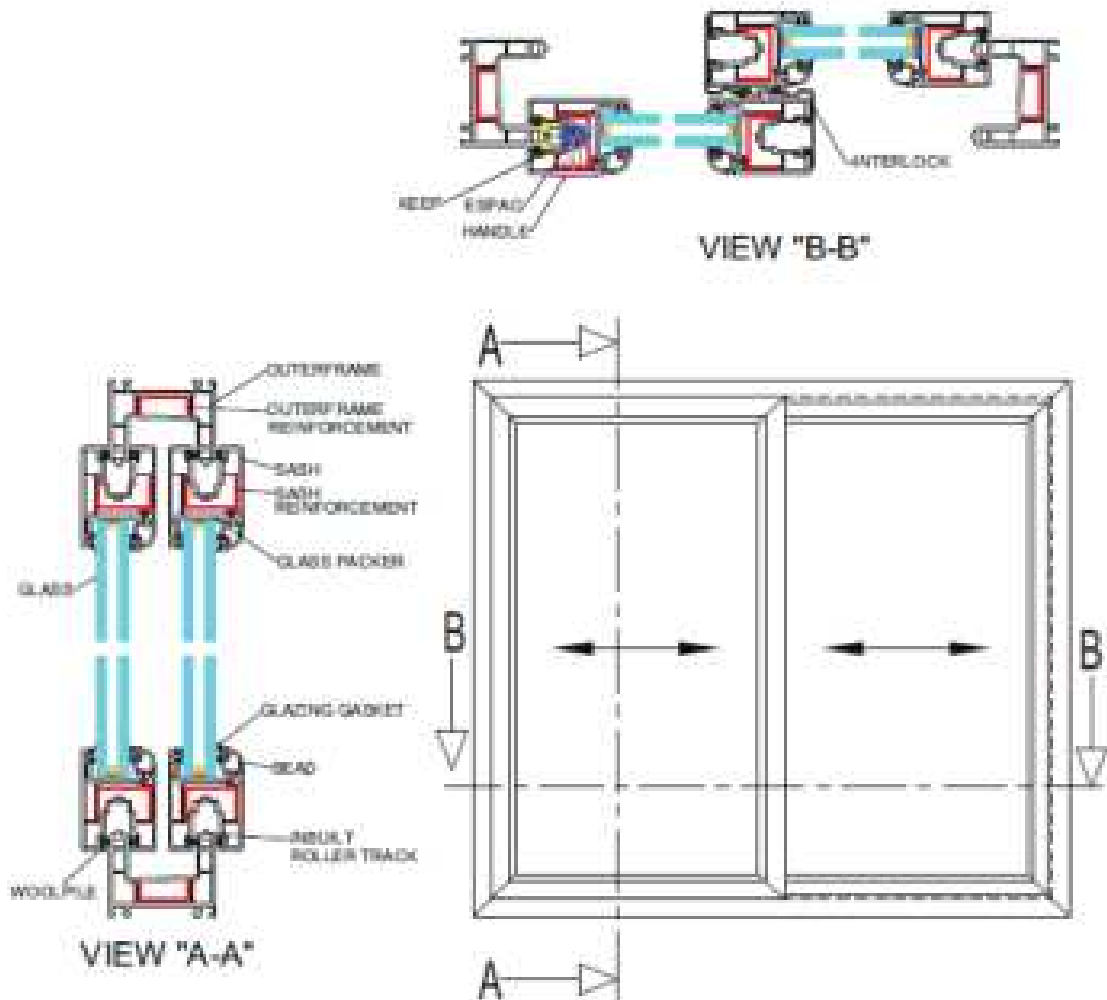


Figure 9.38 : uPVC Doors & Windows (Typical Slider System)

## FIRE RATED DOOR/WINDOW/PARTITION

Sub Head: Wood work and PVC Work

Clause: 9.29

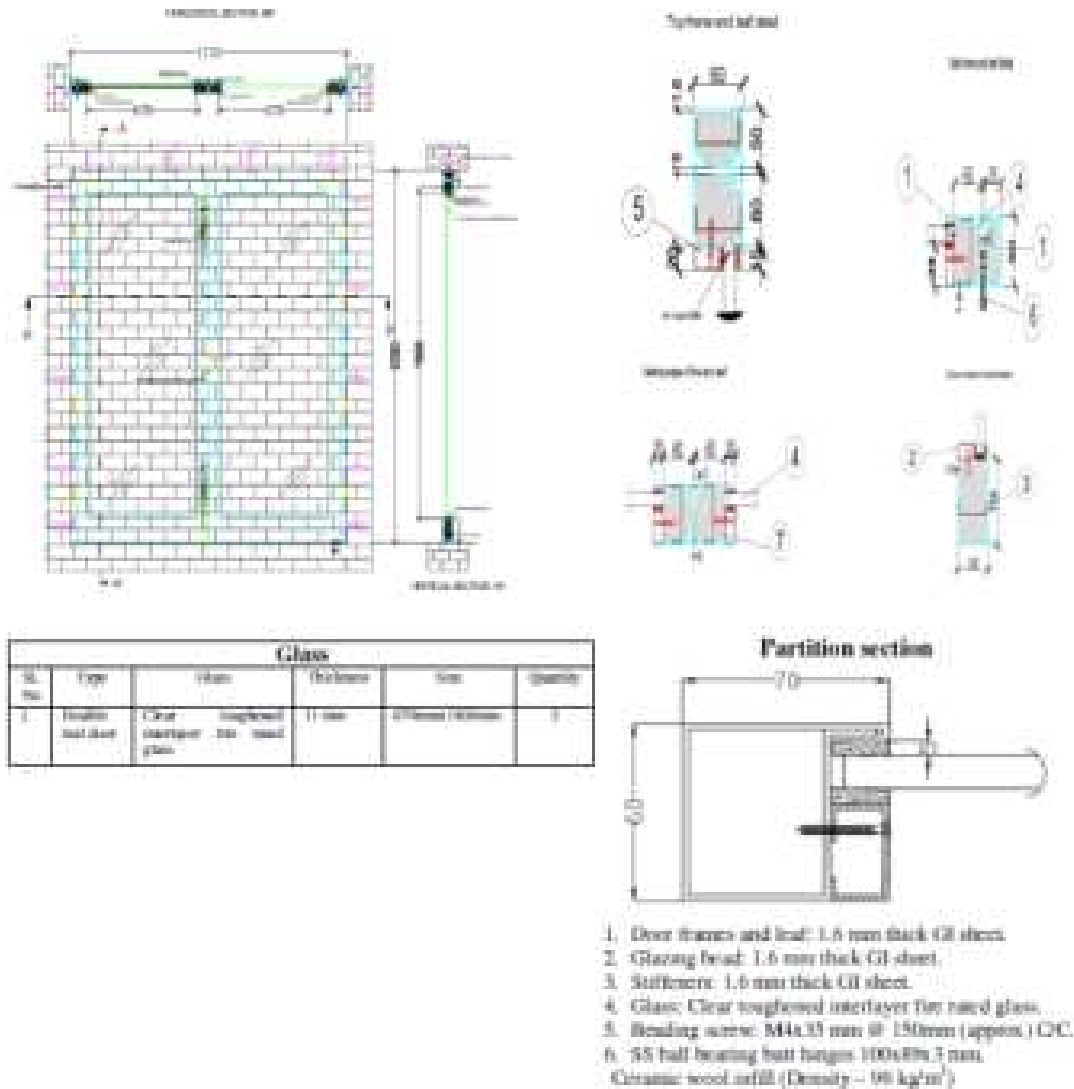


Figure 9.39 : Details of Fire Rated Door/ Window/Partition





# STEEL WORK



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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
1	2	3	4	5	6	7
Steel of arranged by the contractor	10.11	(a) tensile Strength (b) Bend test	Lab	IS:1608 IS:1599	Every 40 MT or part thereof. (Min. Quality :20 MT)	Every 20 tonne or part thereof (Min. Quality: 20 MT)
Steel tubular pipes	10.13	1 Dimensions and surface quality 2 Physical properties 3 Chemical properties	Lab	IS: 1608  IS:2329  IS:2328	Every 15 MT or part thereof.  (Min. Quality :8 MT)	Every 8 tonne or part thereof  (Min. Quality: 8 MT)



## LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	Code No.	Subject
1	IS 63	Whiting for paints and putty
2	IS 198	Varnish gold size
3	IS 228	Structural steel (Standard quality)
4	IS 277	Specification for galvanized steel sheets (Plain and corrugated)
5	IS 419	Putty for use on window frames
6	IS 800	Code of practice for use of structural steel in general in steel construction
7	IS 806	Code of practice for use of steel Tubes in general building construction
8	IS 808	Dimensions for Hot rolled steel beams, columns, channel and angle sections
9	IS 812	Glossary of terms relating to welding and cutting metals
10	IS 813	Scheme of symbols for welding
11	IS 814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
12	IS 816	Code of practice for use of metal arc welding for general construction in mild steel
13	IS 817	Code of practice for training and testing of metal arc welders
14	IS 818	Code of practice for safety and healthy requirements in electric and gas welding and cutting operations
15	IS 822	Code of procedure for inspection of welds
16	IS 823	Manual for metal arc welding in mild steel
17	IS 1038	Steel doors, windows and ventilators
18	IS 1081	Code of practice for fixing and glazing of metal (Steel and aluminium) doors, windows and ventilators
19	IS 1148	Hot rolled steel rivet bars (upto 40 mm diameters) for structural purposes
20	IS 1161	Steel tubes for structural purposes
21	IS 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
22	IS 1200- (Pt. VIII)	Method of measurements of steel work and iron works
23	IS 1363 Part I	Hexagon head bolts, screws, and nuts of product grade C (Hexagon Head bolt)
24	IS 1363 Part II	Hexagon Head Bolts, screws and nuts of product Grade 'C'
25	IS 1363 Part-III	Hexagon Head Bolts, screws and Nuts of product grade 'C'
26	IS 1367	Technical supply conditions for threaded steel fasteners
27	IS 1568	Wire cloth for general purposes
28	IS 1599	Method for bend test
29	IS 1608	Metallic materials - Tensile Testing at Ambient Temperature.
30	IS 1730	Dimensions for stainless steel plates, sheets strips and flats for general engineering purposes
31	IS 1821	Dimensions for clearance holes for bolts and screws
32	IS 1852	Rolling and cutting tolerance for hot rolled steel products
33	IS 1894	Method for tensile testing of steel tubes
34	IS 1977	Structural steel (ordinary quality)
35	IS 2062	Hot Rolled low, medium and high tensile structural steel
36	IS 2074	Ready mixed paint, air drying red oxide zinc chrome priming
37	IS 4351	Specification for steel door frames
38	IS 4454 (Part I)	Steel wires for mechanical springs. Cold drawn unalloyed steel wire.



Sl. No.	Code No.	Subject
39	IS 4711	Methods for sampling of steel pipes, tube and fittings.
40	IS 4736	Hot - dip zinc coating on mild steel tubes
41	IS 4923	Hollow Steel Sections for Structural Use - Specification
42	IS 6248	Metal rolling shutters and rolling grills
43	IS 6911	Stainless steel plate, sheet and strip
44	IS 7452	Specification for hot rolled steel sections for doors, windows and ventilators.



## 10 STEEL WORK

### 10.0 DEFINITIONS/ TERMINOLOGY

#### **Bead**

A single run of weld metal deposited on surface.

#### **Butt Weld**

A weld in which the weld metal lies substantially within the extension of the planes and the surfaces on the parts joined.

#### **Crater**

A depression left in weld metal where the arc was broken or the flame was removed.

#### **End Crater**

A crater at the end of a weld or at the end of a joint.

#### **Fillet Weld**

A weld of approximately triangular cross-section joining two surfaces approximately at the right angles to each other in a lap joint, tee joint or corner joint. It is of two types:

- (a) Continuous
- (b) Intermittent

#### **Fusion Welding**

Any welding process in which the weld is made between metals in a state of fusion without hammering or pressure.

#### **Non- fusion Welding**

A term applied to the deposition, by the Oxy-Acetylene process of filler metal on parent metal without fusion of the latter.

#### **Oxy-Acetylene Pressure Welding**

Pressure welding in which any Oxy-Acetylene flame is used to make the surface to be united plastic. No filler metal is used.

#### **Run**

The metal deposited during one passage of the electrode or blow pipe in the making of a joint.

#### **Throat thickness**

See Fig. 10.1.

#### **Weld**

A union between two pieces of metal at faces rendered plastic or liquid by heat or pressure, or both, Filler metal may be used to effect the union.

### 10.1 MATERIALS

#### **Micro-Alloying Elements**



Elements such as niobium, boron, vanadium and titanium added singly or in combination to obtain higher strength to weight ratio and better toughness, formability and weldability as compared to unalloyed steel of similar strength level.

### **Weldability**

A metallic substance is considered to be weldable by a given process and for the given purpose, when metallic continuity to a stated degree can be obtained by welding using a suitable procedure, so that the joints comply with the requirements specified in regard to both their local properties and their influence on the construction of which they form a part.

### **Controlled Rolling**

A hot rolling process in which the temperature of the steel and its reduction ratio are controlled, particularly during the final rolling passes, in order to achieve fine grain micro structure and optimum mechanical properties.

### **Normalizing Rolling**

A hot rolling process in which the final rolling passes are carried out at a suitable higher temperature, followed by cooling in natural air to a temperature below the transformation temperature, in order to produce a structure, analogous to that obtained by a separate normalizing treatment of hot rolled product.

## **10.1.1 Steel**

**10.1.1.1 Supply of Material:** General requirements relating to supply of structural steel shall conform to IS 8910.

**10.1.1.2 Grades:** There shall be nine grades of steel as given in Tables 10.1 and 10.2. While placing the order the steel should be designated by 'Designation' (See Table 10.1 and 10.2).

**10.1.1.3 Manufacture:** The processes used in the steel making and further hot rolling into steel plates, strips, sections, flats, bars, etc., are left to the discretion of the manufacturer/supplier. If required, secondary refining may follow steel making, as also normalizing rolling/controlled rolling during manufacturing of sections or as per the agreement between the purchaser and the manufacturer/ supplier.

### **10.1.1.4 Freedom from Defects**

10.1.1.4.1 All finished materials shall be well and cleanly rolled to the dimensions, sections and masses specified. The finished material shall be reasonably free from surface flaws; laminations; rough/ jagged and imperfect edges and all other harmful defects.

10.1.1.4.2 Minor surface defects may be removed by the manufacturer/supplier by grinding provided the thickness is not reduced locally by more than 4 percent below the minimum specified thickness. Reduction in thickness by grinding greater than 4 percent but not exceeding 7 per cent may be made subject to mutual agreement between the purchaser and manufacturer/supplier.

10.1.1.4.3 Subject to agreement with the purchaser, surface defects which cannot be dealt with as in may be repaired by chipping or grinding followed by welding and inspection by a mutually agreed procedure such that:

(a) After complete removal of the defects and before welding, the thickness of the item is not to be reduced by more than 20 percent at any place.

(b) Welding is carried out by procedure approved by competent authority with approved electrodes and the welding is ground smooth to the correct nominal thickness; and





(c) Subsequent to the finish grinding, the item may be required to be normalized or otherwise heat-treated at the purchaser's discretion.

10.1.1.4.4 Welding as mentioned in 10.1.1.4.3 is not permissible for grade designation E 250 material.

**10.1.1.5 Chemical Composition:** Ladle Analysis of the steel, when carried out by the method specified in the relevant part of IS 228 or any other established instrumental / chemical method, shall be as given in Table 10.1. In case of dispute, the procedure given in IS 228 and its relevant parts shall be the referee method and where test methods are not specified shall be as agreed to between the purchaser and the manufacturer/supplier.

#### **10.1.2 Rivets**

Rivets shall be made from rivet bars of mild steel as per IS 1148.

#### **10.1.3 Bolts**

These are of two types namely turned and fitted bolts and black bolts. Turned & fitted bolts are turned to exact diameter in automatic lathe. For these bolts, whether reamed or drilled bolts, the same unit stresses are allowed as for rivets. In case of black bolts which are not finished to exact sizes, a lower working stress other than for turned bolts is adopted. They shall conform to IS 1367 - Technical supply conditions for threaded steel fasteners.

#### **10.1.4 Electrodes**

The electrodes required for metal arc welding shall be covered electrodes and shall conform to IS 814.

### **10.2 STEEL WORK IN SINGLE SECTION FIXED INDEPENDENTLY WITH CONNECTING PLATE**

**10.2.0** The steel work in single section of R.S. joists, flats, Tees Angles fixed independently with or without connecting plate, is described in these clauses.

#### **10.2.1 Fabrication**

The steel sections as specified shall be straightened and cut square to correct lengths and measured with a steel tape. The cut ends exposed to view shall be finished smooth. no two pieces shall be welded or otherwise jointed to make up the required length of member.

All straightening and shaping to form, shall be done by pressure. Bending or cutting shall be carried out in such a manner as not to impair the strength of the metal.

#### **10.2.2 Painting**

All surfaces which are to be painted, oiled or otherwise treated shall be dry and thoroughly cleaned to remove all loose scale and loose rust. Surfaces not in contact but inaccessible after shop assembly, shall receive the full specified protective treatment before assembly. This does not apply to the interior of sealed hollow sections. Part to be encased in concrete shall not be painted or oiled. A priming coat of approved steel primer such as Red Oxide/Zinc Chromate primer conforming to IS 2074 shall be applied before any member of steel structure are placed in position or taken out of workshop.

#### **10.2.3 Erection**

Steel work shall be hoisted and placed in position carefully without any damage to itself and other building work and injury to workmen. Where necessary mechanical appliances such as lifting tackle winch etc. shall be used. The suitability and capacity of all plant and equipment used for erection shall be upto the satisfaction of the Engineer-in-Charge.

#### **10.2.4 Measurements**



The work as fixed in place shall be measured in running metres correct to a millimetre and weights calculated on the basis of standard tables correct to the nearest kilogram. The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in Table 8.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower side than permissible variation shall not be acceptable.

Unless otherwise specified, weight of cleats, brackets, packing pieces, bolts, nuts, washers, distance pieces, separators, diaphragm gussets (taking overall square dimension) fish plates, etc. shall be added to the weight of respective items. In riveted work allowance is to be made for weight of rivetheads. Unless otherwise specified an addition of 2.5% of the weight of structure shall be made for shop and site rivetheads in riveted steel structures.

No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall however be made if its area exceeds 0.02 sqm.

The weight of steel sheets, plates and strips shall be taken from relevant Indian standards based on 7.85 K g/m<sup>2</sup> for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### **10.2.5 Rate**

Rate includes the cost of labour and materials required for all the operations described above.

### **10.3 STEEL WORK IN BUILT UP SECTIONS (RIVETED AND BOLTED)**

The steel work in built up section (riveted and bolted) such as trusses, framed work etc. is specified in this clause.

#### **10.3.1 Laying Out**

A figure of the steel structure to be fabricated shall be drawn on a level platform to full scale. This may be done in full or in parts, as shown on drawings or as directed by the Engineer-in-Charge. Steel tape shall be used for measurements.

#### **10.3.2 Fabrication**

Fabrication shall generally be done as specified in IS 800. In major works or where so specified, shop drawings giving complete information for the fabrication of the component parts of the structure including the location, type, size, length and details of rivets, bolts or welds, shall be prepared in advance of the actual fabrication and approved by the Engineer-in-Charge. The drawings shall indicate the shop and field rivets, bolts and welds. The steel members shall be distinctly marked or stenciled with paint with the identification marks as given in the shop drawings.

Great accuracy shall be observed in the fabrication of various members, so that these can be assembled without being unduly packed, strained or forced into position and when built up, shall be true and free from twist, kinks, buckles or open joints. Wooden or metal sheet templates shall be made to correspond to each member, and position of rivet holes shall be marked accurately on them and holes drilled. The templates shall then be laid on the steel members, and holes for riveting and bolting marked on them. The ends of the steel members shall also be marked for cutting as per required dimensions. The base of steel columns and the positions of anchor bolts shall be carefully set out at the required location.

##### **10.3.2.1** The steel section shall be straight or to be straightened or flattened by pressure unless required to be of curvilinear form and shall free from twists. These shall be cut square either by shearing or sawing to



correct length and measured by steel tape. No two pieces shall be welded or joined to make up for the required length of member.

- 10.3.2.2 Making Holes:** Holes through more than one thickness of materials for members, such as compound stanchion and girder flanges shall, where possible, be drilled after the members are assembled and tightly clamped or bolted together. Punching may be permitted before assembly, provided the holes are punched 3mm less in diameter than the required size and reamed after assembly to the full diameter. The thickness of material punched shall be not greater than 16 mm.

#### **Rivet Holes**

The diameter for rivets and black bolts holes shall be taken as the nominal diameter of a rivet/ black bolts plus 1.5 mm for rivets/ bolts of nominal diameter less than or equal to 25 mm and 2.0 mm for rivets of nominal diameter exceeding 25 mm, unless specified otherwise. Holes for turned and fitted bolts shall be drilled or reamed large by 0.2 to 8 mm depending upon the dia. of bolts.

Holes shall have their axis perpendicular to the surface bored through. The drilling or reaming shall be free from burrs, and the holes shall be clean and accurate. Holes for rivets and bolts shall not be formed by gas cutting process.

Holes for counter sunk bolts shall be made in such a manner that their heads sit flush with the surface after fixing.

- 10.3.2.3 Assembly:** Before making holes in individual members, for fabrication and steel work intended to be riveted or bolted together shall be assembled and clamped properly and tightly so as to ensure close abutting or lapping of the surfaces of the different members. All stiffeners shall be fixed (or placed) tightly both at top and bottom without being drawn or caulked. The abutting joints shall be cut or dressed true and straight and fitted close together.

Web plates of girders, which have no cover flange plates, shall have their ends flush with the tops of angles unless otherwise required. The web plate when spliced, shall have clearance of not more than 5mm. The erection clearance of cleated ends of members connecting steel to steel shall preferably be not greater than 1.5 mm. The erection clearance at the ends of beams without web cleats shall not be more than 3 mm at each end but where for practical reasons, greater clearance is necessary, seating designed suitably shall be provided.

Column splices and butt joints of struts and compression members requiring contact for stress transmission shall be accurately, machined and close butted over the whole section. In column caps and bases, the ends of shafts together with the attached gussets, angles, channels etc. after riveting together shall be accurately machined so that the parts connected, butt against each other over the entire surfaces of contact. Connecting angles or channels shall be fabricated and placed in position with great accuracy so that they are not unduly reduced in thickness by machining.

The ends of all bearing stiffeners shall be machined or grounded to fit tightly both at top and bottom.

- 10.3.2.4 Riveting:** Rivets shall be used, where slip under load has to be avoided.

**Preliminaries before Riveting:-** Members to be riveted shall have all parts firmly placed and held together before and during riveting, and special care shall be taken in this respect for all single riveted connections. For multiple riveted connections, a service bolt shall be provided in every third or fourth hole.

#### **Process of Riveting**

The riveting shall be carried out by using machines of the steady pressure type. However, where such facilities are not available hand riveting may be permitted by the Engineer-in-Charge. The rivets shall be heated red hot, care being taken to control the temperature of heating so as not to burn the steel.



Rivets of diameter less than 8mm may be driven cold. Rivets shall be finished neat with heads full and of equal size. The heads shall be central on shanks and shall grip the assembled members firmly.

All loose, burnt, or badly formed rivets with eccentric or deficient heads shall be cut out and replaced. In cutting out rivets, care shall be taken so as not to injure the assembled members. Caulking and recapping shall not be permitted.

For testing rivets, a hammer weighing approx. 0.25 kg shall be used and both heads of the rivet (Specially the machine head) shall be tapped. When so tested, the rivets shall not give a hollow sound and a jar where so specified, other tests shall be carried out to ensure the soundness of rivets.

All rivets heads shall be painted with approved steel primer paint within a week of their fixing.

- 10.3.2.5** Bolting: The nominal length of the bolt shall be the distance from the underside of the head to the further end of the shank. The nominal diameter of the bolt shall be the diameter at the shank above the screwed threads. Bolts, nuts and washers shall be thoroughly cleaned and dipped in double boiled linseed oil, before use. All bolts heads and nuts shall be hexagonal unless specified otherwise. The screwed threads shall conform to IS 1363 and the threaded surface shall not be tapered. The bolts shall be of such length as to project at least two clear threads beyond the nuts when fixed in position, and these shall fit in the holes without any shake. The nuts shall fit in the threaded ends of bolts properly.

Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt shall project through the nut at least two thread. In all cases where the full bearing area of the bolt is to be developed, the bolt shall be provided with a washer of sufficient thickness under the nuts to avoid any threaded portion of the bolt being within the thickness of the parts bolted together.

Where there is a risk of the nuts being removed or becoming loose due to vibrations or reversal of stresses, these shall be secured from slackening by the use of lock nut, spring washers as directed by the Engineer-in-Charge.

### **10.3.3 Erection**

- 10.3.3.0** Steel members shall be hoisted and erected in position carefully, without any damage to itself, other structures and equipment and injury to workmen. The method of hoisting and erection proposed to be adopted by the contractor shall be got approved from the Engineer-in-Charge in advance. The contractor however shall be fully responsible for the work being carried out in a safe and proper manner without unduly stressing the various members and proper equipment such as derricks, lifting tackles, winches, ropes etc. shall be used.

- 10.3.3.1** The work of erection may be done in suitable units as may be directed by the Engineer-in-charge. Fabricated members shall be lifted at such points so as to avoid deformation or excessive stress in members. The structure or part of it placed in position shall be secured against over-turning or collapse by suitable means.

During execution, the steel members shall be securely bolted or otherwise fastened, when necessary, temporarily braced to provide for all loads including those due to erection equipments and its operation to be carried safely by structure during erection. The steel members shall be placed in proper position as per approved drawing, final riveting or permanent bolting shall be done only after proper alignment has been checked and confirmed.

- 10.3.3.2** Trusses shall be lifted only at nodes. The trusses above 8 m in span shall not be lifted by slinging at two mid points of rafters, which shall be temporary braced by a wooden member of a suitable section. After the trusses are placed in position, purlins and wind bracings shall be fixed as soon as possible.



The end of the truss which faces the prevailing winds shall be fixed with holding down bolts, and the other end kept free to move. In case of trusses of spans upto 8 m the free end of the truss shall be laid on lead sheet or steel plate as per design, and the holes for holding down bolts shall be made in the form of oblong slots so as to permit the free movements of the truss end. For larger spans the truss shall be provided with proper bearing as per design.

**10.3.3.3** Columns and stanchions shall be erected truly vertical with the necessary cross bracing etc. and the base shall be properly fixed with the foundation concrete by means of anchor bolts etc. as per drawing.

**10.3.3.4** Anchor bolts to be placed in the concrete foundation should be held in position with a wooden template. At the time of concreting anchor bolt locations shall be provided with suitable timber mould or pipe sleeve to allow for adjustment which shall be removed after initial setting of concrete. The spaces left around anchor bolts shall be linked to as topping channel in the concrete leading to the side of the pedestal and on the underside of the base plate to allow the spaces being grouted up after the base plate is fixed in the position along with the column footing. Grouting shall be of cement mortar 1:3 (1 cement: 3 coarse sand) or as specified.

**10.3.3.5** Bedding of Column, Stanchions etc.: Bedding shall not be carried out until the steel work has been finally levelled, plumbed and connected together. The stanchion shall be supported on steel wedges and adjusted to make the column plumb. For multistoried buildings, the bedding shall not be done until sufficient number of bottom lengths of stanchions have been properly lined, levelled and plumbed and sufficient floor beams are fixed in position. The base plates shall be wedged clear of the bases by M.S. wedges and adjusted where necessary to plumb the columns. The gaps under the base plate may be made upto 25 mm which shall be pressure grouted with cement grouts.

With small columns, if permitted by the Engineer-in-Charge, the column base shall be floated on a thick cement grout on the concrete pedestal. The anchor bolt holes in the base plate may be made about 8 to 15 mm larger than the bolts. In such cases suitable washers shall be provided.

#### **10.3.4 Painting**

Before the members of the steel structure are placed in position or taken out of the workshop these shall be painted as specified in 8.2.2.

#### **10.3.5 Measurements**

The work as fixed in position shall be measured in running metres correct to a millimetre and their weight calculated on the basis of standard tables correct to the nearest kilogram.

The standard weight of steel sections shall conform to IS 808 with tolerance in sizes as per IS 1852. Tolerance in weight is given in table 8.3. Steel sections shall be acceptable within tolerance limits. Payment for steel sections shall be made as per actual weight within tolerances. Sections having weight on higher side than permissible tolerance, may be acceptable but payment shall be made on the basis of standard weight only. Steel sections having weight variations lower than permissible variation shall not be acceptable.

Unless otherwise specified. Weight of cleats, brackets, packing pieces, bolts nuts, washers, distance pieces, separators diaphragm gussets (taking overall square dimensions) fish plates etc. shall be added to the weight of respective items. No deductions shall be made for skew cuts. In riveted work, allowance is to be made for weight of rivetheads. Unless otherwise specified and addition of 2.5% of the weight of structure shall be made for shop and site rivetheads in riveted steel structures. No deduction shall be made for rivet/ or bolt holes (excluding holes for anchor or holding down bolts). Deduction in case of rivet or bolt hole shall, however, be made if its area exceeds 0.02 m<sup>2</sup>.



The weight of steel sheet and strips shall be taken from relevant Indian Standards based on 7.85 kg/m<sup>2</sup> for every millimetre sheet thickness. For rolled sections, steel rods and steel strips, weight given in relevant Indian Standards shall be used.

#### 10.3.6 Rate

The rate shall include the cost of all materials and labour involved in all the operation described above.

### 10.4 STEEL WORK IN BUILT UP SECTION (WELDED)

**10.4.1** The steel work in built up sections (welded) such as in trusses, form work etc. is specified in this clause.

#### 10.4.2 Laying out

It shall be as specified in 10.3.1.

#### 10.4.3 Fabrication

**10.4.3.1** Straightening, shaping to form, cutting and assembling, shall be as per 10.3.2 as far as applicable, except that the words “riveted or bolted” shall be read as “welded” and holes shall only be used for the bolts used for temporary fastening as shown in drawings.

**10.4.3.2 Welding:** Welding shall generally be done by electric arc process as per IS 816 and IS 823. The electric arc method is usually adopted and is economical. Where electricity for public is not available generators shall be arranged by the contractor at his own cost unless otherwise specified. Gas welding shall only be resorted to using oxyacetylene flame with specific approval of the Engineer-in-Charge. Gas welding shall not be permitted for structural steel work. Gas welding required heating of the members to be welded along with the welding rod and is likely to create temperature stresses in the welded members. Precautions shall therefore be taken to avoid distortion of the members due to these temperature stresses.

The work shall be done as shown in the shop drawings which should clearly indicate various details of the joint to be welded, type of welds, shop and site welds as well as the types of electrodes to be used. Symbol for welding on plans and shops drawings shall be according to IS 813.

As far as possible every efforts shall be made to limit the welding that must be done after the structure is erected so as to avoid the improper welding that is likely to be done due to heights and difficult positions on scaffolding etc. apart from the aspect of economy. The maximum dia of electrodes for welding work shall be as per IS 814. Joint surfaces which are to be welded together shall be free from loose mill scale, rust, paint, grease or other foreign matter, which adversely affect the quality of weld and workmanship.

**10.4.3.3 Precautions:** All operation connected with welding and cutting equipment shall conform to the safety requirements given in IS 818 for safety requirements and Health provision in Electric and gas welding and cutting operations.

**10.4.3.4** Operation, Workmanship and process of Welding is described in Appendix B.

**10.4.3.5** Inspection and testing of welds shall be as per IS 822.

**10.4.3.6 Assembly:** Before welding is commenced, the members to be welded shall first be brought together and firmly clamped or tack welded to be held in position. This temporary connection has to be strong enough to hold the parts accurately in place without any disturbance. Tack welds located in places where final welds will be made later shall conform to the final weld in quality and shall be cleaned off slag before final weld is made.

**10.4.3.7 Erection:** The specification shall be as described in 8.3.3 except that while erecting a welded structure adequate means shall be employed for temporary fastening the members together and bracing the





frame work until the joints are welded. Such means shall consists of applying of erection bolts, tack welding or other positive devices imparting sufficient strength and stiffness to resist all temporary loads and lateral forces including wind. Owing to the small number of bolts ordinarily employed for joints which are to be welded, the temporary support of heavy girders carrying columns shall be specially attended. Different members which shall be fillet welded, shall be brought into as close contact as possible. The gap due to faulty workmanship or incorrect fit if any shall not exceed. 1.5 mm if gap exceeds 1.5 mm or more occurs locally the size of fillet weld shall be increased at such position by an amount equal to the width of the gap.

**10.4.3.8 Painting:** Before the member of the steel structures are placed in position or taken out of the workshop these shall be painted as specified in para 10.2.2.

#### **10.4.4 Measurements**

The mode of measurements shall be the same as specified in 10.2.4 except that weight of welding material shall not be added in the weight of members for payment and nothing extra shall be paid for making and filling holes for temporary fastening of members during erection before welding.

#### **10.4.5 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.

### **10.5 COLLAPSIBLE STEEL GATES**

**10.5.0** These shall be of approved manufacture and shall be fabricated from the mild steel sections.

**10.5.1** The gates shall consist of double or single collapsible gate depending on the size of the opening. These shall consist of vertical double channels each 20 x 8 x 2 mm. at 8 cm. centre to centre braced with flat iron diagonals 20 x 5 mm and top and bottom rails of T- iron 40 x 40 x 6 mm @ 3.5 kg/m with 40 mm dia. ball bearings in every fourth double channel, unless otherwise specified. Wherever collapsible gate is not provided within the opening and fixed along the outer wall surface, T- iron at the top may be replaced by flat iron 40 x 8 mm.

The collapsible gate shall be provided with necessary bolts and nuts, locking arrangement, stoppers and handles. Any special fittings like spring, catches and locks, shall be so specified in the description of item where so required. The gate shall open and close smoothly and easily.

#### **10.5.2 Fixing**

T- iron rails shall be fixed to the floor and to the Lintel at top by means of anchor bolts embedded in cement concrete of floor and lintel. The anchor bolts shall be placed approximately at 45 cm centres alternatively in the two flanges of the T- iron. The bottom runner (T-iron) shall be embedded in the floor and proper groove shall be formed along the runner for the purpose. The collapsible shutter shall be fixed at sides by fixing the end double channel with T-iron rails and also by hold- fasts bolted to the end double channel and fixed in masonry of the side walls on the other side. In case the collapsible shutter is not required to reach the lintel, beam or slab level, a Tee-section suitably designed may be fixed at the top, embedded in masonry and provided with necessary clamps and roller arrangement at the top. All the adjoining work damaged in fixing of gate shall be made good to match the existing work, without any extra cost.

#### **10.5.3 Painting**

All the members of the collapsible gate including T-iron shall be thoroughly cleaned off rust, scales, dust etc. and given a priming coat of approved steel primer conforming to IS 2074 before fixing them in position.

#### **10.5.4 Measurements**



The height and breadth shall be measured correct to a cm. The height of the gate shall be measured as the length of the double channels and breadth from outside to outside of the end fixed double channels in open position, of the gate. The area shall be calculated in square metres, correct to two places of decimal.

#### 10.5.5 Rate

The rate shall include the cost of materials and labour involved in all the operations described above.

#### 10.6 M.S. SHEET SLIDING SHUTTER: DELETED

#### 10.7 M.S. SHEET SHUTTERS: DELETED

#### 10.8 ROLLING SHUTTERS

**10.8.1** Rolling shutters shall conform to IS 6248. These shall include necessary locking arrangement and handles etc. These shall be suitable for fixing in the position as specified i.e. outside or inside on or below lintel or between jambs of the opening. The door shall be either push and pull type or operated with mechanical device supplied by the firm. Shutters upto 8 sq. metre shall be of push and pull type and shutters with an area of over 8 sq. metre shall generally be provided with reduction gear operated by mechanical device with chain or handle, if bearings are specified for each of operation, these shall be paid for separately.

**10.8.1.1 Shutter:** The shutter be built up of inter locking lath section formed from cold rolled steel strips. The thickness of the sheets from which the lath sections have been rolled shall be not less than 0.90 mm for the shutters upto 3.5 m width. Shutters above 9 metres width should be divided in 2 parts with provision of one middle fixed or movable guide channel or supported from the back side to resist wind pressure. The lath section shall be rolled so as to have interlocking curls at both edges and a deep corrugation at the centre with a bridge depth of not less than 12 mm to provide sufficient curtain of stiffness for resisting manual pressures and nor mal wind pressure. Each lath section shall be continuous single piece without any welded joint. When interlocked, the lath sections shall have a distance of 75 mm rolling centers. Each alternate lath section shall be fitted with malleable cast iron or mild steel clips securely riveted at either ends, thus locking in the lath section at both ends preventing lateral movement of the individual lath sections. The clips shall be so designed as to fit the contour of the lath sections.

**10.8.1.2 Spring:** The spring shall be of coiled type. The spring shall be manufactured from high tensile spring steel wire or strips of adequate strength conforming to IS 4454- Part I.

**10.8.1.3 Roller and Brackets:** The suspension shaft of the roller shall be made of steel pipe conforming to heavy duty as per IS 1161. For shutter upto 6 metre width and height not exceeding 5 metre, steel pipes of 50 mm nominal bore shall be used. The shaft shall be supported on mild steel brackets of size 375 x 375 x 3.15 mm for shutters upto a clear height of 3.5 metre. The size of mild steel brackets shall be 500 x 500 x 8 mm for shutters of clear height above 3.5 m and upto 6.5 m. The suspension shaft clamped to the brackets shall be fitted with rotatable cast iron pulleys to which the shutter is attached. The pulleys and pipe shaft shall be connected by means of pretensioned helical springs to counter balance the weight of the shutter and to keep the shutter in equilibrium in any partly open position.

**10.8.1.4** When the width of the opening is greater than 3.5 mtr. The cast iron pulleys shall be interconnected with a cage formed out of mild steel flats of at least 32 x 6 mm and mild steel dummy rings made of similar flats to distribute the torque uniformly. Self-aligning two row ball bearing with special cast iron castings shall be provided at the extreme pulley and caging rings shall have a minimum spacing of 15mm and at least 4 number flats running throughout length of roller shall be provided.





**10.8.1.5** In case of shutters of large opening with mechanical device for opening the shutter the roller shall be fitted with a purion wheel at one end which in contact with a worm fitted to the bracket plate, caging and pulley with two ball bearing shall be provided.

**10.8.1.6 Guide Channel:** The width of guide channel shall be 25 mm the minimum depth of guide channels shall be as follows:

Clear width of shutters	Depth of guide channel
Upto 3.5 m	65 mm
3.5 m upto 8 m	75 mm
8 m and above	80 mm

**10.8.1.7** The gap between the two legs of the guide channels shall be sufficient to allow the free movement of the shutter and at the same time close enough to prevent rattling of the shutter due to wind.

**10.8.1.8** Each guide channel shall be provided with a minimum of three fixing cleats or supports for attachment to the wall or column by means of bolts or screws. The spacing of cleats shall not exceed 0.75 m. Alternatively, the guide channels may also be provided with suitable dowels, hooks or pins for embedding in the walls.

**10.8.1.9** The guide channels shall be attached to the jambs, plumb and true either in the overlapping fashion or embedded in grooves, depending on the method of fixing.

**10.8.1.10 Cover:** Top cover shall be of mild steel sheets not less than 0.90 mm thick and stiffened with angle or flat stiffeners at top and bottom edges to retain shape.

**10.8.1.11** Lock plates with sliding bolts, handles and anchoring rods shall be as per IS 6248.

## 10.8.2 Fixing

The arrangement for fixing in different situations in the opening shall be as per IS 6248.

**10.8.2.1** Brackets shall be fixed on the lintel or under the lintel as specified with rawlplugs and screws bolts etc. The shaft along with the spring shall then be fixed on the brackets.

**10.8.2.2** The lath portion (shutter) shall be laid on ground and the side guide channels shall be bound with ropes etc. The shutter shall then be placed in position and top fixed with pipe shaft with bolts and nuts. The side guide channels and cover frames shall then be fixed to the walls through the plate welded to the guides. These plates and bracket shall be fixed by means of steel screws bolts, and rawl plugs concealed in plaster to make their location invisible. Fixing shall be done accurately in a workmen like manner that the operation of the shutter is easy and smooth.

## 10.8.3 Measurements

Clear width and clear height of the opening for rolling shutter shall be measured correct to a mm. The clear distance between the two jambs of the opening shall be clear width and the clear distance between the sill and the soffit (bottom of lintel) of the opening shall be the clear height.

The area shall be calculated in square metres correct to two places of decimal.

## 10.8.4 Rate

The rate shall include the cost of materials and labour involved in all the operations described above including cost of top cover and spring except ball bearing and mechanical device of chain and crank operation, which shall be paid for separately.



## **10.9 ROLLING GRILLS - SHUTTERS**

**10.9.0** Rolling grill shutter is meant to provide visibility or ventilation or both, the degree of protection and safety is less as compared to a rolling shutter. The situations where a certain amount of ventilation combined with safety is required rolling shutter-cum-grill may be provided in which the rolling shutter may have a rolling grill portion either at the top or at the bottom or at both places. In addition, the rolling grill portion may also be provided in the middle of the shutter. The total height of the grill portion in all the segments of rolling shutter-cum-grill shall not exceed 1.0 m and the height of the grill portion in any individual segment shall not be more than 0.5 m.

**10.9.1** Rolling grills shutters are similar in design, construction and operation to rolling shutters and all the provisions of Para 8.8 shall be applicable to rolling grills shutters except in respect of the shutter portion and shall conform to IS 6248.

### **10.9.2 Shutters**

Rolling grill shutter and the rolling grill portion of the rolling shutter-cum-grill shall be fabricated with 8 mm diameter mild steel round bars. Straight bars and bars bent to the required profile are placed alternatively and held in position with 20 mm wide and 5 mm thick mild steel flat links. Straight bars shall be spaced not exceeding 150 mm centre to centre and the bars bent to required profile shall be placed symmetrically between two consecutive straight bars. Unless otherwise specified or directed by the Engineer-in-Charge, bars placed alternatively with straight bars shall be bent to form a corrugated profile such that the pitch of the corrugation is 80 to 120 mm and the depth of corrugation is 80 to 80 mm. all the bent bars shall have uniform profile. Straight bar along with the adjoining bent bars on it both sides shall be held in position by passing the bars through holes in the links. Each link shall have three holes and the length of the links shall be such that the distance from the centre of the hole to the nearest edge of the flat is not less than the diameter of the hole. The corner of the links shall be rounded. All links shall be of uniform size and shape. The spacing of the links measured along the straight bar shall be the same as centre to centre distance between two consecutive crests/ troughs of the bars bent to the required profile. Each bar and link shall be continuous single piece without any joint.

### **10.9.3 Measurement & Rate**

The measurement and rate shall be as specified in 8. 8.3 and 8.8.4 respectively. in case of Rolling Shutter-cum-Grill, where the area of the grill portion is half or less than half the area of opening, it shall be measured and paid as rolling shutter and where the area of grill portion is more than half the area of opening, it shall be measured and paid as rolling grill.

## **10.10 STEEL DOORS, WINDOWS, VENTILATORS AND COMPOSITE UNITS: DELETED**

## **10.11 T-IRON DOORS, WINDOWS AND VENTILATORS FRAMES: DELETED**

## **10.12 PRESSED STEEL DOOR FRAMES: DELETED**

## **10.13 TUBULAR / HOLLOW SECTION TRUSSES: DELETED**

## **10.14 FAN CLAMPS (Fig. 10.9)**

### **10.14.1 The fan clamps shall be of the following types:**

- a. **Type-I:** Fan clamp to be fixed during the laying of R.C.C. slab, shall be of type I, as shown in (Fig. 10.9). This shall be made of 16 mm M.S. bar bent to shape with its ends hooked. The overall height of the clamps shall be made to suit the depth of slab.
- b. **Type-II:** Fan clamps for beams shall be of type II as shown in (Fig. 10.9). It shall be similar to fan clamp, type I, except that its height shall be greater depending on the depth of the beam rib.



- c. **Type-III:** In case low ceiling heights, circular cast iron box for ceiling fan clamp shall be fixed during the laying of R.C.C. slab and shall be as shown in (Fig. 10.9). The size of cast iron box shall be 140mm internal dia with 73 mm height, the thickness of cast iron rim shall be 4.5 mm bottom and top lid shall be of 1.5 mm thick M.S. sheet, with its top surface hacked so as to ensure proper bonding with the concrete. The lids shall be screwed into the cast iron box by means of 3.3mm Dia round head screws one each at the corners. The box can be of M.S. sheet, the thickness of side walls can be reduced to 3 mm without effecting inner dia of the box. The fan clamp shall be made of 12mm dia M.S. bar bent to shape with its ends bent as per drawing.

#### **10.14.2 Fixing**

Holes for inserting the fan clamps in the positions shown in the drawing or as instructed by the Engineer-in-Charge shall be made in the shuttering after the latter has been fixed in position. After steel reinforcement is tied, fan clamps shall be fixed with their loops truly vertical and at the correct depth from the under-side of the slab or beam. The hooked arms and the loop shall be tied to the reinforcement, either directly or through cut pieces of M.S. bars with annealed steel wire 1.6 mm or 1.00 mm thick. The clamp shall neither be disturbed out of position during concreting nor shall they be bent out of shape when shuttering of slabs or beams is removed.

The exposed portion of loops of the clamps shall be given two or more coats of paint, including priming coat, of approved steel primer as ordered by the Engineer-in-Charge.

#### **10.14.3 Measurements**

Clamps of type I and III shall be counted in numbers. Fan clamps type II shall be counted and paid for under fan clamps type I, but they shall in addition be paid for their extra height as determined by the depth of the beam.

#### **10.14.4 Rate**

The rate per fan clamps shall include the cost of labour and materials involved in all the operations described above. In the case of type I and III clamps, the rate shall apply irrespective of the thickness of the slabs.

#### **10.15 M.S. HOLLOW RECTANGULAR DOOR FRAMES (I-TYPE SECTION): DELETED**

#### **10.16 FACTORY MADE GLAZED STEEL DOORS, WINDOWS AND VENTILATORS: DELETED**

#### **10.17 STEEL WORK WELDED IN BUILT-UP SECTIONS USING STRUCTURAL STEEL**

- (a) In Stringers, Treads, landing etc. of Stair cases including use of chequered Plate wherever required
- (b) In Grating, Frames, Guard Bar, Ladder, Railings, Bracket, Gates and similar work.

**10.17.1** General specifications for these items to be same as for steel work welded in built-up sections as mentioned in para 8.4 except that steel used for fabrication of these items to be of type used for structural use/purposes.

**10.17.2** Steel members used for fabricating these items to be designed structurally to withstanding the all loads to be carried out by the members during erection, fixing and functional use in designed life. Work to be executed as per structural drawings.

#### **10.18 STEEL WORK WELDED IN BUILT-UP SECTIONS FOR HAND RAIL USING M.S. TUBULAR/ERW TUBULAR PIPES AND G.I. PIPES**

**10.18.1** General specifications to be same as for steel work welded in built-up section as mentioned in para 10.4.

**10.18.1.1** Hot finished welded (HFW) Hot finished seamless (HFS) and electric resistance welded tube shall conform to IS 1161.



**10.18.1.2** G.I. pipes used for Hand rail to be conforming to IS 1239-Part I for medium grade. GI pipes to be screwed and socketed type and of required nominal bore.

**10.18.1.3** Galvanising of GI pipes shall conform to IS 4736.

**10.18.1.4** All screwed tubes and socket of GI pipes shall have pipe threads conforming to the requirements of IS 554. The fittings for GI pipes to be conforming to IS 1239 (Part-II).

**10.18.1.5** Measurement of Hand Rail of M.S. Tubular/E.R.W Tubular Pipes

The work as fixed in place shall be measured in running metres correct to a centimeter and their weights calculated on the basis of standard tables correct to the nearest kilogram or actual weight whichever is less unless otherwise specified.

## **10.19 DASH FASTENERS**

These dash fasteners shall be of approved manufacture and shall be fabricated from the carbon steel.

**10.19.1** The Grade 6.8 means:

- (a) The first figure indicates the 1/80 of nominal tensile strength in N/mm<sup>2</sup>.
- (b) The second figure indicates 8 times the ratio between lower yield stress and nominal tensile strength.

The yield strength 480 N/mm<sup>2</sup> means the 6.8 grade shall have the tensile strength of 600 N/mm<sup>2</sup>.

The lead of a thread is the distance travelled parallel to the axis in one rotation of a part in relation to a fixed mating part. In single threads, the lead is equal to the pitch. A double thread, it has two ridges starting 180° apart. The lead is twice the pitch. A triple thread, it has three ridges starting 120° apart. The lead is three times the pitch.

### **10.19.2 Fixing**

According to the size (diameter & length) of the dash fasteners, the holes shall be done with precise location for fixing in frame, Masonry/concrete etc. The minimum distance between holes not less than 2.5 times diameter of the fastener.

### **10.19.3 Measurements**

Dash fasteners of each size shall be counted in numbers.

### **10.19.4 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for drilling of hole in frame, Masonry/concrete etc. nor anything deducted for these from the measurement of frame, Masonry/concrete etc.

## **10.20 STAINLESS STEEL RAILING**

The stainless steel of 304 grade of as per IS 6911 : 2017 shall be used for further fabrication of railing as per Architectural Design. **Composition** Stainless steel of 304 grade is most common in 300 series of Austenitic stainless steel.

- (b) It is still sometimes referred to by its old name 18/8 which is derived from the nominal composition of type 304 being 18% chromium and 8% nickel.
- (c) Fabrication of all stainless steel sections should be done only with tools dedicated to stainless steel materials. Tooling and work surfaces must be thoroughly cleaned before use. These precautions are necessary to avoid cross contamination of stainless steel by easily corroded metals that may discolour the surface of the fabricated product. Some specific hints are as under:



- i. Remove all moisture by blowing with dry air or heating with a torch.
- ii. Eliminate organic contaminants like oil, paints, anti-spatter compounds, grease, pencil marks, cutting compounds, adhesive from protective paper, soap used for leak testing etc.
- iii. Stainless steels cannot be flame cut with a torch. Acceptable results are achieved with an arch plasma cutter.
- iv. Be particularly careful to avoid zinc contamination. Do not use brushes or tools previously used on galvanized steel.
- v. Use only stainless-steel wire brushes and use these brushes only on stainless steel.

#### **10.20.2 Fixing**

Fixing with railing with necessary accessories & stainless steel dash fasteners, stainless steel bolts etc. of required size, on the top of the floor or the side of waist slab with suitable arrangement as per approval of Engineer-in-charge.

#### **10.20.3 Measurements**

Only weight of stainless steel members shall be considered in kg, excluding fixing accessories such as nuts, bolts, fasteners etc.

#### **10.20.4 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above. Nothing extra shall be paid for fixing arrangements i.e. drilling, nut & bolts etc.

### **10.21 FLY PROOF WIRE GAUZE**

Wire gauze/Wire Cloth which shall generally conform to IS 1568 shall be regularly woven with equally spaced galvanised mild steel wires in both warp and weft directions. The wire cloth shall be properly selvaged by one or more wires in each edge.

The following wire gauze shall be used:

- i. Galvanised mild steel wire gauze of 1.40mm average aperture width woven with 0.63mm nominal dia shall be used.
- ii. Stainless steel (Grade 304) gauze of 0.5 mm dia wire and 1.4mm aperture on both sides.

The wire gauze shall be bent at right angles in the inner face of steel frame of stiles and rails, turned back and fixed tight with blue tacks at about 75mm centres, fixed alternately in the two faces of the inner face of frame. Over this, M.S. Flat of size 15x3 mm with nuts & bolts fixed alternately in the two faces of the frame at about 75mm centres.

#### **10.21.1 Measurement**

The length and breadth of finished wire gauze on inner face of frame shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

#### **10.21.2 Rates**

The rate includes cost of all operation described above.

### **10.22 GLASS PANES WITH PUTTY AND GLAZING CLIPS**

Glazing in the steel door, windows, clerestory windows shall be provided with glass weight of which shall be not less than density 8 kg/sqm or 13.5 kg/sqm for the specific thickness 4.0 mm or 5.5 mm respectively. Glass panels shall be fixed by providing a thin layer of putty conforming to IS 419 applied between glass pane and all along the length of the rebate and also between glass panes and beading.



**10.22.1** Putty can be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste at the rate of 1 litre of varnish to 18 kg of paste. Fixing of glass panes without beading shall not be permitted. Glazing shall be done after the shutters have been finished.

**10.22.2** Panels of shutters shall be flat and well sanded to a smooth and level surface. Four glazing clips may be provided per glass pane for a size larger than 30 cm x 60 cm for all types, where the glass panes size exceed 80 cm x 200 cm, 6 glazing clips shall be used. In case of doors, windows and ventilators without horizontal glazing bars, the glazing clips may be spaced according to the slots, in the vertical members provided the spacing does not exceed 30 cm otherwise the spacing shall be 30 cm.

**Note:** Where large size glass panes are required to be used or where the door or window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stages. Use of glazing clips shall be specified while placing the order.

**10.22.3** Where specially stipulated, fixing of glass panes may be done with metal or wooden beading instead of mere putty. Where beading are proposed to be used, the manufactures shall be intimated in advance to drill holes for hard screws. Usually beads shall be fixed with screws spaced not more than 8 cm from each corner and the intermediate not more than 20 cm apart. When glass panes are fixed with wooden or metal beading having mitred joints, a thin layer of putty shall be applied between glass panes and sash bars and also between glass panes and the beading.

Size of M.S. beading shall be 8 x 8 mm box section manufactured from 1.6mmthick sheet unless otherwise specified in the item. Where metal beading is specified, extra payment shall be made on this account.

#### **10.22.4 Measurement**

The length and breadth of glass pane shall be measured correct to the nearest cm and area worked out in square metres correct to two places of decimal.

#### **10.22.5 Rate**

The rate includes cost of all the operation described above.

#### **10.23 ANGLE IRON FRAMES FOR DOORS, WINDOWS AND VENTILATORS: DELETED**



MECHANICAL PROPERTIES AND CHEMICAL COMPOSITION OF STEEL

TABLE 10.1

Chemical Composition as per table 1 of IS 2062:2011

(Clause 10.1.1)

Grade Designation	Quality	Ladle Analysis, Percent, Max					Carbon Equivalent (CE), Max	Method of Deoxidation
		C	Mn.	S	P	Si		
1	2	3	4	5	6	7	8	9
<b>E 250</b>	A	0.23	1.50	0.045	0.045	0.40	0.42	Semi-killed/ killed
	BR B0	0.22	1.50	0.045	0.045	0.40	0.41	Semi-killed/ killed
	C	0.20	1.50	0.040	0.040	0.40	0.39	killed
<b>E 275</b>	A	0.23	1.50	0.045	0.045	0.40	0.43	Semi-killed/ killed
	BR B0	0.20	1.50	0.045	0.045	0.45	0.44	Semi-killed/ killed
	C	0.20	1.55	0.040	0.040	0.40	0.41	killed
<b>E 300</b>	A BR B0	0.20	1.50	0.045	0.045	0.45	0.44	Semi-killed/ killed
	C	0.20	1.50	0.40	0.40	0.45	0.44	killed
<b>E 350</b>	A BR B0	0.20	1.55	0.045	0.045	0.45	0.47	Semi-killed/ killed
	C	0.20	1.55	0.040	0.040	0.45	0.45	killed
<b>E 410</b>	A BR B0	0.20	1.60	0.045	0.045	0.45	0.50	Semi-killed/ killed
	C	0.20	1.60	0.045	0.045	0.45	0.50	killed
<b>E 450</b>	A BR	0.22	1.65	0.045	0.045	0.45	0.52	Semi-killed/ killed
<b>E 550</b>	ABR	0.22	1.65	0.020	0.25	0.50	0.54	Semi-killed/ killed
<b>E 600</b>	ABR	0.22	1.70	0.020	0.025	0.50	0.54	Semi-killed/ killed
<b>E 650</b>	ABR	0.22	1.70	0.015	0.025	0.50	0.55	Semi-killed/ killed



Notes:

1. New grade designation system based on minimum yield stress has been adopted.
2. For semi-killed steel, silicon shall be less than 0.10 percent. For killed steel when the steel is killed by aluminium alone, the total aluminium content shall not be less than 0.02 percent. When the steel is killed by silicon alone, the silicon content shall not be less than 0.10 percent. When the steel is silicon-aluminium killed, the silicon content shall not be less than 0.03 percent and total aluminium content shall not be less than 0.01 percent.
3. Steels of qualities A, BR, BO and C are generally suitable for welding processes. The weldability increases from quality A to C for grade designation E 250 and E 275.
4. Carbon equivalent (CE) based on ladle analysis, only.

$$CE = C + \frac{Mn}{6} + \frac{(Cr + Mo + V)}{5} + \frac{(Ni + Cu)}{15}$$

5. Micro-alloying elements like Nb, V and Ti may be added singly or in combination. Total micro-alloying elements shall not be more than 0.25 percent.
6. Alloying element such as Cr, Ni, Mo and 8 may be added agreement between the purchaser and the manufacturer. In case of E 600 and E 650 the limit of Cr and Ni, either singly or in combination, shall not exceed 0.50 percent and 0.60 percent respectively.
7. Copper may be present between 0.20 to 0.35 percent as mutually agreed to between the purchaser and the manufacturer. The copper bearing quality shall be designated with a suffix Cu, for example E 250 Cu. In case of product analysis, the copper content shall be between 0.17 and 0.38 percent.
8. Incidental element - Elements not quoted in Table 10.1I shall not be intentionally added to steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition from scrap or other materials used in manufacture of such elements which affect the harden ability, mechanical properties and applicability.
9. Nitrogen content of steel shall not exceed 0.012 percent which shall be ensured by the manufacturer by occasional check analysis.
10. The steel, if required, may be treated with calcium based compound or rare earth element for better formability.
11. Lower limits for carbon equivalent and closer limits for other elements may be mutually agreed to between the purchaser and the manufacturer.





**TABLE 10.2**  
**Mechanical Properties Composition**  
**(Clause 10.1.1)**

Grade Designation	Quality	Tensile strength Min. MPa	Yield stress, ReH Min. MPa			Percentage Elongation at Gauge length Lo 5.65 So	Internal Bend Diameter Min.)		Charpy V-Notch Impact Energy Min.J	
			<20	20-40	>40		925	>25	At Room Tem	At 20 C
1	2	3	4	5	6	7	8	9	10	11
E 250	A	410	250	240	230	23	2t	3t	-	-
	BR								RT	27
	BO								0	27
	C								(-)20	27
E 275	A	430	275	265	255	22	2t	3t	-	-
	BR								RT	27
	BO								0	27
	C								(-)20	27
E 300	A	440	300	290	280	22	2t	-	-	-
	BR								RT	27
	BO								0	27
	C								(-)20	27
E 350	A	490	350	330	320	22	2t	-	-	-
	BR								RT	27
	BO								0	27
	C								(-)20	27
E 410	A	540	410	390	380	20	2t	-	-	-
	BR								RT	25
	BO								0	25
	C								(-)20	25
E 450	A	570	450	430	420	20	2.5t	-	-	-
	BR								RT	20
E 550	A	650	550	530	520	12			-	-
	BR								RT	15



E 600	A	730	600	580	570	12	3.5t	-	-	-
	BR								RT	15
E 650	A	780	650	630	620	12	4t	-	-	-
	BR								RT	15

**Notes:**

1. In case of product thickness/diameter more than 100 mm, lower minimum limit of tensile strength may be mutually agreed to between the purchaser and the manufacturer /supplier.
2. Bend test not required for thickness > 25 mm for grades E 300 to E 650.

't' is the thickness of the test piece.

3. For sub-quality BR, impact test is optional; if required, at room temperature ( $25 \pm 2^{\circ}\text{C}$ ).  
 $1 \text{ MPa} = 1 \text{ N/mm}^2 = 1 \text{ MN/m}^2 = 0.102 \text{ kgf/mm}^2 = 144.4 \text{ psi}$ .  
 RT= Room Temperature



**TABLE 10.3**  
**(Clause 10.2.4 & 10.3.5)**

Sl. No.	Steel Section	Tolerance in weight per meter percentage		Standard weight as per IS
		Plus Side	Minus Side	
(i)	Beams and columns (RS joists)	(a) Beams $\leq 200$ mm (+) 4	(-) 1	IS 808
		(b) $> 200$ mm 2.5	2.5	
(ii)	Channels	2.5	2.5	IS 808
(iii)	Equal and unequal leg Angles			
	(a) upto 3 mm thickness	5	5	IS 808
	(b) Over 3 mm thickness	5	3	
(iv)	Tee bars			
	(a) Web thickness upto 3 mm	5	5	IS 1173
	(b) Web thickness above 3 mm	2.5	2.5	
(v)	Bulb angles	2.5	2.5	IS 1252
(vi)	Bars in straight length			
	Upto and including 8 mm	7	7	IS 1732
	Over 8 mm and upto and including 16 mm	5	5	
	Over 16 mm	3	3	
(vii)	Bars in coils	Weight tolerance is not applicable		
(viii)	Flats			
	Upto 3 mm thickness	5	5	
	Over 3 mm thickness	5	3	
(ix)	Plates	5	2.5	IS 1730
(x)	Strips	8	8	IS 1730
	Consignment in straight length			
	(i) upto 5 tons	7	7	IS 1730
	(ii) Above 5 tons	5	5	
(xi)	Sheets			
	Thickness			
	Over in mm	Upto and including in mm	Tolerance on calculated weight (Percent)	IS 1730
	-	1.25 mm	$\pm 9$	
	1.25mm	1.60	$\pm 8$	
	1.6 mm	4.00	$\pm 7$	

**WELDING PROCESS  
(Clause 10.4.2.4)**

The work shall be positioned for downward welding wherever possible. Arc length voltage and amperage shall be suited to the thickness of material, type of groove and other circumstances of the work. The welding current and electrode sizes for different types of joints shall be as per IS 9595.

The sequence of welding shall be such as will avoid undue distortion and minimize residual shrinkage stresses. Recommendation of IS 9595 shall be followed.

**Process of Welding**

The electrode manipulation during welding shall be such as to ensure that:

The parent metal is in a fused stage when the filler metal makes contact with it. The weld metal does not overflow upon any unfused parent metal forming overlapping. The parent metal is not under-cut along the weld toes.

The flowing metal floats, the slag, the oxides, and the gas bubbles to the surface behind the advancing pool. In case any of these requirements is unattainable by manipulation, the current shall be adjusted or the electrode size changed.

Each time the arc is started the electrode shall be moved in such a way that the fusion of base metal at the starting point is assured. At the completion of a run the movement of electrode shall be slowed down to fill the arc crater.

After every interruption of the arc except at completion of a run, the arc shall be restarted ahead of the previous deposit and then move back to fill the crater or such alternative technique shall be used as will ensure complete filling of the crater, or complete fusion between the new and old deposit and the base metal at the point of junction, and result in continuity of weld. Before welding operation is completed, all traces of slag shall be removed from the deposit, by chipping if necessary, and the deposit and the adjoining base metal shall be wire brushed and cleaned at all points. The requirements shall apply not only to successive layers, but also to successive beads, and to the over lapping area wherever a junction is made on starting a new electrode.

The welds shall be free from cracks, discontinuity in welding and other defects such as (i) under-size (ii) over-size, (iii) under-cutting and (iv) over-cutting in the case of fillet welds and defects (ii), (iii) & (iv) in the case of butt welds.

All defective welds which shall be considered harmful to the structural strength shall be cut out and rewelded.

In case of welded butt joints in steel of thickness upto 50mm the weld joint shall be subjected to radiographic examination as described in IS 1182.

All welds shall be cleaned of slag and other deposits after completion. Till the work is inspected and approved painting shall not be done. The surface to be painted shall be cleaned of spatter, rust, loose scale, oil and dirt.



**STEEL TUBES FOR STRUCTURAL PURPOSES**  
**AS PER TABLE 1 OF IS 1161: 2014**  
**(Clause 10.13.1)**

Nominal Bore(mm)	Outside Diameter (mm)	Wall Thickness (mm)	Weight (kg/m)
15	21.3	3.2	1.43
20	26.9	3.2	1.87
25	33.7	3.2	2.41
		4.0	2.93
32	42.4	2.6	2.55
		3.2	3.09
		4.0	3.79
40	48.3	2.9	3.25
		3.2	3.56
		4.0	4.37
50	60.3	2.9	4.11
		3.6	5.03
		4.5	6.19
65	76.1	2.9	5.24
		3.6	6.44
		4.5	7.95
80	88.9	3.2	6.76
		4.0	8.38
		4.8	9.96
90	101.6	3.6	8.70
		4.0	9.63
		4.8	11.46
100	114.3	3.6	9.83
		4.5	12.19
		5.4	14.50
110	127.0	4.5	13.59
		4.8	14.47
		5.4	16.19
125	139.7	4.5	15.00
		4.8	15.97
		5.4	17.89
135	152.4	4.5	16.41
		4.8	17.47
		5.4	19.58



Nominal Bore(mm)	Outside Diameter (mm)	Wall Thickness (mm)	Weight (kg/m)
150	165.1	4.5	17.82
		4.8	18.98
		5.4	21.27
		5.9	23.20
		6.3	24.67
		8.0	30.99
150	168.3	4.5	18.18
		4.8	19.35
		5.4	21.69
		6.3	24.17
		8.0	31.63
		10.0	39.04
175	193.7	4.8	22.36
		5.4	25.08
		5.9	27.33
		6.3	29.12
		8.0	36.64
		10.0	45.30
		12.0	53.77
200	219.1	4.8	25.37
		5.6	29.49
		5.9	31.02
		6.3	33.06
		8.0	41.65
		10.0	51.57
		12.0	61.29
225	244.5	5.9	34.72
		6.3	37.01
		8.0	46.66
		10.0	57.83
250	273.0	5.9	38.86
		6.3	41.44
		8.0	52.28
		10.0	64.86
		12.0	77.24
300	323.9	6.3	49.34
		8.0	62.32
		10.0	77.41



Nominal Bore(mm)	Outside Diameter (mm)	Wall Thickness (mm)	Weight (kg/m)
		12.0	92.30
350	355.6	8.0	68.58
		10.0	85.23
		12.0	101.68

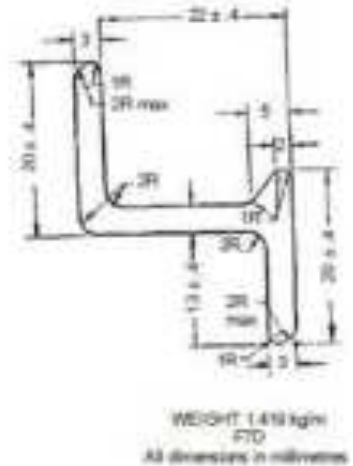
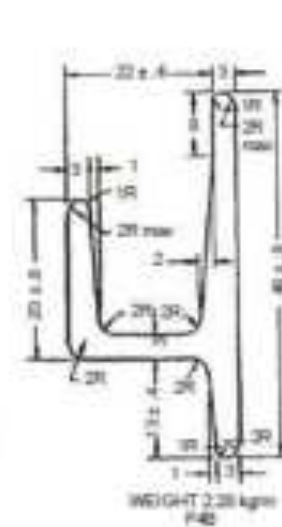
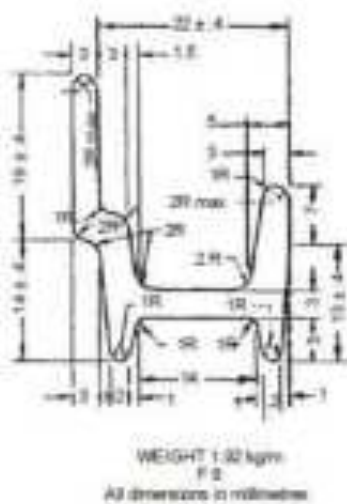
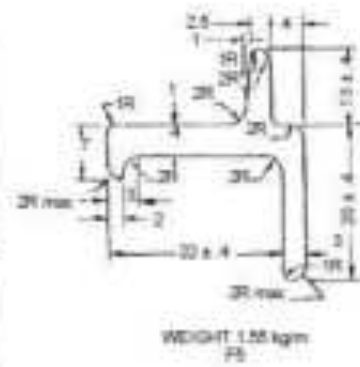
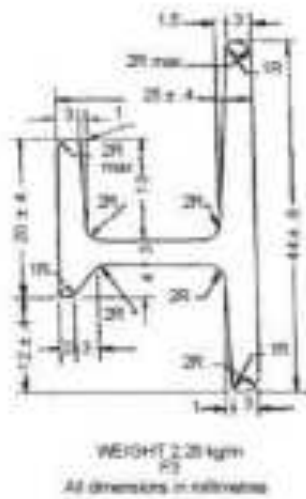
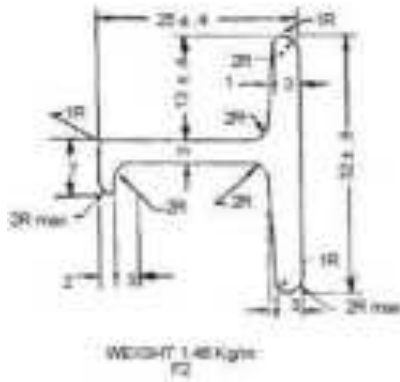
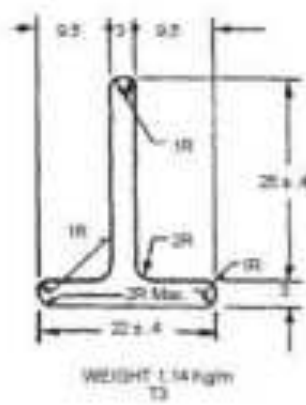
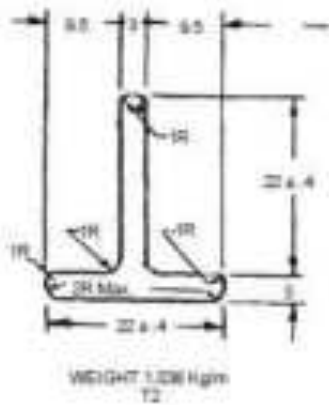


SHAPES, WEIGHTS AND DESIGNATION OF MS ROLLED STEEL SECTION

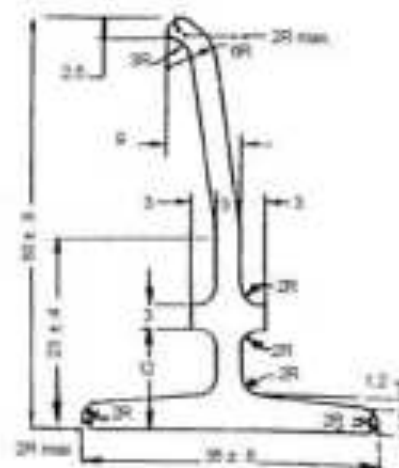
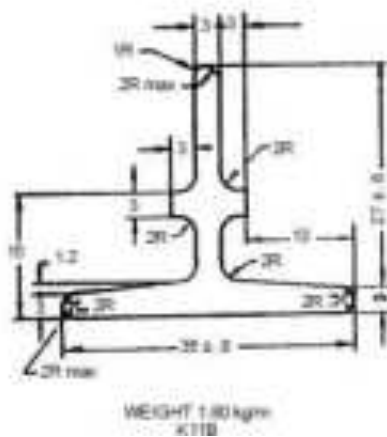
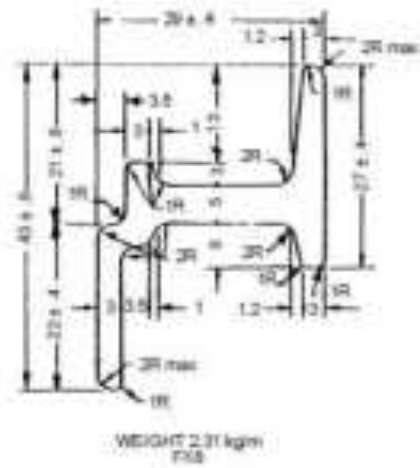
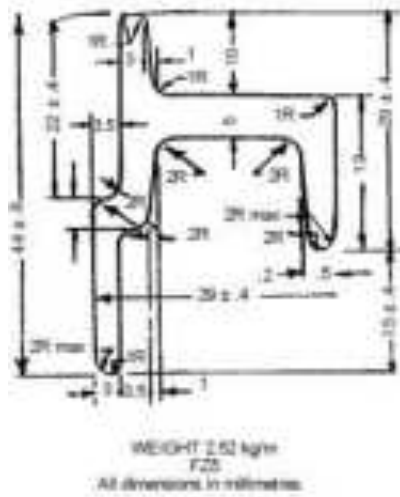
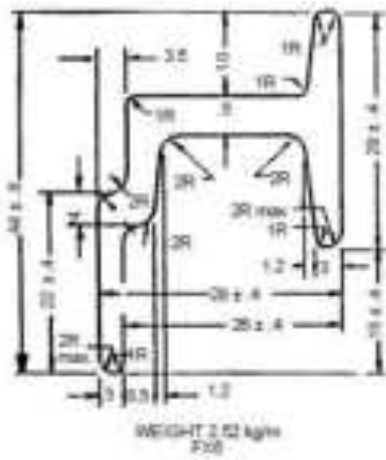
Designation	Wt kg/m	Situation of Use of Section
T2	1.036	Vertical and horizontal glazing bars for doors and shashes: windows, ventilators glazing bars for door side lights subdividing bars for fixed length, sash bars for doors, windows and ventilators wheel steel aluminium or wooden beading is used for fixing glasses.
T3	1.14	Vertical glazing bar for FZ 7 frame
T6	0.839	Vertical and horizontal glazing bar for standard windows and ventilators.
F2	1.46	Inner frames for open-in windows.
F3	2.28	Outer frames for open-in windows.
F5 1.55		(a) Inner and middle frames in centre-hung ventilators
		(b) F5 is sometimes used as inner frames for open-out windows. Also used as inner frame for bottom hung ventilators
		(b) F8 is also used as outer frame for bottom hung ventilators.
F4B	2.28	Central mullion (meeting bar for shutters) for windows and ventilators using F7D as inner frames, outer frames for open-in windows in rainy areas, subdividing bars for openable windows and top-hung ventilators.
F7D	1.419	Inner and outer frames for windows and top hung ventilators, for inner frames for centre-hung ventilators and outer frames for door sidelights.
FX6	2.52	Inner frame for doors
FZ7	1.90	Used as outer frame for industrial shashes. Also used for outer frame for wooden doors
FX8	2.31	Outer frames for doors
FZ5	2.52	Inner frames for doors
K11B 1.80		(a) Vertical coupling mullion for standard windows
		(b) Can be used as horizontal coupling bar when openable windows are to be coupled above fixed ones or between two fixed windows.
		(c) Can also be used as horizontal coupling mullion where windows are not exposed to weather.
K12 B	2.30	Horizontal coupling mullion, also known as weather bar, especially used when the coupled unit is exposed to rain.



## APPENDIX D SHAPES



## APPENDIX D SHAPES





## COLLAPSIBLE STEEL GATE

Sub Head: Steel Work  
Clause: 10.5

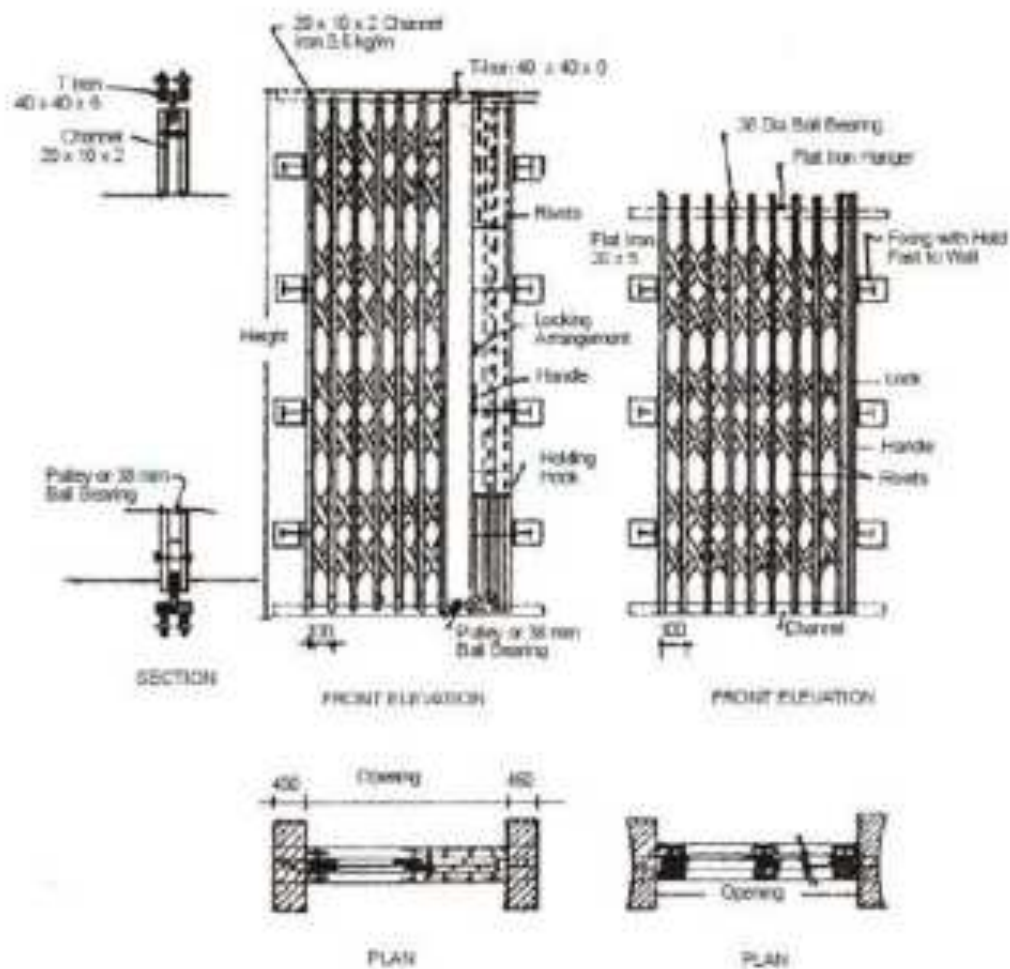


Figure 10.2 : Collapsible Steel Gate

Drawing not to Scale  
All dimensions are in mm

## FAN CLAMPS

Sub Head: Steel Work  
Clause: 10.14

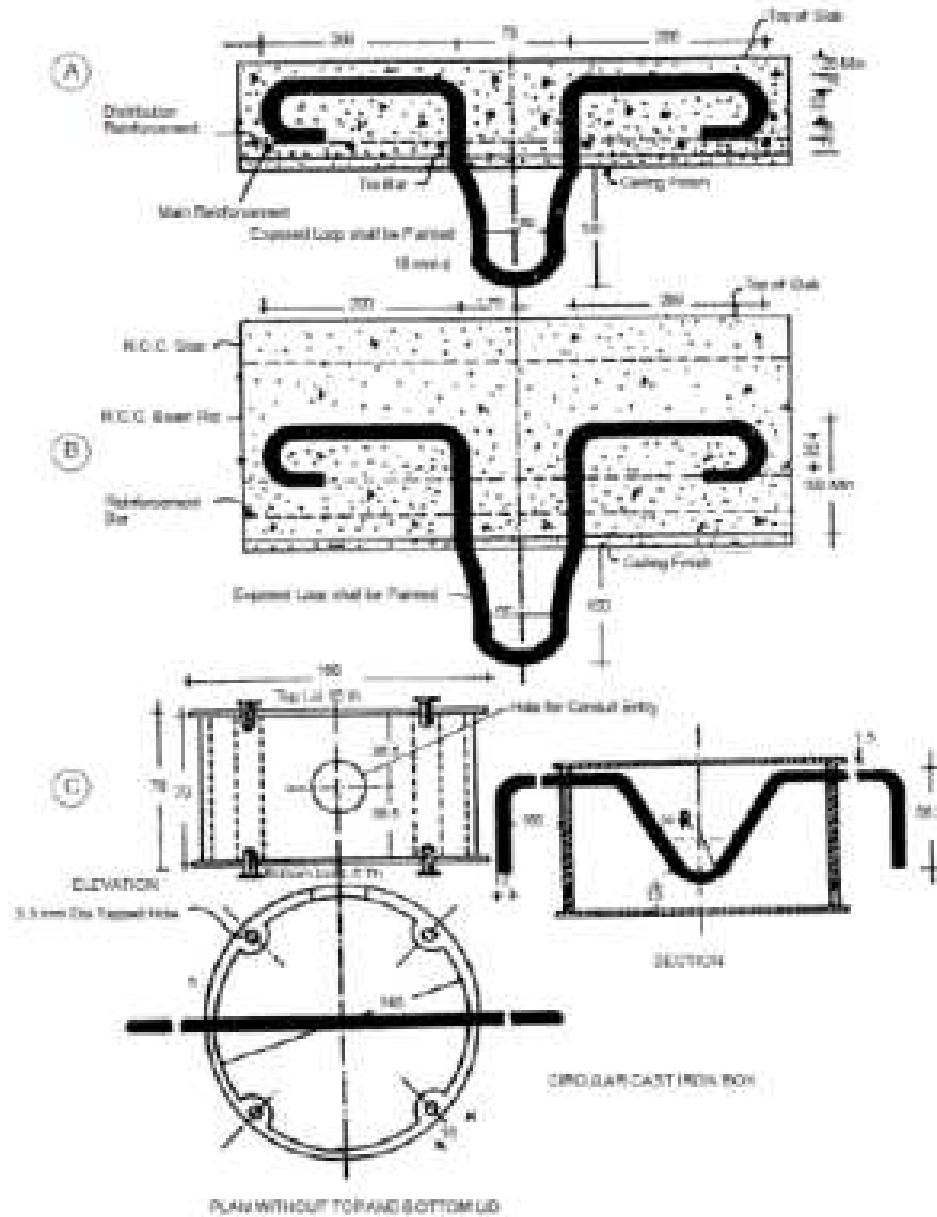


Figure 10.9 : Fan Clamps

Drawing not to Scale  
All dimensions in millimetres



## FLOORING

LOOKING



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### LIST OF MANDATORY TESTS

Material	Clause	Test	Field/ Lab Test	Test Procedure	Frequency of testing for construction work and EPC Project Work	Frequency of testing for maintenance work
1	2	3	4	5	6	7
Terrazzo Tiles	11.10.1 & 11.11.1	1. Transverse strength 2. Water absorption 3 Abrasion test	Lab	IS:1237	One test for every 10,000 Nos. or part thereof for each type and size from single manufacturer. (One test to be done even if the number of terrazzo tiles of any type and size from Single manufacturer is less than 5000 Nos. provided the total number of terrazzo tiles of all types and Sizes from all manufacturers used in work exceed 5000 Nos) (Minimum Qty. 5000 Nos. for all types of sizes from all manufacturers to be used in the work.)	One test for every 10,000 Nos. or part thereof for each type and size from single manufacturer. (One test to be done even if the number of terrazzo tiles of any type and size from Single manufacturer is less than 5000 Nos.  (Minimum Qty. 5000 Nos. for all types of sizes from all manufacturers to be used in the work.)
Pressed Ceramic tiles (for floor)	11.4.11.5 & 11.16	1 Dimensions and surface quality 2 Physical properties 3 Chemical properties	Lab	IS: 13630 Part-2 Part-3 Mohs scale Part-6 Part-7 Part-8	10,000 Nos or part thereof (Minimum Qty. 5000 nos. for each type and size from single manufacturer).	3000 Nos or part thereof (Minimum Qty. 5000 nos. for each type and size from single manufacturer).



## LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl.No.	IS No.	Subject
1.	IS 269	Specification for 33 grade ordinary Portland Cement
2.	IS 401	Code of practice for preservation of timber
3.	IS 451	Technical supply conditions for wood screws
4.	IS 455	Specification for Portland slag cement
5.	IS 661	Code of practice for thermal insulation of cold storages
6.	IS 702	Specification for industrial bitumen
7.	IS 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
8.	IS 1130	Specification for marble (blocks, slabs and tiles)
9.	IS 1141	Code of practice for Seasoning of timber
10.	IS 1200-(Part XI )	Method of measurement of Building and Civil Engineering work (Part 11) paving, floor finishes, dado and skirting
11.	IS 1237- Edition 2.3	Specification for cement concrete flooring tiles
12.	IS 1322	Specification for bitumen felts for water proofing and damp- proofing
13.	IS 1443	Code of practice for laying and finishing of cement concrete flooring tiles
14.	IS 1489 (Part-I)	Specification for Portland pozzolana cement (Part-I) flyash based
15.	IS 1489-(Part II)	Specification for Portland pozzolana cement (Part II) calcined clay based
16.	IS 1580	Specification for bituminous compounds for water proofing and caulking purpose
17.	IS 2114	Code of practice for laying in-situ terrazzo floor finish Code
18.	IS 2571	Code of practice for laying in-situ cement concrete flooring
19.	IS 3622	Specification for sand stone (Slab & Tiles)
20.	IS 3670	Code of practice for construction of timber floors
21.	IS 4457	Acid and/or alkali Resistant tiles.
22.	IS 5318	Code of practice for laying of hard wood parquet and wood block floors
23.	IS 5766	Code of practice for laying of burnt clay brick floor
24.	IS 8041	Specification for rapid hardening Portland cement
25.	IS 8042	Specification for white Portland cement
26.	IS 8043	Specification for hydrophobic Portland cement
27.	IS 8112	Specification for 43 grade ordinary Portland cement



Sl.No.	IS No.	Subject
28.	IS 12330	Specification for sulphate resisting Portland cement.
29.	IS: 13630 (Part-1 to 15)	Methods of Testing of ceramic tiles
30.	IS 13712	Specification for ceramic tiles; definition, classification characteristic and marking
31.	IS 15622	Specification for pressed ceramic tile



## 11 FLOORING

### 11.1 BRICK ON EDGE FLOORING

#### 11.1.1 Bricks

Bricks of Specified class designations shall be used. These shall conform to the specifications described in Subhead 6.0. Broken bricks shall not be used in flooring except for closing the line. The bricks shall be laid on edge.

#### 11.1.2 Mortar

The mortar used shall be as specified (in case of dry bricks flooring fine sand shall be filled in the joints).

#### 11.1.3 Base Concrete

**11.1.3.1** Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slope required for the flooring. Floors in verandah, courtyard kitchens, baths shall have slope ranging from 1: 36 to 1: 48 depending upon locations as decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1: 30 or as decided by the Engineer-in-Charge to drain off washing water. Plinth masonry off-set shall be depressed so as to allow the base concrete to rest on it.

**11.1.3.2** If the base is of lean cement concrete, the flooring shall commence within 48 hours of the laying of base, failing which, the surface of base shall be roughened with steel wire brushes without disturbing the concrete. Before laying the flooring the base shall be wetted and smeared with a coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between sub-grade and flooring.

**11.1.3.3** Where base concrete is not provided, the earth below shall be properly sloped, watered, rammed and consolidated. Before laying the flooring, it shall be moistened.

#### 11.1.4 Soaking of Bricks

Bricks required for flooring shall be perfectly soaked in stacks before use, by profusely spraying clean water at regular intervals for a period of not less than six hours so as to keep them wet to the satisfaction of the Engineer-in-Charge. (In case the joints are to be filled with sand, the bricks need not be soaked).

#### 11.1.5 Laying

**11.1.5.1** The bricks shall be laid on the edge, diagonal herring bone bond, or other pattern as specified or directed by the Engineer-in-Charge.

**11.1.5.2** Bricks shall be laid on edge on 12 mm thick mortar of specified ratio bed and each brick shall be properly bedded and set home by gentle tapping with trowel handle or wooden mallet. It's inside face shall be buttered with mortar, before the next brick is laid and pressed against it.

**11.1.5.3** On completion of a portion of flooring, the vertical joints shall be fully filled from the top with mortar. During laying, the surface of the flooring shall be frequently checked with a straight edge of length at least 2 m, so as to obtain a true plain surface with the required slope.

#### 11.1.6 Joints

Bricks shall be so laid that all joints are full of mortar. The thickness of joints shall not exceed 1.0 cm for brick work with bricks of any class designation. All face joints shall be raked to a minimum depth of 15 mm by raking tool during the progress of work when the mortar is still green so as to provide proper key for the plaster or pointing to be done. Where plastering or pointing is not required to be done, the joints



shall be struck flush and finished at the time of laying. The face of brick work shall be cleaned on the same day on which brick work is done and all mortar droppings removed promptly.

#### 11.1.7 Curing

Brick work shall be protected from rain by suitable covering when the mortar is green. Brick work in cement mortar, shall be kept constantly moist on all faces for a minimum period of seven days. Brick work carried out shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

#### 11.1.8 Measurements

Length and breadth of the flooring shall be measured correct to a cm and area shall be calculated in square metres correct to two places of decimal. Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deduction for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

Brick flooring when laid in diagonal herring bone bond or other pattern as specified or directed by the Engineer-in-Charge shall be measured separately.

#### 11.1.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above, including application of cement slurry on base concrete or RCC slab and cleaning of base. Base concrete shall be paid for separately.

#### 11.1.10 Dry Brick Flooring

All provisions of para's 11.1.1 to 11.1.8 will be applicable except that bricks need not be soaked. Bricks will be laid on a bed of 12 mm thick mud mortar laid to required slope. The joints shall be as thin as possible and not exceeding 5 mm which will be filled with fine sand. No curing is to be done.

**Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above.

### 11.2 CEMENT CONCRETE FLOORING

#### 11.2.1 Cement Concrete

Cement concrete of specified mix grade shall be used and it shall generally conform to the specifications described under sub head 4.0.

#### 11.2.2 Base Concrete

**11.2.2.1** Flooring shall be laid on base concrete where so provided. The base concrete shall be provided with the slopes required for the flooring. Flooring in verandah, Courtyard, kitchens & baths shall have slope ranging from 1: 48 to 1: 60 depending upon location and as decided by the Engineer-in-Charge. Floors in water closet portion shall have slope of 1:30 or as decided by the Engineer-in-Charge to drain off washing water. Further, necessary drop in flooring in bath, WC, kitchen near floor traps ranging from 6 mm to 10 mm will also be provided to avoid spread of water. Necessary margin to accommodate this drop shall be made in base concrete. Plinth masonry off set shall be depressed so as to allow the base concrete to rest on it.

**11.2.2.2** The flooring shall be commenced preferably within 48 hours of the laying of base concrete. The surface of the base shall be roughened with steel wire brushes without disturbing the concrete. Immediately before laying the flooring, the base shall be wetted and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.



- 11.2.2.3** If the cement concrete flooring is to be laid directly on the RCC slab, the top surface of RCC slab shall be cleaned and the laitance shall be removed and a coat of cement slurry @ 2 kg of cement spread over an area of one sqm so as to get a good bond between the base and concrete floor.

### 11.2.3 Thickness

The thickness of floor shall be as specified in the description of the item.

### 11.2.4 Laying

- 11.2.4.1 Panels:** Flooring of specified thickness shall be laid in the pattern including the border as given in the drawings or as directed by the Engineer-in-Charge. The border panels shall not exceed 450 mm in width and the joints in the border shall be in line with panel joints. The panels shall be of uniform size and no dimension of a panel shall exceed 2 m and the area of a panel shall not be more than 2 sqm. The joints of borders at corners shall be mitred for provision of strips.

- 11.2.4.2 Laying of Flooring with Strips:** Normally cement concrete flooring shall be laid in one operation using glass/aluminium/PVC/brass strips/stainless steel strips or any other strips as required as per drawing or instructions of the Engineer-in-Charge, at the junction of two panels. This method ensures uniformity in colour of all the panels and straightness at the junction of the panels. 2 mm PVC strips shall be fixed with their tops at proper level, giving required slopes. Cost of providing and fixing strips shall be included in the rate.

**Concreting:** Cement concrete shall be placed in the panels and be levelled with the help of straight edge and trowel and beaten with thapy or mason's trowel. The blows shall be fairly heavy in the beginning but as consolidation takes place, light rapid strokes shall be given. Beating shall cease as soon as the surface is found covered with a thin layer of cream of mortar. The evenness of the surface shall be tested with straight edge. Surface of flooring be true to required slopes. While laying concrete, care shall be taken to see that the strips are not damaged/disturbed by the labourers. The tops of strips shall be visible clearly after finishing with cement slurry.

**Shuttering:** The panels shall be bounded by angle iron or flats. The angle iron/flat shall have the same depth as the concrete flooring. These shall be fixed in position, with their top at proper level giving required slopes. The surface of the angle iron or flats, to come in contact with concrete shall be smeared with soap solution or non-sticking oil (Form oil or raw linseed oil) before concreting. The flooring shall butt against the unplastered masonry wall.

**Concreting:** The concreting shall be done in the manner described under 9.2.4.2. The angle iron/ flats used for shuttering, shall be removed on the next day of the laying of cement concrete. The ends thus exposed shall be repaired, if damaged with cement mortar 1: 2 (1 cement: 2 coarse sand) and allowed to set for minimum period of 24 hours. The alternate panels shall then be cleaned of dust, mortar, droppings etc. and concrete laid. While laying concrete, care shall be taken to see that the edges of the previously laid panels are not damaged and fresh mortar is not splashed over them. The joints between the panels should come out as fine straight lines.

### 11.2.5 Finishing

- 11.2.5.1** The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some time, till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mixture stiffening the concrete to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided.
- 11.2.5.2** Fresh cement shall be mixed with water to form a thick slurry and spreaded @ 2 kg of cement over an area of one sqm of flooring while the flooring concrete is still green. The cement slurry shall then be properly processed and finished smooth.



**11.2.5.3** The edges of sunk floors shall be finished and rounded with cement mortar 1: 2 (1 cement: 2 coarse sand) and finished with a floating coat of neat cement.

**11.2.5.4** The junctions of floor with wall plaster, dado or skirting shall be rounded off where so specified.

**11.2.5.5** The men engaged on finishing operations shall be provided with raised wooden platform to sit on so as to prevent damage to new work.

#### **11.2.6 Curing**

The curing shall be done for a minimum period of ten days. Curing shall not be commenced until the top layer has hardened. Covering with empty gunnies bag shall be avoided as the colour of the flooring is likely to be bleached due to the remnants of cement dust from the bags.

#### **11.2.7 Precautions**

Flooring in lavatories and bath room shall be laid only after fixing of water closet and squatting pans and floor traps. Traps shall be plugged while laying the floors and opened after the floors are cured and cleaned. Any damage done to W.C.'s squatting pans and floor traps during the execution of work shall be made good.

During cold weather, concreting shall not be done when the temperature falls below 4°C. The concrete placed shall be protected against frost by suitable covering. Concrete damaged by frost shall be removed and work redone. During hot weather, precautions shall be taken to see that the temperature of wet concrete does not exceed 38° C. No concreting shall be laid within half an hour of the closing time of the day, unless permitted by the Engineer-in-Charge. To facilitate rounding of junction of skirting, dado and floor, the skirting/dado shall be laid along with the border or adjacent panels of floor.

#### **11.2.8 Measurement**

Length and breadth shall be measured before laying skirting, dado or wall plaster. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 sqm.

The flooring done either with strips (in one operation) or without strips (in alternate panels) shall be treated as same and measured together.

#### **11.2.9 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above including application of cement slurry on RCC slab or on base concrete including roughening and cleaning the surface but excluding the cost of strips which shall be paid separately under relevant item. Nosing of steps where provided shall be paid for separately in running metre. Nothing extra shall be paid for laying the floor at different levels in the same room or courtyard and rounding off edges of sunk floors. In case the flooring is laid in alternate panels, nothing extra shall be paid towards the cost of shuttering used for this purpose.

### **11.3 CEMENT CONCRETE FLOORING WITH METALLIC HARDENER TOPPING**

**11.3.0** Wherever floors are required to withstand heavy wear and tear, use of floor hardener shall be avoided as far as possible by using richer mixes of concrete, unless the use of a metallic hardener is justified on the basis of cost. Where metallic hardener topping is used, it shall be 12 mm thick.

#### **11.3.1 Metallic Hardening Compound**

The compound shall be of approved quality consisting of uniformly graded iron particles, free from non-ferrous metal particles, oil, grease sand, soluble alkaline compounds. Where so directed by the Engineer-in-Charge it shall be tested as described in Appendix A.





### 11.3.2 Base Concrete

It shall be as specified in 11.2.2.

### 11.3.3 Under Layer

Cement concrete flooring of specified thickness and mix (mentioned in item for under layer) shall be laid as under layer (11.2.1 and 11.2.4). The top surface shall be roughened with brushes while the concrete is still green and the forms/strips shall be kept projecting up 12 mm over the concrete surface, to receive the metallic hardening compound topping.

### 11.3.4 Topping

This shall consist of 12 mm thick layer of mix 1:2 (1 cement: 2 stone aggregate 6 mm nominal size) by volume or as otherwise specified with which metallic hardening compound is mixed in the ratio of 1: 4 (1 metallic concrete hardener: 4 cement) by weight. Metallic hardener shall be dry mixed thoroughly with cement on a clean dry pacca platform. This dry mixture shall be mixed with stone aggregate 6 mm nominal size or as otherwise specified in the ratio of 1: 2 (1 cement: 2 stone aggregate) and well turned over. Just enough water shall then be added to this dry mix as required for floor concrete.

The mixture so obtained shall be laid in 12 mm thickness, on cement concrete floor within 2 to 4 hours of its laying. The topping shall be laid true to provide a uniform and even surface. It shall be firmly pressed into the bottom concrete so as to have good bond with it. After the initial set has started, the surface shall be finished smooth and true to slope with steel floats.

The junction of floor with wall plaster, dado or skirting and finishing operations shall be dealt with as described in 11.2.5.

The men engaged on finishing operations shall be provided with raised wooden platform to sit on, so as to prevent damage to new work.

The specifications for curing, precautions to be taken, 'Measurements' and 'Rates' shall be as specified in 11.2.

## 11.4 CEMENT PLASTER IN RISERS OF STEPS, SKIRTING, DADO

**11.4.0** Plaster at the bottom of wall not exceeding 30 cm in height above the floor shall be classified as skirting. It shall be flush with wall plaster or projecting out uniformly by 6 mm from the wall plaster, as specified. The work shall be preferably carried out simultaneously with the laying of floor. It's corners and junctions with floor shall be finished neatly as specified.

### 11.4.1 Thickness

The thickness of the plaster specified shall be measured exclusive of the thickness of key i.e. grooves or open joints in brick work. The average thickness shall not be less than the specified thickness. The average thickness should be regulated at the time of plastering by keeping suitable thickness of the gauges. Extra thickness required in rounding of corners at junctions of wall shall be ignored.

### 11.4.2 Preparation of Wall Surface

The joints shall be raked out to a depth of at least 15 mm in masonry walls. In case of concrete walls, the surfaces shall be roughened by hacking. The surface shall be cleaned thoroughly, washed with water and kept wet before skirting is commenced.

### 11.4.3 Application

Skirting with specified mortar and to specified thickness shall be laid immediately after the surface is prepared. It shall be laid along with the border or adjacent panels of floor. The joints in skirting shall be



kept true and straight in continuation of the line of joints in borders or adjacent panels. The skirting shall be finished smooth with top truly horizontal and joints truly vertical except where otherwise indicated.

#### **11.4.4 Finishing**

The finishing of surface shall be done simultaneously with the borders or the adjacent panels of floor. The cement to be applied in the form of slurry for smooth finishing shall be at the rate of 2 kg of cement per litre of water applied over an area of 1 sqm.

Where skirting is flush with plaster, a groove 10 mm wide and upto 5 mm deep shall be provided in plaster at the junction of skirting with plaster.

#### **11.4.5 Curing**

Curing shall be commenced on the next day of plastering when the plaster has hardened sufficiently and shall be continued for a minimum period of 7 days.

#### **11.4.6 Measurement**

Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimals for a specified the thickness. Length shall be measured as the finished length of skirting. Height shall be measured from the finished level of floor correct to 5 mm.

#### **11.4.7 Rate**

Rate shall include the cost of all materials and labour involved in all the operations described above.

### **11.5 CEMENT CONCRETE PAVEMENT IN COURTYARD AND TERRACE ETC.**

**11.5.1** Specifications described in 11.2.1, 11.2.2.1, 11.2.3, 11.2.4, 11.2.6 and 11.2.7 shall hold good as far as applicable except that:

- i. The panels shall be of uniform size and no dimension of a panel shall exceed 1.25 m and the area of panel should not exceed 1.25 sqm for the thickness of panels upto 50 mm.
- ii. Concreting shall be done in alternate panels only and no glass/asbestos strips shall be provided.

#### **11.5.2 Finishing**

The finishing of the surface shall follow immediately after the cessation of beating. The surface shall be left for some-time, till moisture disappears from it or surplus water can be mopped up. Use of dry cement or cement and sand mix on the surface to stiffen the concrete or to absorb excessive moisture shall not be permitted. Excessive trowelling shall be avoided. When the surface becomes fairly stiff, it shall be finished rough with wooden floats or where so specified chequered uniformly by pressing a piece of expanded metal of approved size.

#### **11.5.3 Measurements**

Same as 10.2.8 except that the volume will be calculated in cum nearest to two decimal places.

#### **11.5.4 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above except the base concrete below flooring which shall be paid for separately. Chequering to pat tern shall be paid for separately unless otherwise specified.

### **11.6 TERRAZO (MARBLE CHIPS) FLOORING LAID IN SITU: DELETED**

### **11.7 TERRAZO (MARBLE CHIPS) SKIRTING IN SITU: DELETED**

#### **11.7.1 Under Coat**



The under coat of skirting shall be of cement plaster of the thickness and mix described in the item. Specifications given under 11.4.0, 11.4.1 and 11.4.2 shall apply. As regards application, the work shall be carried out in the manner described in para 11.4.3 except that the under coat shall be finished rough with a scratching tool to form a key for the top coat.

#### **11.7.2 Top Coat**

The specifications as in para 11.6.3 shall hold good as far as applicable and shall include cutting to line and fair finish to top edges of terrazo and polishing.

#### **11.7.3 Thickness**

The thickness of the bottom and top coats shall be as specified. The total thickness of skirting specified is of the total thickness of plaster including top coat as measured from the unplastered face of the masonry. Average thickness of the under coat shall not be less than 6 mm and minimum thickness over any portion of the surface shall not be less than 4 mm. The thickness of top coat shall not be less than the thickness specified.

#### **11.7.4 Measurements**

Length and height shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal. Length shall be measured as finished length of skirting. Height shall be measured from the finished level of floor correct to 5 mm where the height of skirting does not exceed 30 cm and when the height exceeds 30 cm it shall be measured correct to a cm.

#### **11.7.5 Rates**

The rate shall include the cost of all materials and labour involved in all the operations described above.

### **11.8 WAX POLISHING**

#### **11.8.1 Application, Polishing and Precautions**

Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the floor/skirting.

**11.8.2** When the layer of the wax is stiffened and surface of floor is saturated with the polish, polishing shall be resorted with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained.

**11.8.3** The fresh polished floor surface shall be spreaded with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed.

#### **11.8.4 Measurements**

Length and breadth shall be measured correct to a cm and its area shall be calculated in sqm correct to two places of decimal.

#### **11.8.5 Rates**

The rate shall include the cost of all materials and labour involved in all the operations described above.

### **11.9 CRAZY MARBLE FLOORING (Fig 11.1)**

#### **11.9.1 Base Concrete**

Crazy marble stone flooring shall be laid on cement concrete base. The base concrete shall be provided with slope required for the flooring in verandahs and courtyards to drain off washing and rain water. The surface of base shall be roughened with steel wire brushes, without disturbing the concrete, wetted and smeared with a floating coat of cement slurry at 2 kg of cement spread over an area of one sqm so as to get a good bond between base and flooring. Before laying the flooring on RCC slabs, the laitance



shall be removed, the surface of slab hacked and a coat of cement slurry at rate of 2 kg of cement spread over an area of one sqm shall be applied so as to get a good bond between RCC slab and floor.

#### 11.9.2 Under Layer

The under layer of crazy marble flooring shall be of cement concrete of thickness 25 mm or as specified. The mix shall normally be 1:2:4 (1 cement: 2 coarse sands: 4 graded stone aggregate 12.5 mm nominal size) by volume unless otherwise specified. It shall conform to the specifications given under para 4.2 of sub-head 'Cement Concrete'.

#### 11.9.3 Top Layer

The mix of crazy marble stone flooring shall consist of white cement with or without pigment, marble powder, marble chips of to 4 mm, marble stone pieces and water. The marble stone pieces shall be hard, sound, dense and pieces homogenous in texture with crystalline and coarse grains. It shall be of with uniform thickness and desired colors, free from stains, cracks, decay and weathering. Before starting the work, the contractor shall get the sample of starting marble stone approved by the Engineer-in-Charge. The marble stone pieces shall be of sizes as approved by the Engineer-in-Charge, but the thickness pieces shall be according to the overall thickness specified which could be achieved but when laid over the under layer as specified. Thus for 43 mm thick floor, the specified thickness of marble pieces will be 18 mm.

The white cement and marble powder shall be mixed in proportion of three parts of cement and one part of marble powder by weight, and the proportion of marble chips to binder mix by volume shall be 7 parts of marble chips to 4 parts of binder mix. The marble chips shall be as specified. It shall be hard, sound, dense and homogeneous in texture. It shall be uniform in colour and free from stains, cracks decay and weathering.

#### 11.9.4 Laying

A coat of cement slurry at the rate of 2 kg of cement per sqm of area shall be spread and then the marble stone pieces shall be set by hand in such a manner that the top surface of all the set marble stones shall be true to the required level and slopes. After fixing the stones, the cement marble chips mixture shall be filled in between the gaps of laid marble stone pieces. The filled surface then shall be trowelled over, pressed and brought to the level of the laid marble stone pieces.

#### 11.9.5 Rate

Payment of marble shall be paid after deducting 10% of plan area in marble.

### 11.10 TERRAZZO TILE FLOORING

#### 11.10.1 Terrazzo Tiles

Terrazzo tiles shall generally conform to IS 1237. Requirements and methods of testing of tiles are described in Appendix B. Unless otherwise specified, the tiles shall be supplied with initial grinding and grouting of wearing layer.

The tiles shall be manufactured in single layer/ monolayer or in double layer. The size of the tile as given in Table 11.2 or as shown in the drawings or as required by the Engineer-in-Charge. Half tiles for use with the full tiles shall be such as to make two half tiles when joined together, match with the dimensions of one full tile.

TABLE 11.2

Length mm	Breadth mm	Minimum Thickness
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		Single Layer or Mono Layer Tile mm	Double Layer Tile mm
200	200	10	15
250	250	12	16
300	300	14	20
300	400	16	25

**11.10.1.1 Tolerance:** Tolerances on length and breadth shall be  $\pm 1$  mm and tolerance on thickness shall be  $+15\%$  of the minimum thickness (no tolerance on the negative side shall be permitted).

The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth, and the difference in thickness between the thickest and the thinnest tile in the sample shall not exceed 10% of the minimum thickness.

**11.10.1.2** The tiles shall be manufactured in a factory under pressure process (with or without vacuum dewatering) or vibration (with or without vacuum dewatering) or combination of both and shall be given the initial grinding with machine and grouting of the wearing layer before delivery to site. The tiles manufactured by pressure alone shall be subjected to hydraulic pressure of not less than 14 N/mm<sup>2</sup>. The wearing layer shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edges of wearing layer may be rounded.

**11.10.1.3** The proportion of cement to aggregate in the backing of the double layer tiles shall be not leaner than 1 : 3 by weight. Single layer/monolayer tiles shall have only the wearing layer. Where coloring material is used in the wearing layer. It shall not exceed 1.0 per cent by weight of cement used in the mix.

**11.10.1.4** The finished thickness of the upper layer shall not be less than 5 mm for size of marble chips ranging from the smallest upto 6 mm and also, not less than 5 mm for size of marble chips ranging from the smallest upto 12 mm, and not less than 6 mm for size of marble chips varying from the smallest upto 20 mm.

## 11.10.2 Laying

**11.10.2.1** Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. The bedding for the tiles shall be with cement mortar of specified proportion and in conformity with provisions in relevant para of chapter on 'Mortar'.

Cement mortar 1:4 (1 Cement: 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall not be less than 10 mm.

**11.10.2.2** Cement mortar bedding shall be spread, tamped and corrected to proper levels and allowed to harden for a day before the tiles are set. If cement mortar is laid in bedding the terrazzo tiles, these shall be set immediately after laying the mortar. Over this bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1 mm and in straight lines or to suit the required pattern. The joints shall be properly cleaned before filling with cement grout of matching colour.

**11.10.2.3** The surface of the flooring during laying shall be frequently checked with a straight edge of length at least 2 metre, so as to obtain a true surface with the required slope.



**11.10.2.4** Where full tiles or half tiles cannot be fixed, tiles shall be cut (sawn) from full tiles to the required size and their edges rubbed smooth to ensure a straight and true joint.

**11.10.2.5** Tiles which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster, skirting or dado. The junction between wall plaster and tiles work shall be finished neatly and without waviness.

**11.10.2.6** After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleared off.

### **11.10.3 Curing, Wax Polishing and Finishing**

**11.10.3.1** The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with grey or white cement mixed with or without pigment to match the shape of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

**11.10.3.2** The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No. 60). Water shall be used profusely during grinding. After grinding the surface shall be thoroughly washed to remove all grinding mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120).

**11.10.3.3** The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge. Wax polish shall be of approved brand and manufacture and in sealed containers. It shall be applied in uniform layer to the dry surface of the floor. When the layer of the wax is stiffened and surface of floor is saturated with the polish, polishing shall be resorted with machine fitted with bobs (pad of rags) and shall be done until shades of all chips have appeared and glossy surface is obtained. The fresh polished floor surface shall be spreaded with dry saw dust to a thickness of about 12 mm uniformly. After the surplus wax has been soaked from the floor surface the saw dust shall be removed.

**11.10.3.4** For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be per mitted in lieu of machine polishing after laying. for hand polishing the following carborundum stones, shall be used:

1st grinding	—	coarse grade stone (No. 60)
Second grinding	—	medium grade (No. 80)
Final grinding	—	fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

**11.10.3.5** After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

**11.10.3.6** If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished.

The finished floor shall not sound hollow when tapped with a wooden mallet.

### **11.10.4 Measurements**



**11.10.4.1** Terrazzo tiles flooring with tiles manufactured from ordinary grey cement without pigment and coloured terrazzo tiles flooring shall be measured separately according to para 9.6.5 Terrazzo tiles flooring shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm before laying skirting, dado or wall plaster shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same room or courtyard.

**11.10.4.2** Terrazzo tile flooring laid in floor borders and similar band shall be measured under the item of terrazzo tile flooring. Nothing extra shall be paid in respect of these and similar bands formed of half size or multiplies of half size standard tiles or other uncut tiles.

**11.10.4.3** Treads of stairs and steps paved with tiles without nosing, shall also be measured under flooring. Moulded nosing shall be paid in running metre except where otherwise stated, returned moulded ends and angles to mouldings shall be included in the description. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm.

#### **11.10.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above. Where cement mortar bedding is used in place of lime mortar the rate will be adjusted accordingly.

### **11.11 TERRAZO TILES IN RISERS OF STEPS, SKIRTING AND DADO**

**11.11.1** The terrazzo tiles shall be as specified in 9.10.1, as far as applicable. The minimum finished thickness of tiles shall, however, be 12 mm. The finished thickness of the upper layer shall be not less than 5 mm for size of marble chips from the smallest upto 12 mm and not less than 6 mm for size of chips varying from the smallest upto 20 mm. Where the bigger sized chips are used the tiles shall be not less than 20 mm thick. The requirements of transverse strength tests specified in Appendix B, shall not apply when the tiles used are less than 20 mm thick.

#### **11.11.2 Preparation of Surface**

The specification for this shall be same as specified in 11.4.2.

#### **11.11.3 Laying**

12 mm thick plaster of cement mortar 1:3 (1 cement: 3 coarse sand) or mix as specified, shall then be applied and allowed to harden. The plaster shall then be roughened with wire brushes or by scratching diagonal lines 2 mm deep at approximately 7.5 cm centres both ways. The back of tiles shall be buttered with a coat of grey cement slurry and edges with grey or white cement slurry with or without pigments to match the shade of tiles and set in the bedding mortar. These shall be tamped and corrected to proper planes and lines. The tiles shall be set in the required pattern and but t jointed. The joints shall be as fine as possible. Top of skirting or dado shall be truly horizontal with projection from finish wall surface not more than tile thickness and joints truly vertical except where otherwise indicated.

The risers of steps, skirting or dado shall rest on the top of the tread or flooring. Where full size tiles cannot be fixed, the tiles shall be cut (sawn) to the required size and their edges rubbed smooth.

#### **11.11.4 Curing, Polishing and Finishing**

The specifications as in 11.10.3 shall hold good as far as applicable. Wax Polishing shall be done only with hand.

#### **11.11.5 Measurements**





The thickness of the skirting shall be as stated. Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread or floor to the top (the underside of tread in the case of steps). This shall be measured correct to 5 mm in case of risers and skirting (not exceeding 30 cm in height). In case of heights more than 30 cm, as in the case of dado and on walls, the height shall be measured correct to a cm and such work shall be paid for separately. The area shall be calculated in square metre, correct to two places of decimal.

Where the height of risers, skirting or dado does not admit of full size or other finished size tiles and the tiles are to be cut (sawn), nothing extra shall be paid for the same.

#### **11.11.6 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be payable for use of cut (sawn) tiles to suit the size of risers, skirting, portions of dado etc.

### **11.12 CHEQUERED TILE FLOORING**

#### **11.12.1 Chequered Tiles**

The tiles shall be of nominal sizes such as 20 × 20 cm, 25 × 25 cm and 30 × 30 cm or of standard sizes with equal sides. The size of tiles to be used shall be as shown in drawings or as required by the Engineer-in-Charge. The centre to centre distance of chequers shall not be less than 2.5 cm and not more than 5 cm.

The overall thickness of the tiles shall not be less than 30 mm. The grooves in the chequers shall be uniform and straight. The depth of the grooves shall not be less than 3 mm. The chequered tiles shall be cement tiles, or terrazzo tiles as specified in the description of the item. The thickness of the upper layer, measured from the top of the chequers shall not be less than 6 mm.

The terrazzo tiles shall be given the first grinding with machine before delivery to site. The tiles shall conform to the specifications for plain cement concrete or terrazzo tiles in respect of method of manufacture and the mix of the backing and wearing layers.

**11.12.2** Laying, curing, Polishing and Finishing shall be as specified in 11.10.2 and 11.10.3 except that wax polishing will not be done and the polishing of the tiles and the chequer grooves, after laying, may be done by hand. Special care shall be taken to polish the grooves in such a manner as to get a uniform section and that their finish shall match with the finish of flat portion of the tiles. Cement concrete tiles normally do not require polishing but where polishing is required the same shall be done as described above.

**11.12.3 Measurement and Rate:** Shall be as specified in 11.10.4 and 11.10.5.

### **11.13 CHEQUERED TILES IN STAIR TREADS (FIG. 11.2)**

#### **11.13.1 Chequered Tiles**

The specifications for tiles shall be as specified in 11.12.1 except in the following respects:

1. The length of the tiles including nosing shall be as specified.
2. The nosing edge of the tile shall be rounded.
3. The minimum thickness of the tile shall be 30 mm.
4. The front portion of the tile for a minimum length of 75 mm from and including the nosing shall have grooves running parallel to the nosing and at centres not exceeding 25 mm. beyond that the tiles shall have the normal chequered pattern.
5. The nosing shall also have the same wearing layer as the top.





### **11.13.2 Preparation of Surface and Laying**

**11.13.2.1** RCC or brick work in treads on which the tiles are to be laid shall be cleaned wetted and mopped. The bedding for tiles shall be with cement mortar 1: 4 (1 cement: 4 coarse sand) or of specified mix. The minimum thickness of bedding mortar at any place shall be 10 mm. Bedding mortar shall be spread, tamped and corrected to proper levels. After laying bedding mortar, neat grey cement slurry of honey like consistency shall be spread over the mortar at the rate of 4.4 kg of cement per square metre over each tread. Tiles shall be washed cleaned and shall be fixed in this grout butting one at another. Each tile being gently tapped with a wooden mallet till it is properly bedded and is in level and line with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines. The surface shall be checked with a straight edge during laying to obtain a true surface.

**11.13.2.2** The square end of the tile shall, as far as possible butt against the riser face of the concrete or brick tread and in any case shall be embedded under the side wall plaster, skirting or dado and under the riser tile or other finish to a depth of not less than 10 mm.

**11.13.2.3** Where full-size tiles cannot be fixed, these shall be cut (sawn) to the required size (along the groove of the chequers where the cut edge is exposed) and used. The cut in the case of embedded edges will be neat and true while the cut in the case of exposed edges shall in addition be rubbed smooth to ensure a straight and true joint.

**11.13.2.4** After the tiles have been laid surplus cement grout shall be cleaned off.

### **11.13.3 Curing, Polishing and Finishing**

The specifications shall be as described in 11.10.3 except that polishing of the treads nosing and chequered grooves, after laying, may be done by hand in the same manner as specified under terrazzo tile flooring. Special care shall be taken to polish the nosing and the grooves in such a manner as to get a uniform, section for the grooves and the nosing and their finish shall match with the finish of the flat portion of the tiles.

### **11.13.4 Measurements**

Chequered tiles on stair treads shall be measured in square metre correct to two places of decimal. Length shall be measured correct to a cm before laying skirting, dado or wall plaster. Width shall be measured correct to a cm from the outer edge of the nosing, as laid, before providing the riser. In the case of the edge tiles of the landing and wide steps, width shall be measured upto the near edge of the chequered stair tread tiles. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

### **11.13.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be payable for cutting the tiles to suit the size of treads and also for nosing.

## **11.14 ACID OR ALKALI RESISTANT TILES**

### **11.14.0 Manufacture and Finish**

The tiles shall be of vitreous ware and free from deleterious substances. The iron oxide content allowable in the raw material shall not exceed 2 percent. The tiles shall be vitrified at the temperature of 1100 °C and above and shall be kept unglazed. The finished tile, when fractured, shall appear fine grained in texture, dense and homogenous. The tiles shall be sound, true to shape, to flat, free from flaws and manufacturing defects affecting their utility.



The tiles shall be conforming to IS 4457. The tiles to be tested for water absorption, compressive strength, acid resistance as per IS 4457. Sampling procedure for acceptance tests and criteria for conformity to be as per IS 4457. The tiles shall be of required colour.

#### **11.14.1 Dimensions and Tolerances**

Ceramic unglazed vitreous acid-resistant tiles shall be made in three sizes namely 98.5 x 98.5 mm, 148.5 x 148.5 mm and 198.5 x 198.5 mm. They shall be available in the following thickness: 35, 30, 25, 20 and 15 mm. The depth of the grooves on the underside of the tile shall not exceed 3 mm. Tolerance on length, breadth and thickness of tiles shall be + 2 percent.

#### **11.14.2 Shape**

The tiles shall be square shaped. Half tiles rectangular in shape shall also be available. Half tiles for use with full tiles shall have dimensions which shall be such as to make two half tiles, when joined together, match with the dimension of full tile. The shape of tiles other than square shall be as agreed to between the purchaser and the manufacturer. Tiles shall be checked for squareness and warp as per IS 4457.

#### **11.14.3 Performance Requirements**

The tiles when tested in accordance with method given in IS 4457, shall conform to be requirement specified in the code (IS 4457).

#### **11.14.4 Loss in Abrasion**

The maximum percentage of loss in abrasion of the ceramic unglazed vitreous acid resistant tiles determined in accordance with the procedure laid down in IS 1237, shall be as mentioned in IS 4457.

#### **11.14.5 Marking**

Tiles shall be legibly marked on the back with the name of the manufacturer or his trademark. Manufacturer's batch number and year of manufacture. Each tile may also be marked with the ISI certification mark.

#### **11.14.6 Preparation of Surface and Laying**

Preparation of surface and laying to be according to para 9.15.4, except the cement used to be acid and or alkali resistant cement and cement mortar to be used to be acid and or Alkali resistant mortar. Thickness of bedding of mortar for flooring to be 10 mm or specified on the item and for dado/skirting to be 12 mm or specified on item.

#### **11.14.7 Pointing and Finishing**

As per para 11.15.5, except that cement used for pointing to be acid and or alkali resistant cement.

#### **11.14.8 Measurements**

As per para 11.15.6.

#### **11.14.9 Rate**

The rate for flooring shall include the cost of all materials and labor involved in all the operations described above. For tiles of sizes upto 0.16 Sqm, unless otherwise specified in the description of the item. Nothing extra shall be paid for the use of cost (Sawn) tiles in the work.

### **11.15 PRESSED CERAMIC TILE FLOORING**

#### **11.15.1 Ceramic Tiles**



The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630. Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1,3,5, and 7 of IS 15622 give the modular preferred sizes and table 2,4,6 and 8 give the most common non modular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width upto 2mm for unrectified floor tiles and upto 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table 10 of IS 15622 with water absorption 3 to 6% (Group BII).

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only upto 50 per cent of the surface area of the edges.

#### **11.15.2 Coloured Tiles**

Only the glaze shall be coloured as specified. The sizes and specifications shall be the same as for the white glazed tiles.

#### **11.15.3 Decorative Tiles**

The type and size of the decorative tiles shall be as follows:

- i. Decorated white back ground tiles

The size of these tiles shall be as per IS 15622.

- ii. Decorated and having coloured back-ground

The sizes of the tiles shall be as per IS 15622.

#### **11.15.4 Preparation of Surface and Laying**

##### **11.15.4.1** Base concrete or the RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped.

The bedding for the tile shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as specified. The average thickness of the bedding shall be 20 mm or as specified while the thickness under any portion of the tiles shall not be less than 10 mm.

##### **11.15.4.2** Mortar shall be spread, tamped and corrected to proper levels and allowed to harden sufficiently to offer a fairly rigid cushion for the tiles to be set and to enable the mason to place wooden plank across and squat on it.

##### **11.15.4.3** Over this mortar bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 3.3 kg of cement per square metre over an area upto one square metre. Tiles shall be soaked in water washed clean and shall be fixed in this grout one after another, each tile gently being tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern.

##### **11.15.4.4** The surface of the flooring during laying shall be frequently checked with a straight edge about 2 m long, so as to obtain a true surface with the required slope. In bath, toilet, WC, kitchen and balcony/verandah flooring, suitable tile drops or as shown in drawing will be given in addition to required slope to avoid spread of water. Further tile drop will also be provided near floor trap.



**11.15.4.5** Where full-size tiles cannot be fixed these shall be cut (sawn) to the required size, and their edge rubbed smooth to ensure straight and true joints. Tiles which are fixed in the floor adjoining the wall shall enter not less than 10 mm under the plaster, skirting or dado.

**11.15.4.6** After tiles have been laid surplus cement slurry shall be cleaned off.

#### **11.15.5 Pointing and Finishing**

The joints shall be cleaned off the grey cement slurry with wire/coir brush or trowel to a depth of 2 mm to 3 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement added with pigment if required to match the colour of tiles. Where spacer lug tiles are provided, the half the depth of joint shall be filled with polysulphide or as specified on top with under filling with cement grout without the lugs remaining exposed. The floor shall then be kept wet for 7 days. After curing, the surface shall be washed and finished clean. The finished floor shall not sound hollow when tapped with a wooden mallet.

#### **11.15.6 Measurements**

Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster and the area calculated in square metre correct to two places of decimal. Where coves are used at the junctions, the length and breadth shall be measured between the lower edges of the coves.

No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre.

#### **11.15.7 Rate**

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above, nothing extra shall be paid for the use of cut (sawn) tiles in the work. Rate shall include colour tiles.

#### **11.16A Pendulum Test for skid resistance**

In case of skid resistance test, Pendulum should be done for dry and wet condition. The criteria of Pendulum reading for various types of flooring material for dry wet conditions is given in Table No. 9.3.

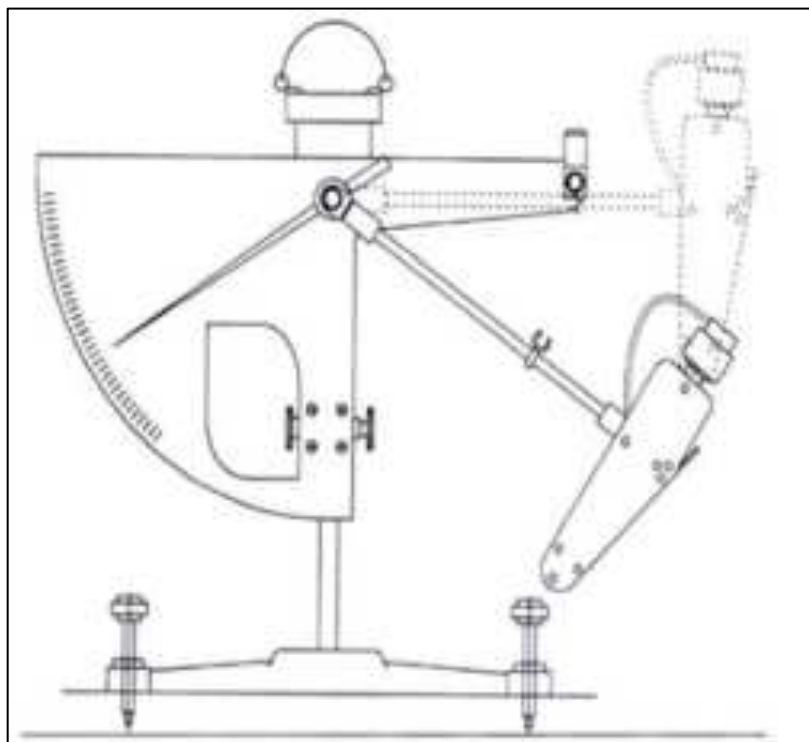
This test consists of Pendulum shaped apparatus that is allowed to fall from certain angle so that it rubs against the surface that is being tested. A four S rubber cap is fitted on its end & it is allowed to fall in a per pendulum arc depending upon the height reached after rubbing against the tested surface, a value is obtained that will be use to classify its slip resistance, is interpreted follows:

**Table No. 11.3**

S. No	Classification of flooring	Pendulum Reading (Range)	Remarks
A.	Dry Areas	25 to 35	For all type of flooring material tested in dry condition
B.	Wet Areas	35 to 64	-do-

#### **Note:**

1. Dry areas – All spaces in residential building except toilet and kitchen.
2. Wet areas – Toilet and Kitchen in residential building, swimming pool, public places, etc.



Pendulum Test Method

#### 11.16 PRESSED CERAMIC TILE FLOORING (VITRIFIED TILE FLOORING)

**11.16.1** Operations as described in 11.15.1 to 11.15.6 shall be followed except the tiles shall conform to Table 12 of IS 15622 (Tiles with water absorption  $E \leq 0.08$  per cent Group B la) and the joint thickness in flooring shall not be more than 1mm.

##### 11.16.2 Rate

The rate for flooring shall include the cost of all materials and labour involved in all the operations described above. Nothing extra shall be paid for the use of cut (sawn) tiles in the work.

#### 11.17 FIXING OF TILE FLOORING WITH CEMENT BASED HIGH POLYMER MODIFIED QUICK SET ADHESIVE (WATER BASED)

**11.17.1** When tile flooring is to be laid over the existing flooring without dismantling old flooring it can be laid with adhesive. The old flooring shall be thoroughly cleaned and checked for undulations, if any shall be rectified with cement mortar 1:3 (1 cement: 3 coarse sand). Old cement concrete surface shall be hacked and cleaned off to have proper bond with the old surface.

**11.17.2** High polymer modified quick set tiles adhesive (conforming to IS 15477) shall be thoroughly mixed with water and a paste of zero slump shall be prepared so that it can be used within 1.5 to 2 hours. It shall be spread over an area not more than one sqm at one time. Average thickness of adhesive shall be 3 mm.

The adhesive so spreader shall be combed using suitable trowel. Tiles shall be pressed firmly **into** the position with slight twisting action checking it simultaneously to ensure good contact gently being tapped with wooden mallet till it is properly backed with adjoining tiles. The tiles shall be fixed within 20 minutes of application of adhesive. The surplus adhesive from the joints, surface of the tiles shall be immediately cleaned.



**11.17.3** The surface of the flooring shall be frequently checked during laying with straight edge of above 2m long so as to attain a true surface with required slope.

**11.17.4** Where spacer lugs tiles are provided these shall be filled with grout with lugs remaining exposed.

**11.17.5** Where full size tile cannot be fixed these shall be cut (sawn) to the required size and edges rubbed smooth to ensure straight and true joints. Tiles which are fixed in floor adjoining to wall shall enter not less than 10 mm under plaster, skirting or dado.

**11.17.6 Finishing:** Para 11.15.5 shall apply.

**11.17.7 Measurements:** Para 11.15.6 shall apply.

**11.17.8 Rate**

Provisions of para 11.15.7 and 11.16.2 shall apply.

**11.18 PRESSED CERAMIC TILES IN SKIRTING & DADO: (Shifted to 8.19)**

Clause shifted to Sub Head 8 (Cladding work) as clause no 8.19

**11.19 MARBLE STONE FLOORING**

**11.19.1 Marble Stone**

It shall be as specified in sub head 8.0.

**11.19.2 Dressing of Slabs**

Every stone shall be cut to the required size and shape, fine chisel dressed on all sides to the full depth so that a straight edge laid along the side of the stone shall be fully in contact with it. The top surface shall also be fine chisel dressed to remove all waviness. in case machine cut slabs are used, fine chisel dressing of machine cut surface need not be done provided a straight edge laid anywhere along the machine cut surfaces is in contact with every point on it. The sides and top surface of slabs shall be machine rubbed or table rubbed with coarse sand before paving. All angles and edges of the marble slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slabs shall be 18, 30 or 40 mm as specified in the description of the item. Tolerance of + 3% shall be allowed for the thickness. In respect of length and breadth of slabs a tolerance of  $\pm 2\%$  shall be allowed.

**11.19.3 Laying**

**11.19.3.1** concrete or the RCC slab on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:4 (1 cement: 4 coarse sand) or as given in the description of the item.

**11.19.3.2** The average thickness of the bedding mortar under the slab shall be 20 mm and the thickness at any place under the slab shall be not less than 12 mm.

**11.19.3.3** The slabs shall be laid in the following manner:

Mortar of the specified mix shall be spread under the area of each slab, roughly to the average thickness specified in the item. The slab shall be washed clean before laying. It shall be laid on top, pressed, tapped with wooden mallet and brought to level with the adjoining slabs. It shall be lifted and laid aside. The top surface of the mortar shall then be corrected by adding fresh mortar at hollows. The mortar is allowed to harden a bit and cement slurry of honey like consistency shall be spread over the same at the rate of 4.4 kg of cement per sqm. The edges of the slab already paved shall be buttered with grey or white cement with or without admixture of pigment to match the shade of the marble slabs as given in the description of the item.



The slab to be paved shall then be lowered gently back in position and tapped with wooden mallet till it is properly bedded in level with and close to the adjoining slabs with as fine a joint as possible. Subsequent slabs shall be laid in the same manner. After each slab has been laid, surplus cement on the surface of the slabs shall be cleaned off. The flooring shall be cured for a minimum period of seven days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge. Joint thickness shall not be more than 1 mm.

Due care shall be taken to match the grains of slabs which shall be selected judiciously having uniform pattern of Veins/streaks or as directed by the Engineer-in-Charge.

**11.19.3.4** The slabs shall be matched as shown in drawings or as instructed by the Engineer-in-Charge.

**11.19.3.5** Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster skirting or dado. The junction between wall plaster and floor shall be finished neatly and without waviness.

**11.19.3.6** Marble slabs flooring shall also be laid in combination with other stones and/or in simple regular pattern/design as described in item of work and/or drawing.

#### **11.19.4 Polishing and Finishing**

Slight unevenness at the meeting edges of slabs shall then be removed by fine chiselling and finished in the same manner as specified in 11.10.3 except that high gloss mirror finish polish shall be done. Cement slurry with or without pigments shall not be applied on the surface before each polishing.

#### **11.19.5 Measurements**

Marble stone flooring with different kind of marble shall be measured separately and in square metre correct to two places of decimal. Length and breadth shall be measured correct to a cm before laying skirting, dado or wall plaster. In the case of radially dressed or circular stone used in the work, the dimensions of the circumscribing rectangle of the dressed stone, shall be measured correct to a centimeter. No deduction shall be made nor extra paid for voids not exceeding 0.20 square metre. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for laying the floor at different levels in the same room. Steps and treads of stairs paved with marble stone slabs shall also be measured under the item of Marble Stone flooring. Extra shall, however, be paid for such areas where the width of treads does not exceed 30 cm. Nosing for treads shall be measured in running metre and paid for extra. The width of treads shall be measured from the outer edge of the nosing, as laid, before providing the riser.

#### **11.19.6 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above. However, extra shall be paid for making special type of pattern/design/flowers as per drawings. No deductions shall be made in rate even if flooring is done without any pattern/design.

### **11.20 MARBLE STONE IN RISERS OF STEPS AND SKIRTING**

**11.20.1** Marble Stone Slabs and Dressing of Slabs shall be as specified in 11.19.1 and 11.19.2 except that the thickness of slabs shall be 18 mm. A tolerance of  $\pm 3\%$  mm shall be allowed, unless otherwise specified in the description of the item.

#### **11.20.2 Preparation of Surface**

It shall be as specified in 11.18.2 where necessary, the wall surface shall be cut uniformly to the requisite depth so that the skirting face shall have the projection from the finished face of wall as shown in drawings or as required by the Engineer-in-Charge. In no case the skirting should project by more than thickness of stone.





### 11.20.3 Laying

The risers of steps and skirting shall be in grey or white cement admixed with or without pigment to match the shade of the stone, as specified in the description of the item, with the line of the slab at such a distance from the wall that the average width of the gap shall be 12 mm and at no place the width shall be less than 10 mm, if necessary, the slabs shall be held in position by temporary M.S. hooks fixed into the wall at suitable intervals. The skirting or riser face shall be checked for plane and plumb and corrected. The joints shall thus be left to harden then the rear of the skirting or riser slab shall be packed with cement mortar 1:3 (1 cement : 3 coarse sand) or other mix as specified in the description of the item. The fixing hooks shall be removed after the mortar filling the gap has acquired sufficient strength.

The joints shall be as fine as possible but not more than 1 mm. The top line of skirting and risers shall be truly horizontal and joints truly vertical, except where otherwise indicated. The risers and skirting slab shall be matched as shown in drawings or as instructed by the Engineer-in- Charge.

### 11.20.4 Curing, Polishing and Finishing

It shall be as specified in 11.19.4 as far as applicable, except that cement slurry with or without pigment shall not be applied on the surface and polishing shall be done only with hand. The face and top of skirting shall be polished.

### 11.20.5 Measurements

Length shall be measured along the finished face of riser or skirting, correct to a cm. Height shall be measured from the finished level of tread or floor to the top (the underside of tread, in the case of steps) correct to 0.5 cm. The areas shall be calculated in square metre correct to two places of decimal.

Dado and lining of pillars etc. shall be measured as 'Marble work in wall lining. if the thickness is upto 25 mm or as "Marble Work" in Jambes, walls, columns and other plain work' if the thickness is more.

### 11.20.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

## 11.21 KOTA STONE FLOORING

### 11.21.1 Kota Stone Slabs

The slabs shall be of selected quality, hard, sound, dense and homogeneous in texture free from cracks, decay, weathering and flaws. They shall be hand or machine cut to the requisite thickness. They shall be of the colour indicated in the drawings or as instructed by the Engineer-in-Charge.

The slabs shall have the top (exposed) face polished before being brought to site, unless otherwise specified. The slabs shall conform to the size required. Before starting the work the contractor shall get the samples of slabs approved by the Engineer-in-Charge.

### 11.21.2 Dressing

Every slab shall be cut to the required size and shape and fine chisel dressed on the sides to the full depth so that a straight edge laid along the side of the stone shall be in full contact with it. The sides (edges) shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges of the slabs shall be true, square and free from chippings and the surface shall be true and plane.

The thickness of the slab after it is dressed shall be 20, 25MM or as specified in the description of the item. Tolerance of  $\pm 2$  mm shall be allowed for the thickness. In respect of length and breadth of slabs Tolerance of  $\pm 5$  mm for hand cut slabs and  $\pm 2$  mm for machine cut slabs shall be allowed.

### 11.21.3 Preparation of Surface and Laying





The specification shall be as described in 11.19.3 except that the edges of the slabs to be jointed shall be buttered with grey cement, with admixture of pigment to match the shade of the slab. The thickness of the joints should be minimum as possible. In any location, it shall not exceed 1 mm.

#### **11.21.4 Polishing and Finishing**

The specifications shall be as described in 11.10.3 except that (a) first polishing with coarse grade carborundum stone shall not be done, (b) cement slurry with or without pigment shall not be applied on the surface before polishing.

#### **11.21.5 Measurements and Rates**

These shall be as described in paras 11.19.5 and 11.19.6.

### **11.22 KOTA STONE IN RISERS OF STEPS, SKIRTING AND DADO**

**11.22.1** Kota Stone Slabs and Dressing shall be as specified in 11.21.1 and 11.21.2 except that the thickness of the slabs shall be 25 mm or as specified in the description of the item. The slabs may be of uniform size if required.

**11.22.2** Preparation of surface shall be as specified in 11.20.3.

**11.22.3** Laying shall be as specified in 11.20.3 except that the joints of the slabs shall be set in grey cement mixed with pigment to match the shade of the slabs.

**11.22.4** Curing, Polishing and Finishing shall be as specified in 11.10.3 except that first polishing with coarse grade carborundum stone shall not be done.

#### **11.22.5 Measurements**

Length shall be measured along the finished face of riser, skirting or dado correct to a cm. Height shall be measured from the finished level of tread of floor to the top (the underside of tread in the case of steps). This shall be measured correct to a mm in the case of risers of steps and skirting and correct to a cm in the case of dado. The area shall be calculated in square metre correct to two places of decimal.

Lining of pillars etc. shall also be measured under this item.

#### **11.22.6 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above.

### **11.23 RED OR WHITE FINE DRESSED SAND STONE FLOORING**

#### **11.23.1 Stone Slabs**

The slabs shall be red or white as specified in the description of the item. The stone slabs shall be hard, sound, durable and tough, free from cracks, decay and weathering. In case of red sand stone, white patches or streaks shall not be allowed. However, scattered spots upto 10 mm diameter will be permitted. Before starting the work the contractor shall get samples of slabs approved by the Engineer-in-Charge.

The slabs shall be hand or machine cut to the requisite thickness along planes parallel to the natural bed of stone and should be of uniform size if required.

#### **11.23.2 Dressing of Slabs**

Every slab shall be cut to the required size and shape and chisel dressed on all sides to a minimum depth of 20 mm. The top and the joints shall be fine tooled so that straight edge laid along the face is fully in contact with it. In case machine cut stones are used, chisel dressing and fine tooling of machine cut surface need not be done provided a straight edge laid anywhere along the machine cut surface is in contact with every point on it.



The thickness of the slabs after dressing shall be 40 mm or as specified in the description of item with a permissible tolerance of  $\pm 2$  mm.

### **11.23.3 Laying**

**11.23.3.1** Base concrete on which the slabs are to be laid shall be cleaned, wetted and mopped. The bedding for the slabs shall be with cement mortar 1:5 (1 cement: 5 coarse sand) or as given in the description of the item.

**11.23.3.2** The average thickness of the bedding mortar under the slabs shall be 20 mm and the thickness at any place under the slabs shall not be less than 12 mm.

**11.23.3.3** The slab shall be laid in the following manner:

Mortar of specified mix shall be spreaded under each slab. The slab shall be washed clean before laying. It shall then be laid on top, pressed and lapped, so that all hollows underneath get filled and surplus mortar works up through the joints. The top shall be tapped with a wooden mallet and brought to level and close to the adjoining slabs, with thickness of joint not exceeding 5 mm. Subsequent slabs shall be laid in the same manner. After laying each slab surplus mortar on the surface of slabs shall be cleaned off and joints finished flush.

**11.23.3.4** In case pointing with other mortar mix is specified, the joint shall be left raked out uniformly and to a depth of not less than 12 mm when the mortar is still green. The pointing shall be cured for a minimum period of 7 days. The surface of the flooring as laid shall be true to levels and slopes as instructed by the Engineer-in-Charge.

**11.23.3.5** Slabs which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the plaster, skirting or dado. The junction between wall plaster skirting and floor shall be finished neatly and without waviness.

**11.23.3.6** The finished floor shall not sound hollow when tapped with wooden mallet.

### **11.23.4 Finishing**

In case of chisel dressed stone flooring slight unevenness, if any existing between the edges of slabs at joints shall then be removed by chiselling in a slant.

### **11.23.5 Measurements**

These shall be as specified in para 11.19.5.

### **11.23.6 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above. Where pointing is to be done, this will be paid extra unless specifically included in the description of the item.

## **11.24 RED OR WHITE FINE DRESSED AND RUBBED SAND STONE FLOORING**

Stone Slabs shall be as specified in 11.23.1.

### **11.24.1 Dressing**

The specifications for dressing the top surface and the sides shall be as described in 11.23.2. in addition, the dressed top and sides shall be table rubbed with coarse grade carborundum stone before paving, to obtain a perfectly true and smooth surface free from chisel marks. The thickness of the slabs after dressing shall be as specified with a permissible tolerance of  $\pm 2$  mm.

### **11.24.2 Laying**



The slabs shall be laid with 3 mm thick or 5 mm thick joints as specified in the description of the item. Where the joints are to be limited to 3 mm thickness, the slabs shall be laid as specified in 11.19.3 except that the bedding mortar shall be as specified in 11.23.3 and sides of the slabs to be jointed shall be buttered with cement mortar 1:2 (1 cement: 2 stone dust) admixed with pigment to match the shade of the slab.

Where the slabs are to be laid with 5 mm thick joints, the specifications for laying shall be as described in 11.23.3. Finishing shall be as specified in 11.23.4 except that chisel marks and unevenness shall be removed by rubbing with coarse grade carborundum stone.

Measurement and Rate shall be as specified in 11.23.5 and 11.23.6.

#### **11.25 WOODEN FLOORING: DELETED**

#### **11.26 WOOD BLOCK FLOORING: DELETED**

#### **11.27 TURF PAVER**

**11.27.1** Turf Paver is used primarily for the creation of grass or gravel access pathways for heavy emergency vehicles and stabilization of areas such as overflow parking, home driveways, golf buggy and equestrian dressage arenas and paths, helicopter landing pads and boat parking ramps. It also serves as a stabilizer for mild slopes and functions as an erosion control measure.

It is a high strength plastic module designed to contain and stabilize grass or decorative gravel with the ability to withstand heavy loads imposed by emergency vehicles such as fire trucks. It replaces asphalt and concrete to create permeable surfaces that may be turfed or planted with ground cover and enable these areas to blend into the aesthetics of their surroundings.

It consists of a network of sturdy porous cells which prevents soil compaction. It has top and bottom notches with a large open base that allow root and plant runners to spread freely for vigorous root development and promote healthy plant growth.

##### **Advantages**

- i. Supports heavy vehicular load
- ii. Does not hinder root and runner growth
- iii. Reduces erosion and soil migration
- iv. Easily installed and removed
- v. Conforms to uneven surfaces
- vi. Supports Green Building Certification

#### **11.27.2 Applications**

Fire engine access lanes, Pedestrian pathways, Residential driveways, Overflow & street shoulder parking areas, Golf buggy paths & Racetrack infields and pit areas 150 mm thick compacted bed of 20 mm nominal size stone aggregate shall be prepared by ramming and consolidation. 150 mm thick jamuna sand shall be spreaded, rammed and consolidated including watering and finishing smooth etc. as per direction of Engineer-in-Charge. The turf paver shall then be laid on finished smooth surface.

#### **11.27.3 Technical Specifications**

Description	Specification
Material	Polypropylene
Dimensions	500 mm x 500 mm



Height	40 mm
Cell Size (diagonal)	70 mm
Weight	4.3 kg/m <sup>2</sup> (Tolerance= (-) 1%)
Compressive Strength (unfilled)	150 t/m <sup>2</sup> (Tolerance= (-) 1%)
Compressive Strength (sand filled)	3000 t/m <sup>2</sup> (Tolerance= (-) 1%)
Service Temperature	-30 °C to 80 °C
Biological Resistance	Unaffected by moulds and algae
Chemical Resistance	Resistant to rot, oils, acids, alkalis, bitumen and naturally occurring soil chemicals

#### 11.27.4 Measurements

Length and breadth correct to a cm of Turf paver surface shall be measured and area shall be calculated in sqm correct to two places of decimal.

#### 11.27.5 Rates

The rate for Turf paver shall include the cost of all materials and labour involved in all operations described above. Nothing extra shall be paid.

### 11.28 BORDER TILES

Border tiles may be use to frame, highlight, and add a decorative edge finish to an area for perfection. Border tiles are often used in kitchens and bathrooms.

The preparation of surfaces, laying, curing and finishing shall be as described under clause 11.19.

#### 11.28.1 Measurement

The length of border tile shall be measured in running metre correct upto a cm.

### 11.29 EPOXY BASED GROUTING FOR TILES:

#### 11.29.1 Epoxy Grout

Grout is the material that is used to fill the space between adjacent tiles and support the joints.

The Epoxy grout consists of mix of 0.70 kg of organic coated filler of desired shade and mixing of 0.10 kg of hardener and 0.20 kg of resin per kg. They have very low water absorption, higher compressive strength and are resistant to staining and easy to maintain. Epoxy grout is a waterless mix formed by mixing a base material (part A) and a hardener (part B). These components are mixed at site just prior to grouting.

Generally, epoxy grouts require no additional sealer to protect the surface.

#### 11.29.2 Application process Surface preparation

It shall be ensured that tiles are firmly set and adhesive or mortar is completely dry for 24 hours. All spacers, pegs, ropes and string shall be removed and joints be cleaned by removing free loose dirt particles.

#### 11.29.3 Preparing mix and application

The complete unit Part A (Base) and Part B (Hardener) shall be properly mixed in given ratio. The desired colour of grout shall be obtained by mixing required quantity of colour with base to ensure homogeneity.



The grout shall be pressed firmly by using a hard rubber squeeze into joints ensuring that joints are completely filled. Excess grout material shall be removed from joints and surface by moving squeeze on grout line after 22 to 25 minutes. The damp sponge shall be used in circular motion on tile surface to achieve the flush joint. After completion of work the grout haze shall be cleaned with clean water or soap solution. The suitable rubber gloves shall be used to avoid skin contact during application.

#### **11.29.4 Measurement**

Length and breadth of grouted tile area shall be measured correct to a cm and the area shall be calculated in sqm correct to two places of decimal.

#### **11.29.5 Rates**

The rate shall include the cost of all materials and labour involved in all operations described above. Nothing extra shall be paid.

### **11.30 ITALIAN MARBLE STONE FLOORING**

Italian marbles Quarried and processed in Italy and these marble raw stones are imported from Italy to India. Italian marble is famous for rendering a high sheen and visual appeal to the ambiance in which it is installed. It is available all over world. Italian Marble gives the rich appearance to the house floor, walls, Kitchen, rooms and bathroom with its beautiful colour and special lusters. Because of its elegant visual it is commonly used for the decorative purpose in buildings.

#### **11.30.1 Italian Marble Stone**

The Italian marble details shall be as specified in sub head 8.0. Other details such as dressing of slabs, laying, polishing, finishing, measurements and rates shall be as specified in clause 11.19 with Italian marble stone in place of Indian marble stone.

#### **11.31 FLAMED FINISH GRANITE STONE FLOORING: DELETED**

**ABRASION TEST FOR CONCRETE HARDENING COMPOUNDS**  
(Clause 11.3.1)**A-1 Preparation of Sample**

25 mm cylinder shall be prepared in ratio 1:2 mix (1 cement: 2 grades stone aggregate 6 mm nominal size by weight) one each with and without the admixture of concrete hardening compound. The concrete hardening compound shall be used in the proportion by weight of cement as recommended by the firm. The cylinder shall be placed inside a damp box for 24 hours and then cured in water for 27 days. After that, they shall be subject to abrasion test on 'Dorry Type Avery Abrasion Testing Machine, using Emery powder No 80 as the abrading medium under the condition given in para A-2 below:

**A-2 Conditions of Test**

- a) Area of rubbing surface shall be same in both the cylinders.
- b) Age of cylinder 28 days
- c) Duration of Test 60 minutes
- d) Total distance traverse During rubbing About 2.4 km
- e) Pressure on rubbing 0.04 kg/cm<sup>2</sup> surface

**A-3 Results of Tests**

The following observations shall be made in both the cases.

- a) Composition of the Test specimen
- b) Mean thickness rubbed away
- c) Percentage loss in weight

**A-4 Remarks**

Percentage loss in weight in the case of cylinders with concrete hardening compound, should not be more than 40% of the percentage loss in the case of cylinder without concrete hardening compound.



**TEST REQUIREMENTS AND PROCEDURE FOR TESTING**  
**“PRE-CAST CEMENT CONCRETE/ TERRAZO TILES”**  
**(Clause 11.10.1 & 11.11.1)**

**B-1 Sampling**

The tiles required of carrying out test described below shall be taken by ‘random sampling’. Each tiles sample shall be marked to identify the consignment from which it was selected. Minimum quantity of tiles for carrying out the test and frequency of test shall be as specified in the list of Mandatory Test. The number of tiles selected for each mandatory test shall be as follows”

For conformity to requirements on shape and dimensions,

- |    |                                    |            |
|----|------------------------------------|------------|
| a) | wearing layer, and general quality | - 12 tiles |
| b) | For wet transverse strength test   | - 6 tiles  |
| c) | For resistance to wear test        | - 6 tiles  |
| d) | For water absorption test          | - 6 tiles  |

Note:

- (1) The tests on the tiles shall not be carried out earlier than 28 days from the date of manufacture.
- (2) The tiles selected for (a) may as well after verification of requirements, be used for (b).

**B-2 Flatness of the Tiles Surface**

The tiles when tested according to procedure laid down in Annex B of IS 1237-2012, the amount of concavity and convexity shall not exceed 1 mm.

**B-3 Perpendicularity**

When tested in accordance with procedure laid down in Annex C of IS 1237-2012, the longest gap between the arm of the square and edge of the tile shall not exceed 2 per cent of the length of edge.

**B-4 Straightness**

When tested in accordance with procedure laid down in Annex D of IS 1237-2012, the gap between the thread and the plane of tile shall not exceed 1 percent of the length of edge.

**B-5 Water Absorption**

When tested in accordance with procedure laid down in Annex E of IS 1237-2012, the average water absorption shall not exceed 10 per cent.

**B-6 Wet Transverse Strength Test**

Six full size tiles shall be tested for the determination of wet transverse strength. When tested in accordance with procedure laid down in Annex F of IS 1237-2012, the average wet transverse strength shall not be less than 3 N/mm<sup>2</sup> (30 kgf/cm<sup>2</sup>)

**B-7 Resistance to Wear Test**

When tested according to Annex G of IS 1237-2012,

For general purpose floor tiles, average wear shall not exceed 3.5 mm and the wear on any individual specimen shall not exceed 4 mm.

For Heavy duty floor tiles, average wear shall not exceed 2 mm and the wear on any individual specimen shall not exceed 2.5 mm.

## CRAZY MARBLE FLOORING

Sub Head : Flooring  
Clause : 11.9

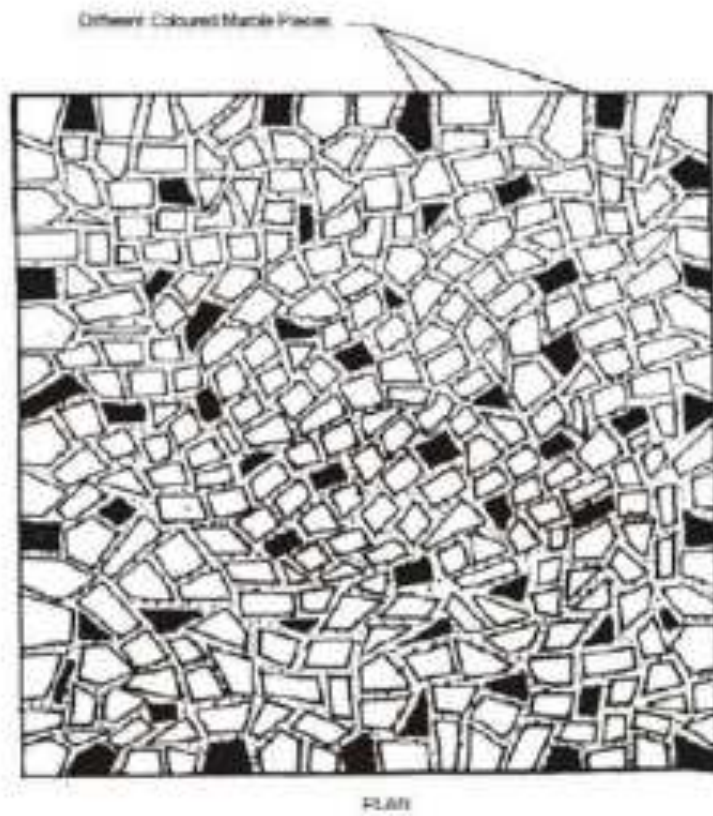


Figure 11.1 : Crazy Marble Flooring

Drawing not to scale



## CHEQUERED TERRAZO TILES

Sub Head : Flooring  
Clause : 11.13

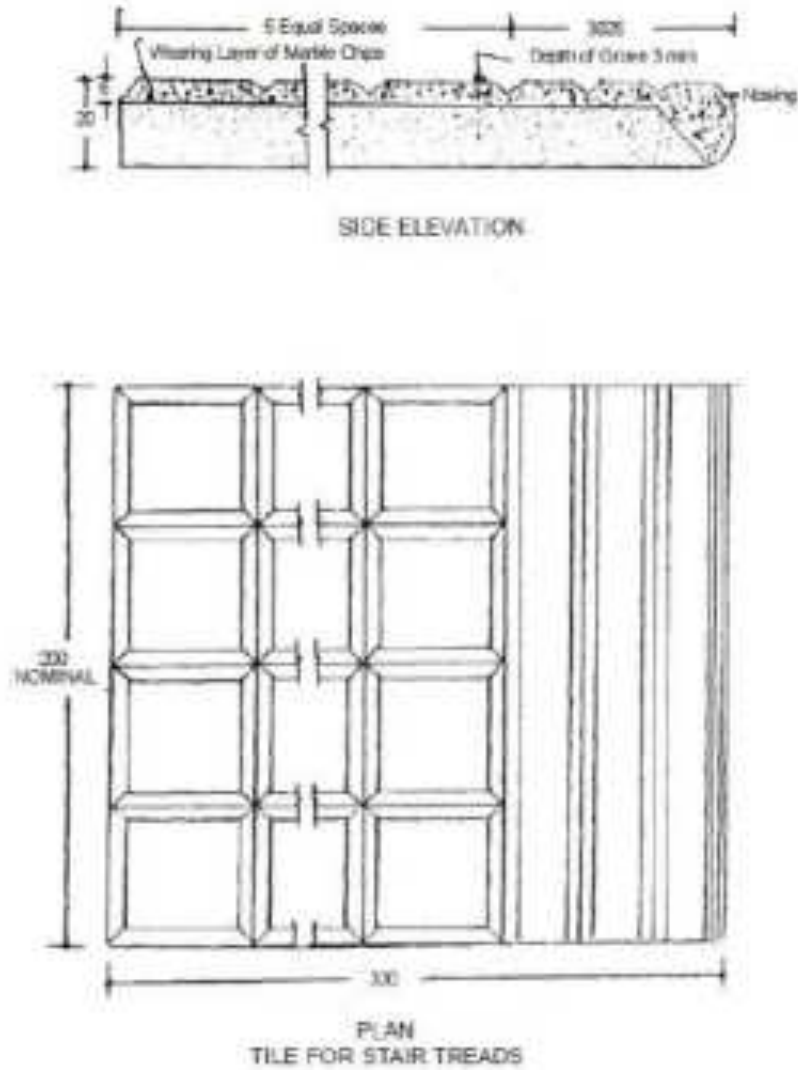


Figure 11.2 : Chequered Terrazo Tiles

Drawing not to scale  
All dimensions are in mm



## ROOFING

COOLING



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## LIST OF BUREAU OF INDIAN STANDARD CODES

Sl.	IS No.	Subject
1.	IS 73	Specification for paving Bitumen
2.	IS 277	Galvanised steel sheets (plain and corrugated)
3	IS 651	Glazed stoneware pipes and fittings
4.	IS 702	Specification for industrial bitumen
5.	IS 1199	Methods of sampling and analysis of concrete
6.	IS 1200 (PT IX)	Method of measurements of building and civil engineering works: Part - 9 Roof covering (including cladding)
7.	IS 1200 (PT X)	Method of measurements of building and civil engineering works: Part -10 ceiling and lining
8	IS 1230	Cast iron rain water pipes and fitting
9.	IS 1367 (PT 13)	Technical supply conditions for threaded steel fasteners Pt .13 hot dip galvanized coating on threaded fasteners
10	IS 2095 (PT 1)	Gypsum plaster boards (Pt.1) plain Gypsum plaster boards
11.	IS 2115	Code of practice for flat roof finish: mud phuska
12.	IS 2633	Method of testing uniformity of coating on zinc coated articles
13.	IS 2645	Specification for integral water proofing compounds for cement mortar and concrete
14.	IS 3007 (PT 1)	Code of practice for laying of asbestos cement sheets: part- 1 corrugated sheets
15.	IS 3007 (PT 2)	Code of practice for laying of asbestos cement sheets part- 2 semi- corrugated sheets
16.	IS 3087	Particle boards of wood and other lignocellulologic materials (medium density) for general purposes - specifications
17.	IS 3144	Methods of test for mineral wool thermal insulation materials
18.	IS 3346	Method of the determination of thermal conductivity of thermal insulation materials
19.	IS 3348	Specification for fibre insulation boards
20.	IS 3384	Specification for bitumen primer for water proofing and damp proofing
21.	IS 4671	Expanded polystyrene for thermal insulation purposes
22	IS 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
23.	IS 5688	Methods of test of per formed b lock type and pipe covering type thermal insulations
24.	IS 6598	Cellular concrete for thermal insulation



Sl.	IS No.	Subject
25.	IS 7193	Specification for glass fibre base coal tar pitch & bitumen felts (Amendment I)
26.	IS 8183	Bonded mineral wool
27.	IS 10192	Specifications for synthetic resin bonded glass fibre (SRBGF) for electrical purposes.
28.	IS 13592	Unplasticised polyvinyl chloride (UPVC) pipes for soil and Waste discharge system for inside and outside building.
29.	IS 14753	Specifications for polymethyl Methacrylate (PMMA) (Arylic) sheets
30	IS 14862	Fibre cement flat sheets - specifications
31	IS 14871	Specifications for products in fibre reinforced cement - Long corrugated or Asymmetrical section sheets and fittings for roofing and cladding.



## 12 ROOFING

### 12.0 TERMINOLOGY

#### Accessories

Purposely made fittings, such as apron flashing pieces, barge boards, bottom glazing flashing, corner piece (corner flashing), eaves filler pieces, expansion joints, hip capping, hip tiles or cap, ridge capping, ridge finials, roof lights, ventilators with which the roof is furnished.

#### Eaves

The lower edge of the inclined roof.

#### Finial

A decorative fitting used at the Junction of ridges and hips to form a water proof covering and at the top of conical, pyramidal, or dome roofs.

#### Flashing

A strip of impervious material, usually metal used to exclude water from the junction between a roof covering and another part of the structure.

#### Gable

Part of wall above the general eaves level at tie end of ridged or partially hipped roof.

#### Gutter

Any form of roof water channel.

#### Hip

The outer angle (more than 180 degree) formed by the inclined ridge between two intersecting roof slopes.

#### Pitch

The angle of inclination with the horizontal of the rafters or substructure surface on which the roof coverings are laid.

In patent glazing, the angle at which the plane of a stretch of glazing is inclined to the horizontal.

#### Pitched Roof

It is a roof having pitch greater than 10 degree to the horizontal.

#### Ridge

The horizontal inter-section at the apex of the two rising roof surfaces inclined in opposite directions.

#### Valley

The re-entrant angle formed by the inter-section of two inclined roof surfaces.

#### Verge

Free edge of a roof surface ending at a gable.

### 12.1 CORRUGATED GALVANISED STEEL SHEET ROOFING





### 12.1.1 C.G.S. Sheets

These shall be of the thickness specified in the description of the item and shall conform to IS 277. The sheets shall be of 275 grade of coating (See Appendix-A) unless otherwise specified in the description of item.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanising shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

### 12.1.2 Purlins

Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters. These shall not be spaced at more than the following distances. (Table 12.1)

**TABLE 12.1**

Thickness of C.G.S. sheet	Maximum spacing of purlin
1.00 mm	2.00 metre
0.80 mm	1.80 metre
0.63 mm	1.60 metre

The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.

### 12.1.3 Slope

Roof shall not be pitched at a flatter slope than 1 vertical to 5 horizontal. The normal pitch adopted shall usually be 1 vertical to 3 horizontal.

### 12.1.4 Laying and Fixing

**12.1.4.1** The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

**12.1.4.2** The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

**12.1.4.3** The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

**12.1.4.4** Lapping in C.G.S. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.S. sheet, before the sheets are fixed in place.

**12.1.4.5** Sheets shall not generally be fixed into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course, the later to cover the junction by at least 7.5 cm.



**12.1.4.6** The laying operation shall include all scaffolding work involved.

**12.1.4.7** Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with galvanised J or L hook bolts and nuts, 8 mm diameter, with bitumen and G.I. limpet washers or with a limpet washer filled with white lead as directed by the Engineer-in-Charge. While J hooks are used for fixing sheets on angle iron purlins, and L hooks are used for fixing the sheet to R.S. joists, timber or precast concrete purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm. Coach screws shall not be used for fixing sheets to purlins.

**12.1.4.8** The galvanised coating on J or L hooks, and bolts shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair serviceability.

The galvanised coating should conform to IS 1367 (Pt. XIII) The mass of coating per square meter of the surface shall be as under:

**Mass and Equivalent Thickness of Coating**

Minimum Average		Minimum Individual	
Mass (g/m <sup>2</sup> )	Thickness (µm)	Mass (g/m <sup>2</sup> )	Thickness (µm)
375	54	300	43

**12.1.4.9** Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by galvanised iron bolts and nuts 25 × 6 mm size, each bolt provided with a bitumen and a G.I. limpet washer or a G.I. limpet washer filled with white lead. As the overlap at the sides extends to two corrugations, these bolts shall be placed zigzag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 60 cm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

## **12.1.5 Wind Tie**

Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified. These shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. The ties shall be paid for separately unless described in the item of roofing.

## **12.1.6 Finish**

The roof when completed shall be true to lines, and slopes and shall be leak proof.

## **12.1.7 Measurements**

**12.1.7.1** The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

**12.1.7.2** The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc. shall be included in the measurements of the roof.



**12.1.7.3** Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed.

**12.1.7.4** No deduction in measurement shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

#### **12.1.8 Rate**

The rate shall include the cost of all the materials and labour involved in all the operations described above including a coat of approved steel primer and two coats of approved steel paint on overlapping of C.G.S. sheets. This includes the cost of roof sheets, galvanised iron J or L hooks, bolts and nuts, galvanised iron seam bolts and nuts, bituminous and galvanised iron limpet washers etc.

### **12.2 RIDGES AND HIPS OF PLAIN GALVANISED STEEL SHEETS**

#### **12.2.1 Ridges and Hips**

Ridges and hips of C.G.S. roof shall be covered with ridge and hip sections of plain G.S. sheet with a minimum lap of 20 cm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 20 cm. The ridges and hips shall be of 60 cm overall width plain G.S. sheet, 0.6 mm or 0.8 mm thick as given in the description of the item and shall be properly bent in shape.

#### **12.2.2 Fixing**

**12.2.2.1** Ridges shall be fixed to the purlins below with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to the purlins.

**12.2.2.2** Similarly, hips shall be fixed to the roof members below such as purlins, hip and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members. At least one of the fixing bolts shall pass through the end laps of ridges and hips, on either side. If this is not possible extra hook bolts shall be provided.

**12.2.2.3** The end laps of ridges and hips shall be joined together with C.G.S sheet by galvanised iron seam bolts 25 x 6 mm size each with a bitumen and G.I. washer or white lead as directed by the Engineer-in-Charge. There shall be at least two such bolts in each end lap.

**12.2.2.4** Surface of C.G.I. sheets of ridge and hip sections and the roofing sheets which overlap each other shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.S. Sheets before they are fixed in place.

#### **12.2.3 Finish**

The edges of the ridges and hips shall be straight from end to end and their surfaces should be plane and parallel to the general plane of the roof. The ridges and hips shall fit in squarely on the sheets.

#### **12.2.4 Measurement**

The measurements shall be taken for the finished work in length along the centre line of ridge or hip, as the case may be, correct to a cm. The laps in ridges and hips and between ridges and hips shall not be measured.

#### **12.2.5 Rate**



The rate shall include the cost of all labour and materials specified above, including painting, cost of seam bolts and any extra G.I. hook bolts, nuts and washers, required.

## **12.3 VALLEY AND FLASHING OF PLAIN GALVANISED STEEL SHEETS**

### **12.3.1 Valley and Flashing**

Valley shall be 90 cm wide overall plain G.S. sheet 1.6 mm thick or other size as specified in the item bent to shape and fixed. They shall lap with the C.G.S. sheets not less than 25 cm width on other side. The end laps of valley shall also be not less than 25 cm.

Valley sheets shall be laid over 25 mm thick wooden boarding if so required.

Flashing shall be of plain G.S. sheet of 40 cm overall width 1.25 mm thick or 1.00 mm thick as specified in the item bend to shape and fixed. They shall lap not less than 15 cm over the roofing sheets. The end laps between flashing pieces shall not be less than 25 cm.

### **12.3.2 Laying and Fixing**

Flashing and valley sheets shall be fixed to the roof members below, such as purlins and valley rafters with the same 8 mm dia G.I. hook bolts and nuts and bitumen and G.I. limpet washers which fix the sheets to those roof members.

At least one of the fixing bolts shall pass through the end laps of the valley pieces on other side. If this is not possible extra hook bolts shall be provided. The free end of flashing shall be fixed at least 5 cm inside masonry with the mortar of mix 1: 3 (1 cement: 3 coarse sand). Refer Fig. 12.3.

**12.3.3** Surface of G.S. sheets under overlaps shall be painted with a coat of approved primer and two coats of approved paint suitable for painting G.S. sheets.

### **12.3.4 Finish**

The edges of valley and flashing should be straight from end to end. The surfaces should be true and without bulges and depressions.

### **12.3.5 Measurements**

The length of the valleys and flashing shall be measured for the finished work correct to a cm. The laps along the length of the valley or flashing pieces, including the portion embedded in masonry, shall not be measured.

### **12.3.6 Rates**

The rate for valleys, shall be for all the labour and materials specified above, including painting, cost of seam bolts and the cost of requisite G.I. hook bolts, nuts and washers required over and above those needed for connecting the roof sheets to the roof members. The rate for valleys shall exclude the cost of boarding underneath which shall be paid for separately. The rate for flashing shall be for all the labour and materials specified above and shall include the cost of painting and mortar for fixing in wall.

## **12.4 GUTTERS MADE OF PLAIN GALVANISED STEEL SHEETS (FIG. 12.2)**

### **12.4.1 Gutters**

Gutter shall be fabricated from plain G.S. Sheets of thickness as specified in the item. Eaves gutters shall be of the shape and section specified in the description of the item. The overall width of the sheet referred to therein shall mean the peripheral width of the gutter including the rounded edges. The longitudinal edges shall be turned back to the extent of 12 mm and beaten to form a rounded edge. The ends of the sheets at junctions of pieces shall be hooked into each other and beaten flush to avoid leakage.



#### **12.4.2 Slope**

Gutter shall be laid with a minimum slope of 1 in 120.

#### **12.4.3 Laying and Fixing**

- 12.4.3.1** Gutter shall be supported on and fixed to M.S. flat iron brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1.20 metres.
- 12.4.3.2** Where these brackets are to be fixed to the sides of rafters, they shall be of 40 × 3 mm section bend to shape and fixed rigidly to the sides of rafters with 3 Nos. 10 mm dia bolts, nuts and washers. The brackets shall overlap the rafter not less than 30 cm and the connecting bolts shall be at 12 cm centres.
- 12.4.3.3** Where the brackets are to be fixed to the purlins, the brackets shall consist of 50 × 3 mm M.S. flat iron bent to shape with one end turned at right angle and fixed to the purlin face with 2 Nos. of 10 mm dia bolts nuts and washers. The bracket will be stiffened by provision of 50 × 3 mm. M. S. flat whose over hung portion bent to right angle shape with its longer leg connected to the bracket with 2 Nos. 6 mm dia M.S. bolts, nuts and washers and its shorter leg fixed to face of purlin with 1 No. 10 mm dia, bolt, nut and washer. The overhang of the vertical portion of the bracket from the face of the purlin shall not exceed 22.5 cm with this arrangement. The spacing of the brackets shall not exceed 1.20 metres.
- 12.4.3.4** The gutter shall be fixed to the brackets with 2 Nos. G.I. bolts and nuts 6 mm dia, each fitted with a pair of G.I. and bitumen washers. The connecting bolts shall be above the water line of the gutters.
- 12.4.3.5** For connection to down take pipes, a proper drop end or funnel shaped connecting piece shall be made out of G.S. sheet of the same thickness as the gutter and riveted to the gutter, the other end tailing into the socket of the rain-water pipe. Wherever necessary stop ends, angles etc., should be provided.

#### **12.4.4 Finish**

The gutters when fixed shall be true to line and slope and shall be leakproof.

#### **12.4.5 Measurements**

Measurements shall be taken for the finished work along the centre line of the top width of the gutter connection to a cm. The hooked lap portion in the junctions and gutter lengths shall not be measured. The number of brackets which are fixed to purlins with stiffener flats should be measured separately.

#### **12.4.6 Rate**

The rate shall include the cost of all labour and materials specified above, including all specials such as angles, junctions, drop ends or funnel shaped connecting pieces, stop ends etc., flat iron brackets and bolts and nuts required for fixing the latter to the roof members. Brackets of 50 × 3 mm flats fixed to purlins with stiffener flats will be paid extra.

#### **12.5 NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT CORRUGATED SHEET ROOFING (FIG. 12.4): DELETED**

#### **12.6 NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT SEMI-CORRUGATED SHEET ROOFING: DELETED**

#### **12.7 RIDGES AND HIPS OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.4): DELETED**



**12.8 OTHER ROOFING ACCESSORIES OF NON ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.5): DELETED**

**12.9 EAVES AND VALLEY GUTTERS OF NON-ASBESTOS REINFORCED BY ORGANIC FIBRES AND/OR INORGANIC SYNTHETIC FIBRES CEMENT (FIG. 12.6): DELETED**

**12.10 PAINTING OF ROOF SLAB WITH HOT BITUMEN**

**12.10.1 Preparing the Surface**

The surface shall be painted only when it is thoroughly dry. The surface to be painted shall be cleaned with wire brushes and cotton or gunny cloth. All loose materials and scales shall be removed and the surface shall be further cleaned with a piece of cloth lightly soaked in kerosene oil.

**12.10.2 Painting with Bitumen**

**12.10.2.1** The contractor shall bring the bitumen to site in its original packing and shall open and use it in the presence of the Engineer-in-Charge or his authorised representative. The containers shall not be removed from the site until the painting job is completed and the Engineer-in-Charge has satisfied himself regarding the quantity of bitumen actually used and has given his permission to remove the empty containers.

**12.10.2.2** The surface prepared and treated shall be painted uniformly with bitumen of approved quality such as residual type petroleum bitumen of penetration 80/100, hot cut back bitumen or equivalent as per specifications of the manufacturer. The coat of bitumen shall be continued 15 cm along the vertical surfaces joining the roof. In case of parapet walls it shall be continued upto the drip courses.

**12.10.2.3** Residual type petroleum bitumen of penetration 80/100 shall be heated to a temperature of not less than 180 degree C and not more than 190 degree C and shall be applied on the roof surface at not less than 180 degree C. Similarly, hot cut back bitumen shall be heated to a temperature of not less than 165 degree C and not more than 170 degree C and shall be applied on the surface at not less than 165 degree C.

**12.10.2.4** Care shall be taken to see that no blank patches are left. The quantity of bitumen to be applied per 10 square metres of roof surface shall be 17 kg, unless otherwise stipulated in the description of the item. It shall be carefully regulated so that the application is uniform at the stipulated rate of 17 Kg. per 10 square metres.

**12.10.3 Spreading Sand**

Immediately after painting, dry, clean sharp coarse sand at the rate of 60 cubic decimeter per 10 sqm. shall be evenly spread and levelled over the surface when the bitumen is still hot.

**12.10.4 Measurements**

The superficial area of the surface painted shall be measured in square metres. No deduction in measurements shall be made for unpainted areas of roof slab occupied by chimney stacks, roof lights etc. of areas, each upto 40 sq. decimetre. The measurements of length and breadth shall be taken correct to a cm.

**12.10.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above.

**12.11 MUD PHUSKA TERRACING WITH BRICK TILE PAVING: DELETED**

**12.12 PAVING OVER MUMTY ROOFS WITH BRICKS TILE: DELETED**

**12.13 CEMENT CONCRETE GOLA (FIG. 12.7)**



### 12.13.1 Cement Concrete

The specifications for concrete shall be the same as described in subhead 4.0 of concrete work.

### 12.13.2 Gola

A chase of 75 mm wide and 75 mm deep shall be cut in the parapet wall just above the junction of mud phuska or lime concrete with parapet wall and it shall be filled with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 10 mm and down gauge) the external face finish with a slope of 1: 0.75 and the exposed surface of the gola shall be plastered with cement mortar 1:3 (1 cement: 3 fine sand).

Expansion joint at every 3.5 to 4.5 metres shall be provided and filled with bitumen filler. The bitumen filler shall be prepared by mixing bitumen, cement and coarse sand in the ratio of 80: 1: 0.25 (80 kg of hot bitumen: 1 kg of cement and 0.25 cum of coarse sand).

### 12.13.3 Curing

The finished surface shall be cured for at least 7 days.

### 12.13.4 Measurements

The length of the finished gola shall be measured at its junction with the wall face correct to a cm. No deduction shall be made in measurements for gaps for water outlets.

### 12.13.5 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including the cost of bitumen filler in expansion joint. The rate includes for all turnings and roundings at all the corners and risers.

## 12.14 KHURRAS (FIG. 12.7)

**12.14.0** The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be of size 45 cm x 45 cm unless otherwise specified in the description of the item and shall be made of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) or other mix as stipulated in the description of the item.

### 12.14.1 Laying

**12.14.1.1** A PVC sheet of size 1 m x 1 m x 400 micron (alternatively, aluminium foil of 32 SWG) shall be laid under the khurra and then cement concrete shall be laid over it to average thickness of 50 mm with its top surface lower than the level of adjoining roof surface by not less than 50 mm.

**12.14.1.2** The concrete shall be laid to a size greater than the stipulated size of the khurra in such a way that the adjoining terracing shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlet, the slope being as much as possible and in no case less than 20 mm cement concrete at the outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

**12.14.1.3** The khurras and the sides of the outlet shall then be rendered with 12 mm coat of cement plaster 1:3 mix (1 cement: 3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished. The sides of the khurras and sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10 cm wide and by 20 cm high or as directed by the Engineer-in-Charge.

**12.14.1.4** In cases where rain water is to be disposed off through rain water pipes, iron grating shall be provided at the outlet as a safeguard against choking, if so directed by the Engineer-in-Charge. Iron gratings, shall be of overall size 20 × 25 cm. with an outer frame of 15 × 3 mm M.S. flat to which 4 Nos M.S. bars





of 10 mm dia shall be welded in a vertical direction keeping equal clear spacing of 2.5 cm. or as directed by the Engineer in Charge.

#### **12.14.2 Measurements**

Khurras shall be counted in numbers.

#### **12.14.3 Rate**

The rate is for each completed khurra of the specified size and is inclusive of the cost of all materials and labour in forming the khurras and outlet opening as described above, except for iron gratings which shall be paid for separately.

#### **12.15 RED OR WHITE SAND STONE ROOFING: DELETED**

#### **12.16 WOODEN CEILING: DELETED**

#### **12.17 CEILING WITH FIBRE INSULATING BUILDING BOARDS: DELETED**

#### **12.18 PARTICLE BOARD /MULTIPURPOSE CEMENT BOARD CEILING: DELETED**

#### **12.19 PLAIN/SEMI PERFORATED PARTICLE BOARD TILES CEILING: DELETED**

#### **12.19A G.I. METAL TILES CEILING**

##### **12.19A.1 Frame**

The frame work shall consists of G.I spring tee of specified size fixed to main C carrier with the help of suspension Brackets. The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The pre-painted steel 'C' wall angle of size 20×30×20 mm and 0.5mm thick shall be fixed along the periphery of the room with nylon sleeves and wooden screws at 300 mm center to center. The main 'C' carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick shall be fixed with cleats of size 37×27×25×1.6 mm and rawl plugs of size 38×12 mm.

##### **12.19A.2 Ceiling Tiles**

Ceiling tiles shall be of GI metal plain beveled of specified white color of size 600x600 mm and 0.5 mm thick with 25 mm height made of GI sheet having galvanizing of 100 gms/sqm and electro statically polyester powder coated of minimum 60 microns thickness including factory painted after bending with or without perforation.

##### **12.19A.3 Fixing of Ceiling Tiles**

The ceiling tiles shall be placed over the GI frame and clip-in with frame.

##### **12.19A.4 Measurements**

These shall be the same as under 12.19.4.

##### **12.19A.5 Rate**

The rate shall include the cost of all the materials and labour involved in all the operations described above including scaffolding etc.

#### **12.20 TRANSLUSCENT WHITE ACRYLIC PLASTIC (PMMA) SHEET CEILING: DELETED**

#### **12.21 PLASTER OF PARIS (GYPSUM ANHYDROUS) CEILING OVERWOODEN STRIPS: DELETED**

#### **12.22 RAIN WATER SPOUTS**

**12.22.0** The sectional area of rain water spouts provided shall be generally at the rate of 1 square cm per 70 to 80 square decimetre of roof area drained. However in locations subject to excessive and high intensities of rainfalls, the area of spouts provided may be suitably increased to suit local conditions. No spout shall





be less than 80 mm in diameter. The spacing of spouts shall be arranged to suit the position of openings in the wall.

#### 12.22.1 Stone Ware Spouts

The spouts shall be 100 mm in diameters and 60 cm long.

**12.22.1.1** The stone ware pipe shall be perfectly sound, free from fine cracks, imperfections of glazing etc. They must be straight cylindrical and of standard nominal diameter and length and depth of socket as given in IS 651. Full length of pipes shall be used on the work. They must be thoroughly salt glazed inside and outside shall generally conform to IS 651.

**12.22.1.2 Fixing:** These shall be provided at the mouths of khurras and shall be fixed in cement mortar 1:3 (1 cement: 3 coarse sand) with the socket embedded in the masonry and the spigot end projecting outside. The masonry all-round the pipe and socket shall be thoroughly wetted and the holes shall be given a coat of cement mortar all-round. The S.W. pipe shall then be inserted and fixed with a surround of mortar. In case the hole has become much larger than the size of the pipe, cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 12.5 mm nominal size) shall be used to fill in the annular space. The spouts shall slope downward at the rate of 1 in 6. The projection outside the wall shall be uniform and not less than 40 cm. The entrance into the pipe shall be smoothly rounded to meet the internal bore of the pipe to facilitate easy flow. Care shall be taken to ensure that the vertical plane through the centre line of the spouts is at right angles to the plane of the wall. Spouts in a row shall be true to line.

**12.22.1.3 Measurements:** Spouts shall be measured in numbers.

**12.22.1.4 Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding.

### 12.23 CAST IRON RAIN WATER PIPES (FIG. 12.8)

#### 12.23.1 Cast Iron Pipes

Pipes shall conform to IS 1230 and shall be perfectly, smooth and cylindrical, their inner and outer surfaces being as nearly as practicable concentric. These shall be sound and of uniform castings, free from laps, pin holes or other imperfections and shall be neatly finished and carefully fitted both inside and outside. The ends of pipes shall be reasonably square to their axes.

#### 12.23.2 Dimensions

C.I. rain water pipes shall be of the dia specified in the description of the item and shall be in full length of 1.8 metre including socket ends of the pipes, unless shorter lengths are required at junctions with fittings. The pipe lengths shall be in each case be with socket. The pipes shall be supplied without ears unless otherwise specifically mentioned. The pipes supplied shall be factory painted (with a tar base composition) both inside and outside which shall be smooth and tenacious.

Every pipe shall ring clearly when struck all over with a light hand hammer. When shorter pipes are cut from full lengths they shall be cut with a hacksaw. The sizes, weights, sockets and tolerances of pipes shall be as shown in Table 12.7.

**TABLE 12.7**

**Dimensions and Weight of C.I. Rain Water Pipes**

Nominal size of pipes (Internal diameter in mm)	50	75	100	125	150
PIPE					

External diameter in mm Tolerance in mm	53	79	104	130	156
	± 3	± 3	± 3.50	± 3.50	± 4.00
Thickness in mm Tolerance in mm	3.00	3.00	3.00	3.00	4.00
Nominal weight of 1800 mm long pipe without ears in kg Tolerance in weight Tolerance in length in mm	± 1	± 1	± 1	± 1	± 1
	7.50	11.00	14.00	20.00	26.00
	(-) 10%	(-) 10%	(-) 10%	(-) 10%	(-) 10%
	± 13.00	± 13.00	± 13.00	± 13.00	± 13.00
<b>SOCKET</b>					
Internal diameter in mm Tolerance in mm	63	89	114	139	167
	± 3.00	± 3.00	± 3.00	± 3.00	± 3.00
Thickness in mm Tolerance in mm	4.00	4.00	4.00	4.00	4.00
Internal depth in mm Tolerance in mm	± 1.00	± 1.00	± 1.00	± 1.00	± 1.00
	60	65	65	75	75
	± 10	± 10	± 10	± 10	± 10

**Note:**

1. All dimensions are in mm.
2. Pipes weighing more than the nominal weight may be accepted provided they comply in every other respect with the requirements of this standard.
3. The above table applies only to rain water pipes fixed on wall face.
4. For pipes and fittings which are to be embedded in masonry, specifications shall correspond with those of pipes for soil, waste, and vent pipes. For their weights, specifications under chapter 19.0 shall be referred to.

### 12.23.3 Fixing and Jointing

**12.23.3.1** Pipes shall be either fixed on face of wall or embedded in masonry, as required in the description of the item.

**12.23.3.2** Plain pipes (without ears) shall be secured to the walls at all joints with M.S. holder bat clamps. The clamps shall be made from 1.6 mm thick galvanised M.S. sheet of 30 mm width, bent to the required shape and size so as to fit tightly on the socket of the pipe, when tightened with screw bolts. It shall be formed out of two semi-circular pieces, hinged with 6 mm dia M.S. bolt on one side and provided with flanged ends on the other side with hole to fit by the screw bolt and nut, 40 mm long. The clamp shall be provided with a hook made out of 27.5 cm long 10 mm diameter M.S. bar, rivetted to the ring at the centre of one semi circular piece. The details of the clamps are shown in Fig 12.8. The clamps shall be fixed to the wall by embedding their hooks in cement concrete block 10 x 10 x 10 cm in 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) for which necessary holes shall be made in the wall at proper places. The clamps shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning and painting of pipes.

Note: Where G.I. sheet clamps are not provided, M.S. sheet clamps of 3 mm thick and 20 mm wide shall be used for making the clamps.



**12.23.3.3** The pipes shall be fixed perfectly vertical or to the lines as directed. The spigot of the upper pipe shall be properly fitted in the socket of the lower pipe such that there is a uniform annular space for filling with the jointing material. The annular space between the socket and the spigot shall be filled with a few turns of spun yarn soaked in neat cement slurry. These shall be pressed home by means of caulking tool. More skins of yarn shall be wrapped if necessary and shall be rammed home. The joint shall then be filled with stiff cement mortar 1:2 (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth at top at an angle of 45 degree sloping up. The joints shall be kept wet for not less than 7 days by tying a piece of gunny bag, four fold, to the pipe and keeping it moist constantly.

**12.23.3.4** Where pipes are to be embedded in masonry, these shall be fixed in masonry work as it proceeds. In such cases care shall be taken to keep the pipes absolutely vertical or to the line as directed by the Engineer-in-Charge. The pipe shall have a surrounding of 12 mm minimum thickness of mortar at every portion of the external surface. The mortar shall be of the same mix as is used in the masonry. The joint shall be caulked with lead as soon as the next length of pipe is placed in position.

The open end (socket end) of the pipe shall be kept closed till the next length is fitted and jointed, to prevent any brick bats or concrete or pieces of wood falling in and choking the pipe.

The depth of lead from the lip of socket shall be 25 mm minimum. In case of 100 mm dia. 75 mm and 50 mm pipes, the quantity of lead required per joint shall be 1.00 kg, 0.66 kg and 0.50 kg respectively for purpose of reckoning theoretical Consumption.

In order to ensure that required quantity of lead is poured into the joint and to control wastage of lead, at the beginning, three or four samples shall be made and the quantum of lead per joint approved by the Engineer-in-Charge.

The actual consumption of lead should be within  $\pm 5\%$  of the approved sample job subject to the provision that a variation of  $\pm 20\%$  shall be allowed over the theoretical quantity of lead due to dimensional tolerances allowed as per Indian Standards. This variation includes allowances of wastage also.

The spigot end shall butt the shoulder of the socket and leave no gap in between. The annular space between the socket and the spigot will be first well packed in with spun yarn leaving 25 mm from the lip of the socket for the lead. The joint shall then be lead caulked as described in detail under jointing of S.C.I soil, waste and vent pipes.

## **12.24 CAST IRON ACCESSORIES FOR RAIN WATER PIPES (FIG. 12.8)**

### **12.24.1 C.I. Fittings**

C.I. accessories such as bends of various degrees, heads, offsets of different projections, branches and shoes shall conform to IS 1230.

Bends shall be of the nearest standard degree as actually required at site. Heads shall be of the flat or corner type as required. Offsets shall be of the projection as stipulated in the description of the item. Branches shall be single or double as described in the item and shall be of the nearest standard degree as actually required. Standard shoes shall be of overall vertical length, 180 mm for 75 mm dia., 205 mm for 100 mm dia and 275 mm for 150 dia sized pipe from top of socket to lowest tip of shoe. Shoes of longer lengths if used shall be in lengths 300 mm, 375 mm, 450 mm, or 600 mm from top of socket to lowest tip of shoe of as actually required at site.

### **12.24.2 Dimensions**

The fittings shall be of the diameter specified in the description of the item.

The thickness of the fittings and details of spigots and sockets shall be same as those of the corresponding size of straight pipes. The fittings shall be supplied without ears unless otherwise



specifically mentioned in the item. The fittings shall be factory painted with a tar basis composition both inside and outside which shall be smooth and tenacious. Every fittings shall ring clearly when struck all over with a light hard hammer. The fittings shall be of standard size and their individual weights shall conform to the weights given in the Table 12.8.

**TABLE 12.8**

**Weight of C.I. Rain Water Pipe Fittings**

S.N o	Description	75 mm dia (weight in kg)	100 mm dia (weight in kg)	150 mm dia (weight in kg)	Unit
1	2	3	4	5	6
1.	Bends (Plain)	3.20	4.50	9.10	Each
2.	Offsets (Plain)				
	(a) 55 mm projection	2.70	5.00	8.20	Each
	(b) 75 mm projection	3.20	5.50	9.10	Each
	(c) 115 mm projection	4.10	5.90	9.50	Each
	(d) 150 mm projection	4.50	6.40	10.40	Each
	(e) 225 mm projection	5.00	7.30	11.80	Each
	(f) 300 mm projection	6.00	8.60	12.70	Each
3.	Branches (Plain)				
	Single	5.00	7.30	14.50	Each
	Double	6.80	10.00	19.10	Each
4.	Standard shoes (Plain)	3.20	4.10	8.60	Each
5.	Longer shoes (Plain)				
	(a) 300 mm	3.20	5.00	-	Each
	(b) 375 mm	4.10	5.50	-	Each
	(c) 450 mm	5.50	6.40	-	Each
	(d) 600 mm	7.30	8.60	-	Each
6.	Heads	6.40	6.80	11.30	Each
7.	Extras:				
	(a) For ears cast on any fitting and short pipes	0.90	0.90	1.35	Each
	(b) For inspection doors fitted on any fitting	1.80	1.80	2.25	Each

**Note:**



1. The above table applies only to rain water fittings which are part of pipe lines fixed on wall face. Permissible tolerance in weight of fittings shall be 5%.
2. For fittings to be used with pipe lines to be embedded in masonry, specifications shall correspond with those of pipe fittings for soil, waste and vent pipes. For their weights, specifications under S.C.I. soil, waste and vent pipes may be referred to.

**12.24.3** Fixing and jointing shall be as specified in 12.23.3.

#### **12.24.4 Measurements**

The fittings shall be measured by numbers. Where longer shoes are used in lieu of standard shoes specified in the description of the item, they shall be measured as standard shoes of 180 mm, 205 mm and 275 mm for 75 mm dia, 100 mm dia and 150 mm dia respectively in number and the extra lengths of the shoes shall be measured and paid for under the corresponding size of pipes.

#### **12.24.5 Rate**

The rate shall include in the case of fittings fixed on the face of wall, the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing the M.S. holder bat clamps in walls and the anchoring concrete. Unless otherwise specified in the description of the item, the rate shall apply for fittings without access doors. In the case of fittings forming part of a rain water pipe line embedded in masonry, the rate shall be for supplying and embedding the fittings in masonry but shall not include for the jointing and lead caulking which shall be paid for separately.

### **12.25 THERMAL INSULATION FOR ROOFING**

#### **12.25.1 With Cellular Concrete:**

**12.25.1.1** Types and Grades: Cellular concrete is a light weight concrete formed by producing gas or air bubbles in cement slurry or a cement sand slurry. Cellular concrete shall conform to IS 6598 and shall be of following two types depending on the manner of manufacture.

Type I: High pressure steam cured (auto-claved) materials in the form of precast blocks.

Type II: Materials cured under natural conditions (that is under ambient pressure and temperature) by water. The material may be either cast in situ or may be in the form of precast blocks.

Grades - Each of these two types of the material shall have three grades, namely:

Grade A - Light weight cellular concrete;

Grade B - Medium weight cellular concrete and; Grade C - Heavy weight cellular concrete.

#### **12.25.1.2 Materials:**

- a) Aggregate: A variety of siliceous fines, such as ground quartz sand shale, flyash and granulated slag may be used in the manufacture of cellular concrete.
- b) Water and binder shall conform to para 3.1.1 and 3.1.2 of Specifications.
- c) Gassing Agents: Organic foaming agents based on resin soap, glue, surface active agents, or fine aluminium powder, zinc, dust, calcium carbide, calcium by pocheride etc. may be used for gassing the concrete.

**12.25.1.3 Dimensions:** The dimensions of the type I and type II precast cellular concrete block shall be either 50 or 60 cm in length, 20, 25 or 30 cm in width and 7.5, 10, 15, 25 or 40 cm in thickness.

**12.25.1.3.1 Tolerance:** A tolerance of  $\pm 3$  percent shall be allowed on width and height and  $\pm 1$  percent on thickness.



#### 12.25.1.4 Requirement for Cellular Concrete

TABLE 12.9

S. No.	Characteristics	Grade A	Grade B	Grade C	Test Reference
1.	Density in	Upto	321 to	400 to	IS 5688
	kg/cum	320	400	500	
2.	Crushing Strength				
	in kg/sq. cm.				
	(Type I)	7.0	12.0	20.0	-do-
	(Type II)	2.5	4.5	8.0	
3.	Thermal conductivity in				
	kW/cm deg C	0.7	0.85	1.0	IS 3346
	at 50 deg. C mean				
	temperature				
4.	Capillary absorption not to exceed 20% in case of type I cellular concrete when tested as per Appendix A of IS 6598.				

**12.25.1.5 Sampling:** In a consignment, cellular concrete of the same type and grade and manufactured approximately in the same period shall be grouped to form a lot. If it is in the form of blocks, a lot shall be made up of not more than 1000 blocks. If the material is in situ, not more than 10 tons of materials shall constitute a lot.

If the material is transported in lorries and received as such, the material in lorry (or vehicle load) & may conveniently be termed as lot.

Each lot shall be tested for all the requirements separately.

If the lot is made up of precast blocks, the number of sample blocks to be tested shall be selected at random as per the following Table 12.10.

TABLE 12.10

Lot Size	Sample size (Block to be sampled)(n)	Permissible No. of defectives (Visual and dimensional requirements) (a)
Up to 100	5	0
101 to 300	8	0
301 to 500	13	0
501 to 1000	20	1

**12.25.1.6 General:** Cellular concrete if done with precast blocks shall be laid on terrace slab after thoroughly cleaning the surface. The blocks shall be laid over a layer of 12 mm average thick cement mortar 1: 4 (1 cement: 4 coarse sand) and the joints shall also be filled properly with neat cement slurry. The joints shall be staggered. Thickness of joints shall be as minimum as possible and not more than 5 mm.



**12.25.1.7 Measurements:** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work. No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

**12.25.1.8 Rate:** The rate shall include the cost of all materials and labour required in providing cellular concrete.

#### **12.25.2 With Resin Bonded Fibre Glass Wool (Bonded Mineral Wool)**

**12.25.2.1 Material:** The material shall be mineral wool made from rock slag or glass processed from a molten state into fibrous form and shall be bonded with a suitable binder. Bonded mineral wool shall conform to specifications of group I of IS 8183.

**12.25.2.2 Dimensions:** The bonded mineral wool shall be supplied in width of 50, 60, 75 and 100 cms, and length of 100, 120 and 140 cms and the thickness of the bonded mineral wool shall be 25, 40, 50, 65 or 75 mm.

**12.25.2.3 Tolerances:** For width and length, the dimensional tolerances of the bonded mineral wool slabs shall be  $\pm 1\%$ . for nominal thickness in the range 25 to 75 mm the tolerance shall be -2 mm. An excess, in all dimensions is permitted.

#### **12.25.2.4 Requirements for Fibre Glass Wool**

**TABLE 12.11**

Sl. No.	Characteristics	Group I	Test Reference
1.	Bulk density	12 to 15 kg/cum	IS 3144
2.	Recovery after compression	not less than 90% of original thickness	Annex. A of IS 8183
3.	Shot content max	500 micron - 5% 250 micron - 15%	IS 3144
4.	Moisture content and absorption	not more than 2%	IS 3144
5.	Incombustibility	Incombustible	IS 3144
6.	Thermal conductivity at mean temperature 50 deg.C	0.49 mw/ cm°C	IS 3346
7.	Sulphur content	Not more than 0.6%	IS 3144

**12.25.2.5 General:** Bonded mineral wool insulation can be either laid over false ceiling or alternatively it can be fixed to the ceiling when the space above false ceiling is being used for carrying return air. In the first case the bonded mineral wool can either be fixed with suitable adhesive to the false ceiling board or else it can simply be rolled over the suspended false ceiling.

In the second case when space above false ceiling is to be used for carrying return air 1.5" x 1.5" slotted angle (3" length) shall be fixed to the ceiling by means of rawl plugs at 2' 0" spacing. Draw 14 gauge tie wires from the slots. Make a mat of mineral wool insulation backed with scrim cloth with a light coating of Plaster of Paris or polythene faced hessian and 24g x 1" wire mesh netting. The joints of wire netting



should be butted and tightly laced down with G.I. wire. Stretch the mat tightly across the angles holding it in place by means of tie wires.

**12.25.2.6 Measurements:** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surfaces in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

**12.25.2.7 Rate:** The rate shall include the cost of all materials and labour required in providing bonded mineral wool.

### 12.25.3 With Expanded Polystyrene:

**12.25.3.1 Material:** Expanded polystyrene shall conform to IS 4671. It is of two types as given below:

- Type N - Normal
- Type SE - It shall be of self-extinguishing type when tested in accordance with Appendix E of IS 4671.

**12.25.3.2 Dimensions:** The size of the finished boards shall be 1.0 × 0.5 m or as specified and having a thickness of 15, 20, 25, 40, 50, 60, 75 or 100 mm.

**12.25.3.2.1 Tolerances:** The tolerances on length, width and thickness of the finished board shall be ±2 mm.

### 12.25.3.3 Requirements for Expanded Polystyrene for General Use:

**TABLE 12.12**

S. No.	Characteristics	Requirements at various nominal apparent densities in kg/cum					Test Reference
		15	20	25	30	35	
1.	Thermal conductivity (K. value) (a) at 0°C (b) at 10°C	0.34 0.37	0.32 0.35	0.30 0.33	0.29 0.32	0.28 0.30	IS 3346
2.	Compressive strength at deformation in Kg/sq.cm Min. 10%	0.7	0.9	1.1	1.4	1.7	IS 4671 Appendix A
3.	Cross breaking strength in kg/sq. cm Min.	1.4	1.6	1.8	2.2		IS 4671 Appendix B
4.	Water vapour permeance in g/sqm 24 hrs. Max.	50	40	30	20		IS 4671 Appendix C
5.	Thermal stability Percent Max.	1	1	1	1		IS 4671 Appendix D
6.	Water absorption	less than 0.5% by volume (after 24 hrs. immersion)					IS 4671 Appendix E





#### 12.25.3.4 Sampling:

In a single consignment all the items of the same type, shape and dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot. For the purpose of judging conformity to the requirements each lot shall be considered separately. The number of sample items for this purpose shall depend on the size of the lot and shall be in accordance with col. 1 & 2 of Table No. 12.13 given below. The sample shall be taken at random from the lot.

**TABLE 12.13**

<i>No. of items in the lot</i>	<i>No. of sample items</i>	<i>Permissible number of defective sample items</i>
1	2	3
Upto 25	3	0
26 to 100	5	0
101 to 300	8	0
301 to 1000	13	0
1001 to 3000	20	1
3001 and above	32	2

#### 12.25.4 With Exfoliated Vermiculite:

**12.25.4.1 Material:** Exfoliated vermiculite consists of vermiculite mineral which has been expanded many times of its original volume after being subjected to high temperature (700 degree C to 1000 degree C).

It is utilised as a thermal insulation material after mixing it with a cementitious material.

#### 12.25.4.2 Requirements of Exfoliated Vermiculite for General Use

**12.25.4.2.1** Exfoliated vermiculite in loose fill condition should conform to following:

**TABLE 12.14**

<i>S.No</i>	<i>Characteristics</i>		<i>Type-I</i>	<i>Type-II</i>	<i>Type-III</i>	<i>Type-IV</i>
1.	Density in kg/m	Min.	56	64	80	96
		Max	12	128	144	160
2.	Thermal Conductivity at mean temp. 25 deg. C in mw/cm deg. C		0.72	0.72	0.72	0.72
3.	Guarding: As per following table. Accumulated % age retained on sieves having square holes, by wt					

**TABLE 12.15**



Size designation	9.51 mm		4.76 mm		2.38 mm		1.19 mm		595 mcn		297 mcn		149 mcn	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Type-I	0	40	30	90	65	98	85	100	-	-	-	-	-	-
Type-II	-	-	0	95	20	80	75	100	90	100	97	100	-	-
Type-III	-	-	-	-	0	10	20	70	65	95	75	98	90	100
Type-IV	-	-	-	-	-	-	0	5	15	65	60	98	90	100

**12.25.4.2.2** Exfoliated vermiculite after being mixed with a cementitious material should conform to following:

**TABLE 12.16**

S.No.	Characteristics	Requirements
1.	Consistency	35 to 45% or 178 to 229 mm
2.	Dry covering capacity in sqm of 100 kg of material 1 cm thick	34 sqm
3.	Compressive strength at 5% deformation min.	103.5 KN/sqm
4.	Liner shrinkage after 24 hrs. at 1800 Deg. F max.	3%
5.	Thermal conductivity max. at mean temperature 95 deg.C.	1.37 mw/cm deg.C.

**12.25.4.3 Sampling & Testing:** If any of the test data obtained on the samples tested fail to conform to the requirements given above, the material shall be rejected.

**12.25.4.4 General:** Exfoliated vermiculite along with cementitious material is mixed with water in the required proportion (as specified by manufacturers). This mix is to be immediately spread over the terrace slab in prescribed thickness. No curing need be done. After laying the insulation, the entire surface shall be cement plastered with cement mortar 1:4 of 20 mm thickness.

**12.25.4.5 Measurements:** Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

No deduction shall be made for openings of areas upto 40 square decimetre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 40 square decimetre in area, deduction for the full opening will be made, but nothing extra will be paid for any extra material or labour involved in forming such openings.

Boarding fixed to curved surfaces in narrow widths shall be measured and paid for separately. Circular cutting and waste shall be measured and paid for separately in running metres.

**12.25.4.6 Rate:** The rate shall include the cost of all materials and labour in providing exfoliated vermiculite.

## 12.25A HEAT RESISTANCE TERRACE TILES

### 12.25A.1 Terrace tiles

Heat resistance terrace tiles are basically ceramic floor tiles which reflects solar radiation. These tiles are used on the floor of the terrace to prevent building from getting heated. These are used on the roof of any building or balcony. These can be used on wall of a building which are directly exposed to sunlight.



### 12.25A1.1 Solar Refractive Index (SRI)

It is a measure of the constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. SRI is calculated according to ASTM E1980.

### 12.25A.1.2 Benefits of Heat Resistance Tiles:

1. Reduce inside building temperature.
2. Save electricity.
3. Lower power demand.
4. Save burning fossil fuel by power plants.
5. Lower emission of green house.
6. Reduction of global warming.
7. Reduce conduction of heat into building.

### 12.25A.1.3 Requirement for Heat Resistance Terrace Tiles

**TABLE 12.17**

S. No.	Characteristics	Requirement
1	Size	300mm x 300mm x 20mm
2	Solar refractive index	Not less than 78
3	Solar reflection	Not less than 0.70
4	Initial emittance	Not less than 0.75

#### 12.25A.1.3.1 Tolerance

Tolerances on length and breadth shall be plus or minus one millimeter, and tolerance on thickness shall be plus 5 mm. The variation of dimensions in any one delivery of tiles shall not exceed 1 mm on length and breadth and in thickness not less than plus 3 mm.

### 12.25A.2 Laying

**12.25A.2.1** Base concrete or RCC slab on which the tiles are to be laid shall be cleaned, wetted and mopped. Cement mortar 1:4 (1 Cement : 4 coarse sand) bedding shall be used. Average thickness of the bedding mortar shall be 20 mm and the thickness at any place shall not be less than 10 mm.

**12.25A.2.2** Cement mortar bedding shall be spread, tamped and corrected to proper levels. If cement mortar is laid in bedding the tiles, then tiles shall be set immediately after laying the mortar. Over this bedding neat grey cement slurry of honey like consistency shall be spread at the rate of 4.4 kg of cement per square metre over such an area as would accommodate about twenty tiles. Tiles shall be washed clean and shall be fixed in this grout one after another, each tile being gently tapped with a wooden mallet till it is properly bedded, and in level with the adjoining tiles. The joints shall be kept as thin as possible not exceeding 1 mm and in straight lines or to suit the required pattern. The joints shall be properly cleaned before filling with grout of mix of white cement and marble powder in the ratio of 1:1.

**12.25A.2.3** The surface of the flooring during laying shall be frequently checked with a straight edge of length at least 2 metre, so as to obtain a true surface with the required slope.

**12.25A.2.4** Where full tiles or half tiles cannot be fixed, tiles shall be cut (sawn) from full tiles to the required size and their edges rubbed smooth to ensure a straight and true joint.



**12.25A.2.5** Tiles which are fixed in the floor adjoining the wall shall enter not less than 12 mm under the skirting which shall be fixed upto 150mm height along the parapet walls in the same manner.

**12.25A.2.6** After the tiles have been laid, surplus cement grout that may have come out of the joints shall be cleared off.

### **12.25A.3 Curing, Polishing and Finishing**

**12.25A.3.1** The day after the tiles is laid all joints shall be cleaned of the grey cement with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed and cleaned. Joints shall then be grouted with white cement mixed marble powder in the ratio of 1:1. The same cement slurry shall be applied to the entire surface of the tiles in a thin coat with a view to protect the surface from abrasive damage and fill the pin holes that may exist on the surface.

**12.25A.3.2** The floor shall then be kept wet for a minimum period of 7 days. The surface shall thereafter be grounded evenly with machine fitted with coarse grade grit block (No. 60). Water shall be used profusely during grinding. After grinding, the surface shall be thoroughly washed to remove all grinded mud, cleaned and mopped. It shall then be covered with a thin coat of grey or white cement, mixed with or without pigment to match the colour of the topping of the wearing surface in order to fill any pin hole that appear. The surface shall be again cured. The second grinding shall then be carried out with machine fitted with fine grade grit block (No. 120).

**12.25A.3.3** The final grinding with machine fitted with the finest grade grit blocks (No. 320) shall be carried out the day after the second grinding described in the preceding para or before handing over the floor, as ordered by the Engineer-in-Charge.

**12.25A.3.4** For small areas or where circumstances so require, hand grinding/polishing with hand grinder may be permitted in lieu of machine polishing after laying. For hand polishing the following carborundum stones, shall be used:

1st grinding — coarse grade stone (No. 60)

Second grinding — medium grade (No.80)

Final grinding — fine grade (No. 120)

In all other respects, the process shall be similar as for machine polishing.

**12.25A.3.5** After the final polish, oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with a 'namdah' block (pad of woollen rags). The following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

**12.25A.3.6** If any tile is disturbed or damaged, it shall be refitted or replaced, properly jointed and polished. The finished floor shall not sound hollow when tapped with a wooden mallet.

### **12.25A.4 Measurements**

**12.25A.4.1** Heat resistance terrace tiles shall be measured as laid in square metre correct to two places of decimal. For length and breadth dimensions correct to a cm including skirting shall be taken. No deduction shall be made nor extra paid for voids not exceeding 0.20 sqm. Deductions for ends of dissimilar materials or other articles embedded shall not be made for areas not exceeding 0.10 square metre. Nothing extra shall be paid for use of cut tiles nor for laying the floor at different levels in the same terrace.

### **12.25A.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above.

## **12.26 UNPLASTICISED POLYVINYL CHLORIDE PIPES AND FITTINGS**



### 12.26.1 UPVC Pipes

Pipes shall conform to Type A pipes of IS 13592. The internal and external surfaces of the pipes shall be smooth and clean and free from groovings and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in the wall thickness shall be permissible provided the wall thickness remains within the permissible limit.

### 12.26.2 Colour of Pipe

Surface colour of the pipes shall be dark shade of grey or as specified.

### 12.26.3 Marking

Each pipe shall be clearly and indelibly marked with the following information at intervals not more than 3 meter.

- a) Manufacturer's name or trade mark.
- b) Nominal outside dia of pipe.
- c) Type A
- d) Batch number.

### 12.26.4 Dimensions

**12.26.4.1 Diameter and Wall Thickness:** Mean outside diameter, outside diameter at any point and wall thickness for type -A manufactured plain or with socket shall be as given in Table- 1 of IS 13592.

UPVC rain water pipes shall be of the dia, specified in the description of the item and shall be in nominal lengths of 2,3,4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerances on specified length shall be + 10 mm and - 0 mm.

### 12.26.5 Fixing and Jointing

Pipes shall be either fixed on face of wall or embedded in masonry as required in the description of the item.

Plain pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x 50 x 50 mm hard wood plugs, screwed with M.S. screws of required length i/c cutting brick work and fixing in cement mortar 1:4 (1 cement: 4 coarse sand). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

### 12.26.6 Installation in Wall/Concrete

The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted into the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

### 12.26.7 Fittings

Fittings used shall be of the same make as that of the PVC pipes Injection moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 3.2 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.



### 12.26.8 Measurements

The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a cm. excluding all fittings along its length.

### 12.26.9 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above including jointing but excluding the supply and fixing of wall plugs and PVC clips which shall be paid for separately.

**Note:** These pipes shall be used only in shaft or unexposed location to avoid damage to these pipes due to willful act.

## 12.27 THERMAL INSULATION OVER EXISTING WALL WITH FIBER GLASS WOOL

### 12.27.1 Material & Fixing:

Resin Bonded fiber glass wool conforming to IS: 8183 having density 24 kg/ m<sup>3</sup>, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded fiber glass wool is to be fixed over existing wall with screw, rawl plug and washers and held in position by criss crossing G.I. wire.

### 12.27.2 Precaution:

All wet trades such as plastering, conducting and painting etc. be completed prior to start of insulation over existing wall. Electrical chasing or drawing lines & cables, etc are to be in place before start of insulation work. The area shall be made dry prior to ceiling installation work. Care should be taken while placing resin bounded glass wool over existing wall so that there will be no displacement to grid.

### 12.27.3 Measurements:

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

### 12.27.4 Rate:

The rate shall include the cost of all materials and labour involved in all the operations described above.

## 12.28 CALCIUM SILICATE TILES FALSE CEILING

### 12.28.1 Materials & Fixing:

8 mm thick fully perforated calcium silicate board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process to give stable crystalline structure with minimum compressive strength 225 kg/ sq. cm, bending strength 100 kg/sq. cm, of size 595x595 mm, having perforation of dia. 10 mm with minimum perforated area 18 % with non woven tissue on the back side, having an NRC (Noise Reduction Coefficient) of 0.85, with 50 mm thick rock wool of 48 kg /cum backing shall be used.

Frame is made up of interlocking metal grid of hot dipped galvanized steel sections ( galvanized @ 120 grams/ sqm, both side inclusive) consisting of main "T" runner with suitably spaced joints to get required length and of size 24x38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to center and cross "T" of size 24x25 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main "T" at 600 mm center to center to form a grid of 1200x600 mm and secondary cross "T" of length 600 mm and size 24x25 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and wall angle of size 24x24x0.3 mm etc. complete.



Main “T” runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x 1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm GI adjustable rods with galvanized butterfly level clips of size 85 x 30 x 0.8 mm spaced at 1200 mm center to center along main T, bottom exposed width of 24 mm of all T sections shall be pre-painted with polyester paint, all complete for all heights as per specifications, drawings and as directed by Engineer-in-charge. false ceiling tiles of approved texture shall be laid in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc.

Manufacturers test certificate/ report of invoice shall be submitted for every delivery challan by suppliers.

#### **12.28.2 Precaution:**

All wet trades such as plastering, conduiting and painting etc, be completed prior to start of false ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (Worker should preferably wear clean soft cotton gloves while placing tile).

#### **12.28.3 Measurements:**

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

#### **12.28.4 Rate:**

The rate shall include the cost of all materials and labour involved in all the operations described above.

### **12.29 CALCIUM SILICATE BOARD FALSE CEILING**

#### **12.29.1 Material & Fixing:**

8 mm thick Calcium Silicate Board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process shall be used.

Frame work is made of special section, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/ sqm (both side inclusive) as per IS : 277 and consisting of angle cleat of size 25mm wide x 1.6mm thick with flanges of 27mm and 37mm, at 1200mm c/c, one flange fixed to the ceiling with dash fastener 12.5mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25 x 10 x 0.50mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I channels 45 x 15 x 0.90mm running at the spacing of 1200 mm c/c, to which the ceiling section 0.5mm thick bottom wedge of 80mm with tapered flanges of 26 mm each having lips of 10.5mm, at 450mm c/c, shall be fixed in a direction perpendicular to G.I intermediate channel with connecting clip made out of 2.64mm dia x 230mm long G.I wire at every junction, including fixing perimeter channels 0.50mm thick 27mm high having flanges of 20mm and 30mm long.

The perimeter of ceiling fixed to wall/ partitions with the help of rawl plugs at 450mm centre, with 25mm long dry wall screws @ 230mm interval, including fixing of Calcium Silicate Board to ceiling section and perimeter channels with the help of dry wall screws of size 3.5 x 25mm at 230mm c/c, including jointing & finishing to a flush finish of tapered and square edges of the board with recommended jointing





compounds, jointing tapes, finishing with jointing compounds in three layers covering up to 150mm on both sides of joints and two coats of primer suitable for boards, all as per manufacture's specification and also including the cost of making opening for light fittings, grills, diffusers, cut outs made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the Engineer in charge but excluding the cost of painting.

Manufacturers test certificate/ report of invoice shall be submitted for every delivery challan by suppliers.

#### **12.29.2 Precaution:**

All wet trades such as plastering, conducting and painting etc, be completed prior to start of false ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work.

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

#### **12.29.3 Measurements:**

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding

0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

#### **12.29.4 Rate:**

The rate shall include the cost of all materials and labour involved in all the operations described above.

### **12.30 THERMAL INSULATION OF CEILING**

#### **12.30.1 Material & Fixing:**

Resin Bonded Rockwool conforming to IS: 8183, density 48 kg/m<sup>3</sup>, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. The Wire mesh of 12.5 mm x 24 gauge shall be used. Fixing shall be done to ceiling with metallic cleats (50x50x3 mm) @ 60 cm and wire mesh of 12.5mm x 24-gauge for wire mesh for top most ceiling of building.

#### **12.30.2 Precaution:**

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work. Care should be taken while placing resin bonded Rockwool into the wire mesh so that there will be no displacement to grid.

#### **12.30.3 Measurements:**





Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

#### **12.30.4 Rate:**

The rate shall include the cost of all materials and labour involved in all the operations described above.

### **12.31 THERMAL INSULATION OVER EXISTING FALSE CEILING**

#### **12.31.1 Material & Fixing:**

Resin Bonded Rockwool conforming to IS: 8183, density 48 kg/ m<sup>3</sup>, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded Rockwool is to be placed over existing false ceiling and to be held in position by criss crossing G.I. wire.

#### **12.31.2 Precaution:**

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation ceiling works. Air conditioning duct work is to be completed preferably even before the suspension of the grid section. Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work. No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/manufacturer guide line. The area shall be made dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool over existing false ceiling so that there will be no displacement to grid.

#### **12.31.3 Measurements:**

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.

#### **12.31.4 Rate:**

The rate shall include the cost of all materials and labour involved in all the operations described above.

### **12.32 THERMAL INSULATION OVER EXISTING WALL**

#### **12.32.1 Material & Fixing:**

Resin Bonded Rockwool conforming to IS: 8183, density 48 kg/ m<sup>3</sup>, 50 mm thick, wrapped in 200 G Virgin Polythene bags shall be used. Resin Bonded Rockwool is to be fixed over existing wall with screw, rawl plug and washers and held in position by criss crossing G.I. wire.

#### **12.32.2 Precaution:**

All wet trades such as plastering, conducting and painting etc, be completed prior to start of insulation over existing wall. Electrical chasing or drawing lines & cables, etc are to be in place before start of insulating work. The area shall be dry prior to ceiling installation work. Care should be taken while placing resin bounded Rockwool over existing wall so that there will be no displacement to grid.

#### **12.32.3 Measurements:**

Length and breadth shall be measured correct to a cm. Areas shall be calculated nearest to 0.01sqm. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening will be made.



**12.32.4 Rate:**

The rate shall include the cost of all materials and labour involved in all the operations described above.

**GALVANISED STEEL SHEETS**  
(Clause 12.1.1)**A-1 Dimensions**

A-1.0 Sizes of plain Sheet: The plain sheets shall be supplied in any combination of the following lengths, widths and thickness.

- a) Length: 2500 and 3000 mm
- b) Width: 900 and 1000 mm
- c) Thickness: 0.50, 0.63, 0.80, 1.00 mm

A-1.1 In case of sheets supplied in coil, the internal diameter of coil shall be 450, 510 and 610 mm and the mass of each coil shall not exceed 12 tonne.

A-1.1.1 Coils weighing more than 12 tonnes may be supplied subject to mutual agreement between the contracting parties.

A-1.2 Corrugated sheets.

A1.2.1 Length- The length of the corrugated sheets shall be as follows: 2500, 3000 mm

**A-2 Zinc Coating**

The weight of coating referred to in this specification shall represent the total weight of zinc both side inclusive.

On any sample selected at random from the delivery, one set of three samples each 50 x 50 mm or 50 mm diameter shall be selected at random from one sheet for every 500 G.S. sheets, the coating for the different classes shall be within the limit specified in table below:

**TABLE I**

Mass of Coating (Total Both Sides)

Grade of coating	Minimum average coating Triple spot test g/sqm	Minimum coating single spot test g/sqm*
600	600	510
450	450	380
350	350	300
275	275	235

\* minimum individual value obtained in triple spot test.

**A-3 Mass**

The mass of sheets and coils shall be calculated as given in Table II on the basis of nominal dimensions and mass of zinc coating.



**TABLE II**

Calculation of Mass of Sheets or Coils

Type of materials	Order of calculation	Method of calculation	Number of Numerals in resultant value
Sheet	Mass of single sheet	Nominal mass of single sheet plus mass of zinc coating	Rounded off to 4 effective figures
	Total mass	Mass of single sheet (kg) x number of sheets	Rounded off to integral value of kg
Coil	Unit mass of coil	Unit mass of sheet ( $\text{kg/m}^2$ ) x width (mm) $\times 10^{-3}$	Rounded off to 3 effective figures
	Mass of single coil	Unit mass of coil ( $\text{kg/m}$ ) x length (m)	
	Total mass (kg)	Total mass of each coil	Integral number of kg

**Note:**

- Nominal mass of single sheet shall be calculated by calculating the volume of the sheet and multiplying the same with density of sheet (density 7.85 g/ cubic cm) and rounding the same to 4 effective figures.
- Mass of the coating shall be calculated by multiplying the surface area of single sheet with indicated nominal coating mass (g/square metre) as shown for triple spot test (Table I).
- For calculation of corrugated sheet mass, the width before corrugation shall be considered while calculating the area.

**A-4 Corrugations**

The depth and pitch of corrugation shall be as follows:

Grade	Depth of Corrugation (mm)	Pitch of Corrugation (mm)
A	17.5	75
B	12.5	75

The number of corrugations shall be 8, 10, 11 or 13 per sheet. The overall width of the sheets before and after corrugation shall be as given in Table below.

**TABLE III**

Details of Corrugations

Number of corrugations	Grade	Nominal overall width of sheet measured between crowns of outside corrugations	
		Before corrugation mm	After corrugation Mm
(1)	(2)	(3)	(4)



8	A	750	660
10	A	900	810
11	A	1000	910
13	A	1200	1110
8	B	750	680
10	B	900	830
11	B	1000	930
13	B	1200	1130

## C.G.S. SHEETS

Sub Head: Roofing  
Clause: 12.1

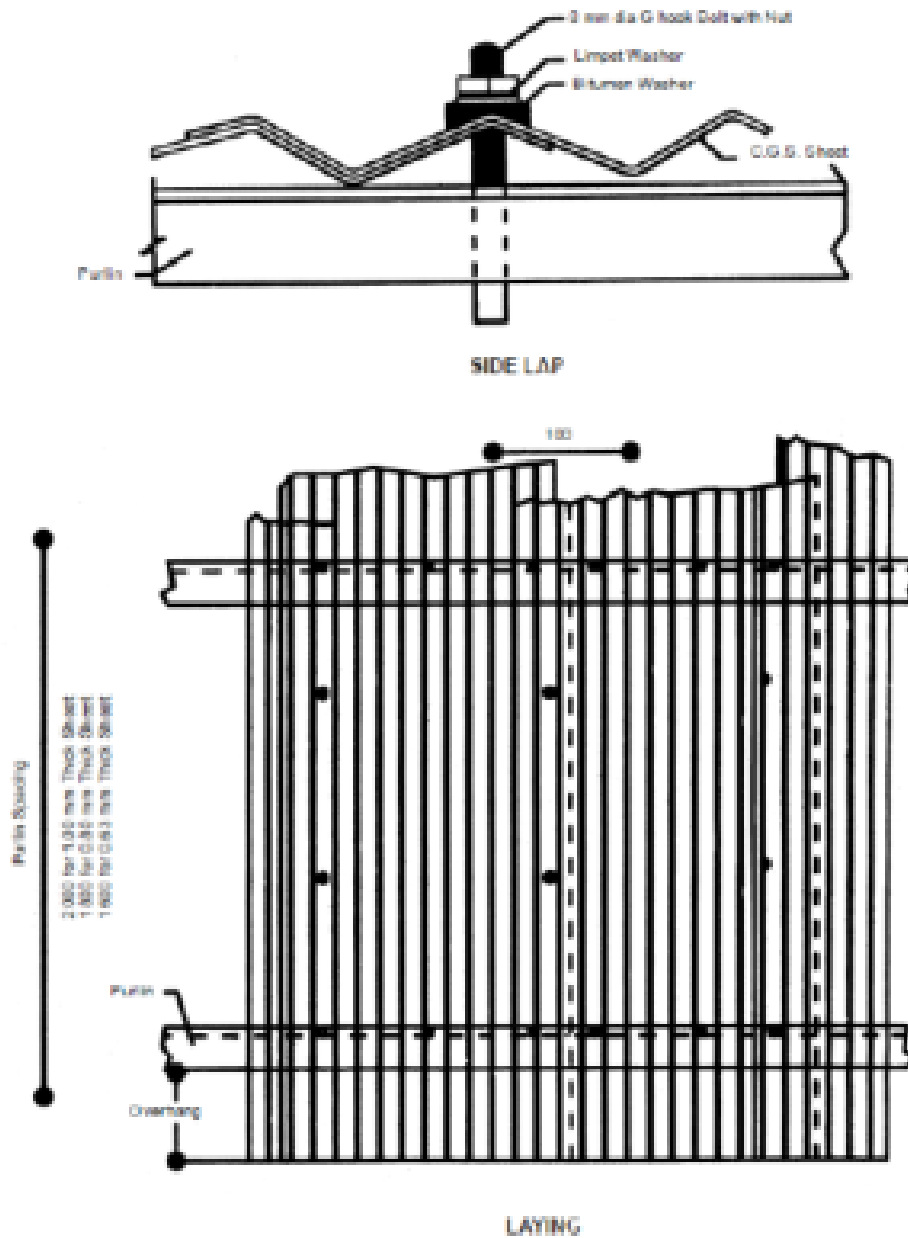


Figure 12.1 : C.G.S Sheets

Drawing not to scale  
All dimensions are in mm

## GALVANISED STEEL SHEET GUTTER

Sub Head : Roofing

Clause : 12.1

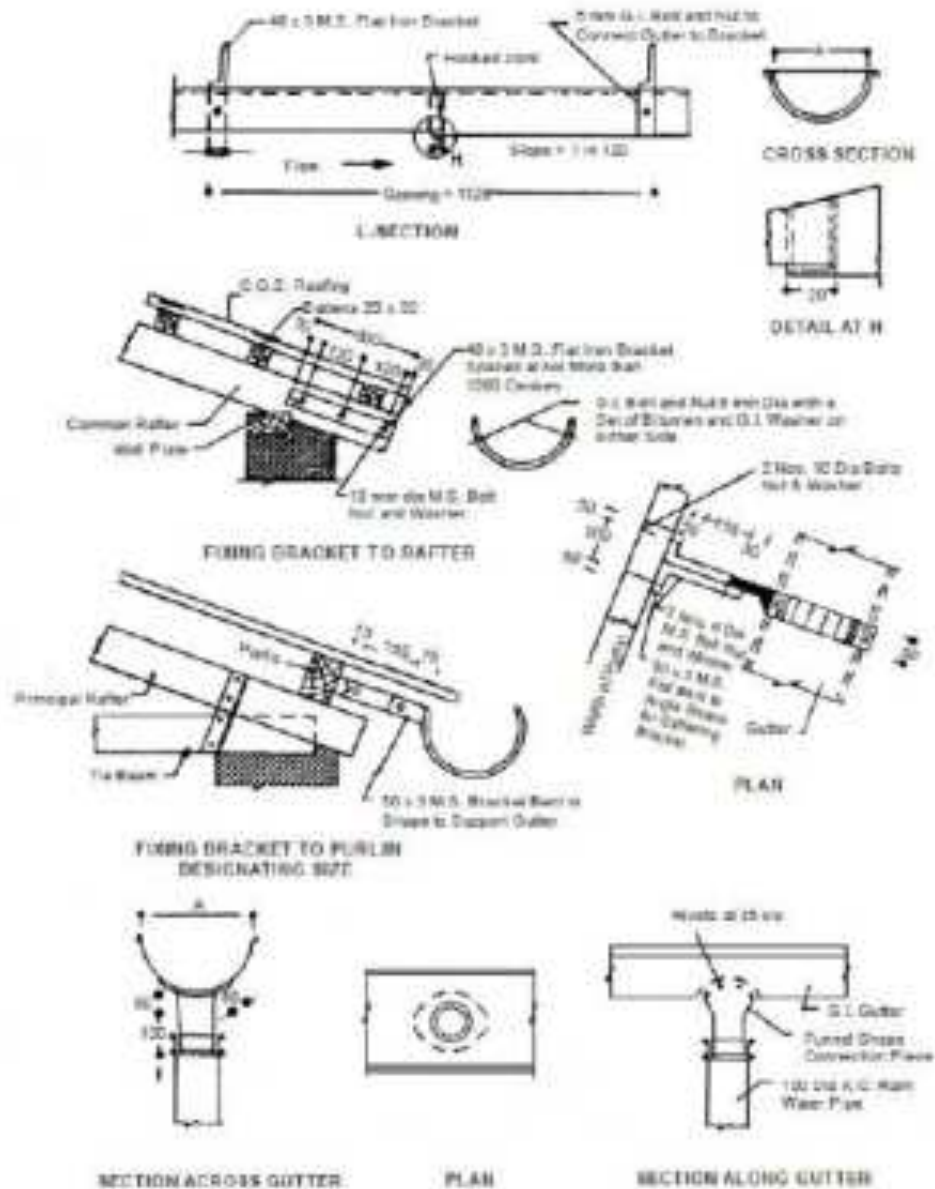


Figure 12.2 : Galvanised Sheet Shutter

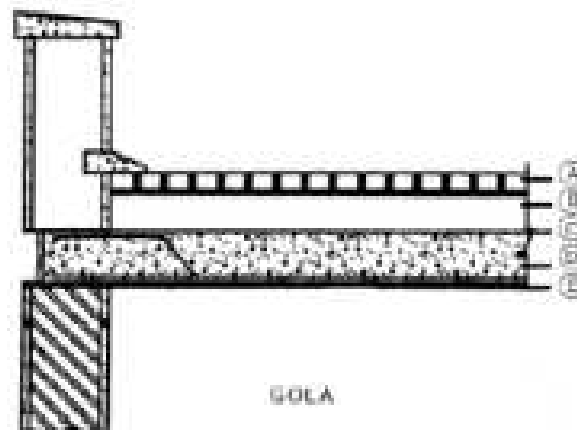
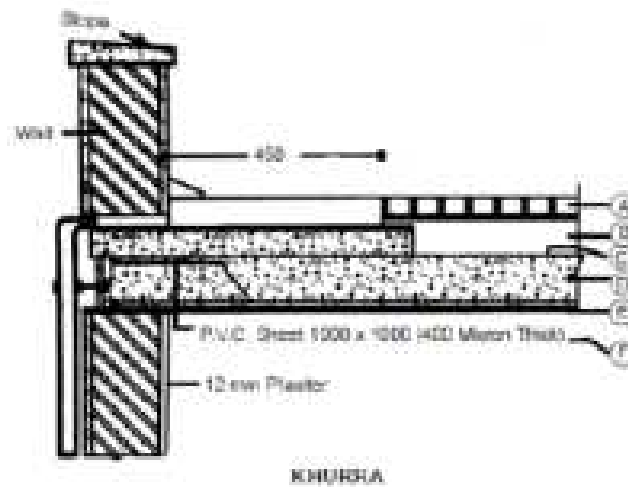
Drawing not to scale  
All dimensions are in mm





## CEMENT CONCRETE KHURRA - GOLA

Sub Head: Roofing  
Clause: 12.13 and 12.14



- (A) Brick Tiles
- (B) Mud Plaster/White Concrete
- (C) Painting with Hot Duminum EDHOS at 1.7 litres/sq.m.
- (D) R.C.C. Slab
- (E) 8 mm Thick Ceiling Plaster Finished neat and Thick Coat of White Washing or Kraft Paper
- (F) P.V.C. Sheet 1000 x 1000 (400 Micron Thick)

Figure 12.7 : Cement Concrete Khurra-Gola

Drawing not to scale  
All dimensions are in mm

## HOLDER BAT CLAMP

Sub Head: Roofing  
Clause: 12.23 & 12.24

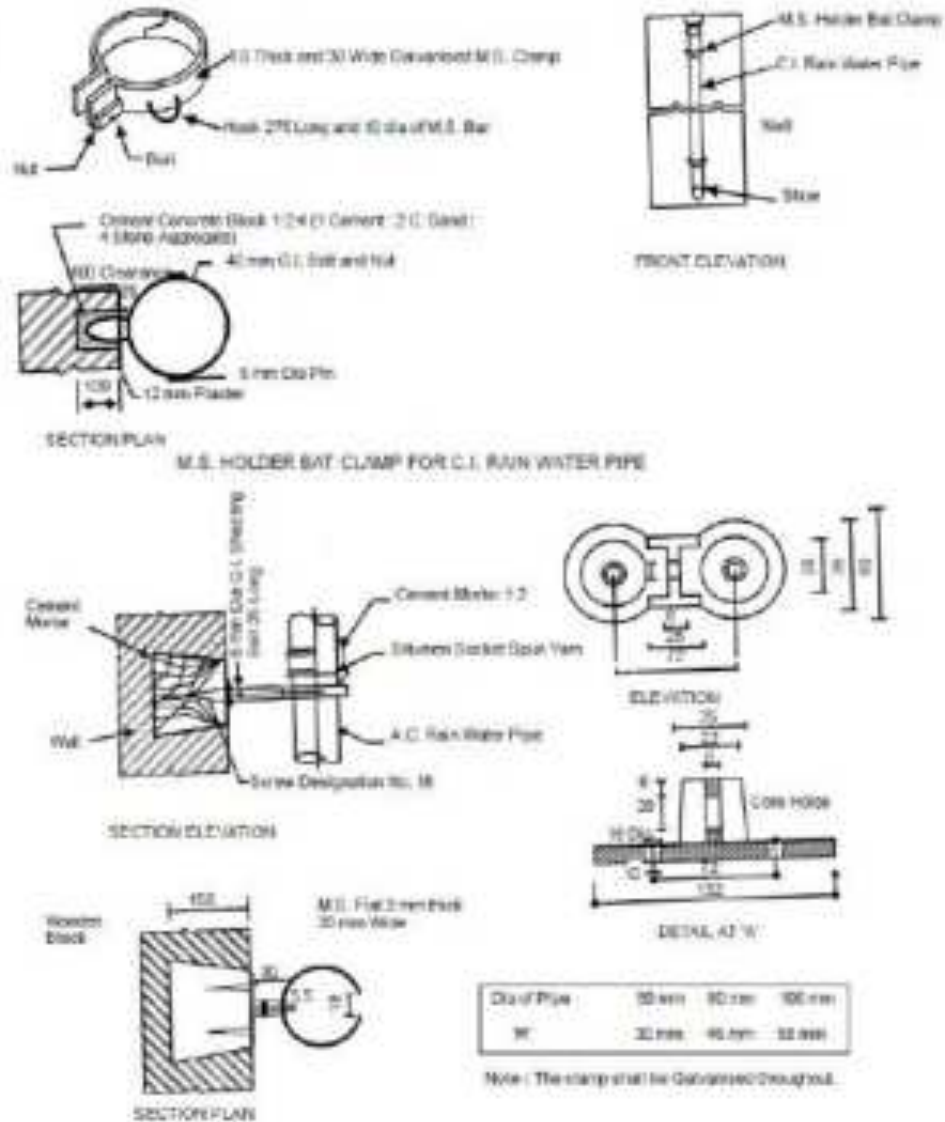


Figure 12.8 : Holder Bat Clamps

Drawing not to scale  
All dimensions are in mm



## FINISHING



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## LIST OF BUREAU OF INDIAN STANDARD CODES

Sl.	IS No.	Subject
1.	IS 16(Pt-I)	Shellac: Part: I — Hand Made Shellac
	IS 16(Pt-II)	Shellac: Part: II — Machine Made Shellac
2.	IS 75	Linseed Oil Raw and Refined
3.	IS 77	Linseed Oil Boiled for Paints
4.	IS 102	Ready Mixed Paint, Brushing, Red Lead, Nonsetting, Priming
5.	IS 104	Specification for Ready Mixed Paint, Brushing, Zinc Chrome, Priming
6.	IS 109	Ready Mixed Paint, brushing, priming Plaster to Indian Standard Colour No.361, 631 White and off White
7.	IS 117	Ready Mixed Paint, Brushing, Finishing Exterior, Semigloss for General Purposes to Indian Standards Colours.
8.	IS 133	Enamel, Interior (a) Under Coating (b) Finishing
9.	IS 137	Ready Mixed Paint, Brushing, Matt or Egg Shell Flat, Finishing Interior to Indian Standard Colour as required
10.	IS 158	Ready Mixed Paint, Brushing, Bituminous Black, Lead Free, Acid, Alkali and Heat Resisting
11.	IS 217	Specification for Cut Back Bitumen
12.	IS 218	Specification for Creosote and Anthracene Oil for Use as Wood Preservatives
13.	IS 290	Coal Tar Black Paint
14.	IS 337	Varnish, Finishing Interior
15.	IS 341	Black Japan, Types 'A', 'B' & 'C'
16.	IS 347	Varnish, Shellac for General Purposes
17.	IS 348	French Polish
18.	IS 419	Putty for Use on Window Frames
19.	IS 427	Distemper, Dry Colour as Required
20.	IS 428	Distemper, Oil Emulsion, Colour as Required
21.	IS 524	Varnish, Finishing, Exterior, Synthetic Air Drying
22.	IS 533	Gum Spirit of Turpentine (Oil of Turpentine)
23.	IS 712	Specification For Building Limes
24.	IS 1200 (Pt-XII)	Method of Measurements of Building and Civil Engineering Works: Part: XII — Plastering and Pointing
25.	IS 1200 (Pt-XIII)	Method of Measurements of Building and Civil Engineering Works: Part: XIII — White Washing, Colour Washing Distempering and Painting of Building Surfaces.



Sl.	IS No.	Subject
26.	IS 1200 (Pt-XV)	Methods of Measurements of Building and Civil Engineering Works: Part : XV - Painting, Polishing, Varnishing etc.
27.	IS 2339	Aluminium Paint for General Purposes, in Dual Container
28.	IS 2547 (Pt-II)	Gypsum Building Plasters Pt. II Premixed Light Weight Plasters
29.	IS 2932	Enamel, Synthetic, Exterior (a) Undercoating, (b) Finishing
30.	IS 2933	Enamel, Exterior (a) Undercoating (b) Finishing
31.	IS 5410	Cement Paint
32.	IS 5411 (Pt-1)	Plastic Emulsion: Paint Part I For Interior Use
33.	IS 6278	Code of Practice for White Washing and Colour Washing
34.	IS 12777	Method for classification of flame spread of products





## 13 FINISHING

### 13.1 CEMENT PLASTER

The cement plaster shall be 12 mm, 15 mm or 20 mm thick as specified in the item.

#### 13.1.1 Scaffolding

For all exposed brick work or tile work double scaffolding independent of the work having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in buildings, single scaffolding shall be permitted. In such cases the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one meter in width or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

**Note:** In case of special type of brick work, scaffolding shall be got approved from Engineer-in-charge in advance.

#### 13.1.2 Preparation of Surface

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scrapping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

#### 13.1.3 Mortar

The mortar of the specified mix using the type of sand described in the item shall be used. It shall be as specified in Subhead 3.0. For external work and under coat work, the fine aggregate shall conform to grading zone III. For finishing coat work the fine aggregate conforming to grading zone IV shall be used.

#### 13.1.4 Application of Plaster

**13.1.4.1** Ceiling plaster shall be completed before commencement of wall plaster.

**13.1.4.2** Plastering shall be started from the top and worked down towards the floor. All putlog holes shall be properly filled in advance of the plastering as the scaffolding is being taken down. To ensure even thickness and a true surface, plaster about 15 × 15 cm shall be first applied, horizontally and vertically, at not more than 2 metres intervals over the entire surface to serve as gauges. The surfaces of these gauged areas shall be truly in the plane of the finished plaster surface. The mortar shall then be laid on the wall, between the gauges with trowel. The mortar shall be applied in a uniform surface slightly more than the specified thickness. This shall be brought to a true surface, by working a wooden straight edge reaching across the gauges, with small upward and sideways movements at a time. Finally the surface shall be finished off true with trowel or wooden float according as a smooth or a sandy granular texture is required. Excessive troweling or over working the float shall be avoided.

**13.1.4.3** All corners, arrises, angles and junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering corners, arrises, provision of grooves at junctions



etc. where required shall be done without any extra payment. Such rounding, chamfering or grooving shall be carried out with proper templates or battens to the sizes required.

When suspending work at the end of the day, the plaster shall be left, cut clean to line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scrapped cleaned and wetted with cement slurry before plaster is applied to the adjacent areas, to enable the two to properly join together. Plastering work shall be closed at the end of the day on the body of wall and not nearer than 15 cm to any corners or arrises. It shall not be closed on the body of the features such as plasters, bands and cornices, nor at the corners of arrises. Horizontal joints in plaster work shall not also occur on parapet tops and copings as these invariably lead to leakages. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

No portion of the surface shall be left out initially to be patched up later on. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

#### **13.1.5 Thickness**

Where the thickness required as per description of the item is 20 mm the average thickness of the plaster shall not be less than 20 mm whether the wall treated is of brick or stone. In the case of brick work, the minimum thickness over any portion of the surface shall be not less than 15 mm while in case of stonework the minimum thickness over the bushings shall be not less than 12 mm.

#### **13.1.6 Curing**

Curing shall be started as soon as the plaster has hardened sufficiently not to be damaged when watered.

The plaster shall be kept wet for a period of at least 7 days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer-in-Charge may approve. The dates on which the plastering is done shall be legibly marked on the various sections plastered so that curing for the specified period thereafter can be watched.

#### **13.1.7 Finish**

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

#### **13.1.8 Precaution**

Any cracks which appear in the surface and all portions which sound hollow when tapped, or are found to be soft or otherwise defective, shall be cut out in rectangular shape and redone as directed by the Engineer-in-Charge.

- i. When ceiling plaster is done, it shall be finished to chamfered edge at an angle at its junction with a suitable tool when plaster is being done. Similarly, when the wall plaster is being done, it shall be kept separate from the ceiling plaster by a thin straight groove not deeper than 6 mm drawn with any suitable method with the wall while the plaster is green.
- ii. To prevent surface cracks appearing between junctions of column/beam and walls, 150 mm wide chicken wire mesh should be fixed with U nails 150 mm centre to centre before plastering the junction. The plastering of walls and beam/column in one vertical plane should be carried out in one go. For providing and fixing chicken wire mesh with U nails payment shall be made separately.

#### **13.1.9 Measurements**



- 13.1.9.1** Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two places of decimal.
- 13.1.9.2** Thickness of the plaster shall be exclusive of the thickness of the key i.e. grooves, or open joints in brick work.
- 13.1.9.3** The measurement of wall plaster shall be taken between the walls or partitions (the dimensions before the plaster shall be taken) for the length and from the top of the floor or skirting to the ceiling for the height. Depth of coves or cornices if any shall be deducted.
- 13.1.9.4** The following shall be measured separately from wall plaster.
- (a) Plaster bands 30 cm wide and under
  - (b) Cornice beadings and architraves or architraves moulded wholly in plaster.
  - (c) Circular work not exceeding 6 m in radius.
- 13.1.9.5** Plaster over masonry pilasters will be measured and paid for as plaster only.
- 13.1.9.6** A coefficient of 1.63 shall be adopted for the measurement of one side plastering on honeycomb work having 6 x 10 cm. opening.
- 13.1.9.7** Moulded cornices and coves.
- (a) Length shall be measured at the centre of the girth.
  - (b) Moulded cornices and coves shall be given in square metres the area being arrived at by multiplying length by the girth.
  - (c) Flat or weathered top to cornices when exceeding 15 cm in width shall not be included in the girth but measured with the general plaster work.
  - (d) Cornices which are curved in their length shall be measured separately.
- 13.1.9.8** Exterior plastering at a height greater than 10 m from average ground level shall be measured separately in each storey height. Patch plastering (in repairs) shall be measured as plastering new work, where the patch exceeds 2.5 sqm. extra payment being made for preparing old wall, such as dismantling old plaster, raking out the joints and cleaning the surface. Where the patch does not exceed 2.5 sqm in area it shall be measured under the appropriate item. under sub head 'Repairs to Buildings.'
- 13.1.9.9** Deductions in measurements, for opening etc. will be regulated as follows:
- (a) No deduction will be made for openings or ends of joists, beams, posts, girders, steps etc. upto 0.5 sqm in area and no additions shall be made either, for the jambs, soffits and sills of such openings. The above procedure will apply to both faces of wall.
  - (b) Deduction for opening exceeding 0.5 sqm but not exceeding 3 sqm each shall be made for reveals, jambs, soffits sills, sills, etc. of these openings.
    - i. When both faces of walls are plastered with same plaster, deductions shall be made for one face only.
    - ii. When two faces of walls are plastered with different types of plaster or if one face is plastered and other is pointed or one face is plastered and other is unplastered, deduction shall be made from the plaster or pointing on the side of the frame for the doors, windows etc. on which width of reveals is less than that on the other side but no deduction shall be made on the other side.
- Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of plaster and/or pointing as the case may be.



- iii. For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each plastered face of wall.
- (c) For opening exceeding 3 sqm in area, deduction will be made in the measurements for the full opening of the wall treatment on both faces, while at the same time, jambs, sills and soffits will be measured for payment.

In measuring jambs, sills and soffits, deduction shall not be made for the area in contact with the frame of doors, windows etc.

#### **13.1.10 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.

### **13.2 CEMENT PLASTER WITH A FLOATING COAT OF NEAT CEMENT**

**13.2.1** The cement plaster shall be 12, 15 or 20 mm thick, finished with a floating coat of neat cement, as described in the item.

**13.2.2** Specifications for this item of work shall be same as described in 13.1 except for the additional floating coat which shall be carried out as below.

When the plaster has been brought to a true surface with the wooden straight edge (clause 13.1.4.2) it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in 13.1.4 shall apply.

### **13.3 18 MM CEMENT PLASTER (TWO COAT WORK)**

**13.3.1** The specification for scaffolding and preparation of surface shall be as described in 13.1

#### **13.3.2 Mortar**

The mix and type of fine aggregate specified in the description of the item shall be used for the respective coats. Generally, the mix of the finishing coat shall not be richer than the under coat unless otherwise described in item.

Generally coarse sand shall be used for the under coat and fine sand for the finishing coat, unless otherwise specified for external work and under coat work, the fine aggregate shall conform to grading zone III. For finishing coat work the fine aggregate conforming to grading zone IV shall be used.

#### **13.3.3 Application**

**13.3.3.1** The plaster shall be applied in two coats i.e. 12 mm under coat and then 6 mm finishing coat and shall have an average total thickness of not less than 18 mm.

**13.3.3.2 12 mm Under Coat:** This shall be applied as specified in 13.1.4 except that when the plaster has been brought to a true surface a wooden straight edge and the surface shall be left rough and furrowed 2 mm deep with a scratching tool diagonally both ways, to form key for the finishing coat. The surface shall be kept wet till the finishing coat is applied.

**13.3.3.3 6 mm Finishing Coat:** The finishing coat shall be applied after the under coat has sufficiently set but not dried and in any case within 48 hours and finished in the manner specified in 13.1.4.

**13.3.4** Specifications for Curing, Finishing, Precautions, Measurements and Rate shall be as described under 13.1.



### **13.4 6 MM CEMENT PLASTER ON CEMENT CONCRETE AND REINFORCED CEMENT CONCRETE WORK**

#### **13.4.1 Scaffolding**

Stage scaffolding shall be provided for the work. This shall be independent of the walls.

#### **13.4.2 Preparation of Surface**

Projecting burrs of mortar formed due to the gaps at joints in shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition concrete surfaces to be plastered shall be pock marked with a pointed tool, at spacings of not more than 5 cm. Centres, the pock being made not less than 3 mm deep. This is to ensure a proper key for the plaster. The mortar shall be washed off and surface, cleaned off all oil, grease etc. and well wetted before the plaster is applied.

#### **13.4.3 Mortars**

Mortar of the specified mix using the types of sand described in the item shall be used. It shall be as specified in 3.2.

#### **13.4.4 Application**

To ensure even thickness and a true surface, gauges of plaster 15 x 15 cm. shall be first applied at not more than 1.5 m intervals in both directions to serve as guides for the plastering. Surface of these gauged areas shall be truly in the plane of the finished plaster surface. The plaster shall be then applied in a uniform surface to a thickness slightly more than the specified thickness and shall then be brought to true and even surface by working a wooden straight edge reaching across the gauges. Finally the surface shall be finished true with a trowel or with wooden float to give a smooth or sandy granular texture as required. Excess troweling or over working of the floats shall be avoided. The plastering and finishing shall be completed within half an hour of adding water to the dry mortar.

Plastering of ceiling shall not be commenced until the slab above has been finished and centring has been removed. In the case of ceiling of roof slabs, plaster shall not be commenced until the terrace work has been completed. These precautions are necessary in order that the ceiling plaster is not disturbed by the vibrations set up in the above operations.

#### **13.4.5 Finish**

The plaster shall be finished to a true and plumb surface and to the proper degree of smoothness as required. The work shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds.

#### **13.4.6 Thickness**

The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5 mm.

#### **13.4.7 Curing**

The specifications shall be as detailed in 13.1.6.

#### **13.4.8 Precautions**

The specifications shall be as detailed in 13.1.8.

#### **13.4.9 Measurements**

**13.4.9.1** Length and breadth shall be measured correct a cm. and its area shall be calculated in sqm. correct to two places of decimal. Dimensions before plastering shall be taken.



- 13.4.9.2** Thickness of plaster shall be exclusive of the thickness of the key i.e. depth or rock marks and hacking.
- 13.4.9.3** Plastering on ceiling at height greater than 5 m above the corresponding floor level shall be so described and shall be measured separately stating the height in stages of 1 m or part thereof.
- 13.4.9.4** Plastering on the sides and soffits of the projected beams of ceiling at a height greater than 5 m above the corresponding floor level shall be measured and added to the quantity measured under 13.4.9.3.
- 13.4.9.5** Plastering on spherical and groined ceiling and circular work not exceeding 6 m in radius, shall be measured and paid for separately.
- 13.4.9.6** Flowing soffits (*viz.* portion under spiral stair case etc.) shall be measured and paid for separately.
- 13.4.9.7** Ribs and mouldings on ceiling shall be measured as for cornices, deductions being made from the plastering on ceiling in case the width of the moulding exceed 15 cm.
- 13.4.9.8** The mode of measurement of exterior plastering and patch plastering (in repairs) shall be as laid down in 11.1.9.8
- 13.4.9.9** Deduction shall not be made for openings or for ends of columns, or columns caps of 0.5 sqm each in area and under. No additions will be made either for the plastering of the sides of such openings. For openings etc. of areas exceeding 0.5 sqm deduction will be made for the full opening but the sides of such openings shall be measured for payment.

**13.4.10 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.

**13.5 6 MM CEMENT PLASTER FOR SLAB BEARING**

- 13.5.1** Cement plaster shall be 6 mm thick finished with a floating coat of neat cement and thick coat of lime wash on top of walls for bearing of slabs.

**13.5.2 Application**

The plaster shall be applied over the cleaned and wetted surface of the wall. When the plaster has been brought to a true surface with the wooden straight edge (Clause 13.1.4) it shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied for floating coat shall be 1 kg per sqm. Smooth finishing shall be completed with trowel immediately and in no case later than half an hour of adding water to the plaster mix. The rest of the specifications described in 13.1.4 shall apply.

**13.5.3 Lime wash**

This shall be applied in a thick coat after curing the plaster for three days.

**13.5.4 Measurements**

Length and breadth shall be measured correct to a cm and area worked out in sqm correct to two places of decimal.

**13.5.5 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.

**13.6 NEAT CEMENT PUNNING**

- 13.6.1** The specifications given for floating coat described in 13.2.1 shall apply.
- 13.6.2** Specification for scaffolding and curing shall be as described in 13.1.1 and 13.1.6. respectively. Specifications for Finish and Precautions shall be as described in 13.1.7. and 13.1.8.



### 13.6.3 Measurements

- 13.6.3.1** The measurements for cement punning shall be taken over the finished work. The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm correct to two places of decimal.
- 13.6.3.2** Punning over Plaster on bands, skirting, coping, cornices, drip courses, string courses etc. shall not be measured separately but only as wall surfaces. In these cases the measurements shall be taken girthed over the above features.
- 13.6.3.3** Punning over plaster on circular work also, of any radius shall be measured only as wall surfaces, and not separately.
- 13.6.3.4** Cement punning in patch repairs irrespective of the size of the patch shall be measured as new work, and in this case the rate shall include for cutting the patch to rectangular shape before lime punning.
- 13.6.3.5** Deductions in measurements for openings shall be regulated generally as described in 13.1.9.9.

### 13.6.4 Rate

The rate shall include the cost of all labour and materials involved in all the operations described above.

## 13.7 ROUGH CAST PLASTER

- 13.7.1** Rough cast finish comprises of a mixture of sand and gravel in specified proportions dashed over a freshly plastered surface.

### 13.7.2 Scaffolding

Scaffolding shall be done as specified in 13.1.1.

### 13.7.3 Preparation of Surface

The joints shall be raked out, dust and loose mortar, shall be brushed out. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

### 13.7.4 Mortar

Mortar of specified mix using the type of sand described in the item shall be used, where coarse sand is to be used, the fineness modulus of the sand shall not be less than 2.5 mm.

### 13.7.5 Application

- 13.7.5.1** The plaster base over which rough cast finish is to be applied shall consist of two coats, under layer 12 mm thick and top layer 10 mm.
- 13.7.5.2 12 mm Under Layer:** This shall be applied in the same manner as specified in para 13.1.3 under 18 mm cement plaster except that the finishing, after the mortar has been brought to a level with the wooden straight edge, shall be done with wooden float only.
- 13.7.5.3 Top Layer:** The top layer shall be applied a day or two after the under layer has taken initial set. The latter shall not be allowed to dry out, before the top layer is laid on. The mortar used for applying top layer shall be sufficiently plastic and of rich mix 1 : 3 (1 cement : 3 fine sand) or as otherwise specified so that the mix of sand and gravel gets well pitched with the plaster surface. In order to make the base plastic, about 10% of finely grouted hydrated lime by volume of cement, shall be added when preparing mortar for the top layer.

### 13.7.6 Finish

It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. The rough cast mixture shall consist of sand or gravel or crushed stone of uniform colour from 2.36 mm to 12.5 mm or as specified and in the proportions as specified accurately to the effect required. The mixture





shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix get well pitched into the plaster base. The mix shall again be dashed over the vacant spaces if any so that the surface represents a homogeneous surface of sand mixed with gravel. A sample of rough cast plaster shall be got approved by the Engineer-in-Charge.

**13.7.7** Specification for other details like precautions, measurement and rate shall be as described under 13.1.

### **13.8 PEBBLE DASH FINISH (IN SITU WORK)**

**13.8.1** The specification shall be the same as for rough cast plaster, except that the washed pebble or crushed stone graded from 12.5 mm to 6.3 mm or as specified shall be dashed over the plaster base and the vacant spaces if any shall be filled in by pressing pebbles or crushed stone as specified by hand, so that the finished surface represents a homogeneous surface.

**13.8.2** Specification for scaffolding, preparation of surface, Mortar, Measurements and Rate shall be as described under 13.7.

### **13.9 PLAIN BANDS OF CEMENT MORTAR**

**13.9.0** Plain band is a plaster strip of uniform width not exceeding 30 cm and of uniform thickness, provided for decorative or other purpose flush with, sunk below or projecting beyond, the wall plaster. A flush band is one where due to the difference in mix or shade of the mortar, the band is executed as a separate and distinct operation from the wall plaster.

#### **13.9.1 Thickness**

The thickness of a raised band is the thickness of the projection beyond the plane of the wall plaster.

In the case of a flush or a sunk band, the thickness will be the thickness of the plaster measured from the untreated wall surface.

#### **13.9.2 Preparation of Surfaces and Application**

**13.9.2.1** In the case of flush or sunk bands the joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing the scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

**13.9.2.2** In case of raised band, the surface shall be prepared as specified in 13.1.4. The surface of the wall plaster behind the band shall be left rough and furrowed 2 mm deep with a scratching tool, diagonally both ways to form key for the band. No reduction in the rate for the above backing wall plaster shall, however, be made for not finishing the same smooth.

#### **13.9.3 Mortar**

Mortar of the mix and type of sand specified in the description of the item shall be used.

#### **13.9.4 Finish**

The bands shall be finished exactly to the size as shown in the drawings. The horizontal or vertical lines of bands shall be truly parallel and straight and the surfaces shall be finished truly plane and smooth. The lines and surfaces shall be checked with fine threads for straightness, level and accuracy.

**13.9.5 Scaffolding, Curing and Precaution shall be as described under 13.1.**

#### **13.9.6 Measurements**





Length will be measured in running metres correct to a cm. The length shall be taken along the finished face. The width shall not be measured by girth. For width of band 30 cm or below, the width shall be measured in cm correct to 5 mm. The quantity shall be calculated in metre-cm units.

#### **13.9.7 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above. Nothing extra shall be paid for mitres, stops nor for bands on curved surfaces of whatever radius, they may be. The rate is also inclusive of all rounding or chamfering at corners, arrisers, providing grooves at junctions etc.

### **13.10 MOULDED BANDS OF CEMENT MORTAR (SINGLE COAT WORK)**

**13.10.1** Moulded band is a plaster strip of uniform width but with varying thickness across its section formed over wall plaster for decorative purposes. The sectional periphery of the band is formed by a combination of straight lines or of curves or of straight lines and curves.

#### **13.10.2 Thickness**

The higher thickness stipulated in the description of the item shall refer to the upper limiting thickness of the moulding at its most projected portion, measured from the wall plaster.

**13.10.3** Preparation of Surface, Mortar, Scaffolding, Curing and Precautions shall be as specified under 13.9.

#### **13.10.4 Application and Finish**

Proper templates conforming accurately to the sectional periphery of the moulded band shall be got approved, before use. The finished band shall be true to the template at all sections. The lines of the band shall be truly parallel and straight and surfaces smoothly finished.

#### **13.10.5 Measurements**

The width of the band 30 cm or below shall be measured in cm correct to 5 mm and shall be measured along the sectional periphery of the moulded band, from wall plaster face to wall plaster face. The length shall be measured, in running metres correct to a cm. It shall be taken along the finished face of the band at the centre of its girth. The quantity should be calculated in metre-cm units.

#### **13.10.6 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above. Nothing extra shall be paid for mitres, stops nor for bands on curved surfaces of whatever radius, they may be. The rate is also inclusive of all rounding or chamfering at corners, arrisers etc.

### **13.11 MOULDED BANDS OF CEMENT MORTAR (TWO COAT WORK)**

**13.11.1** Moulded band is a plaster strip of uniform width but with varying thickness across its section formed over wall plaster for decorative purposes. The sectional periphery of the band is formed by a combination of straight lines or of curves or of straight lines and curves.

#### **13.11.2 Thickness**

The higher thickness stipulated for the under coat in the description of the item shall refer to the upper limiting thickness of the under coat of the moulding at its most projected portion from the wall plaster.

The thickness stipulated for the finishing coat is the uniform thickness of the finished peripheral surface of the moulded band from the under coat.

#### **13.11.3 Mortar**

The under coat shall consist of cement mortar 1 : 5 (1 cement : 5 coarse sand) and the top coat shall be of cement mortar 1 : 4 (1 cement : 4 fine sand) unless otherwise specified in the description of item.

#### 13.11.4 Application and Finish

Proper templates conforming to the sectional periphery of the moulded band as at the stages of the under coat and the finished final coat shall be made and got approved and used at the proper stages in executing the bands to true and accurate profile. The lines of the bands as finally completed shall be truly parallel and straight and the surfaces smoothly finished.

13.11.5 All other details shall be as specified under 13.10.

#### 13.12 CEMENT WATER PROOFING COMPOUND

13.12.1 It shall be used for cement mortar for plastering or concrete work.

##### 13.12.2 Water Proofing Compound

Integral cement water proofing compound conforming to IS 2645 and of approved brand and manufacture, enlisted by the Engineer-in-Charge from time to time shall be used.

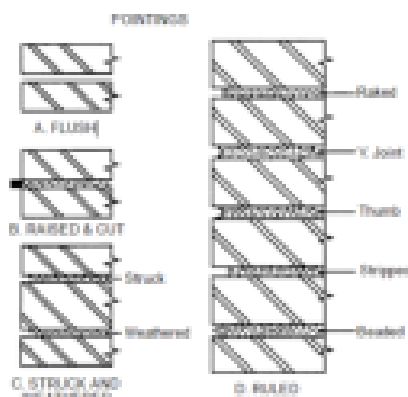
13.12.3 The contractor shall bring the materials to the site in their original packing. The containers will be opened and the material mixed with dry cement in the proportion by weight, recommended by the manufacturers or as specifically described in the description of the item. Care shall be taken in mixing, to see that the water proofing material gets well and integrally mixed with the cement and does not run out separately when water is added.

13.12.4 It shall be measured by weight.

13.12.5 The rate shall include the cost of all labour and materials involved in all the operations described above.

#### 13.13 POINTING ON BRICK WORK, TILE WORK AND STONE WORK

13.13.0 Pointing shall be of the type shown in figure below:



Drawings not to Scale

##### 13.13.1 Scaffolding

For all exposed brick work, tile work or stone work independent double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong tied together with horizontal pieces over which scaffolding planks shall be fixed.

For all other work in building, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not be allowed in



pillars/columns less than one metre in width, or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

Note: In case of special type of work, scaffolding shall be got approved from Engineer-in-Charge in advance.

### 13.13.2 Preparation of surface

The joints shall be raked out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before pointing is commenced.

In case of concrete surface if a chemical retarder has been applied to the form work, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

The joints shall be raked to such a depth that the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall not be less than 12 mm.

### 13.13.3 Mortar

Mortar of specified mix shall be used. It shall be as specified under Chapter 3.0.

### 13.13.4 Application and Finishing

**13.13.4.1** The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall then be finished with the proper tool, in the manner described below:

**13.13.4.2 Flush Pointing:** The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

**13.13.4.3 Ruled Pointing:** The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as shown in drawings or as instructed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

**13.13.4.4 Cut or Weather Struck Pointing:** The mortar shall first be pressed into the joints. The top of the horizontal joints shall then be neatly pressed back about 3 mm or as directed, with the pointing tool so that the joints are sloping from top to bottom.

The vertical joints shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles.

**13.13.4.5 Raised and Cut Pointing:** Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm raised and width 10 mm more as directed.

**13.13.4.6** The superfluous mortar shall then be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape required and the edges are straight, neat and clean.

### 13.13.5 Curing

The pointing shall be kept wet for seven days. During this period, it shall be suitably protected from all damages.



The pointing lines shall be truly horizontal and vertical except where the joints are slanting as in rubble random masonry. Lines of joints from different directions should meet neatly at the junctions instead of crossing beyond.

### **13.13.6 Measurements**

**13.13.6.1** Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres upto two places of decimal.

**13.13.6.2** The various types of pointing for example, struck, keyed, flush, tuck, etc. shall each be measured separately.

**13.13.6.3** Pointing on different types of walls, floors, roofs etc. shall each be measured separately. The type and material of the surface to be pointed shall be described.

**13.13.6.4** Pointing in a single detached joint as for flashing shall be given in running metres.

**13.13.6.5** For jambs, soffits, sills etc. for opening not exceeding 0.5 sqm each in area, ends of joists, beams, posts, girders, steps etc. not exceeding 0.5 sqm each in area and opening not exceeding 3 sqm each deductions and additions shall be made in the following way, in case of pointing on external face only.

- (a) No deduction shall be made for ends of joists, beams, posts etc. and openings not exceeding 0.5 sqm each, and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings.
- (b) Deductions for openings exceeding 0.5 sqm but not exceeding 3 sqm each shall be made as follows and no additions shall be made for reveals, jambs, soffits, sills, etc. for these openings.
- (c) When both the faces of the wall are pointed with the same pointing deduction shall be made for one face only.
- (d) When two faces of wall are pointed with different pointings or if one face is plastered and other is pointed or plastered, deduction shall be made from the plaster or pointing on the side of frames for doors, windows, etc. on which the width of the reveal is less than that on the other side, but no deduction shall be made from the other side.
- (e) Where width of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of pointing or plaster as the case may be.
- (f) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each pointed face of wall.

**13.13.6.6** In case of openings of area above 3 sqm each, deduction shall be made for the openings, but jambs, soffits and sills shall be measured.

**13.13.6.7** The following shall be measured separately.

- (a) Raking out joints for old work only shall be measured and given in square metres.
- (b) Raking out joints of old work built in mud mortar, lime mortar and cement mortar shall each be measured separately.
- (c) Raking out joints of different types of old walls, floors etc. shall each be measured separately.
- (d) Raking single detached joints as for flashing old work shall be given in running metres.

### **13.13.7 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above.

## **13.13A CEMENT BASED POLYMER MODIFIED MORTAR**

### **13.13A.1 Materials**



Polymer modified mortar is a two component polymer modified repair mortar composed of powder component based on cement binder, properly graded aggregates and additives & second component is liquid polymer of approved make it is to be mixed with water on site to produce a highly consistent, high strength cement mortar. It is specially designed for repairs of RCC members like beams & columns, slabs & walls because it provides high compressive strength, high resistance to chlorides and carbon dioxide.

### **13.13A.2 Scaffolding**

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder or jhoola these will be permitted in place of scaffolding.

### **13.13A.3 Areas of Application**

Repair & Reinstatement of Spalled concrete in RCC members beams, columns etc.

### **13.13A.4 Method of Application**

#### **13.A.4.1 Surface Preparation**

Expose fully any corroded steel in the repair area and remove all scale and corrosion deposits mechanically or ideally by grit blasting. Clean the surface and remove loose concrete, any dust, oil paint, grease etc.

#### **13.A.4.2 Priming**

Apply zinc primer of approved make over the cleaned re-bars & allow to dry before repair. The substrate should be primed by applying one neat/clear of bonding agent of approved make.

#### **13.A.4.3 Mixing**

For normal application use of potable water as per manufacturer's specifications. First add polymer into water and mix for 2 minutes. Then add powder slowly and mix till homogeneous mix is obtained. Mixing must be done with a mixer.

#### **13.A.4.4 Application**

Apply the mix to the prepared substrate by hand when primer becomes tacky. Ensure that the material has reached evenly behind bars. Mix can be applied in required thickness as per item in a single application. Mild cure the prepared surface with water for 3 days.

### **13.13A.5 Measurements**

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Pre- measurements of the patches to be plastered shall be recorded after the old plaster has been cut and surface prepared.

### **13.13A.6 Rates**

The rate includes the cost of all the materials and labour involved in all the operations described above.

## **13.14 WHITE WASHING WITH LIME**

### **13.14.1 Scaffolding**

**13.14.1.1** Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed.



**13.14.1.2** For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Note: In case of special type of brick work, scaffolding shall be got approved from Engineer-in-Charge in advance.

**13.14.1.3** Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

**13.14.1.4** For white washing the ceiling, proper stage scaffolding shall be erected.

#### **13.14.2 Preparation of Surface**

Before new work is white washed, the surface shall be thoroughly brushed free from mortar droppings and foreign matter.

In case of old work, all loose particles and scales shall be scrapped off and holes in plaster as well as patches of less than 50 cm area shall be filled up with mortar of the same mix. Where so specifically ordered by the Engineer -in- Charge, the entire surface of old white wash shall be thoroughly removed by scrapping and this shall be paid for separately. Where efflorescence is observed the deposits may be brushed clean and washed. The surface shall then be allowed to dry for atleast 48 hours before white washing is done.

#### **13.14.3 Preparation of Lime Wash**

**13.14.3.1** The lime wash shall be prepared from fresh stone white lime (Narnaul or Dehradun quality). The lime shall be thoroughly slaked on the spot, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 40 gm of gum dissolved in hot water, shall be added to each 10 cubic decimetre of the cream. The approximate quantity of water to be added in making the cream will be 5 litres of water to one kg of lime.

**13.14.3.2** Indigo (Neel) upto 3 gm per kg of lime dissolved in water, shall then be added and stirred well. Water shall then be added at the rate of about 5 litres per kg. of lime to produce a milky solution.

#### **13.14.4 Application**

**13.14.4.1** The white wash shall be applied with moonj brushes to the specified number of coats. The operation for each coat shall consist of a stroke of the brush given from the top downwards, another from the bottom upwards over the first stroke, and similarly one stroke horizontally from the right and another from the left before it dries.

**13.14.4.2** Each coat shall be allowed to dry before the next one is applied. Further each coat shall be inspected and approved by the Engineer-in-Charge before the subsequent coat is applied. No portion of the surface shall be left out initially to be patched up later on.

**13.14.4.3** For new work, three or more coats shall be applied till the surface presents a smooth and uniform finish through which the plaster does not show. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

**13.14.4.4** For old work, after the surface has been prepared as described in para 13.14.2 a coat of white wash shall be applied over the patches and repairs. Then a single coat or two or more coats of white wash as stipulated in the description of the item shall be applied over the entire surface. The white washed surface should present a uniform finish through which the plaster patches do not appear. The washing on ceiling should be done prior to that on walls.

**Note:** In case of Hessian ceiling, on no account, lime shall be used as it rots cloth and hessian.



### 13.14.5 Protective Measures

Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashings and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned. Damages if any to furniture or fittings and fixtures shall be recoverable from the contractor.

### 13.14.6 Measurements

**13.14.6.1** Length and breadth shall be measured correct to a cm. and area shall be calculated in sqm correct to two places of decimals.

**13.14.6.2** Measurements for Jambs, Soffits and Fills etc. for openings shall be as described in 13.1.9.

**13.14.6.3** Corrugated surfaces shall be measured flat as fixed and the area so measured shall be increased by the following percentages to allow for the girthed area.

Corrugated non-asbestos cement sheet	20%
Semi corrugated non-asbestos cement sheet	10%

**13.14.6.4** Cornices and other such wall or ceiling features shall be measured along the girth and included in the measurements.

**13.14.6.5** The number of coats of each treatment shall be stated. The item shall include removing nails, making good holes, cracks, patches etc. not exceeding 50 sq. cm. each with material similar in composition to the surface to be prepared.

**13.14.6.6** Work on old treated surfaces shall be measured separately and so described.

### 13.14.7 Rate

The rate shall include all material and labour involved in all the operations described above.

### 13.15 SATNA LIME WASHING

**13.15.1** Satna lime wash shall be used as a base coat where so specified. The specifications for 'white washing with lime shall apply except that Satna or Katni quality lime shall be used in place of Narnaul or Dehradun quality lime and the wash will be mixed to a thicker consistency. The other details and specifications described in 13.14 will apply in toto.

### 13.16 WHITE WASHING WITH WHITING

#### 13.16.1 Preparation of Mix

Whiting (ground white chalk) shall be dissolved in sufficient quantity of warm water and thoroughly stirred to form a thin slurry which shall then be screened through a clean coarse cloth. Two kg of gum and 0.4 kg of copper sulphate dissolved separately in hot water shall be added for every cum of the slurry which shall then be diluted with water to the consistency of milk so as to make a wash ready for use.

**13.16.2** Other specifications described in 13.14 shall apply in this case also.

### 13.17 COLOUR WASHING

**13.17.1** The mineral colours, not affected by lime, shall be added to white wash. Indigo (Neel) shall however, not be added. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface. If it is blotchy or otherwise badly applied, it shall be redone by the contractor.





For new work, the priming coat shall be of white wash with lime or with whiting as specified in the description of the item. Two or more coats shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface has been prepared as described in 13.14.2 a coat of colour wash shall be applied over the patches and repairs. Then a single coat, or two or more coats of colour wash, as stipulated in the description of the item shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

**13.17.2** Other specifications as described under 13.14.

### **13.18 DRY DISTEMPERING**

#### **13.18.1 Materials**

Dry distemper of required colour (IS 427) and of approved brand and manufacture shall be used. The shade shall be got approved from the Engineer-in-Charge before application of the distemper. The dry distemper colour as required shall be stirred slowly in clean water using 6 decilitres (0.6 litre) of water per kg of distemper or as specified by the makers. Warm water shall preferably be used. It shall be allowed to stand for at least 30 minutes (or if practicable over night) before use. The mixture shall be well stirred before and during use to maintain an even consistency.

Distemper shall not be mixed in larger quantity than is actually required for one day's work.

#### **13.18.2 Preparation of Surface**

**13.18.2.1** Before new work is distempered, the surface shall be thoroughly brushed free from mortar droppings and other foreign matter and sand papered smooth.

**13.18.2.2** New plastered surfaces shall be allowed to dry completely, before applying, distemper.

**13.18.2.3** In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt, etc.

**13.18.2.4** Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

#### **13.18.3 Priming Coat**

Water thinnable cement primer for interior wall surface, having VOC content less than 50 gms/lit shall be applied over the prepared surface in case of new work.

#### **13.18.4 Application**

**13.18.4.1** In the case of new work, the treatment shall consist of a priming coat as para 13.18.3 followed by the application of two or more coats of distemper till the surface shows an even colour.

**13.18.4.2** For old work, the surface prepared as described in para 13.14 shall be applied one or more coats of distemper till the surface attains an even colour.

**13.18.4.3** The application of each coat shall be as follows:

The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat.

**13.18.4.4** The subsequent coats shall be applied only after the previous coat has dried.





**13.18.4.5** The finished surface shall be even and uniform and shall show no brush marks.

**13.18.4.6** Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day.

**13.18.4.7** After each day's work, the brushes shall be washed in hot water and hung down to dry. Old brushes which are dirty or caked with distemper shall not be used.

**13.18.5** The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14.

### **13.19 OIL EMULSION (OIL BOUND) WASHABLE DISTEMPERING**

#### **13.19.1 Materials**

Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufacture shall be used. The primer where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper and primer shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer-in-Charge.

#### **13.19.2 Preparation of the Surface**

**13.19.2.1** For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

**13.19.2.2** In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

#### **13.19.3 Application**

**13.19.3.1 Priming Coat:** The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described in 13.18.4.

**Note:** If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied.

Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered surfaces if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint conforming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced. For old work no primer coat is necessary.



**13.19.3.2 Distemper Coat:** For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be tho- roughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

**13.19.4** The specifications in respect of scaffolding, protective measures and measurements shall be as described under 13.14.

#### **13.19.5 Rate**

The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

### **13.19A 1<sup>st</sup> QUALITY ACRYLIC DISTEMPER**

#### **13.19A.1 Materials**

1<sup>st</sup> quality acrylic distemper having VOC content less than 50 gms/litre of approved brand and manufacture shall be used. The acrylic distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper shall be brought by the contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the Engineer-in-Charge.

#### **13.19A.2 Preparation of the Surface**

**13.19A.2.1** For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

**13.19A.2.2** In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

#### **13.19A.3 Application**

**13.19A.3.1 Priming Coat:** The priming coat shall be with distemper primer or cement primer, as required in the description of the item. The application of the distemper primer shall be as described in 13.18.4.



**Note:** If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied. For old work no primer coat is necessary.

**13.19A.3.2 Distemper Coat:** For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat. For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be thoroughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

**13.19A.4** The specifications in respect of scaffolding, protective measures and measurements shall be as described under 13.14.

#### **13.19A.5 Rate**

The rate shall include the cost of all labour and materials involved in all the above operations (including priming coat) described above.

### **13.20 CEMENT PRIMER COAT**

Cement primer coat is used as a base coat on wall finish of cement, lime or lime cement plaster or on non-asbestos cement surfaces before oil emulsion distemper Paints are applied on them. The cement primer is composed of a medium and pigment which are resistant to the alkalies present in the cement, lime or lime cement in wall finish and provides a barrier for the protection of subsequent coats of oil emulsion distemper Paints.

Primer coat shall be preferably applied by brushing and not by spraying. Hurried priming shall be avoided particularly on absorbent surfaces. New plaster patches in old work should also be treated with cement primer before applying oil emulsion Paints etc.

#### **13.20.1 Preparation of the Surface**

The surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

#### **13.20.2 Application**

The cement primer shall be applied with a brush on the clean dry and smooth surface. Horizontal strokes shall be given first and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks. It shall be allowed to dry for at least 48 hours, before oil emulsion Paint is applied.

The Specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.1.4.



## 13.21 CEMENT PAINT

### 13.21.1 Material

The cement Paint shall be (conforming to IS 5410) of approved brand and manufacture.

The cement Paint shall be brought to the site of work by the contractor in its original containers is sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in- Charge. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed and permission obtained from the Engineer-in-Charge.

### 13.21.2 Preparation of Surface

For New Work, the surface shall be thoroughly cleaned of all mortar dropping, dirt dust, algae, grease and other foreign matter by brushing and washing. Pitting in plaster shall be made good and a coat of water proof cement.

### 13.21.3 Preparation of Mix

Cement Paint shall be mixed in such quantities as can be used up within an hour of its mixing as otherwise the mixture will set and thicken, affecting flow and finish. Cement Paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement Paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken to add the cement Paint gradually to the water and not *vice versa*. The second stage shall comprise of adding further one part of water to the mix and stirring thoroughly to obtain a liquid of workable and uniform consistency. In all cases the manufacturer's instructions shall be followed meticulously.

The lids of cement Paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere the cement Paint rapidly becomes air set due to its hygroscopic qualities.

In case of cement Paint brought in gunny bags, once the bag is opened, the contents should be consumed in full on the day of its opening. If the same is not likely to be consumed in full, the balance quantity should be transferred and preserved in an airtight container to avoid its exposure to atmosphere.

### 13.21.4 Application

**13.21.4.1** The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work.

**13.21.4.2** The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

**13.21.4.3** For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade.

**13.21.4.4** For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

### 13.21.5 Precaution

Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces.



If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

- 13.21.6** The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14. The coefficient for cement Paint on RCC Jalli shall be the same as provided in Sl. No. 7 of Table 1 under para 13.23.6.4 for painting trellis for Jaffri work.

## **13.22 EXTERIOR PAINTING ON WALL**

### **13.22.1 Material**

The paint shall be (Textured exterior paint/Acrylic smooth exterior paint/premium acrylic smooth exterior paint/100% premium acrylic emulsion paint) of approved brand and manufacture.

This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in- Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

### **13.22.2 Preparation of Surface**

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

### **13.22.3 Application**

Base coat of water proofing cement paint

- 13.22.3.1** All specifications in respect of base coat of water proofing cement paint shall be as described under 11.22.

- 13.22.3.2** Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

- 13.22.3.3** Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

- 13.22.4** The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14.

## **13.22A DELUXE MULTI SURFACE PAINT FOR INTERIORS AND EXTERIORS**

### **13.22A.1 Material**



The paint shall be (Deluxe multi surface paint for interiors and exteriors) of approved brand and manufacture. This paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in- Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

#### **13.22A.2 Preparation of Surface**

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the Engineer in charge after inspection before painting is commenced.

#### **13.22A.3 Application**

Base coat of special primer of same manufacturer shall be used.

**13.22A.3.1** All specifications in respect of base coat of water proofing cement paint shall be as described under 13.21.

**13.22A.3.2** Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the Engineer-in-charge shall be followed meticulously.

The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust.

**13.22A.3.3** Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

**13.22A.4** The specifications in respect of scaffolding, protective measures, measurements and rate shall be as described under 13.14.

### **13.23 PAINTING**

#### **13.23.1 Materials**

Paints, oils, varnishes etc. of approved brand and manufacture shall be used. Only ready mixed Paint (Exterior grade) as received from the manufacturer without any admixture shall be used. If for any reason, thinning is necessary in case of ready mixed Paint, the brand of thinner recommended by the manufacturer or as instructed by the Engineer-in-Charge shall be used.

Approved Paints, oil or varnishes shall be brought to the site of work by the contractor in their original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the contractor and the Engineer-in -Charge. The empties shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge.

#### **13.23.2 Commencing Work**

Painting shall not be started until the Engineer -in-Charge has inspected the items of work to be painted, satisfied himself about their proper quality and given his approval to commence the painting work.





Painting of external surface should not be done in adverse weather condition like hail storm and dust storm. Painting, except the priming coat, shall generally be taken in hand after practically finishing all other building work.

The rooms should be thoroughly swept out and the entire building cleaned up, at least one day in advance of the Paint work being started.

### **13.23.3 Preparation of Surface**

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

### **13.23.4 Application**

**13.23.4.1** Before pouring into smaller containers for use, the Paint shall be stirred thoroughly in its containers, when applying also, the Paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform.

**13.23.4.2** The painting shall be laid on evenly and smoothly by means of crossing and laying off, the latter in the direction of the grains of wood. The crossing and laying off consists of covering the area over with Paint, brushing the surface hard for the first time over and then brushing alternately in opposite direction, two or three times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

**13.23.4.3** Where so stipulated, the painting shall be done by spraying. Spray machine used may be (a) high pressure (small air aperture) type, or (b) a low pressure (large air gap) type, depending on the nature and location of work to be carried out. Skilled and experienced workmen shall be employed for this class of work. Paints used shall be brought to the requisite consistency by adding a suitable thinner.

**13.23.4.4** Spraying should be done only when dry condition prevails. Each coat shall be allowed to dry out thoroughly and rubbed smooth before the next coat is applied. This should be facilitated by thorough ventilation. Each coat except the last coat, shall be lightly rubbed down with sand paper or fine pumice stone and cleaned off dust before the next coat is laid.

**13.23.4.5** No left over Paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

**13.23.4.6** No hair marks from the brush or clogging of Paint puddles in the corners of panels, angles of mouldings etc. shall be left on the work.

**13.23.4.7** In painting doors and windows, the putty round the glass panes must also be painted but care must be taken to see that no Paint stains etc. are left on the glass. Tops of shutters and surfaces in similar hidden locations shall not be left out in painting. However, bottom edge of the shutters where the painting is not practically possible, need not be done nor any deduction on this account will be done but two coats of primer of approved make shall be done on the bottom edge before fixing the shutters.

**13.23.4.8** On painting steel work, special care shall be taken while painting over bolts, nuts, rivets overlaps etc.

**13.23.4.9** The additional specifications for primer and other coats of Paints shall be as according to the detailed specifications under the respective headings.

### **13.23.5 Brushes and Containers**

After work, the brushes shall be completely cleaned of Paint and linseed oil by rinsing with turpentine. A brush in which Paint has dried up is ruined and shall on no account be used for painting work. The



containers when not in use, shall be kept closed and free from air so that Paint does not thicken and also shall be kept safe from dust. When the Paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth, so that they are clean, and can be used again.

### 13.23.6 Measurements

**13.23.6.1** The length and breadth shall be measured correct to a cm. The area shall be calculated in sqm (correct to two places of decimal), except otherwise stated.

**13.23.6.2** Small articles not exceeding 10 sq. decimetre (0.1 sqm) of painted surfaces where not in conjunction with similar painted work shall be enumerated.

**13.23.6.3** Painting upto 10 cm in width or in girth and not in conjunction with similar painted work shall be given in running metres and shall include cutting to line where so required.

**Note:** Components of trusses, compound girders, stanchions, lattices and similar work shall, however, be given in sq. metres irrespective of the size or girth of members. Priming coat of painting shall be included in the work of fabrication.

**13.23.6.4** In measuring painting, varnishing, oiling etc. of joinery and steel work etc. The coefficients as indicated in following tables shall be used to obtain the area payable. The coefficients shall be applied to the areas measured flat and not girthed.

**TABLE 13.1**  
**Equivalent Plain Areas of Uneven Surface**

S.No	Description of work	How measured	Multiplying coefficient
1	2	3	4
<b>I. Wood work doors, windows Etc.</b>			
1.	Panelled or framed and braced doors, windows etc.	Measured including flat (not girthed including)	1.30 (for each side)
2.	Ledged and battened or ledged, battened and braced doors, windows etc.	Chowkhat or frame, Edges, chocks, cleats, etc. shall be deemed to be included in the item.	-do-
3.	Flush doors etc.	-do-	1.20 (for each side)
4.	Part panelled and part glazed or gauzed doors, window etc. (Excluding painting of wire gauze portion)	-do-	1.00 (for each side)
5.	Fully glazed or gauzed doors, windows etc. (Excluding painting of wire gauze portion)	-do-	0.80 (for each side)
6.	Fully venetioned or louvered doors, windows etc.	-do-	1.80 (for each side)





7.	Trellis (or Jaffri) work one way or two way	Measured flat overall, no deduction shall be made for open spaces, supporting members shall not be measured separately	2 (for painting all over)
8.	Carved or enriched work	Measured flat	
9.	Weather boarding	Measured flat (not girthed supporting framework shall not be measured separately	1.20 (for each side)
10.	Wood shingle roofing	Measured flat (not girthed)	1.10 (for each side)
11.	Boarding with cover fillets and match boarding	Measured flat (not girthed)	1.05 (for each side)
12.	Tile and slate battening	Measured flat overall no deductions shall be made for open spaces	0.80 (for painting all over)
<b>II. Steel work doors, windows Etc.</b>			
13.	Plain sheeted steel doors or windows	Measured flat (not girthed) including frame edges etc.	1.10 (for each side)
14.	Fully glazed or gauzed steel doors and windows (excluding painting of wire gauze portion)	-do-	0.50 (for each side)
15.	Partly panelled and partly glazed or gauzed doors and windows (excluding painting of wire gauze portion)	-do-	0.80 (for each side)
16.	Corrugated sheeted steel doors or windows	-do-	1.25 (for each side)
17.	Collapsible gates	Measured flat	1.50 (for painting all over)
18.	Rolling shutters of interlocked laths	Measured flat (size of opening) all over; jamb guides, bottom rails and locking arrangement etc. shall be included in the item (top cover shall be measured separately)	1.10 (for each side)



III. General			
19.	Expanded metal, hard drawn steel wire fabric of approved quality, grill works and gratings in guard bars, balustrades, railing partitions and MS Bars in windows frames.	Measured flat overall; no deduction shall be made for open spaces; supporting members shall not be measured separately	1 (for Paint all over)
20.	Open palisade fencing and gates including standards, braces, rails stays etc. in timber or steel	-do- (See note No.12)	1 (for Paint all over)
21.	Corrugated iron sheeting in roofs, side cladding etc.	-do- Measured flat (not girthed)	1.14 (for each side)
22.	AC corrugated sheeting in roofs, side cladding etc.	-do-	1.20 (for each side)
23.	AC semi corrugated sheeting in roofs, side cladding etc. or Nainital pattern using plain sheets	-do-	1.10 (for each side)
24.	Wire gauze shutters including painting of wire gauze	-do-	1.00 (for each side)

#### Explanatory Notes for Table 13.1

1. Measurements for doors windows etc., shall be taken flat (and not girthed) over all including chowkhuts or frames, where provided. Where Chowkhuts or frames are not provided, the shutter measurements shall be taken.
2. Where doors, windows etc., are of composite types other than those included in Table 1 the different portion shall be measured separately with their appropriate coefficients, the centre line of the common rail being taken as the dividing line between the two portions.
3. The coefficients for door and windows shall apply irrespective of the size of frames and shutter members.
4. In case steel frames are used the area of doors, windows shutters shall be measured flat excluding frames.
5. When the two faces of a door, window etc. are to be treated with different specified finishes, measurable under separate items, the edges of frames and shutters shall be treated with the one



or the other type of finish as ordered by the Engineer-in-Charge and measurement of this will be deemed to be included in the measurement of the face treated with that finish.

6. In the case where shutters are fixed on both faces of the frames, the measurement for the door frame and shutter on one face shall be taken in the manner already described, while the additional shutter on the other face will be measured for the shutter only excluding the frame.
7. Where shutters are provided with clearance at top or/and bottom each exceeding 15 cm height, such openings shall be deducted from the overall measurements and relevant coefficient shall be applied to obtain the area payable.
8. Collapsible gates shall be measured for width from outside to outside of gate in its expanded position and for height from bottom to top of channel verticals. No separate measurements shall be taken for the top and bottom guide rails rollers, fittings etc.
9. Coefficients for sliding doors shall be the same as for normal types of doors in the table. Measurements shall be taken outside to outside of shutters, and no separate measurements shall be taken for the painting guide rails, rollers, fittings etc.
10. Measurements of painting as above shall be deemed to include painting all iron fittings in the same or different shade for which no extra will be paid.
11. The measurements of guard bars expanded metal, hard drawn steel wire fabric of approved quality, grill work and gratings, when fixed in frame work, painting of which is once measured else where shall be taken exclusive of the frames. In other cases the measurements shall be taken inclusive of the frames.
12. For painting open palisade fencing and gates etc., the height shall be measured from the bottom of the lowest rail, if the palisades do not go below it, (or from the lower end of the palisades, if they project below the lowest rail), upto the top of rails or palisades whichever are higher, but not up to the top of standards when the latter are higher than the top rails or the palisades.

**13.23.6.5** Width of moulded work of all other kinds, as in hand rails, cornices, architraves shall be measured by girth.

**13.23.6.6** For trusses, compound girders, stanchions, lattice girders, and similar work, actual areas will be measured in sq. metre and no extra shall be paid for painting on bolt heads, nuts, washers etc. even when they are picked out in a different tint to the adjacent work.

**13.23.6.7** Painting of rain water, soil, waste, vent and water pipes etc. shall be measured in running metres of the particular diameter of the pipe concerned. Painting of specials such as bends, heads, branches, junctions, shoes, etc. shall be included in the length and no separate measurements shall be taken for these or for painting brackets, clamps etc.

**13.23.6.8** Measurements of wall surfaces and wood and other work not referred to already shall be recorded as per actual.

**13.23.6.9** Flag staffs, steel chimneys, aerial masts, spires and other such objects requiring special scaffolding shall be measured separately.

#### **13.23.7 Precautions**

All furnitures, fixtures, glazing, floors etc. shall be protected by covering and stains, smears, splashings, if any shall be removed and any damages done shall be made good by the contractor at his cost.

#### **13.23.8 Rate**



Rates shall include cost of all labour and materials involved in all the operations described above and in the particular specifications given under the several items.

### 13.24 PAINTING PRIMING COAT ON WOOD, IRON OR PLASTERED SURFACES

#### 13.24.1 Primer

13.24.1.1 The primer for wood work, iron work or plastered surface shall be as specified in the description of item.

13.24.1.2 Primer for plaster/wood work/Iron & Steel/Aluminium surfaces shall be as specified below:

TABLE 13.2

S.No	Surfaces	Primer to be used
1.	Wood work (hard and soft wood)	Pink conforming to IS 3536
2.	Resinour wood and plywood	Aluminium primer conforming to IS 3585
3.	A. Aluminium and light alloys	Zinc chromate primer conforming to IS 104
	B. Iron, Steel and Galvanized steel	Red Oxide Zinc chromate Primer conforming IS 2074
4.	Cement/ Concrete /RCC/ Brick work, Plastered surfaces, non-asbestos surfaces to receive Oil bound distemper or Paint finish.	Cement primer conforming to IS 109

13.24.1.3 The primer shall be ready mixed primer of approved brand and manufacture.

13.24.1.4 Where primer for wood work is specified to be mixed at site, it shall be prepared from a mixture of red lead, white lead and double boiled linseed oil in the ratio of 0.7 kg : 0.7 kg : 1 litre.

13.24.1.5 Where primer for steel work is specified to be mixed at site, it shall be prepared from a mixture of red lead, raw linseed oil and turpentine in the ratio of 2.8 kg : 1 litre : 1 litre.

13.24.1.6 The specifications for the base vehicle and thinner for mixed on site primer shall be as follows:

- White Lead:** The White lead shall be pure and free from adulterants like barium sulphate and whiting. It shall conform to IS 103.
- Red Lead:** This shall be in powder form and shall be pure and free from adulterants like brick dust etc. It shall conform to IS 102.
- Raw Linseed Oil:** Raw linseed oil shall be lightly viscous but clear and of yellowish colour with light brown tinge. Its specific gravity at a temperature of 30 degree C shall be between 0.923 and 0.928.

Note: The oil shall be mellow and sweet to the taste with very little smell. The oil shall be of sufficiently matured quality. Oil turbid or thick, with acid and bitter taste and rancid odour and which remains sticky for a considerable time shall be rejected. The oil shall conform in all respects to IS 75. The oil shall be of approved brand and manufacture.

- Double Boiled Linseed Oil:** This shall be more viscous than the raw oil, have a deeper colour and specific gravity between 0.931 and 0.945 at a temperature of 30 degree C. It shall dry with a glossy surface. It shall conform in all respects to IS 77. The oil shall be of approved brand and manufacture.



**Turpentine:** Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall conform to IS 533.

**13.24.1.7** All the above materials shall be of approved manufacture and brought to site in their original packing in sealed condition.

### **13.24.2 Preparation of Surface**

**13.24.2.1 Wooden Surface:** The wood work to be painted shall be dry and free from moisture.

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before Paint is applied. After obtaining approval of Engineer-in-Charge for wood work, the priming coat shall be applied before the wood work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

**13.24.2.2 Iron & Steel Surface:** All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface of wrought iron during rolling which becomes loose by rusting, shall be removed.

All dust and dirt shall be thoroughly wiped away from the surface. If the surface is wet, it shall be dried before priming coat is undertaken.

**13.24.2.3 Plastered Surface:** The surface shall ordinarily not be painted until it has dried completely. Trial patches of primer shall be laid at intervals and where drying is satisfactory, painting shall then be taken in hand. Before primer is applied, holes and undulations, shall be filled up with plaster of paris and rubbed smooth.

### **13.24.3 Application**

The primer shall be applied with brushes, worked well into the surface and spread even and smooth. The painting shall be done by crossing and laying off as described in 13.22.3.3.

### **13.24.4 Treatment on Steel for Aggressive Environment**

**13.24.4.1** A second coat of ready mixed red oxide zinc chromate primer may be applied where considered necessary in aggressive environment such as near Industrial Establishment and Coastal regions where the steel members are prone to corrosion. The second coat (which shall be paid for separately) is to be applied after placing the member in position and just before applying Paint. The second coat of primer is not necessary in case of painting with synthetic enamel Paint as it is applied over an under coat of ordinary Paint.

**13.24.4.2** The specifications described under 13.33 shall hold good so far as they are applicable.

### **13.24A EPOXY PAINT**

#### **13.24A.1 Material**

This product has got excellent adhesion properties and offers a balanced aesthetic and corrosion protective surface. Epoxy offers good resistance to water and humidity.



Epoxy coating are used because of their outstanding chemical resistance, durability, low porosity and strong bond strength and it provides dry tough and protective coatings. Epoxy coatings are created, by chemical reaction using an epoxide resin and polyamine hardener.

#### **13.24A.2 Painting new surface**

**13.24A.2.1** Surface must be dried, cleaned & made free from oil, grease, dirt, dust & all other contaminants that could interfere with adhesion of coating.

#### **13.24A.2.2 Application**

Epoxy paint is supplied in two parts i.e. (base and hardener). Stir the base and hardener separately. Mix hardener gradually into the base under continuous stirring as per mixing ratio as specified by the manufacturers.

The epoxy paint shall be consumed with in the working pot life as specified by the manufacturers. Part mixing should be avoided.

To achieve optimum performance of the product, minimum 2-3 coats by brushing would be required to get the desired dry film thickness (DFT) as specified by the manufacturer. Relative humidity in the environment should preferably be below 85%.

#### **13.24A.2.3 Cleaning**

All equipments/apparatus shall be cleaned immediately after use with thinner especially the hose pipes, gun, all spray equipments etc. All surplus material should be disposed off in compliance with environmental pollution rules etc.

**13.24A.2.4** General Safety Contact of the product with skin specially with eyes should be avoided. Use of face mask is mandatory during whole process. Proper ventilation is required and all safety procedures and precautions are to be adopted for executing epoxy painting process.

#### **13.24A.2.5 Measurement**

Measurements, Rate and other details shall be as specified in Para 13.23 as far as they are applicable.

### **13.25 PAINTING SYNTHETIC ENAMEL PAINT OVER G.S. SHEETS**

#### **13.25.1 Synthetic enamel**

Paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S. sheets shall be painted with a priming coat of one coat of redoxide zinc chromate Paint. Primer shall be applied before fixing sheets in place.

#### **13.25.2 Preparation of Surface**

**13.25.2.1 Painting New Surface:** The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm of area and is applied for ensuring proper adhesion of Paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and the surface washed and dried and rusted surface shall be touched with synthetic enamel paint of approved brand, manufacturer and shade.



**13.25.2.2 Painting Old Surface:** If the old Paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with synthetic enamel paint.

If the old Paint is blistered and flaked, it shall be completely removed as described in 13.41. Such removal shall be paid for separately and painting shall be treated as on new work.

### **13.25.3 Application**

The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning. The second or additional coats shall be applied when the previous coat has dried.

**13.25.4** The specifications described in 13.23 shall hold good so far as they are applicable.

## **13.26 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS**

**13.26.1** The primer shall be prepared on site or shall be of approved brand and manufacture as specified in the item.

Paint shall be anti-corrosive bitumastic Paint, aluminium Paint or other type of Paint as specified in the description of the item.

### **13.26.2 Painting New Surface**

**13.26.2.1 Preparation of Surface:** The surface shall be prepared for priming coat as described in 13.24.2.2.

**13.26.2.2 Application:** The number of coat of painting over the priming coat shall be as stipulated in the description of the item. The application of Paint over priming coat shall be carried out as specified in 13.25.

**13.26.2.3 Measurements:** Measurements will be taken over the finished line of pipe including specials etc. in running metres, correct to a cm.

Pipes of different diameters of bore shall be measured and paid for separately.

Specials and fittings such as holder bat clamps, plugs etc. will not be measured separately.

**13.26.2.4 Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above, including painting of all specials and fittings.

**13.26.2.5** Specifications described in 13.22 shall hold good as far as they are applicable.

### **13.26.3 Painting on Old Surface**

**13.26.3.1** The surface shall be prepared as specified in 13.25.1.2.

**13.26.3.2** The specifications for application shall be as described in 13.22.3.

**13.26.3.3** Measurements, rate and other details shall be as specified in 13.26.2.3.

## **13.27 PAINTING WITH WOOD PRESERVATIVE**

**13.27.1** Oil type wood preservative of specified quality and approved make, conforming to IS 218 shall be used. Generally, it shall be creosote oil type-I or anthracene oil.

### **13.27.2 Painting on New Surface**

**13.27.2.1 Preparation of Surface:** Painting shall be done only when the surface is perfectly dry to permit of good absorption. All dirt, dust or other foreign matter shall be removed from the surface to be painted. All roughness shall be sand papered and cleaned.





**13.27.2.2 Application:** The preservative shall be applied liberally with a stout brush and not daubed with rags or cotton waste. It shall be applied with a pencil brush at the joints of the wood work. The first coat shall be allowed at least 24 hours to soak in before the second (the final) coat is applied. The second coat shall be applied in the same manner as the first coat. The excess of preservative which does not soak into the wood shall be wiped off with a clean dry piece of cloth.

**13.27.2.3** The specifications described in 13.23 shall hold good in so far as they are applicable.

### **13.27.3 Painting on Old Surface**

The work shall be done in the same manner as on new surface except that only one coat shall be done.

## **13.27A FIRE RETARDANT PAINT**

### **13.27A.1 Material**

Ready to use, intumescent coating which effectively retards the flame spread and penetration of heat through their intumescent sublimative-ablative and synergetic flame suppressing action. On contact with flame, flame control intumescent fire retardant coating, decomposes and puff up (intumesce) forming a thick, dense, spongy foam layer that retards heat penetration and flame spread.

### **11.27A.2 Polishing new surface**

#### **11.27A.2.1 Preparation of surface**

Preparation of surface shall be as described in para 13.23.3. Surface must be dry, free from dust, oil, wax, greases.

#### **11.27A.2.2 Application**

To achieve optimum performance of product apply fire retardant paint @ 2.86 litre/10 sqm per coat or as specified by manufacturers in multiple coats with brush etc. using conventional French polish process to achieve good result.

#### **11.27A.2.3 Measurement**

Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

## **13.28 COAL TARRING**

**13.28.1** Coal tar of approved manufacture conforming to IS 290 shall be used. The tar, to every litre of which 200 gm of unslaked lime has been added, shall be heated till it begins to boil. It must then be taken off the fire and kerosene oil added to it slowly at the rate of one part of kerosene oil to six or more parts by volume and stirred thoroughly. The addition of lime is for preventing the tar from running.

### **13.28.2 Coal Tarring New Surface**

**13.28.2.1 Preparation of Surface:** This shall be done as specified in 13.24.2 except that sand papering is not necessary. Where iron work is to be painted it shall be free from scales and rust before painting.

**13.28.2.2 Application:** The mixture shall be applied as hot as possible with a brush. The second coat shall be applied only after the first coat has thoroughly dried up. Where possible, the article to be tarred, shall be dipped in the hot mixture for better results. The quantity of tar to be used for the first or second coat shall be not less than 0.16 and 0.12 litre per sqm respectively. Thinning with kerosene oil shall be suitably done to ensure this.

**13.28.2.3** The specifications described in 13.23 shall hold good in all other respects, so far as they are applicable.

### **13.28.3 Coal Tarring old Surface**





The work shall be done in the same manner as specified in 13.28.2 except that only one coat using 0.12 litre per sqm. area shall be done.

### **13.29 SPRAY PAINTING WITH FLAT WALL PAINT ON NEW SURFACE**

**13.29.0** The work shall include a priming coat of 'Distemping Primer' or 'Cement Primer' as specified in the description of the item. Flat wall Paint shall normally be applied on walls 12 months after their completion, in which case Distemper primer will suffice. If the walls are to be painted earlier, the primer coat shall consist of cement primer.

**13.29.1** The primer and the flat wall Paint shall be of approved brand and manufacture and of the required shade.

**13.29.2** The surface shall be prepared as described in 13.20.1.

#### **13.29.3 Application**

**13.29.3.1 Primer Coat:** The specified primer shall be painted or sprayed over the surface in an even and uniform layer.

**13.29.3.2 Painting Coats:** When the surface is dry, the spray painting with the wall Paint in uniform and even layers will be done to the required number of coats. Each coat shall be allowed to dry overnight and lightly rubbed with very fine grade of sand paper and loose particles brushed off before the next coat is sprayed.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The Air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted.

At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

If after the final coat of wall Paints, the surface obtained is not upto the mark, further one or more coats as required shall be given after rubbing down the surface and dusting off all loose particles to obtain a smooth and even finish. If the primer or wall Paint gets thickened during the application, it shall be thinned suitably with the thinner recommended by the manufacture. Adequate ventilation shall be provided to disperse spray fumes. Fitments and floor shall be protected from the spray.

**13.29.4** The specifications described in 13.23 shall hold good for all other details as far as applicable.

### **13.30 SPRAY PAINTING WITH FLAT PAINT ON OLD SURFACE**

**13.30.1** Where the old Paint is in sound condition, renewal shall be carried out as described below, otherwise the old Paint shall be completely stripped and spray painting shall be carried out as over new work. Such removal shall be paid for separately.

**13.30.2** The flat wall Paint shall be of approved brand and manufacture and of required shade.

#### **13.30.3 Preparation of Surface**

The surface shall be washed to remove dust and dirt. A mild detergent solution like soap water shall be used for washing and the surface shall also be rubbed down lightly with abrasive paper when dry. Any patches appearing on the surface shall first be touched up with a coat of Paint. These shall be allowed to dry and then rubbed down lightly.

#### **13.30.4 Application**



The Paint shall then be applied with spraying machine in uniform and even layer. A second coat shall be applied if considered necessary by the Engineer-in-Charge but only after the first coat is complete dry and hard.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the surface in uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The Air pressure shall not be kept too high as otherwise the Paint will fog up and will be wasted. At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt. Incorrect adjustments shall be set right, as otherwise they result in variable spray patterns, runs, sags and uneven coats.

**13.30.5** The specifications described in 13.22 shall hold good for all other details, as far as they are applicable.

### **13.31 WALL PAINTING WITH PLASTIC EMULSION PAINT**

**13.31.0** The plastic emulsion Paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These Paints are to be used on internal surfaces except wooden and steel.

**13.31.1** Plastic Emulsion Paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

#### **13.31.2 Painting on New Surface**

**13.31.2.1** The wall surface shall be prepared as specified in 13.23.3.

**13.31.2.2 Application:** The number of coats shall be as stipulated in the item. The Paint will be applied in the usual manner with brush, spray or roller. The Paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non-absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

#### **13.31.2.3 Precautions**

- (a) Old brushes if they are to be used with emulsion Paints, should be completely dried of turpentine or oil Paints by washing in warm soap water. Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the Paint from hardening on the brush.
- (b) In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.
- (c) Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.
- (d) Washing of surfaces treated with emulsion Paints shall not be done within 3 to 4 weeks of application.

**13.31.2.4** Other details shall be as specified in 13.23 as far as they are applicable.

#### **13.31.3 Painting on Old Surface**

**13.31.3.1 Preparation of Surface:** This shall be done, generally as specified in 13.24.2.1 except that the surface before application of Paint shall be flattened well to get the proper flat velvety finish after painting.



**13.31.3.2 Application:** The number of coats to be applied shall be as in description of item.

The application shall be as specified in 13.31.2.2 except that thinning with water shall not normally be required.

Other details shall be as specified in 13.23 as far as applicable.

### **13.32 PAINTING WITH SYNTHETIC ENAMEL PAINT**

**13.32.1** Synthetic Enamel Paint (conforming to IS 2933) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of ordinary Paint of shade to match the top coat as recommended by the same manufacturer as far the top coat shall be used.

#### **13.32.2 Painting on New Surface**

**13.32.2.1** Preparation of surface shall be as specified in 13.24.2 as the case may be.

**13.32.2.2 Application:** The number of coats including the undercoat shall be as stipulated in the item.

- (a) *Under Coat:* One coat of the specified ordinary Paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.
- (b) *Top Coat:* Top coats of synthetic enamel Paint of desired shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

**13.32.2.3** Other details shall be as specified in 13.22 as far as they are applicable.

#### **13.32.3 Painting on Old Surface**

**13.32.3.1 Preparation of Surface:** Where the existing Paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified Paint. The surface shall again be rubbed and made smooth and uniform.

If the old paint is blistered and flaked it will be necessary to completely remove the same as described in para 13.41. Such removal shall be paid for separately and the painting shall be treated as on new surface.

**13.32.3.2 Painting:** The number of coats as stipulated in the item shall be applied with synthetic enamel Paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

**13.32.3.3** Other details shall be specified in 13.22 as far as they are applicable.

### **13.33 PAINTING WITH ALUMINIUM PAINT**

**13.33.1** Aluminium Paint shall be (conforming to IS 2339) of approved brand and manufacture. The Paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

#### **13.33.2 Preparation of Surface**

**13.33.2.1 Steel Work (New Surfaces):** All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

**13.33.2.2 C.G.S. Sheets (New Surfaces):** The preparation of surface shall be as specified in 13.25.1.1.



**13.33.2.3 Steel Work or C.G.S. sheets (Old Surfaces):** The specifications shall be as described in 13.25.1.2.

#### **13.33.3 Application**

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the Paint during used. Also the Paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

**13.33.4** Other details shall be as specified in 13.23 as far as they are applicable.

#### **13.34 PAINTING WITH ACID PROOF PAINT**

**13.34.1** Acid proof Paint of approved brand and manufacture and of the required shade shall be used.

**13.34.2** Preparation of surface and application shall be as specified under 13.32 for new/old surface as the case may be.

**13.34.3** Other details shall be as specified in 13.23 as far as they are applicable.

#### **13.35 PAINTING WITH ANTI-CORROSIVE BITUMASTIC PAINT**

**13.35.1** Ready mixed Paint (conforming to IS 158) shall be of approved brand and manufacture. It shall be black, lead free, acid-alkali-heat-water resistant.

**13.35.2** Preparation of surface and application shall be as specified in 13.32 for painting on new or old surfaces as the case may be.

The drying time between consecutive coats, however, shall be not less than 3 hours.

**13.35.3** Other details shall be as specified in 13.23 as far as applicable.

#### **13.36 FLOOR PAINTING**

**13.36.1** Floor Paint of approved brand and manufacture and of the required colour shall be used.

##### **13.36.2 Preparation of Surface**

All dirt, grease shall be removed from the floor by wiping with rags, soaked in turpentine and scraping where necessary and then washing with warm water, containing caustic soda or washing soda in solution. The floor should then be rinsed thoroughly with water and dried. Cracks and holes shall then be filled with specified filler as recommended by the manufacturer and rubbed smooth.

It should be noted that the painting with floor paints shall not be done over concrete surfaces less than two years old. Old surface shall be prepared as specified in 13.32.3.1

##### **13.36.3 Application**

The number of coats as in the description of the item shall be applied. Each coat shall be allowed to dry for not less than 24 hours before the next coat is applied. The flooring should not be brought into use for a week after final coat so that the painted surface can thoroughly harden.

##### **13.36.4 Measurement**

Measurements shall be as per actual length and breadth being measured correct to a cm. The details given under 13.23.6 shall hold good as far as applicable.

**13.36.5** Other details shall be as specified in 13.23 as far as applicable.

#### **13.37 VARNISHING**



**13.37.0** Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler.

**13.37.1** Varnish (conforming to IS 347 for the finishing and undercoats shall be of the approved manufacturer.

### **13.37.2 Varnishing on New Surfaces**

**13.37.2.1 Preparation of Surface:** New wood work to be varnished shall have been finished smooth with a carpenter's plane. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:

On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and the surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

**13.37.2.2 Sizing or Transparent Wood Filler Coat:** The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

- (a) *Sizing:* When sizing is stipulated, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow.

Any joining up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish. Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household utensils which are likely to disturb the size coatings and thus expose bare wood. Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.

- (b) *Transparent Wood Filler Coat:* Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described in 13.37.2.1 shall be given as application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

**13.37.2.3 Application of Varnish:** The number of coats to be applied shall be as stipulated in the description of the item.

The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhances the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, latter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnish shall be worked in every direction,



with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean.

Rubbing down and flattening the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from draughts and damp air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary Paint brushes. Brushes shall be well worn and perfectly clean.

**13.37.2.4** Other *details* shall be as specified in 13.23 as far as they are applicable.

### **13.37.3 Varnishing on Old Surface**

**13.37.3.1 Preparation of Surface:** If the old varnished surface is firm and sound it shall be cleaned of rease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and

smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in 13.37.2.1. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish as described in para 13.41 and such removal shall be paid for separately outside the rate for varnishing. Further the varnishing itself will have to be done like new work and will be paid for as such.

**13.37.3.2 Application:** The specification shall be same as described in 13.37.2.3 as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

Other details shall be as specified in 13.23 as far as they are applicable.

## **11.37A MELAMINE POLISH**

### **11.37A.1 Material**

Melamine is an organic compound that is often combined with formaldehyde to produce melamine resin, a synthetic polymer that is fire resistant and heat tolerant. The resin is a versatile material that has a highly stable structure. It is a closed pore polish i.e. it makes the wood non- breathable product that protects wood from mainly hot and cold surfaces placed over it.

### **11.37A.2 Polishing Old Surface**

#### **11.37A.2.1 Preparation of surface**

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Surface must be dry, free from dust, oil, wax, greases etc.

#### **11.37A.2.2 Application**

Mix melamine (matt or gloss) base with the catalyst in the specified ratio as per manufacturers specification. Add melamine thinner upto 30% (as specified by the manufacturer) by volume of mixture. Stir it and allow it to mature for 2-3 minutes. The melamine is sprayed, using spray gun pressure of 45-55 psi, from a distance of 7"-10" from substrate.

Precaution: Avoid eye contact, use of mask is mandatory during whole process.





### 11.37A.2.3 Measurement

Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

### 13.38 FRENCH SPIRIT POLISHING

**13.38.1** Pure shellac conforming to IS 16 varying from pale orange to lemon yellow colour, free from resin or dirt shall be dissolved in methylated spirit at the rate of 140 gm of shellac to 1 litre of spirit. Suitable pigment shall be added to get the required shade. Ready made polish conforming to IS 348 can also be used.

#### 13.38.2 Polishing New Surface

**13.38.2.1 Preparation of Surface:** The surface shall be cleaned. All unevenness shall be rubbed down smooth with sand paper and well dusted. Knots if visible shall be covered with a preparation of red lead and glue size laid on while hot. Holes and indentations on the surface shall be stopped with glazier's putty. The surface shall then be given a coat of wood filler made by mixing whiting (ground chalk) in methylated spirit at the rate of 1.5 Kg of whiting per litre of spirit. The surface shall again be rubbed down perfectly smooth with glass paper and wiped clean.

**13.38.2.2 Application:** The number of coats of polish to be applied shall be as described in the item.

A pad of woolen cloth covered by a fine cloth shall be used to apply the polish. The pad shall be moistened with the polish and rubbed hard on the wood, in a series of overlapping circles applying the mixture sparingly but uniformly over the entire area to give an even level surface. A trace of linseed oil on the face of the pad facilitates this operation. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cotton cloth slightly dampened with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

**13.38.2.3** Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

#### 13.38.3 Polishing Old Surface

**13.38.3.1 Preparation of Surface:** If the old polished surface is not much soiled it shall be cleaned of grease and dirt by rubbing with turpentine and then rubbed with fine sand paper.

If the old polished surface is much soiled then it will be necessary to remove the entire polish as described in 13.41 and such removal shall be paid for separately outside the rate of polishing. Further the polishing itself will have to be done like new work and will be paid for as such.

**13.38.3.2 Application:** The specifications shall be same as described in 13.38.2.2 as far as applicable.

**13.38.3.3** Measurements, Rate and other details shall be as specified in 13.23 as far as they are applicable.

### 13.39 BEES WAXING OR POLISHING WITH READY MADE WAX POLISH

**13.39.1** The polishing shall be done with bees waxing prepared locally or with readymade wax polish of approved brand and manufacture, as stipulated in the description of item.

Where bees waxing is to be prepared locally, the following specifications for the same shall apply.

Pure bees wax free from paraffin or stearine adulterants shall be used. Its specific gravity shall be 0.965 to 0.969 and melting point shall be 63 degree C. The polish shall be prepared from a mixture of bees wax, linseed oil, turpentine and varnish in the ratio of 2 : 1.5 : 1 : 0.5 by weight.

The bees wax and boiled linseed oil shall be heated over a slow fire. When the wax is completely dissolved the mixture shall be cooled till it is just warm and turpentine and varnish added to it in the required proportions and the entire mixture shall be well stirred.

#### 13.39.2 Waxing New Surface



**13.39.2.1 Preparation of Surface:** Preparation of surface shall be as described in 13.37.2.1 with the exception that knotting, holes and cracks shall be stopped with a mixture of fine saw dust formed of the wood being treated, beaten up with sufficient bees wax to give it cohesion.

**13.39.2.2 Application:** The polish shall be applied evenly with a clean soft pad of cotton cloth in such a way that the surface is completely and fully covered. The surface is then rubbed continuously for half an hour.

When the surface is quite dry, a second coat shall be applied in the same manner and rubbed continuously for one hour or until the surface is dry.

The final coat shall then be applied and rubbed for two hours (more if necessary) until the surface has assumed a uniform gloss and is dry, showing no sign of stickiness. The final polish depends, largely on the amount of rubbing which should be continuous and with uniform pressure with frequent changes in the direction. Other details shall be as specified in 13.23 as far as they are applicable.

### **13.39.3 Waxing Old Surfaces**

**13.39.3.1 Preparation of Surface:** The wood work shall be cleaned of all smoke and grease by washing with lime water. The surface shall then be washed with soap and completely dried. Then it shall be prepared smooth as specified in 13.37.2.1.

**13.39.3.2 Application:** The polish shall be applied in the manner specified in 13.39.2.2. In this case one or two coats shall be applied as necessary to get uniform gloss, instead of three coats in the case of new work.

**13.39.3.3** Other details shall be as specified in 13.22 as far as they are applicable.

### **13.40 LETTERING WITH PAINT**

**13.40.1** Black, Japan Paint (conforming to IS 341) or ready mixed Paint as ordered by the Engineer- in-Charge shall be used. The Paint shall be of approved brand and manufacture. Ordinary ready mixed Paint shall be of the shade required by the Engineer-in-Charge.

#### **13.40.2 Lettering on New Surface**

**13.40.2.1 Application:** The letters and figures shall be to the heights and width as ordered by the Engineer-in-Charge. These shall be stencilled or drawn in pencil and got approved before painting. They shall be of uniform size and finished neatly. The edges shall be straight or in pleasant smooth curves. The thickness of the lettering shall be as approved by the Engineer-in-Charge. Lettering shall be vertical or slanting as required.

Two or more coats of Paint shall be applied till uniform colour and glossy finish are obtained.

**13.40.2.2 Measurements:** Measurements shall be taken in terms of letter cm (the measurement relates to the vertical height of the lettering). The letter heights shall be measured correct to a cm. Dots, dashes, punctuations and other similar marks or lines shall not be measured for payment.

In Devanagari Script Dots & Matras occurring with the letters shall not be measured. Half letter shall be measured as full letter. The height of letters shall be measured excluding the Matras projecting above the heading and matras below the letters.

**13.40.2.3 Rate:** Rate shall include the cost of all labour and materials involved in the operations described above. The rate per cm height of letter shall hold good irrespective of the width of the letters or figures or the thickness of the lettering.

The same rate will apply irrespective of whether black Japan or ready mixed Paint of any shade as required is used.

#### **13.40.3 Relettering on Old Surface**





**13.40.3.1** Painting shall be done over the existing letters and shall accurately follow their lines and curves. One or more coat of Paints shall be applied till a uniform colour and glossy finish is obtained.

**13.40.3.2** Measurements and Rate shall be as specified under 13.40.2.

### **13.41 REMOVING OLD PAINT**

#### **13.41.1 With Patent Paint Remover**

**13.41.1.1** Patent Paint removers shall consist of volatile organic liquids thickened with waxes and other ingredients to retard the evaporation of the liquid and to enable a substantial layer of remover to be applied to the surface. The Paint remover shall be of a brand and manufacture approved by the Engineer-in-Charge. It shall be free from alkaline matter and non-caustic so that it can be handled by workmen without injury. It shall be of non inflammable quality as far as possible.

**13.41.1.2 Application:** Paint remover shall be used where burning off with blow lamp is not suitable. The Paint remover shall be applied liberally with a brush and allowed to remain on the surface for a period depending on the particular brand of remover used and on the thickness of the Paint coating to be removed. When the Paint film lifts and wrinkles under the action of the remover it shall be stripped with a sharp instrument. If the film is not thoroughly removed a second coat of remover may be applied if necessary over such patches and then the film thoroughly scrapped.

After the surface has been stripped, it shall be washed down with mineral turpentine to remove all traces of paraffin wax, which forms one of the ingredients of patent Paint remover and which if left in place will prevent the Paint from drying. The cleaned surface shall be suitably prepared for application of Paint or other finish.

**13.41.1.3 Precautions:** Where the Paint remover used is of the inflammable type, suitable precaution against risk of fire shall be taken. Neighbouring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.

**13.41.1.4 Preparation of Surface:** The surface shall then be prepared as described in 13.24.2.

**13.41.1.5 Measurements:** Specification for 13.23.6 shall hold good.

**13.41.1.6 Rate:** Rate shall include the cost of all labour and materials involved in all operations described above.

**13.41.1.7** Other details shall be as specified 13.23 as far as possible.

#### **13.41.2 With Caustic Soda Solution**

**13.41.2.1 Application:** Caustic soda dissolved with 48 times its volume of water shall be applied to the old Paint with a brush and when the Paint film lifts and wrinkles it shall be thoroughly scrapped of in the same way as described in 13.41.1.2. After the surface has been stripped thoroughly, it shall be rinsed with several changes of clean water to remove all traces of alkali, which if allowed to remain are liable to spoil the new Paint applied over it. A little acetic acid or vinegar added to the final change of rinsing water helps to neutralize any remaining alkali.

**13.41.2.2 Precautions:** Caustic soda as its name implies is a corrosive liquid and care should be taken to see that no liquid spills over the skin or clothing.

**13.41.2.3** Preparation of Surface, Measurements, Rate and other details shall be as specified under 13.41.1.

#### **13.41.3 With Blow Lamp**

**13.41.3.1** The Paint shall be removed either with a blow lamp or with air acetylene equipment. The flame shall be allowed to play upon the Paint just enough to soften it without charring either the Paint or the background. The softened Paint shall then be removed with a stripping knife following the flame as it is



moved up the surface. Burning off shall begin at the bottom of the vertical surface and shall proceed upwards.

**13.41.3.2 Precautions:** Removal with blow lamp shall not be done on narrow or carved under cut surfaces or where there is risk of damage to neighbouring materials such as panes in glazed windows.

**13.41.3.3** Preparation of surface, Measurements, Rate and other details shall be as described under 13.41.1. Neighbouring painted surfaces which are not to be treated should be properly protected from contact with Paint remover.

## **13.42 WASHED STONE GRIT PLASTER**

**13.42.1** Scaffolding shall be as specified in 13.1.1.

**13.42.2** Preparation of surface shall be as specified in 13.1.2 and 13.4.2.

### **13.42.3 Materials**

**13.42.3.1** Stone chippings obtained by crushing hard stone shall be free of dust and deleterious material. 10 mm nominal size stone chippings, where specified, shall pass 100% through 12.5 mm sieve and fully retained on 6.3 mm sieve. Stone chippings shall be thoroughly washed with water and sieved before use.

**13.42.3.2 Mortar:** Cement mortar for under coat and cement mortar to be mixed with stone chippings for top coat shall be as specified in 3.5.

### **13.42.4 Application of Plaster**

**13.42.4.1 12 mm Under Coat:** Under coat of cement mortar 1:4 (1 cement : 4 coarse sand) shall be applied as specified in 13.1.3 except that the finishing, after the mortar has been brought to level with the wooden straight edge, shall be done with wooden float only. The surface shall be further roughened by furrowing with a scratching tool. Furrowing shall be done diagonally both ways and shall be about 2 mm deep to provide a key for the top coat. The scratched lines shall not be more than 10 cm apart. The surface shall be kept wet till top coat is applied.

**13.42.4.2 15 mm Top Coat:** Top coat comprising cement mortar and stone chippings shall have an overall proportion of 1:0.5:2 (1 cement : 0.5 coarse sand : 2 stone chippings 10 mm nominal size) or as specified. The top coat shall be applied a day or two after the under coat has taken the initial set. The surface of the under coat shall be cleaned and a coat of cement slurry at 2 kg of cement per sqm shall be applied before the application of coat. The top coat shall be applied in uniform thickness on the under coat after the application of slurry and sufficiently pressed with wooden float for proper bonding with the under coat. Vacant space, if any shall be filled with the specified mix.

### **13.42.5 Finish**

The top coat of plaster shall be finished to a true and plumb surface. The surface shall be tested frequently as the work proceeds with a true straight edge not less than 2.5 m long and with plumb bobs. All horizontal lines and surfaces shall be tested with a level and all jambs and corners with a plumb bob as the work proceeds. All the corners angles and junctions shall be truly vertical or horizontal as the case may be. Rounding or chamfering of corners junctions etc. Where required shall be true to template.

Finished surface of the top coat after the mix has taken the initial set, shall be scrubbed and washed with suitable brushes and plain water. Scrubbing and washing shall continue till the stone chippings are sufficiently exposed. Stone chippings which may come out while scrubbing shall be replaced using the specified mortar mix. A sample of the washed stone grit plaster shall be got approved from the Engineer-in-Charge.

### **13.42.6 Grooves**



Grooves of size 15 mm x 15 mm or as specified shall be provided as shown on the drawing or as required by the Engineer-in- Charge. Tapered wooden battens to match the size and shape of the grooves shall be fixed on the under coat with nails before the application of the top coat and these shall be removed carefully so that the edges of the panels of top coat are not damaged. Damage, if any, shall be made good by the contractor.

#### **13.42.7 Curing**

Curing shall be started 24 hours after finishing the plaster. The plaster shall be kept wet for a period of seven days. During this period, it shall be suitably protected from all damages at the contractor's expense by such means as the Engineer-in-Charge may approve.

#### **13.42.8 Measurements**

**13.42.8.1** Length and breadth shall be measured correct to the nearest cm and the area shall be calculated in sqm correct to two places of decimal.

**13.42.8.2** Measurements shall be taken for the work actually done with deductions for all openings and addition for all jambs soffits and sills. However, no deduction is to be made for the grooves provided as specified in 13.42.6.

**13.42.8.3** Washed stone grit plaster on circular surfaces not exceeding 6 m in radius and on external surfaces at a height greater than 10 m shall be measured separately.

#### **13.42.9 Rates**

The rates shall include the cost of all labour and materials involved in all the operations described above except for providing grooves. The length of grooves shall be measured in running metres and paid for separately.

### **13.43 GYPSUM LIGHT WEIGHT PLASTER**

**13.43.1** Scaffolding shall be as specified in 13.11.

**13.43.2** Preparation of surface shall be as specified in 13.1.2 and 13.4.2.

#### **13.43.3 Materials**

**13.43.3.1** Premixed light weight plasters essentially consist of retarded hemihydrate gypsum plaster and light weight aggregate which are characterized by low density, high thermal insulation and sound absorption properties. Other additions may be incorporated to impart desired properties. The physical and chemical requirements shall conform to IS 2547 (Pt. II).

**13.43.3.2** The minimum recommended water-premixed plaster ratio is 1:2 as per standard practice or as recommended by the manufacturers.

#### **13.43.4 Application of Plaster**

**13.43.4.1** Application of plaster shall be as specified in 13.1.4.1 to 13.1.4.4.

#### **13.43.5 Thickness**

Where the thickness required, as per description of the item is 12 mm, the average thickness of the plaster shall not be less than 12 mm whether wall treated is of brick/block/RCC work.

#### **13.43.6 Finish**

The plaster shall be finished as specified in 13.1.7.

#### **13.43.7 Measurement**

Measurement of plaster shall be as specified in 13.1.9.1 to 13.1.9.9.



#### **13.43.8 Rate**

Rate shall include the cost of all labour & material involved in all the operations described above.

#### **13.44 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS: DELETED**

#### **13.45 PAINTING WITH WOOD PRESERVATIVE: DELETED**

#### **13.46 WALL PAINTING WITH PLASTIC EMULSION PAINT:**

**13.46.0** The plastic emulsion paint is not suitable for application on external, wood and iron surface and surfaces which are liable to heavy condensation. These paints are to be used on internal surfaces except wooden and steel.

**13.46.1** Plastic emulsion paint as per IS 5411 of approved brand and manufacture and of the required shade shall be used.

#### **13.46.2 Painting on New Surface**

**13.46.2.1** The wall surface shall be prepared as specified in 13.31.

**13.46.2.2 Application:** The number of coats shall be as stipulated in the item. The paint will be applied in the usual manner with brush, spray or roller. The paint dries by evaporation of the water content and as soon as the water has evaporated the film gets hard and the next coat can be applied. The time of drying varies from one hour on absorbent surfaces to 2 to 3 hours on non- absorbent surfaces.

The thinning of emulsion is to be done with water and not with turpentine. Thinning with water will be particularly required for the under coat which is applied on the absorbent surface. The quantity of water to be added shall be as per manufacturer's instructions.

The surface on finishing shall present a flat velvety smooth finish. If necessary more coats will be applied till the surface presents a uniform appearance.

#### **13.46.2.3 Precautions**

- a. Old brushes if they are to be used with emulsion paints, should be completely dried of turpentine or oil paints by washing in warm soap water.
- b. Brushes should be quickly washed in water immediately after use and kept immersed in water during break periods to prevent the paint from hardening on the brush.
- c. In the preparation of wall for plastic emulsion painting, no oil base putties shall be used in filling cracks, holes etc.
- d. Splashes on floors etc. shall be cleaned out without delay as they will be difficult to remove after hardening.
- e. Washing of surfaces treated with emulsion paints shall not be done within 3 to 4 weeks of application.

**13.46.2.4** Other details shall be as specified in 13.23 as far as they are applicable.

#### **13.46.3 Painting on Old Surface**

**13.46.3.1 Preparation of Surface:** This shall be done, generally as specified in 13.31.3.1 except that the surface before application of paint shall be flattened well to get the proper flat velvety finish after painting.

**13.46.3.2 Application:** The number of coats to be applied shall be as in description of item.

**13.46.3.3** The application shall be as specified in 13.31.3.2 except that thinning with water shall not normally be required.



**13.46.3.4** Other details shall be as specified in 13.23 as far as applicable.

**Note: Clause 13.46 brought from Sub Head 14 (Repairs to buildings) clause no 14.26**

#### **13.47 PAINTING WITH SYNTHETIC ENAMEL PAINT:**

**13.47.1** Synthetic enamel paint (conforming to IS 2932) of approved brand and manufacture and of the required colour shall be used for the top coat and an undercoat of ordinary paint of shade to match the top coat as recommended by the same manufacturer as far the top coat shall be used.

##### **13.47.2 Painting on New Surface**

**13.47.2.1** Preparation of surface shall be as specified in 13.25.1.1 as the case may be.

**13.47.2.2 Application:** The number of coats including the undercoat shall be as stipulated in the item.

- a. Under Coat: One coat of the specified ordinary paint of shade suited to the shade of the top coat, shall be applied and allowed to dry overnight. It shall be rubbed next day with the finest grade of wet abrasive paper to ensure a smooth and even surface, free from brush marks and all loose particles dusted off.
- b. Top Coat: Top coats of synthetic enamel paint of desired shade shall be applied after the undercoat is thoroughly dry. Additional finishing coats shall be applied if found necessary to ensure properly uniform glossy surface.

**13.47.2.3** Other details shall be as specified in 13.23 as far as they are applicable.

##### **13.47.3 Painting on Old Surface**

**13.47.3.1 Preparation of Surface:** Where the existing paint is firm and sound it shall be cleaned of grease, smoke etc. and rubbed with sand paper to remove all loose particles dusted off. All patches and cracks shall then be treated with stopping and filler prepared with the specified paint. The surface shall again be rubbed and made smooth and uniform.

If the old paint is blistered and flaked it will be necessary to completely remove the same as described in para 13.41. Such removal shall be paid for separately and the painting shall be treated as on new surface.

**13.47.3.2 Painting:** The number of coats as stipulated in the item shall be applied with synthetic enamel paint. Each coat shall be allowed to dry and rubbed down smooth with very fine wet abrasive paper, to get an even glossy surface. If however, the surface is not satisfactory additional coats as required shall be applied to get correct finish.

**13.47.3.3** Other details shall be specified in 13.23 as far as they are applicable.

**Note: Clause 13.47 brought from Sub Head 14 (Repairs to buildings) clause no 14.28**

#### **13.48 PAINTING WITH ALUMINIUM PAINT:**

**13.48.1** Aluminium paint shall be (conforming to IS 2339) of approved brand and manufacture. The paint comes in compact dual container with the paste and the medium separately.

The two shall be mixed together to proper consistency before use.

##### **13.48.2 Preparation of Surface**



**13.48.2.1 Steel Work (New Surfaces):** All rust and scales shall be removed by scraping or brushing with steel wire brushes and then smoothened with sand paper. The surface shall be thoroughly cleaned of dust.

**13.48.2.2 C.G.S. Sheets (New Surfaces):** The preparation of surface shall be as specified in 13.33.2.

**13.48.2.3 Steel Work or C.G.S. Sheets (Old Surfaces):** The specifications shall be as described in 13.33.2.3.

### **13.48.3 Application**

The number of coats to be applied shall be as given in the item. Each coat shall be allowed to dry for 24 hours and lightly rubbed down with fine grade sand paper and dusted off before the next coat is applied. The finished surface shall present an even and uniform appearance.

As aluminium paste is likely to settle in the container, care shall be taken to frequently stir the paint during used. Also the paint shall be applied and laid off quickly, as surface is otherwise not easily finished.

**Note: Clause 13.48 brought from Sub Head 14 (Repairs to buildings) clause no 14.29**



## REPAIRS TO BUILDING





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### LIST OF BUREAU OF INDIAN STANDARD CODES

Sl.	BIS No.	Subject
1	IS 419	Specifications for Putty for use in Window Frames
2	IS 14900	Specifications for Transparent Float Glass



## 14 REPAIRS TO BUILDINGS

### 14.1 REPAIRS TO PLASTER

**14.1.0** The work includes cutting the patch and preparing the wall surface. Patches of 2.50 square metres and less in area shall be measured under item of 'Repairs to Plaster' under this sub-head. Plastering in patches over 2.5 square metres in area shall be paid for at the rate as applicable to new work under sub head 'Finishing'.

#### 14.1.1 Scaffolding

Scaffolding as required for the proper execution of the work shall be erected. If work can be done safely with the ladder or jhoola these will be permitted in place of scaffolding.

#### 14.1.2 Cutting

The mortar of the patch, where the existing plaster has cracked, crumbled or sounds hollow when gently tapped on the surface, shall be removed. The patch shall be cut out to a square or rectangular shape at position marked on the wall as directed by the Engineer-in-Charge or his authorized representative. The edges shall be slightly under cut to provide a neat joint.

#### 14.1.3 Preparation of Surface

The masonry joints which become exposed after removal of old plaster shall be raked out to a minimum depth of 10 mm in the case of brick work and 20 mm in the case of stone work. The raking shall be carried out uniformly with a raking tool and not with a basuli, and loose mortar dusted off. The surface shall then be thoroughly washed with water, and kept wet till plastering is commenced.

In case of concrete surfaces, the same shall be thoroughly scrubbed with wire brushes after the plaster had been cut out and pock marked as described in 13.1.2. The surface shall be washed and cleaned and kept wet till plastering is commenced.

#### 14.1.4 Application of Plaster

Mortar of specified mix with the specified sand shall be used. The method of application shall be as described for single coat plaster work of the specified mix and under Chapter 13. The surface shall be finished even and flush and matching with the old surrounding plaster. All roundings necessary at junctions of walls, ceilings etc. shall be carried out in a tidy manner as specified in sub-head 13.0.

All dismantled mortar & rubbish etc. shall be disposed off within 24 hours from its dismantling promptly as directed by the Engineer-in-Charge.

#### 14.1.5 Protective Measure

Doors, windows, floors, articles of furniture etc. and such other parts of the building shall be protected from being splashed upon. Splashing and droppings, if any, shall be removed by the contractor at his own cost and the surface cleaned. Damages, if any, to furniture or fittings and fixtures shall be recoverable from the contractor.

#### 14.1.6 Curing

Curing shall be done as per plaster work with special reference to the particular type of plaster mix as described under sub-head 'finishing'.

#### 14.1.7 Finishing

After the plaster is thoroughly cured and dried the surface shall be white washed or colour washed to suit the existing finishing as required unless specified.

#### 14.1.8 Measurements



Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Patches below 0.05 square metre in area shall not be measured for payment.

Pre- measurements of the patches to be plastered shall be recorded after the old plaster has been cut and wall surface prepared.

#### **14.1.9 Rate**

The rate includes the cost of all the materials and labour involved in all the operations described above including lead as described in the item for disposal of old dismantled plaster /material.

### **14.2 FIXING DOOR, WINDOW OR CLERESTORY WINDOW CHOWKHATS IN EXISTING OPENING**

#### **14.2.1 Making Holes**

**14.2.1.1** In case of door frames without sills, holes 40 mm deep shall be made in the floor for fixing the lower end of verticals of the frames. For doors with sills, the sill plates shall be partly fixed in the floor so that they project above the floor to the height as directed by the Engineer-in-Charge.

**14.2.1.2** For embedding hold fasts of doors, windows or clerestory windows, the requisite number of holes at the correct positions shall be cut out in the masonry. The size of the holes shall be such that the chowkhats with the hold-fasts can be conveniently erected in position. Where necessary, masonry shall be chipped uniformly to facilitate easy insertion of the frame in the opening.

**14.2.1.3** Special care shall be taken when holes are made in load bearing pillars or wall portions separated by openings to ensure that beams etc. supported by them are properly propped up. In such portions cutting holes shall be done on one side at a time. The sides of the holes shall be truly parallel and perpendicular to the plane of the wall. Due care shall be taken, not to disturb the adjoining masonry and the masonry under the bearings of lintels and arches etc. spanning the opening. The holes shall then be cleaned of all dust, mortar and brick bats or stone pieces and thoroughly wetted.

#### **14.2.2 Fixing**

The sides of chowkhats of door, window or clerestory window abutting against or to be embedded in masonry shall be painted with two coats of coal tar before being placed in position. The chowkhats shall then be inserted in position with their hold-fasts bolted tight. The chowkhats shall then be adjusted to proper line and plumb and secured in position by temporary bracing which shall not be disturbed or removed until the hold fasts are embedded in the masonry and the concrete block has set. The concrete to be used for embedding hold- fasts shall be cement concrete 1:3:6 mix (1 cement : 3 coarse sand : 6 graded stone aggregate 20 mm nominal size).

The minimum size of concrete block in which the hold-fasts will be embedded shall be 30 x 10 x 15 cm for 35 cm long holdfasts. The concrete of the block shall completely fill the hole made in the masonry for the purpose. The chase cut in the floor shall be cut square and construction joint shall be provided filled in with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and rendered smooth at the top and finished to match the existing type of floor.

#### **14.2.3 Finishing**

After the surface surrounding the hold-fasts has sufficiently dried it shall be cleaned of dust etc. and wetted. It shall then be plastered with cement mortar 1:4 (1 cement : 4 fine sand) flush and matching with the surrounding plaster work. In case of exposed brick work, stone work, the finishing shall be done to match the surrounding. Any other portion of the wall opening, if damaged, shall be repaired in similar way.

After the cement plaster patches have been thoroughly cured and dried, they shall either be white washed or colour washed as required unless otherwise specified. All malba and debris obtained from cutting etc. shall be disposed off to the nearest dumping ground promptly as directed by Engineer- in-Charge.

#### **14.2.4 Measurements**



The chowkhats of doors, window and clerestory windows shall be enumerated separately.

#### **14.2.5 Rate**

The rate shall apply irrespective of the size of the chowkhat upto a maximum area of opening

3.75 square metres for doors, 2.5 square metres for windows and 1.2 square metres for clerestory windows. The rate is inclusive of labour and materials involved in all the operations described above, excluding (a) cost of chowkhats and (b) cost of supplying and fixing the hold-fasts including C.C. block and bolts.

### **14.3 FIXING CHOWKHATS IN EXISTING OPENING IN BRICKS / RCC WALL WITH DASH FASTNERS**

**14.3.1** In case of door frames without sills, holes 40 mm deep shall be made in the floor for fixing the lower end of verticals of the frames. For doors with sills, the sill plates shall be partly fixed in the floor so that they project above the floor to the height as directed by the Engineer-in-Charge.

**14.3.1.1** For fixing dash fasteners /chemical fasteners of doors, windows or clerestory windows, the requisite number of holes at the correct positions shall be in the masonry/RCC wall. The size of holes shall be such that the fasteners can be conveniently placed in position. Where necessary, masonry shall be chipped uniformly to facilitate easy insertion of the frame in the opening.

**14.3.1.2** Special care shall be taken when holes are made in load bearing pillars or wall portions separated by openings to ensure that beams etc. supported by them are properly propped up. In such portions cutting holes shall be done on one side at a time. The sides of the holes shall be truly parallel and perpendicular to the plane of the wall. Due care shall be taken, not to disturb the adjoining masonry and the masonry under the bearings of the lintels and arches etc. spanning the opening. The holes shall then be cleaned of all dust, mortar and brick bats or stone pieces and thoroughly wetted.

#### **14.3.2 Fixing**

The sides of chowkhats of door, window or clerestory window abutting against or to be embedded in masonry shall be painted with two coats of coal tar before being placed in position. The chowkhats shall then be inserted in position tight. The chowkhats shall then be adjusted to proper line and plumb and secured in position by temporary bracing which shall not be disturbed or removed until the fasteners are embedded in the masonry /RCC wall.

#### **14.3.3 Finishing**

After the surface surrounding the hold-fasts has sufficiently dried it shall be cleaned of dust etc. and wetted. It shall then be plastered with cement mortar 1:4 (1 cement: 4 fine sand) flush and matching with the surrounding plaster work. In case of exposed brick work, stone work, the finishing shall be done to match the surrounding. Any other portion of the wall opening, if damaged, shall be repaired in similar way.

After the cement plaster patches have been thoroughly cured and have dried, they shall either be white washed or colour washed as required unless otherwise specified. All malba and debris obtained from cutting etc. shall be disposed off to the nearest dumping ground.

#### **14.3.4 Measurements**

The chowkhats of doors, window and clerestory windows shall be enumerated separately.

#### **14.3.5 Rate**

The rate shall apply irrespective of the size of the chowkhat upto a maximum area of opening 3.75 square metres for doors, 2.5 square metres for windows and 1.2 square metres for clerestory windows. The rate is inclusive of labour and materials involved in all the operations described above, including cost of dash fasteners chemical fasteners but excluding cost of chowkhat.

### **14.4 MAKING OPENING IN THE MASONRY CONSTRUCTION AND FIXING CHOWKHATS FOR DOORS, WINDOWS AND CLERESTORY WINDOWS**



- 14.4.0** Before making opening it is necessary to examine that the wall exclusive of opening is adequate to take the load coming on the structure. All the structural members supported on the walls which have direct bearing over the area in which opening is to be made, shall be properly supported with props to relieve the load from masonry wall till the lintel over the opening is strong enough to take the load. Care should also be taken not to disturb the adjoining masonry.

All precautions as explained in Chapter 15.0 (Demolition and Dismantling) should be followed in case of dismantling the external walls. The portion to be dismantled may be clearly marked on both sides of the wall. Dismantling shall be carried out from top to bottom within the marked area. The sides of the opening shall be as far as possible, parallel and perpendicular to the plane of wall.

#### **14.4.1 Making Opening**

- 14.4.1.1** The openings for fixing door/window frames shall be to the extent of accommodating the hold fast. The hold fasts shall be fixed in cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 stone aggregate 20 mm nominal size) or in masonry as required. Where only opening is to be made in the masonry, the width of the opening shall be such that the sides of the masonry can be built true to line and plumb and such masonry built shall conform to the specifications of the particular type of masonry in which the opening is made with particular reference to size of corner stones etc. In order to get continuity with old masonry, proper key shall be provided. The height of the opening shall be such that it can accommodate the required depth of the RCC lintel also.
- 14.4.1.2** The sides of opening in masonry shall be cleaned of all dust, mortar, brick bats/loose stones, chips etc. and the surface left rough and thoroughly wetted.
- 14.4.1.3** The lintel shall be invariably cast first in the opening made for the purpose. One side of the shuttering shall be kept open in the beginning till the concrete is laid. The shuttering shall then be fixed for half of the opening and concreting completed.
- 14.4.1.4** Curing of lintel casted shall be done for a minimum period of 7 days.
- 14.4.1.5** Precast RCC lintel or R.S. Joist may also be used if directed by the Engineer-in-Charge.

#### **14.4.2 Fixing Chowkhats**

Fixing of chowkhats shall be done as specified in 14.2.2.

#### **14.4.3 Finishing**

- 14.4.3.1** After the surface of the sides of masonry opening and lintel are sufficiently dry and set, it shall be cleaned free of dust, loose mortar etc. and wetted thoroughly. It shall then be plastered or pointed as required flush with the surrounding masonry work. Any other portion of the wall if damaged shall be finished in similar manner.
- 14.4.3.2** After the cement plaster/pointing has been thoroughly cured and have dried the surface shall be either white or colour washed/painted as required. The surface of the wall which is spoiled due to splashing of mortar shall be cleaned forthwith.

#### **14.4.4 Measurements**

The openings made for doors, windows, clerestory windows shall be measured correct to cms and area shall be calculated in square metres correct to two places of decimal.

#### **14.4.5 Rate**

The rate shall apply per sqm of opening. The rate is inclusive of labour and material involved in all the operations described above.

Cost of Chowkhats, cost of CC blocks, cost of supplying the hold-fasts bolts, cost of R.C.C lintel or R.S. Joist which shall be paid for separately.

### **14.5 RENEWING FLOATING GLASS PANES WITH PUTTY AND NAILS**



#### 14.5.1 Removing Broken Glass Panes

Old putty shall be raked out with hack knife. The brad (small nails without head) and pieces of broken glass shall be removed from the rebates of the sash bars. The pieces of glass panes as found useful shall be handed over to the Engineer-in-Charge of the work. No glass shall be inserted in frames until they have been primed and prepared for painting so that the wood may not draw oil out of the putty.

#### 14.5.2 Floating Glass Panes

The floating glass panes shall conform to specifications described in IS 14900.

#### 14.5.3 Fixing

The floating glass panes shall be so cut that it fits slightly loose in the frame and as specified in A&B of IS 14900. A thin layer of Putty conforming to IS 419 shall be prepared by mixing one part of white lead with three parts of finely powdered chalk and then adding the boiled linseed oil to the mixture to form a stiff paste and adding varnish to the paste @ 1 litre of varnish to 18 kg. of paste. The putty so prepared in the form of a stiff paste shall be drawn along the inner edge of the rebate, for bedding the back of the glass panes. The glass pane shall then be put in position, pressed home against the thin layer of the putty, and secured in rebate by new brads. The brads shall not be spaced more than 7.5 cm from each corner and not more than 15 cm apart. The putty shall then be applied in the rebate uniformly, sloping from the inner edge of the rebate. In doing this care shall be taken to keep the putty a little within the inner edge of the rebate and surplus putty removed so that none of it is seen through the glass from the inside. The putty so filled in the rebates shall be levelled smooth and finished in a straight line. When dried the putty shall be covered with a coat of paint of approved quality and shade to match the existing finish of joinery work.

The floating glass panes shall be cleaned with methylated spirit. All splashings or droppings of washing and paints shall be removed. All rubbish and unserviceable materials shall be disposed off to the dumping ground promptly as per the direction of Engineer-in-Charge.

#### Thickness and Tolerance of Floating Glass

Thickness	Tolerance
4 mm	± 0.3 mm
5 mm	± 0.3 mm
6 mm	± 0.3 mm

**Note:** Frosted glass panes should be replaced with frosted glass panes. These shall be fixed with frosted face on the inside.

#### 14.5.4 Measurements

Length and breadth of glass panes shall be measured correct to a cm. The area of the glass panes as fixed shall be calculated in square metre correct to two places of decimal.

#### 14.5.5 Rate

The rate shall include the cost of labour and materials involved in all the operations described above.

#### 14.6 RENEWING FLOATING GLASS PANES WITH WOODEN FILLETS: DELETED

#### 14.7 RENEWING FLOATING GLASS PANES AND REFIXING EXISTING WOODEN FILLETS: DELETED

#### 14.8 PROVIDING NEW WOODEN FILLETS: DELETED

#### 14.9 RENEWAL OF OLD PUTTY OF GLASS PANES

14.9.1 The old putty shall be removed as specified in 14.5.1 and new putty fixed as specified in 14.5.3.

#### 14.9.2 Measurements





The work shall be measured in running metres. The length along the rebate shall be measured correct to a cm.

#### **14.9.3 Rate**

The rate shall include the cost of labour and materials involved in all the operations described above.

#### **14.10 REFIXING OLD GLASS PANES WITH PUTTY AND NAILS**

**14.10.1** Specification same as described in 14.5 above. Except for the glass panes, old glass panes will be used for which nothing extra will be paid.

#### **14.11 FIXING OLD GLASS PANES WITH WOODEN FILLETS**

**14.11.1** Specifications same as described in para no. 14.6 above except for the glass panes. Old glass panes will be used for which nothing extra shall be paid.

#### **14.12 FIXING FAN CLAMPS IN EXISTING R.C.C. SLABS**

**14.12.1** The fan clamps to be fixed in an existing R.C.C. slab shall be of type shown in Fig. 14.1. These shall be made of 16 mm dia M.S. bar.

##### **14.12.1 Fixing**

A 15 x 7.5 cm size chase shall be cut from the ceiling to expose the reinforcement and upto 2.5 cm clear round the reinforcement bar as directed. This shall be done without any damage to adjoining portion of the ceiling.

The two arms at the ends of the clamps shall be passed through the space over the reinforcement bar from the bottom of the slab. Then the two arms shall be bent down about 1.5 cm by means of a crow bar. The clamp shall be held in position and chase in the ceiling filled with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The ceiling shall then be finished to match the existing surface and properly cured.

The exposed portion of the clamp shall be given two or more coats of paint including one priming coat of shade as directed by the Engineer-in-Charge.

##### **14.12.2 Measurements and Rate**

Clamps shall be counted in numbers. The rate per fan clamp shall include the cost of labour and materials involved in all the operations described above. The rate shall apply irrespective of the thickness of the slab.

#### **14.13 REGRADING OF MUD PHUSKA TERRACING: DELETED**

#### **14.14 REPLACING RED OR WHITE SAND STONE SLABS IN ROOFING**

##### **14.14.1 Dismantling Roof**

The general specifications given in 15.1 shall apply. The cracked or decayed stone slabs as marked by the representative of the Engineer-in-Charge shall be removed after dismantling the tile covering with mud phuska over it if any, or other type of covering over the stone slabs.

Mud phuska terracing with tile brick covering shall be dismantled as per 14.13.1 over the specified cracked or decayed tiles to an area extending 15 cm on all sides of stone slabs. This area may be increased by the Engineer-in-Charge, if found necessary. Stone slabs shall then be dismantled and carried down and stacked properly.

In case the stone slabs are not covered at top with mud phuska or lime terracing, the decayed or cracked stone slabs shall be dismantled and carried down or lowered with ropes and stacked properly.

##### **14.14.2 Relaying of Stone Slab Roofing**

Before placing the stone slab the condition of the existing wooden battens shall be checked by suitable methods and replaced if required by Engineer-in-Charge. The upper surface of the wooden battens and



beams supporting the stone slab, shall be painted with two coats of coal tar if not already treated and with one coat of coal tar if originally treated.

The specifications for stone slabs, laying, finishing and curing, shall be as described under 12.15.

#### **14.14.3 Relaying of Mud Phuska with Tile**

The specifications shall be as described in 14.13.2 to 14.13.4 and shall be paid for separately.

#### **14.14.4 Curing and Measurements**

Shall be done as described in 12.11.5 and 12.11.6.

**14.14.5** All unserviceable material shall be disposed off to the dumping ground as directed by the Engineer-in-Charge.

#### **14.14.6 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above, except the cost of wooden battens which shall be paid for separately.

### **14.15 RENEWING WOODEN BATTENS /BEAMS IN ROOFS: DELETED**

### **14.16 PANELLED GLAZED OR PANELLED AND GLAZED SHUTTERS: DELETED**

### **14.17 TRELLIS (JAFFRI) WORK: DELETED**

### **14.18 FITTINGS**

**14.18.0** Fitting shall be of mild steel brass, aluminium or as specified. Some mild steel fittings may have components of cast iron. These shall be well made, reasonably smooth, and free from sharp edges and corners, flaws and other defects. Screw holes shall be counter sunk to suit the head of specified wood screws. These shall be of the following types according to the material used.

#### *(a) Mild Steel Fittings*

These shall be bright satin finish black stone enamelled or copper oxidised (black finish), nickel chromium plated or as specified.

#### *(b) Brass Fittings*

These shall be finished bright satin finish or nickel chromium plated or copper oxidised or as specified.

#### *(c) Aluminium Fittings*

These shall be anodised to natural matt finish or dyed anodic coating not less than grade AC 10 of IS 1868.

The fittings generally used for different type of doors and windows are indicated in Appendix H of SH: 9 (Wood and PVC Work) attached. The fittings to be actually provided in a particular work shall, however, be decided by the Engineer-in-Charge.

Screws used for fittings shall be of the same metal, and finish as the fittings. However, chromium plated brass screws or stainless steel screws shall be used for fixing aluminium fittings. These shall be of the size as indicated in respective figures.

Fittings shall be fixed in proper position as shown in the drawings or as directed by the Engineer-in-Charge. These shall be truly vertical or horizontal as the case may be. Screws shall be driven home with screw driver and not hammered in. Recesses shall be cut to the exact size and depth for the counter sinking of hinges.

#### **14.18.1 Butt Hinges**

(a) Cast brass butt hinges light/ordinary or heavy.



**14.18.1.1 Cast Brass Butt Hinges:** These shall be light/ordinary or heavy as specified. These shall be well made and shall be free from flaws and defects of all kinds. These shall be finished bright or chromium plated or oxidised or as specified. These shall generally conform to IS 205.

**Hinge Pin:** Hinge pin shall be made of brass or of phosphor bronze. The hinge pins shall be firmly rivetted and shall be properly finished. The movement of the hinge pin shall be free, easy and square and shall not have any play or shake.

**Knuckles:** The number of knuckles in each hinge shall not be less than five. The number of knuckles in case of sizes less than 40 mm shall be three. The sides of the knuckles shall be straight and at right angle to the flap. The movement of the hinge pin shall be free and easy and working shall not have any play or shake.

**Screw Holes:** The screw holes shall be clean and counter sunk and of the specified size for different types and size of hinges. The size of the holes shall be such that when it is counter sunk it shall be able to accommodate the full depth of counter sunk head of wood screw specified.

**14.18.1.2 Sampling and Criteria for Conformity:** The number of butt hinges to be selected from a lot shall depend on the size of lot and shall be in accordance with Table 12. Butt hinges for testing shall be taken at random from at least 10 per cent of the package subject to a minimum of three, equal number of hinges being selected from each package. All butt hinges selected from the lot shall be checked for dimensional and tolerance requirements. Defects in manufacture and finish shall also be checked. A lot shall be considered conforming to the requirements of this specification if the number of defective hinges among those tested does not exceed the corresponding number given in Table 14.2.

**TABLE 14.2**

<i>Lot size</i>	<i>Sample size</i>	<i>Permissible No. of defective hinges</i>
<i>Upto 200</i>	<i>15</i>	<i>0</i>
<i>201 to 300</i>	<i>20</i>	<i>1</i>
<i>301 to 500</i>	<i>30</i>	<i>2</i>
<i>501 to 800</i>	<i>40</i>	<i>2</i>
<i>801 and above</i>	<i>55</i>	<i>3</i>

**Note:** Any hinge which fails to satisfy the requirements of any one or more of the characteristics shall be considered as defective hinge.

#### **14.18.2 Spring Hinges: (Single or double acting)**

**14.18.2.1** These shall be single acting when the shutter is to open on one side only or double acting when the shutter opens on both sides. These shall be made of M.S. or brass as specified, and shall generally conform to IS 453.

Hinges shall work smoothly and shall hold the door shutter truly vertical in closed position. Each double-acting spring hinge shall withstand the following tests which shall be carried out after fixing it to a swing door in the normal manner.

- When the door is pushed through 90° and released 2000 times on each side in quick succession the hinge shall show no sign of damage or any appreciable deterioration of the components during or on completion of the test.
- The door shall require a force of  $2.0 \pm 0.5$  kg for 100 mm hinges and  $3.0 \pm 0.5$  kg for 125 mm and 150 mm hinges at a distance of 45 cm from the hinge pin to move the door through 90°.

The size of spring hinge shall be taken as the length of the plate.



**14.18.2.2** These shall be of the following type:

- (a) **Mild Steel:** The cylindrical casing shall be made either from M.S. sheet of 1.60 mm thickness, lap jointed and brazed, welded and rivetted, or from solid drawn tube of thickness, pressed to form the two casing. It shall be stove enamelled black or copper oxidized or as specified.
- (b) **Cast Brass:** The cylindrical casing shall be made either from brass sheet of 1.60 mm thickness, lap jointed and brazed, or from solid drawn brass tube of not less than 1.60 mm thickness. It shall be satin, bright nickle — plated or copper oxidized or as specified.

**14.18.2.3 Sampling:** The number of spring hinges shall be selected from the lot and this number shall depend on the size of the lot and shall be in accordance with Table 14.3.

**TABLE 14.3**

<i>Lot size</i>	<i>Sample size</i>	<i>Permissible No. of defective spring hinges</i>
1 to 25	3	0
26 to 50	6	0
51 to 100	12	0
101 to 200	15	0
201 to 300	20	1
301 to 500	30	2
501 to 800	40	2
801 and above	55	3

### **14.18.3 Flush Bolts (Fig. 14.3)**

**14.18.3.1** These should generally conform to IS 5187. These shall be of cast brass, cast aluminium alloy or extruded aluminium alloy as specified. Only one material shall be used in the manufacture of all the components of flush bolts except spring which shall be of phosphor bronze or steel strip.

When the rod is completely in its maximum bolting position it shall be retained in that position by the spring. The length of the bolt shall be such that, when the bolt is pulled down, the top of the bolt shall be flush with the top of the lip face. The top of the bolt shall be given a taper of 45° to enable easy pull or push.

**14.18.3.2** Brass flush bolts shall be satin or bright polished. Alternatively they may be nickel or chromium plated as specified in IS 4827 or copper oxidised in accordance with IS 1378. Aluminium flush bolts shall be anodised and the quality of the anodised finish shall not be less than grade AC 15 of IS 1868.

**Note:** The working of flush bolts is found satisfactory only in case of shutters made of high quality timber like teakwood properly seasoned and when there is no warping due to changes in weather Brass flush bolts which give a more satisfactory performance are costly and uses scarce materials. Hence use of flush bolts is to be discouraged.

### **14.18.4 Floor Door Stopper (Fig. 14.4)**

**14.18.4.1** The floor door stopper shall conform to IS 1823. This shall be made of cast brass of overall size as specified and shall have rubber cushion. The shape and pattern of stopper shall be approved by the Engineer-in-Charge. It shall be of brass finished bright, chromium plated or oxidised or as specified. The size of floor stopper shall be determined by the length of its plate. It shall be well made and shall have four counter sunk holes for fixing the door stoppers to the floor by means of wood screws. The body or housing of the door stopper shall be cast in one piece and it shall be fixed to the cover plate by means of brass or



mild steel screws and cover plate shall be of casting or of sheet metal. The spring shall be fixed firmly to the pin. Tongue which would be pressed while closing or opening of the door shall be connected to the lower part by means of copper pin. On the extreme end a rubber piece shall be attached to absorb shock. All parts of the door stopper shall be of good workmanship and finish, burrs and sharp edges removed. It shall be free from surface and casting defects. Aluminium stopper shall be anodised and anodic film shall not be less than grade AC-10 of IS 1868.

**14.18.4.2 Sampling and Criteria for Conformity:** It shall be same as specified in 9.15.20.2.

**TABLE 14.4**  
**Requirements for Rubber**

<i>Particulars</i>	<i>Requirements</i>	<i>Testing procedure</i>
Relative density Max	1.3	IS 3400 (Part IX)
Hardness	60 ± 5	IS 3400 (Part II)
Change in initial hardness ageing for 24 hours at 100° ± 1° C	+5	IS 3400 (Part II)

#### **14.18.5 Hanging Rubber Door Stopper**

**14.18.5.1** These shall be of cast brass, finished bright, chromium plated or as specified. Aluminium stopper shall be anodised and the anodic coating shall not be less than grade AC-10 of IS:1868. The size and pattern of the door stopper shall be approved by the Engineer-in-Charge. The size shall be determined by its length.

#### **14.18.6 Casement Brass Stays (Straight Peg Type) (Fig. 14.5)**

**14.18.6.1** These shall be made of mild steel, cast brass, aluminium (extruded section) or plastic (Polypropylene) as specified. Mild steel casement stays shall be a copper oxidised (black finish) or as specified. Cast brass stays shall be finished bright or chromium plated or as specified. Aluminium stays shall be anodised and the anodic coating shall not be less than grade AC-10 of IS 1868. Aluminium and M.S. stays shall be made from channel section. The stays shall not weigh less than that indicated below :

200 mm	0.24 kg each
250 mm	0.28 kg each
300 mm	0.33 kg each

**14.18.6.2** The shape and pattern of the stays shall be approved by the Engineer-in-Charge. The size of stays shall be determined by its length as shown in the plate. The plastic (Polypropylene) stays shall conform to IS 6318.

#### **14.18.7 Fan Light Pivots**

**14.18.7.1** These shall generally conform to IS 1837. These shall be of mild steel or cast brass or Aluminium or as specified. The brass, fan light pivots shall be finished bright, chromium plated or as specified. M.S. fan light pivot shall be copper oxidized (black finish) or as specified. The base and socket plate of M.S. fan light pivots shall be made from minimum 3.0 mm M.S. sheet and the pivot shall be of round M.S. bar of minimum 10 mm diameter projecting out by minimum 12 mm length and firmly rivetted to the base plate.

**14.18.7.2** The base and socket plate of cast brass fan light pivots shall be made from minimum 3.0 mm thick brass plate and the projected pivot shall not be less than 12 mm diameter and 12 mm length, cast in single piece with the base plate.

#### **14.19 WHITE WASH WITH LIME (Shifted to 13.14)**



Clause shifted to Sub Head 13 (Finishing) as clause no. 13.14

#### **14.20 DRY DISTEMPER (Shifted to 13.18)**

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.18

#### **14.21 OIL EMULSION (OIL BOUND): (Shifted to 13.19)**

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.19

#### **14.22 CEMENT PAINT: (Shifted to 13.21)**

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.21

#### **14.23 PAINTING READY MIXED PAINT OVER G.S. SHEETS**

**14.23.0** Ready mixed paint, suitable for painting over G.S. sheets, of approved brand and manufacture and of the required shade shall be used. New or weathered G.S. sheets shall be painted with a priming coat of one coat of redoxide zinc chromate paint. Primer shall be applied before fixing sheets in place.

##### **14.23.1 Preparation of Surface**

**14.23.1.1 Painting New Surface:** The painting of new G.S. sheets shall not usually be done till the sheets have weathered for about a year. When new sheets are to be painted before they have weathered they shall be treated with a mordant solution prepared by mixing 38 gm of copper acetate in a litre of soft water or 13 gm hydrochloric acid in a solution of 13 gm each of copper chloride, copper nitrate and ammonium chloride dissolved in a litre of soft water. This quantity of solution is sufficient for about 235 sqm. to 280 sqm of area and is applied for ensuring proper adhesion of paint. The painting with the mordant solution will be paid for separately.

Before painting on new or weathered G.S. sheets, rust patches shall be completely cleaned with coarse emery paper and brush. All grease marks shall also be removed and the surface washed and dried and rusted surface shall be touched with readymixed paint of red lead.

**14.23.1.2 Painting Old Surface:** If the old paint is firm and sound, it shall be cleaned of grease, smoke etc. The surface shall then be rubbed down with sand paper and dusted. Rusty patches shall be cleaned up and touched with red lead.

If the old paint is blistered and flaked, it shall be completely removed as described in 13.41. Such removal shall be paid for separately and painting shall be treated as on new work.

##### **14.23.2 Application**

The number of coats to be applied shall be as in the description of item. In the case of C.G.S. sheets, the crowns of the corrugations shall be painted first and when these get dried the general coat shall be given to ensure uniform finish over the entire surface without the crowns showing signs of thinning.

The second or additional coats shall be applied when the previous coat has dried.

**14.23.3** The specifications described in 13.23 shall hold good so far as they are applicable.

#### **14.24 PAINTING CAST IRON RAIN WATER, SOIL, WASTE AND VENT PIPES AND FITTINGS: (Shifted to 13.44)**

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.44

#### **14.25 PAINTING WITH WOOD PRESERVATIVE (Shifted to 13.45)**

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.45

#### **14.26 WALL PAINTING WITH PLASTIC EMULSION PAINT (Shifted to 13.46)**

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.46





## 14.27 PAINTING WITH ENAMEL PAINT

**14.27.1** Enamel Paint (conforming to IS 2933) of approved brand and manufacture and of the required colour shall be used.

For the under coat, the paint of same quality but of shade to suit that of the top coat shall be used.

**14.27.2** Preparation of surface and application shall be as specified under 13.32 for painting on new surfaces or old surfaces, as the case may be.

**14.27.3** Other details shall be as specified in 13.23 as far as applicable.

## 14.28 PAINTING WITH SYNTHETIC ENAMEL PAINT: (Shifted to 13.47)

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.47

## 14.29 PAINTING WITH ALUMINIUM PAINT (Shifted to 13.48)

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.48

## 14.30 PAINTING WITH ANTI CORROSIVE BITUMASTIC PAINT: (Shifted to 13.35)

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.35

## 14.31 VARNISHING

**14.31.0** Ordinary copal varnish or superior quality spray varnish shall be used. The work includes sizing of transparent wood filler.

**14.31.1** Varnish (conforming to IS 347) for the finishing and undercoats shall be of the approved manufacturer.

### 14.31.2 Varnishing on New Surfaces

**14.31.2.1 Preparation of Surface:** New wood work to be varnished shall have been finished smooth with a carpenter's plane. Knots shall be cut to a slight depth. Cracks and holes shall be cleaned of dust. The knots, cracks etc. shall then be filled in with wood putty made as follows:

On a piece of wood say 20 x 15 cm face and on the side where cross grains appear, a small quantity of glue size shall be poured and the surface scraped with the edge of a fine carpenter's chisel. Very fine wood powder shall be mixed with the glue and the stiff paste thus formed shall be used for the filling.

The fillings when dry shall be rubbed down with a carpenter's file and then the entire surface shall be rubbed down perfectly smooth with medium grained and fine sand papers and wiped with dry clean cloth so that it presents uniform appearance. In no case shall sand papers be rubbed across the grains, as in this case even the finest marks will be visible when the varnishing is applied.

**14.31.2.2 Sizing or Transparent Wood Filler Coat :** The surface shall then be treated with either glue sizing or with transparent wood filler coat as stipulated in the description of item.

- (c) *Sizing:* When sizing is stipulated, an application of thin clean size shall be applied hot on the surface. When dry, the surface shall be rubbed down smooth with sand paper and cleaned. It shall then be given another application of glue size nearly cold. The sized wood work shall again be rubbed down smoothly with fine sand paper and cleaned. The surface shall be perfectly dry and all dust shall be removed not only from the surface but also from the edges and joints before varnishing is commenced. If the wood work is to be stained, the staining colour shall be mixed with the second coat of the size which must be applied evenly and quickly keeping the colour on the flow.

Any joining up with work already dry will show badly. The object of application of the glue size is to seal the pores in wood to prevent absorption of the oil in the varnish.

Glue sizing is inadvisable on floors, table tops and other horizontal surfaces likely to carry wet household utensils which are likely to disturb the size coatings and thus expose bare wood. Where glue sizing is omitted to be done the rate for the work shall be suitably reduced.



- (d) *Transparent Wood Filler Coat*: Where instead of glue sizing, transparent wood filler application is stipulated in the item, then the surface prepared as described in 13.37.2.1 shall be given as application of the filler with brush or rag in such a way that the filler fills up all the pores and indentations and levels up the surface. It shall be allowed to dry for 24 hours. Then it shall be cut and rubbed with emery paper so that the surface of the wood is laid bare, with the filler only in the pores and crevices of the wood.

**14.31.2.3 Application of Varnish:** The number of coats to be applied shall be as stipulated in the description of the item.

The undercoat shall be with a flatting varnish. This dries hard and brittle and when cut and rubbed down to produce a smooth surface enhances the gloss of the finishing varnish. The top coat shall be given with stipulated brand of finishing varnish.

The varnish shall be applied liberally with a full brush and spread evenly with short light strokes to avoid frothing. If the work is vertical the varnish shall be crossed and recrossed and then laid off, latter being finished on the upstrokes so that varnish, as it sets, flows down and eliminates brush marks, the above process will constitute one coat. If the surface is horizontal, varnish shall be worked in every direction, with light quick strokes and finish in one definite direction so that it will set without showing brush marks, in handling and applying varnish care should be taken to avoid forming froth or air bubbles. Brushes and containers shall be kept scrupulously clean.

Rubbing down and flatting the surface shall be done after each coat except the final coat with fine sand paper.

The work shall be allowed to dry away from droughts and damp air. The finished surface shall then present a uniform appearance and fine glossy surface free from streaks, blister etc.

Any varnish left over in the small container shall not be poured back into the stock tin, as it will render the latter unfit for use.

Special fine haired varnishing brushes shall be used and not ordinary paint brushes. Brushes shall be well worn and perfectly clean.

**14.31.2.4** Other details shall be as specified in 13.23 as far as they are applicable.

### **14.31.3 Varnishing on Old Surface**

**14.31.3.1 Preparation of Surface:** If the old varnished surface is firm and sound it shall be cleaned of grease and dirt with turpentine and then rubbed with wet sand paper until the surface is clean and smooth. It shall be dried and wiped clean with a soft cloth. Knots, holes and cracks shall be stopped as specified in 13.37.3. The entire surface shall then be rubbed down smooth with sand paper and wiped clean.

If the old varnished surface is peeled or cracked then it will be necessary to remove the entire varnish as described in para 13.41 and such removal shall be paid for separately outside the rate for varnishing. Further the varnishing itself will have to be done like new work and will be paid for as such.

**14.31.3.2 Application:** The specification shall be same as described in 13.37.3.2 as far as applicable except that the coats to be applied will be with the stipulated quality of varnish for finishing coat.

**14.31.3.3** Other details shall be as specified in 13.23 as far as they are applicable.

### **14.32 LETTERING WITH PAINT: (Shifted to 13.40)**

Clause shifted to Sub Head 13 (Finishing) as clause no. 13.40

### **14.33 DOUBLE SCAFFOLDING**

Specifications are same as described in sub head RCC work. (Figure 14.6)

### **14.34 FIXING OLD WIND TIES: DELETED**

### **14.35 BRICK WORK IN MUD MORTAR: DELETED**

### **14.36 BRASS CURTAIN RODS**





#### 14.36.1 Material

The brass curtain rods of required dia 20mm/25mm with wall thickness 1.25mm shall be provided with 2 no. brass brackets fixed with brass screws to the wall by means of wooden plugs/PVC Rawl Plugs. The size of brass screws shall not less than 60mm length.

#### 14.36.2 Measurements

Curtain rod shall be measured in running meter two nos. brass brackets including necessary screw.

**14.36.3 Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above.

#### 14.37 FIXING MS ROUND OR SQUARE BARS IN WOODEN FRAME OF WINDOW: DELETED

#### 14.38 WOODEN KARRIES FOR ROOFING: DELETED

#### 14.39 DOUBLE SCAFFOLDING SYSTEM UPTO SEVEN STOREY HEIGHT MADE WITH MS TUBE

The double scaffolding made with 40mm dia and 25mm dia pipe shall be erected along the wall surface. The MS pipe of heavy duty with wall thickness 4mm shall be used for the scaffolding. The scaffolding shall be erected in double row system and at every 9m height the extra 1 row of 40mm dia pipe perpendicular to wall surface shall be provided to secure the both layer of vertical pipe in the wall for better stability. It should be strong enough to with stand all coming load / wind pressure/tilt etc. The double scaffolding consist of 2 rows of vertical with horizontal and diagonal bracing forming essentially a structure independent of the building. The bottom of the scaffolding shall be fixed in suitable MS chair on base plate of minimum 12mm thick and 25x25cm size. The plate should be properly placed firm plate concrete floor. The frame work of scaffolding made with 40mm dia MS tube

1.5m centre to centre horizontal and vertical joint with cup and lock system and MS fixtures etc. MS tube challies and MS tube staircase in scaffolding for working platform etc. shall also be provided. The scaffolding system shall be stiffened with bracings, runners, connection with the building etc. wherever required for inspection of work at required locations with essential safety features for the workman etc. complete as per directions and approval of Engineer-in-charge.

- Note:-
1. The condition of MS tube and required claddings should be in good condition and should not have been used more than the specified time/nos. Scaffolding system shall remain the property of the contractor after completion of work.
  2. This item to be used for maintenance work judiciously, necessary deduction for scaffolding in the existing item to be done.

#### 14.39.1 Measurement & Rate

The elevational area of the scaffolding shall be measured for payment in sqm. The payment will be made once irrespective of duration of scaffolding.

#### 14.40 REPAIR TO PLASTER IN PATCHES

The repair to plaster of thickness 12mm to 20mm in patches of area upto 2.5 sqm shall be done with white cement polymer modified self curing mortar. Before applying the mortar cutting the patch in proper regular (square/ rectangle) shape, racking out joints and preparing the wall to receive the plaster shall be done. The payment shall be made in area of patches measured in sqm.

#### 14.40.1 Measurements

Patch repair shall be measured in sqm.

**14.40.2 Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above.

#### 14.41 CLEANING



#### **14.41.1 CLEANING OF WATER STORAGE TANKS**

**14.41.1.1** The Water Storage Tanks at terrace upto 2000 lt. capacity at all heights shall be cleaned with pressure water jetting with chemical mixed water with suitable pump arrangement and followed by coconut brushes, duster etc. including removal of silt, rubbish from the tank and cleaning the tank with fresh water disinfecting with bleaching powder @0.5gm per litre capacity of tank including marking the date of cleaning on the side of tank body with the help of stencil and paint and disposing of malba all complete as per direction of Engineer-in-charge. (The old date already written on tank should be removed with paint remover or black paint and if date is not written with the stencil or old date is not removed deduction will be made Rs.0.10 per litre) (if during cleaning any GI fittings or ball cock is damaged that is to be replaced by contractor at his own cost and nothing extra will be paid on this account).

##### **14.41.1.2 Measurement**

Cleaning of water storage tank shall be measured in litre.

##### **14.41.1.3 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above.

#### **14.41.2 CLEANING AND DE-SILTING OF GULLY TRAP**

**14.41.2.1** The gully trap/chamber shall be cleaned and de-silted in following manner:

1. Removal of rubbish mixed with earth by deployment of sufficient manual labour.
2. Disposal of the accumulated malba, rubbish to the approved dumping ground with the help of trolley/wheel barrows properly lined with PVC sheet to avoid splashes of the sewage/ rubbish on the ground.

All above mentioned 2 operations shall be done by making all adequate safety arrangement to the labour including providing them medical aid, rubber gloves, helmets, masks, oxygen cylinder etc. and make the site neat and clean after completion of work.

The payment to be making is inclusive of all operation like labour, material and T&P whichever is required.

##### **14.41.2.2 Measurement & Rate**

Cleaning and de-silting of gully trap shall be measured and payment in numbers. The payment to be making is inclusive of all operations like labours, materials and T&P whichever is required.

#### **14.41.3 CLEANING OF CHOKED SEWER LINE**

**14.41.3.1** The choked / blocked sewer line shall be cleaned in following steps:

3. The manhole covers shall be kept open for same time before the cleaning of sewer line so as to escape the foul gases.
4. Sucking the choked malba material by diesel running, vehicle mounting hydraulic operated suction/jetting cleaning machine with appropriate capacity as per requirement.
5. Disposal of the accumulated malba, rubbish to the approved dumping ground with the help of trolley/wheel barrows properly lined with PVC sheet to avoid splashes of the sewage/ rubbish on the ground.

All above mentioned 2 operations shall be done in presence of supervisor and by making all adequate safety arrangement to the labour including providing them medical aid, rubber gloves, helmets, masks, oxygen cylinder etc.

##### **14.41.3.2 Measurement & Rate**



Cleaning and desilting of sewer line shall be measured and payment in numbers. The payment to be making is inclusive of all operations like labours, materials and T&P whichever is required.

#### **14.41.4 CLEANING OF UNDERGROUND SUMP, OVER HEAD R.C.C. TANK**

The process of cleaning of underground sump, Over Head R.C.C. Tank (independent staging) will be done in following operations:-

1. Tank shall be emptied of water by pumping & bottom shall be cleaned of silt and other deposits.
2. Entire surface area of the sump shall be cleaned with pressure jetting of water mixed with cleaning chemical atleast two times and thoroughly etc. and finally washing with simple water jet to clean properly the wall surface.
3. Chlorination of RCC internal surface by liquid chlorine.
4. The treated surface shall be dried using air jetting and all loose particles shall be removal from the surface.
5. Finally the surface shall be treated with ultraviolet radiation etc. as per direction of Engineer- in-Charge.

All above mentioned four (4) operations shall be done by making all adequate safety arrangement to the labour including providing them medical aid, rubber gloves, helmets, masks etc.

##### **14.41.4.1 Measurement**

Cleaning of internal surface area of underground sump, Over Head RCC tanks shall be measured in sqm.

**14.41.4.2 Rate:** The rate shall include the cost of all materials and labour and T&P involved in all the operations described above.

#### **14.42 DISCONNECTING DAMAGED OVERHEAD/TERRACE**

The execution/operation of the item is as under:

1. Closing the water supply line tank by means gate valve /stop cock etc.
2. Emptying the water tank completely.
3. The Water tank supply connection will be disconnected and the delivery pipe line shall also be disconnected by removing all the fitting and fixtures completely.
4. The delivery pipes from the bottom of the tank shall also be disconnected from the tank.
5. Removing the water storage tank from terrace and shifting it to the ground floor by mechanical means or by manual with all safety reasons as directed by Engineer-in-charge.

##### **14.42.1 Measurement & Rate**

The measurements of overhead/ terrace PVC water storage tanks of any size shall be measured in numbers and payment shall be made on each basis.

#### **14.43 REPLACEMENT OF OLD DAMAGED W.C. SEATS**

The execution/operation of the item is as under:

1. Dismantling and taking out the old WC seat and "S" or "P" trap at site complete with all operations including all necessary materials, labour and disposal of dismantled material i/c malba, debris etc. including lead upto dumping ground.
2. Providing "S" or "P" trap and water closet squatting pan (Indian type) of approved brand of good quality.



3. Fixing the W.C. with trap in position along with trap by making all arrangement of connecting it to the flushing cistern. Thereafter the gap left in the filled up portion is to be leveled by cement concrete 1:5:10 and floor tiles of same shade are also to be provided over it to match the floor of the toilet.

#### **14.43.1 Measurement & Rate**

The measurements and payment of replaced W.C Seats shall be made on each basis

#### **14.44 CUTTING HOLES OF REQUIRED SIZE IN BRICK MASONRY WALL**

Cutting holes of required size in brick masonry wall for fixing of exhaust fan including providing and fixing 300mm dia PVC pipe conforming BIS-12818 and making good the same etc. complete. The hole shall be cut with cutting tool by marking hole all round the circle with the help of power drill machine so that the adjoining wall should not get damaged.

#### **14.44.1 Measurement & Rate**

The measurements and payment of cutting holes and finishing etc. shall be made on each basis

#### **14.45 DISMANTLING W.C. PAN OF ALL SIZES**

Dismantling W.C. Pan of all sizes including disposal of dismantled materials i/c malba all complete as per directions of Engineer-in-Charge. The W.C. seat is taken out along with trap and the area is to be cleaned off all dust and rubbish etc. Thereafter the hole left in the flooring is to be leveled by cement concrete 1:5:10 and floor tiles of same shade are also to be provided over it to match the floor of the toilet room.

#### **14.45.1 Measurement & Rate**

The measurements and payment of dismantling W.C. Pan of all sizes shall be made on each basis.

#### **14.46 HACKING OF CC FLOORING**

Hacking the CC flooring including cleaning the surface etc. complete as per direction of the Engineer-in-Charge. The hacking of CC flooring is done with chisel and hammer to make the top surface of flooring rough before laying tile/ marble/granite flooring etc. The hacking should be at least 10 nos. in 30x30cm area of the floor.

#### **14.46.1 Measurement & Rate**

The measurements and payment of hacking of CC flooring shall be made on sqm.

#### **14.47 DISMANTLING 15 TO 40MM DIA G.I. PIPE**

Dismantling 15 to 40mm dia G.I. pipe including stacking of dismantled pipes (within 50 metres lead) as per direction of Engineer-in-Charge. The pipe dismantling is done from tap point to main line. The 15mm dia is to be dismantled first and thereafter the dismantling/taking out the pipe shall proceed towards bigger dia pipe at the last. The pipe is removed from its joints/sockets/T-section gently with pipe wrench/tool so that the old pipe is not get damaged and the same can be reused where required. The old dismantle pipe will be stacked dia wise and connected fittings are also to be stored properly for reuse.

#### **14.47.1 Measurement & Rate**

The measurements and payment of **Dismantling G.I. pipe** shall be made on meter.

#### **14.48 TAKING OUT EXISTING WOODEN DOOR SHUTTER AND RE-FIXING THE SAME AFTER REPAIRS**

Taking out existing wooden door shutter, repair by de-screwing hinges etc. and re-fixing the repaired door shutters to existing door frames, including replacement of hinges with screws etc. as required, all complete as per the direction of the Engineer-in-charge. The old shutter is to be taken out by removing the screws from the hinges by screw driver/screw fixing equipment (electric driven). Thereafter, the damaged part of the shutters such as styles/ panels/veneering etc. is replaced with new one and the door shutter is prepared for re-fixing to the door frame. During re-fixing the position of hinges if required may be shifted for proper anchorage with 50mm stainless steel screw with cross head. The re-fixing with butt hinges by means of screws is done with



the help of electric driven screw driving equipment. The whole door including chokhat is to be re-painted with required colour to match the door and shutter with the same shade.

#### 14.48.1 Measurement & Rate

The measurements and payment shall be made on each basis.

### 14.49 WATER PROOFING TREATMENT WITH APP (ATACTIC POLYPROPYLENE POLYMERIC) MEMBRANE

Water proofing treatment of roofs with APP modified polymeric membrane shall be either five course, seven course as specified in the item. In selecting the combinations of layers of APP membrane, consideration shall be given to the type and construction of buildings, climate and atmospheric conditions and the degree of permanence required. Five course treatment is a normal treatment suitable to moderate rainfall conditions (less than 50 cm.) and seven course treatment is suitable for heavy rainfall (50 cm and above). Seven course treatment with APP modified polymeric membrane 2.00 mm thick and weight 3.00 kg./sqm. to suitable for very heavy conditions of rainfall (more than 150 cm.).

#### 14.49.1 Materials

**14.49.1.1** The bitumen primer shall conform to the requirements laid down in IS 3384.

**14.49.1.2** APP Modified Membrane: It is a polymeric water proofing membrane manufactured to high standards. It is five layered APP modified polymeric membrane with centre core as 20 micron HMHDPE/ 100 micron HMHDPE High Molecular High Density Polyethylene Film, is the heart of the membrane and protects against water and moisture. The centre core is sandwiched on both sides by high quality polymeric mix with properties of high softening point, high heat resistance and cold resistivity to make it ideal for all water proofing treatment. The polymeric mix is protected on both sides with 20 micron HMHDPE film. The membrane is available in variable thickness and weights. Usual width is 1.0 m.

Important physical and chemical parameter of the membrane shall be as given in Table 14.5 for guidance.

**TABLE 14.5**

Centre Core	Film	Thickness	Weight
20 micron HMHPDE	20 micron HMHPDE	1.5 mm	2.25 kg/ sqm.
100 micron HMHPDE	20 micron HMHPDE	2.00 mm	3.00 kg./ sqm.

Where proprietary brands Atactic Polypropylene modified polymeric membrane is proposed to be used by the contractor, they shall conform in all respect to the specification in the preceding paras and manufactured by a company of repute.

**14.49.1.3 Bonding Material:** This shall consist of blown type bitumen conforming to IS 702 or residual bitumen 85/25 conforming to IS 73 heated to the correct working temperature of 180°C. The penetration of the bitumen shall not be more than 40 when tested in accordance with IS 1203, unless otherwise specified each coat of bonding material shall be of blown type bitumen of grade 85/25 heated to a working temperature of 180 degree C and applied @ 1.20 kg. per square metre of the surface area.

**14.49.1.4 Surface Finish:** Surface finish shall be with brick tiles of class designation 100 grouted with cement mortar 1:3 (1 cement : 3 fine sand) with 2% integral water proofing compound by weight of cement over a 12 mm thick layer of cement mortar 1:3 (1 cement: 3 fine sand) and finished neat, as shown in Fig. 14.7. Surface finish shall be measured and paid for separately.

**14.49.1.5 Preparation of Surface:** The surface to be treated shall have a minimum slope of 1 to 120. This grading shall be carried out with cement concrete or cement plaster with coarse sand, as desired, to the average thickness required and finished smooth. Such grading shall be paid for separately.



Junctions between the roof and vertical faces of parapet walls, chimneys etc. shall be chased by running triangular fillets 7.5 x 7.5 cm. size, cement concrete. At the drain mouths, the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water. Cement concrete where shall be 1:2:4 mix (1 Cement: 2 Coarse sand: 4 Graded stone aggregate 20 mm. Nominal size). The provision of fillets shall be deemed to be covered by the item of water proofing and shall not be measured or paid for separately.

In existing roof where gola and drip course are provided at the junction of roof and vertical face of parapet wall, chimney stacks, etc. These shall be dressed suitably and finished smooth so as to ensure an easy and gradual turning of the flashing. Any dismantlement or forming and finishing smooth the junction for forming the base of the flashing shall not be measured or paid for separately and shall be deemed to form part of the preparation of the surface.

While the grading of roof surface is being done, it shall be ensured that the outlet drain pipe have been fixed and mouth at the entrance have been eased and rounded off properly for easy flow of water. When any pipe passes through the roof to be treated, angular fillet of shape shown in Fig.

22.11 shall be built around it for the water proofing treatment to be taken over it. These fillets shall not be measured or paid for separately. For carrying over and tucking in the water proofing felts into the parapet walls, chimneys stacks etc. a horizontal groove 6.5 cm. deep, 7.5 cm. wide section with its lower edge at not less than 15 cm. above the graded roof surface shall be left on the inner face of the same; during construction if possible. When such groove has not been left, the same shall be cut out neatly and the base at rear of the groove shall be finished smooth with cement plaster 1:4 (1 cement: 4 coarse sand). Such cutting of the groove and its finishing smooth shall be part of the water proofing or paid for separately. No deduction shall be made either for not making the groove or when the latter has already been left in the masonry by the construction agency. Tucking in the water

proofing felt will be required where the parapet wall exceeds 45 cm. in the height from the graded surface. Where the height is 45 cm. or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness. In the case of low dividing walls of height 30 cm. or less, outlets therein shall be cut open for full height and the bottom and sides shall be rendered smooth and corners rounded and such treatment shall not be measured and paid for separately. Where expansion joints are left in the slab the provision of dwarf walls and/or RCC slabs for covering them and finishing the surface smooth shall be the responsibility of the construction agency, which had laid the roof slab and will not be included in the operation of water proofing. The graded surface of the roof and concrete fillets and the faces of walls shall be thoroughly cleaned with wire brushed and all loose scales etc. removed. The surface shall then be dusted off. Any crack in the roof shall be cut to V section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement

: 4 coarse sand) or blown type petroleum bitumen of IS grade 85/25, or approved quality conforming to IS 702. Such cleaning of the surface or treating the cracks shall not be paid for separately.

**14.49.1.6 Treatment:** The water treatment shall be of five or seven course as specified.

In seven course treatment, the first four courses shall be the same as for five course treatment. The fifth course shall be a layer of APP modified polymeric membrane. The sixth course shall be a coat of bonding material and the top most seventh course shall be of specified surface finish.

#### **14.49.1.7 Laying**

- (a) First course shall be a coat of bitumen primer @ 0.40 kg per sqmt followed by subsequent course as per treatment required.
- (b) Drain outlets shall be given a four or six course treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment





laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.

- (c) The APP modified polymeric membrane shall be cut to the required length, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked up to crest. The membrane shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m are suitable lengths. The roof surface shall be cleaned and dry before starting the membrane treatment. Each length of membrane shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled membrane as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be levelled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner.

Each strip shall overlap the preceding one by at least 7.5 cm. at the longitudinal edges and 10 cm. at the ends. All overlaps shall be firmly bonded with a blow lamp and levelling down unevenness. The fourth layer of bonding material in the five course treatment shall be carried out in a similar manner after the flashing has been completed.

- (d) In a seven course treatment the fifth layers of membrane shall be laid in the manner already described, taking care that laps in the membrane are staggered from those in the earlier layer. The sixth layer of bonding material shall be carried out after the flashing is done.
- (e) High Parapet Walls, Chimney Stacks etc.: Membrane shall be laid as flashing wherever junctions of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The lower layer of flashing membrane in a six course treatment shall overlap the roof water proofing by not less than 20 cm. while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing membrane in five course treatment over the roofing membrane shall be 10 cm.

The flashing shall consist of the same five or seven course treatment as for the roof except that the final course shall be replaced by an application of 12 mm thick cement plaster 1:3 on the vertical and sloping faces only, of the flashing as shown in Fig 14.8. The overlap along the length of flashing shall stagger with those in the second layer of flashing membrane (in a seven course treatment and with the joints in the roof membrane).

The upper edge of the finishing membrane shall be well tucked into the flashing grooves in the parapet, chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing (see Fig. 14.7).

After the top flashing membrane layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing membrane and the horizontal overlaps and vertical and sloping surfaces of the flashing at the specified rate.

- (f) Low Parapet Walls: Where parapet walls are of height 45 cm. or less, membrane flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried upto the full height of the wall and taken right across the top of



the parapet and down on the external vertical faces to a minimum distance of 5 cm. (see Fig 14.8).

- (g) Low Dividing Walls: Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carried down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls (see Fig. 14.10).

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

- (h) Expansion Joints: Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and dwarf walls by not less than 7.5 cm. and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roofs slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of the cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. Nothing agency extra shall be paid for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

- (i) Pipes: Where vertical pipe outlets are met with, 7.5 x 7.5 cm fillets of lime or cement concrete of the type and section shown in Fig. 14.10 shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid.

The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

**14.49.1.8 Measurement:** Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal. Measurements shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints and at pipe projections etc. Overlaps and tucking into flashing grooves shall not be measured. Vertical and sloping surfaces of water proofing treatment shall also be measured under the five or seven course treatment as the case may be, irrespective of the fact that the final course is replaced by bitumen primer. No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 0.4 sqm nor anything shall be paid for forming such openings. For areas exceeding 0.40 sqm deduction will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

**14.49.1.9 Rate:** The rate shall include the cost of all labour and materials involved in all the operations described above. The top most layer shall be paid for separately.

**Clause 14.49 brought from Sub Head 22 (Water Proofing) clause no 22.11**

#### **14.50 FIVE LAYERED WATER PROOFING TREATMENT WITH ATACTIC POLYPROPYLENE POLYMER MODIFIED PREFABRICATED MEMBRANE**

**14.50.1** Atactic Polypropylene Polymer modified prefabricated five layer water proofing membrane shall be of thickness as specified. In selecting thickness of membrane due consideration shall be given to the type and construction of building, climate and atmospheric condition and permanence required. Five layered





treatment 2.00 mm thick with glass fibre is with a normal duty treatment suitable for pitched roofs. Five layered 3.00 mm thick with glass fibre matt treatment is suitable for moderate condition of rainfall (50 to 150 mm) and fine layered 3.00 mm thick with non-woven polyester matt treatment is suitable for heavy condition of rainfall.

#### 14.50.1.1 Materials

Bitumen primer for bitumen membrane shall have density at 25°C in the range of 0.87 - 0.89 kg./litre and viscosity of 70-160 CPS primer shall be applied @ of 0.40 litre/sqm.

**14.50.1.2 Atactic Polypropylene Polymer Modified Prefabricated Membrane:** It is a polymeric water proofing membrane. This shall be one of the following types:

- (i) 2 mm thick with glass fibre matt.
- (ii) 3 mm thick glass fibre matt.
- (iii) 3 mm thick with non-woven polyester matt.

It is prefabricated five layered black finish water proofing membrane comprising of centre core of 50 gsm. Glass fibre matt/170 gsm nonwoven polyester matt sandwiched on both sides by APP polymer modified bitumen which is protected on both sides by 20 micron thermofusible polyethylene sheet. Composite thickness of the membrane including all five layers shall be 2/3 mm with glass fibre matt and 3 mm with non woven polyester matt. It is available in 1 m width and variable lengths.

**Physical and chemical parameters of the membrane shall be as given in Table 14.6**

**TABLE 14.6**

Sl. No.	No. of Layers	Thickness	Elongation at 23° C in longitudinal transverse direction	Joint strength in longitudinal and Transverse direction	Tear strength in longitudinal Transverse direction	Softening Point	Cold flexibility
1	2	3	4	5	6	7	8
1	Five Layered reinforced with fibre glass	2 mm	3 N/5 cm.	350/300 N/5 cm.	60/80 N	150°	-2°C
2	Five layered reinforced with fibre glass	3 mm	3.3 N/5 cm.	350/3000 N/5 cm.	60/80 N	150°	-3°C
3	Five layered reinforced with non-woven polyester matt.	3 mm	40/50 N/5 cm.	650 N/450 N/5 cm.	300/250 N	150°	-2°C



When tested Atactic polypropylene modified black finished is proposed to be used shall conform in all respects to the specification in the preceding paras. The work should be got done through authorized applicator/ specification agency.

**14.50.1.3 Preparation of Surface:** The surface to be treated shall have a minimum slope of 1 in 120 or as specified, provision specified in clause 14.49.1.5 shall apply for preparation of surface except for pitched roof where surface shall be cleaned off any loose material dust etc.

To ensure good adhesion between the surface and water proofing treatment suitable method to dry the surface shall be adopted. All hair line cracks in the surface should be filled with approved sealant.

**14.50.1.4 Treatment:** The water proofing shall consist of prefabricated five layered 2 mm / 3 mm membrane as shown in Fig. 14.11. The choice of 2 mm or 3 mm membrane will depend on the type of roof i.e. pitched or flat and importance of building, durability, cost and rainfall etc.

**14.50.1.5 Laying:** Bitumen primer @ 0.40 lts/sqm shall be applied to the prepared roof, drain and all other surfaces where polymer modified membrane is to be laid. The five layered water proofing membrane shall be laid using Butane torch and sealing all joints and preparing the surface complete. Drain outlets shall be given same treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.

The APP polymer modified prefabricated water proofing membrane shall be cut to the required length. Water proofing membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked upto crest. APP water proofing membrane shall be laid in 6 to 8 m lengths. The roof surface shall be cleaned and bitumen primer shall be applied in the correct quantity, over this specified water proofing membrane shall be laid with butane torch after allowing 24 hours for primer to dry. Each strip shall overlap the preceding one by at least 10 cm. at the longitudinal edges and 15 cm. at the ends. All overlaps shall be firmly bonded with bitumen primer and levelled by heating the overlap with butane torch.

If the roof is accessible the treatment is protected by brick tiles laid over 12 mm thick cement mortar of specified grade bedding and joints sealed with cement mortar of which shall be measured and paid for separately.

APP water proofing membrane shall be laid as flashing wherever junction of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The upper edge of flashing membrane shall be well tucked into the flashing grooves in the parapets, chimney stack etc. to a depth of not less than 6.5 cm; corresponding applications of primer coat shall also be made. The flashing treatment shall be firmly held in the grooves and it shall be sealed with the approved sealant after terminating the membrane.

Where parapet walls are of height 45 cm or less AP water proofing membrane flashing shall be provided in the same manner as for splashing in the core of high parapet walls except that upper edge shall be carried out the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm.

Where low dividing walls or inverted beams are met with, the same treatment shall be provided as for the main roof, the lateral bearing carried down both sides of the wall and overlapping the roof treatment.

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment same as for the main roof.

Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing treatment. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precise RCC cover slabs as given in Fig. 14.10. The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the slopping junction fillets



and the vertical faces of the walls to the underside of the cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm. width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of cover slabs shall be the responsibility of construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the junction fillets or for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

**14.50.1.6 Measurements:** Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal.

Measurement shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints at pipe projections etc. overlaps and tucking into flashing grooves shall not be measured.

No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 40 square decimeter (0.4. sqm.) nor any thing shall be paid for forming such openings. For areas exceeding 0.40 sqm. deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

**14.50.1.7 Rate:** The rates shall include the cost of all labour and materials involved in all the operations described above.

**Clause 14.50 brought from Sub Head 22 (Water Proofing) clause no 22.12**

#### **14.51 EXTRA FOR COVERING OF APP MODIFIED PREFABRICATED MEMBRANE WITH GEOTEXTILE**

**14.51.1** If the water proofing treatment of flat roof has been done with APP modified five layered membrane and the roof is accessible, a separation layer on top of membrane should be laid before any protected treatment is done. Brick tiles in cement mortar or 25 mm thick cement concrete 1:2:4 shall be laid as final layer as shown in Fig. 14.11.

Geotextile 120 gm. Non woven 100% polyester of thickness 1.0 to 1.25 mm manufactured by a company of repute shall be used.

Geotextile of the specified thickness is bonded to the water proofing membrane with intermittent touch by heating the membrane by Butane torch as per manufacturing recommendations.

**14.51.2 Measurements:** Length and breadth shall be measured correct to two places of decimal, measurement shall be taken over the entire exposed area of roofing.

**14.51.3 Rate:** The rate shall include the cost of all labour and material involved in all the operation described above. Final layer of brick tiles or 25 mm thick cement concrete shall be measured and paid for separately.

**Clause 14.51 brought from Sub Head 22 (Water Proofing) clause no 22.13**

#### **14.52 PROVIDING ROUND THE CLOCK SECURITY GUARD WITHOUT GUN: DELETED**

#### **14.53 PROVIDING ROUND THE CLOCK SECURITY GUARD WITH GUN: DELETED**

#### **14.54 REPAIR TO DAMAGED CONCRETE:**

##### **14.54.1 MICRO CONCRETING:**

##### **14.54.1.1 Temporary Supports:**

The R.C.C. members should be properly supported before chipping the damage / loose concrete. The props provided shall be adequate to provide sufficient structural supports to the load carrying members.



#### **14.54.1.2 Surface Preparation of Concrete:**

All the damage / loose cracked concrete shall be removed by chipping to expose the reinforcing bars. The concrete shall be chipped to a minimum depth of 10mm behind the reinforcing bars. The area to be repaired should be profiled to get rectangular or square shape with an inward tapering edge.

#### **14.54.1.3 Surface Preparation of Reinforcement:**

The exposed reinforcement bars shall be cleaned thoroughly to remove all traces of rust, scales, etc., by using wire brush, emery paper etc. The lateral ties/stirrups shall also be cleaned in the same way. After removal of corroded portion, the diameter of the reinforcement shall be checked and compared with the drawings.

#### **14.54.1.4 Provision of Additional Reinforcement:**

As the diameter of reinforcing bars is reduced substantially (say >20%) additional bars shall be provided as per the design. This additional reinforcement shall be properly anchored to the existing concrete by providing adequate shear connectors. Weld mesh may also be provided if found necessary.

#### **14.54.1.5 Provision of Shear Connectors:**

Shear connectors of 8mm diameter shall be provided in holes of 14mm diameter and 75 mm deep. These shall be provided at every 500 mm c/c on all the faces of the beams in staggered form. The holes shall be cleaned with compressed air or water jet to remove all the dust etc. and then the shear connectors shall be fixed in the holes using polyester resin anchor grout. Additional reinforcements and shear connectors provided.

#### **14.54.1.6 Priming of Reinforcement Bars:**

The exposed and cleaned reinforcing bar shall be provided with a coat of Epoxy Zinc Primer such that the coated film will have a dry film thickness of 40 microns. The film shall be continuous especially in the regions where pitting, imperfections etc., are present on the surface of the bars. It is important that the rear portion of the bars should not be left without coating. A second coat if needed may be provided to achieve a uniform and continuous film. The additional reinforcement provided and also the shear connectors shall be coated with Epoxy Zinc Primer. The weld mesh if provided shall also be coated with Epoxy Zinc Primer.

#### **14.54.1.7 Provision of Epoxy Based Bonding Agent:**

The base and hardener component of epoxy resin based bonding agent must be mixed well to get a uniform grey coloured mix. Apply the material to properly cleaned and dry concrete substrate using stiff nylon brush by scrubbing it well into the substrate. The coat should be uniform and well spread on the entire surface area of the repair patch. The mixed material must be applied before the elapse of its pot life and the new repair mortar must be applied before the elapse of overlay time. As a fully dried epoxy resin coat acts as debonding layer, the repair material should be applied whilst the bonding coat is tacky. In case the applied epoxy bond coat gets dry, an extra coat should be applied before application of repair mortar.

#### **14.54.1.8 Formwork and Shuttering:**

Slurry tight and strong form work shall be provided. The shuttering for encasement shall be kept ready such that the formwork shall be placed in position and fixed such that the micro concrete can be poured into the formwork within the overlay time of the bonding agent (5 hours). Adequate supports shall be provided for the formwork. Care should be taken to ensure leak proof shuttering. Under no circumstance the slurry should flow out of the shuttering during pouring of micro concrete.



#### **14.54.1.9 Mixing of Micro Concrete:**

It should be mixed using the appropriate water powder ratio as mentioned in the product data sheet. The mixing shall be done mechanically and under no circumstance hand mixing shall be done. Mixing shall be carried out for 3 to 5 minutes to ensure that homogeneous mix is obtained without any bleeding or Segregation. In hot climate ice cooled water shall be used to maintain the temperature of mixed material. If the encasing thickness is more than 100 mm, add stone aggregates up to 50 % by weight of micro concrete to the mixed micro concrete directly into the mixer hopper. The stone aggregates must be 12 mm and down and shall be clean, washed and dried. The mixing should be done for 3 minutes in mixer and then pre weighed stone aggregates into the mixer. Mix further for 2 minutes till lump free mix is obtained Additional reinforcements provided for jacketing Strengthening of column with micro concrete Removing Shuttering: The shuttering from the sides of the R C members shall be removed after a period of 24 hours. However, the formwork of the soffit shall be retained and removed after 3 days.

#### **14.54.1.10 Pouring Of Micro Concrete:**

The mixer should be poured into the formwork using a suitable funnel or through a hose pipe. It must be poured from one end only. A suitable hopper / funnel arrangement shall be made at site to facilitate the pouring operations. The pouring operation shall be continuous and it shall not be stopped unless the job is completed. To achieve this sufficient mixers / drilling machines and work force shall be arranged at site.

#### **14.54.1.11 Curing:**

All the repaired and encased area shall be fully cured as per standard concrete practices. Curing compound shall be used for effective curing of sides and soffits of beams. if a curing compound is applied, care shall be taken to ensure that proper surface preparation is carried out so as to remove any traces of curing compound on the surface. If this is of done, it may lead to debonding of any protective coating applied on top.

#### **14.54.1.12 Measurements**

Length, breadth and height shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal. Pre- measurements of the patches to be concreted shall be recorded after the old concrete has been removed and surface prepared.

#### **14.54.1.13 Rates**

The rate includes the cost of all the materials and labour involved in all the operations described above.

### **14.54.2 FIBRE WRAP(GFRP/CFRP):**

#### **14.54.2.1 Structure Preparation:**

Basic repairs must be made to the structure prior to strengthening with FRP. Spaded concrete removed, corroded or damaged steel addressed and major cracks injected.

#### **14.54.2.2 Surface Preparation:**

The surface to be repaired is typically rubbed off to smooth out irregularities, remove contaminants and radius sharp corners. This can be performed by shot or sand blasting, water jet or grinder.

#### **14.54.2.3 Primer:**

In order to promote adhesion and prevent the surface from drawing resin from the FRP, a low viscosity epoxy primer is applied with a roller until the substrate is locally saturated.

#### **14.54.2.4 Putty:**

An adhesive, high viscosity putty is applied when necessary to the surface to fill in 'bug holes' offsets or voids.



#### **14.54.2.5 Cutting Fabric:**

An adhesive, high viscosity putty is applied when necessary to the surface to fill in 'bug holes' offsets or voids.

#### **14.54.2.6 Saturating Fabric:**

On large, high volume projects, the fabric can be saturated using Edge Structural Composites' custom saturator. For lower volumes and shorter strips, the fabric can be either saturated on a table, or the surface can be coated with resin and the dry fabric applied.

#### **14.54.2.7 Applying Fabric:**

The pre-wetted, or dry, fabric is carefully laid onto the surface and smoothed out to remove air bubbles and ensure that the fibers are straight.

#### **14.54.2.8 Quality Control Monitoring:**

During the cure, 2 to 6 hours depending on ambient conditions, the fabric is checked to ensure that all air bubbles are removed and that the fabric is not sagging. Edge Structural Composites highly recommends that a trained, qualified inspector monitor application.

#### **14.54.2.9 Top Coat:**

Once cured and inspected, FRP system can be coated with any coating, for aesthetic blending and low maintenance protection.

#### **14.54.2.10 Measurements**

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metre correct to two places of decimal.

#### **14.54.2.11 Rates**

The rate includes the cost of all the materials and labour involved in all the operations described above.

## FIXING OF FAN CLAMPS IN EXISTING R.C.C. SLABS

Sub Head : Repairs to Buildings

Clause : 14.12

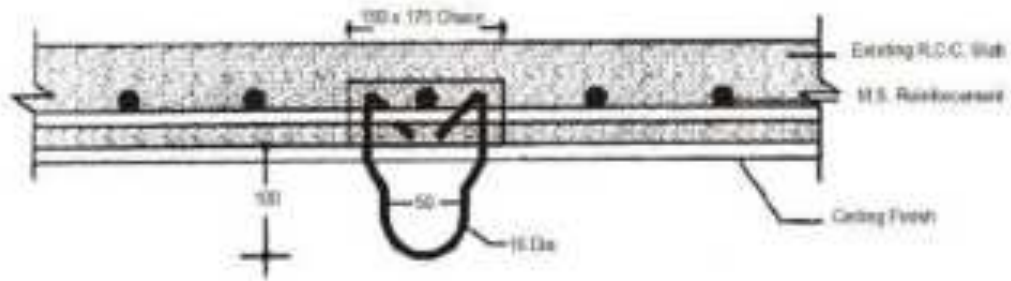


Figure 14.1 : Fixing of Fan Clamps in Existing R.C.C. Slabs

Drawing Not to Scale  
All dimensions are in mm



## TERMINOLOGY TIMBER DOOR, WINDOW & VENTILATOR COMPONENTS

Sub Head : Repairs to Buildings

Clause : 14.16

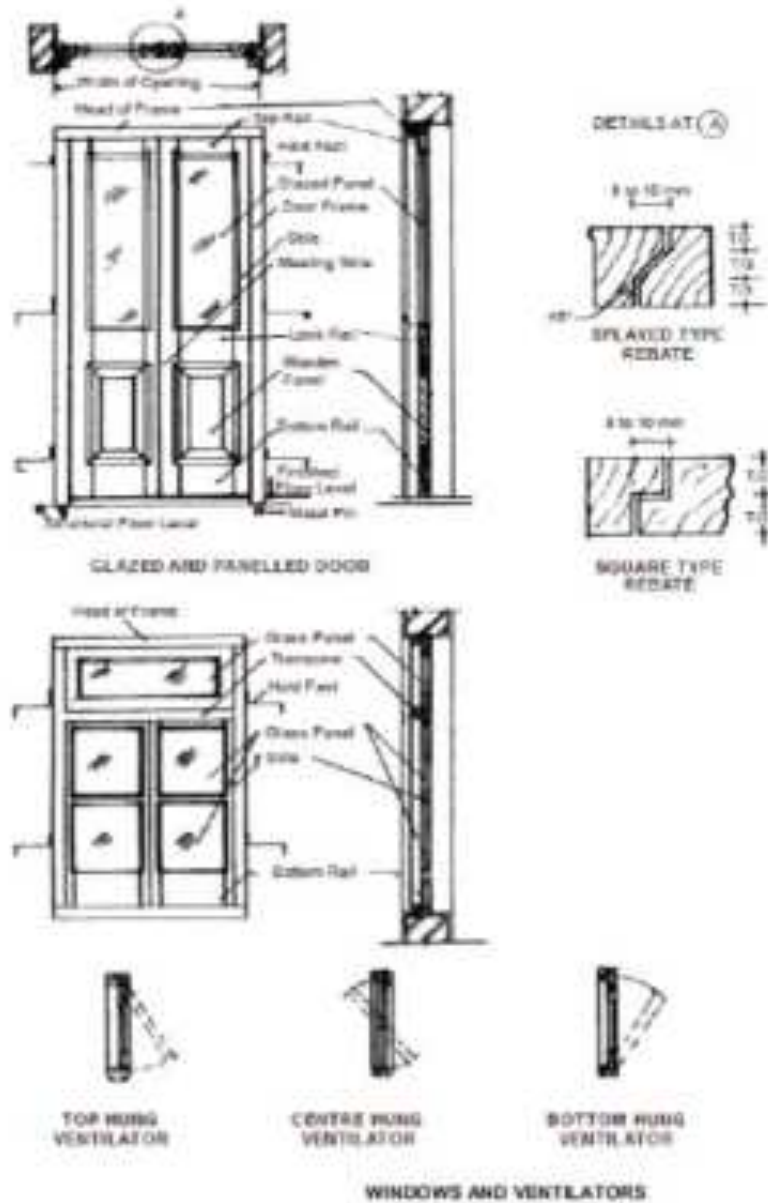


Figure 14.2 : Terminology Timber Door, Window & Ventilator Component

Drawing Not to Scale  
All dimensions are in mm



## FLUSH BOLTS

Sub Head : Repairs to Buildings  
Clause : 14.18.3

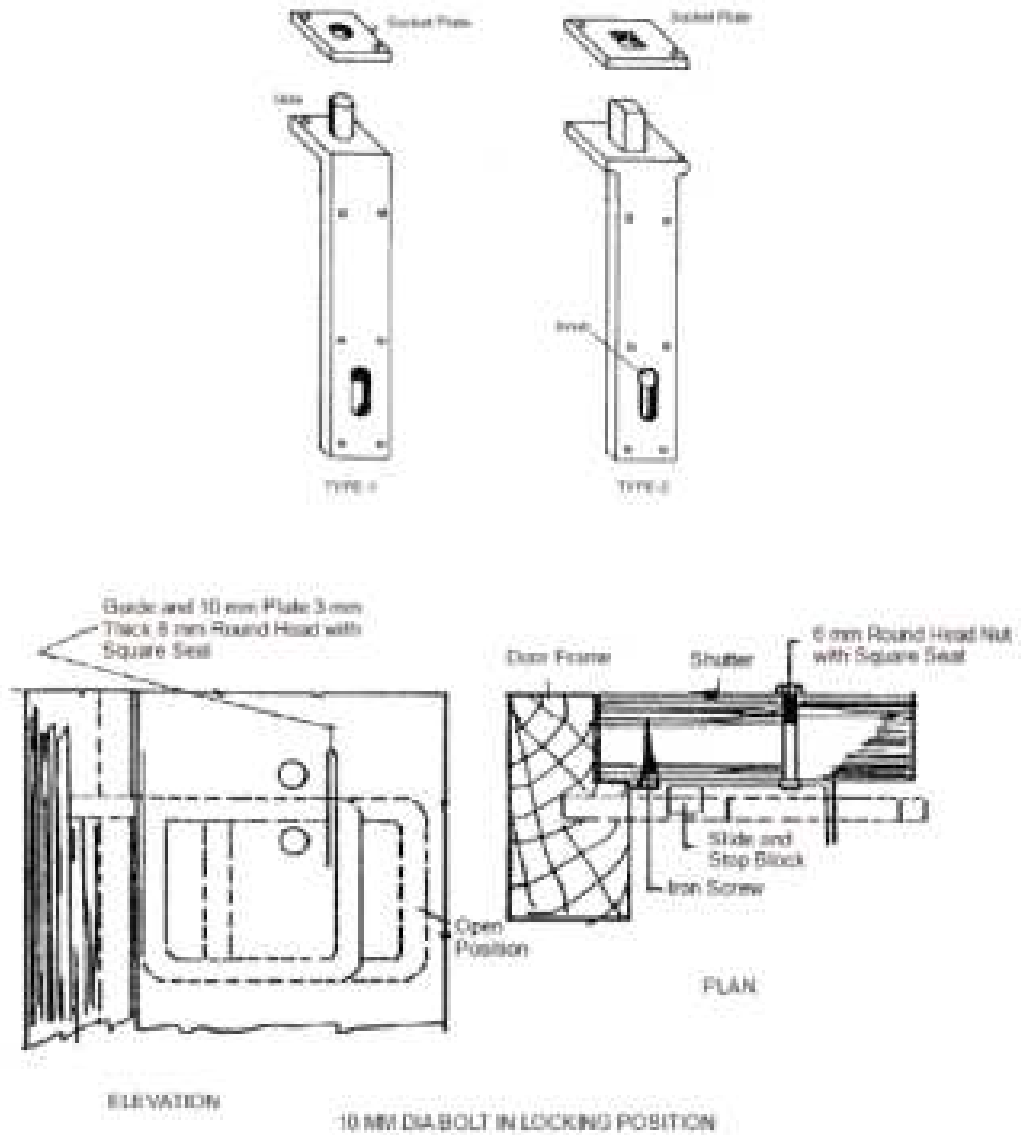


Figure 14.3 : Flush Bolts

Drawing Not to Scale





## TYPICAL DETAILS OF MULTI-STAGE SHUTTERING

Sub Head : Repairs to Buildings

Clause : 14.33

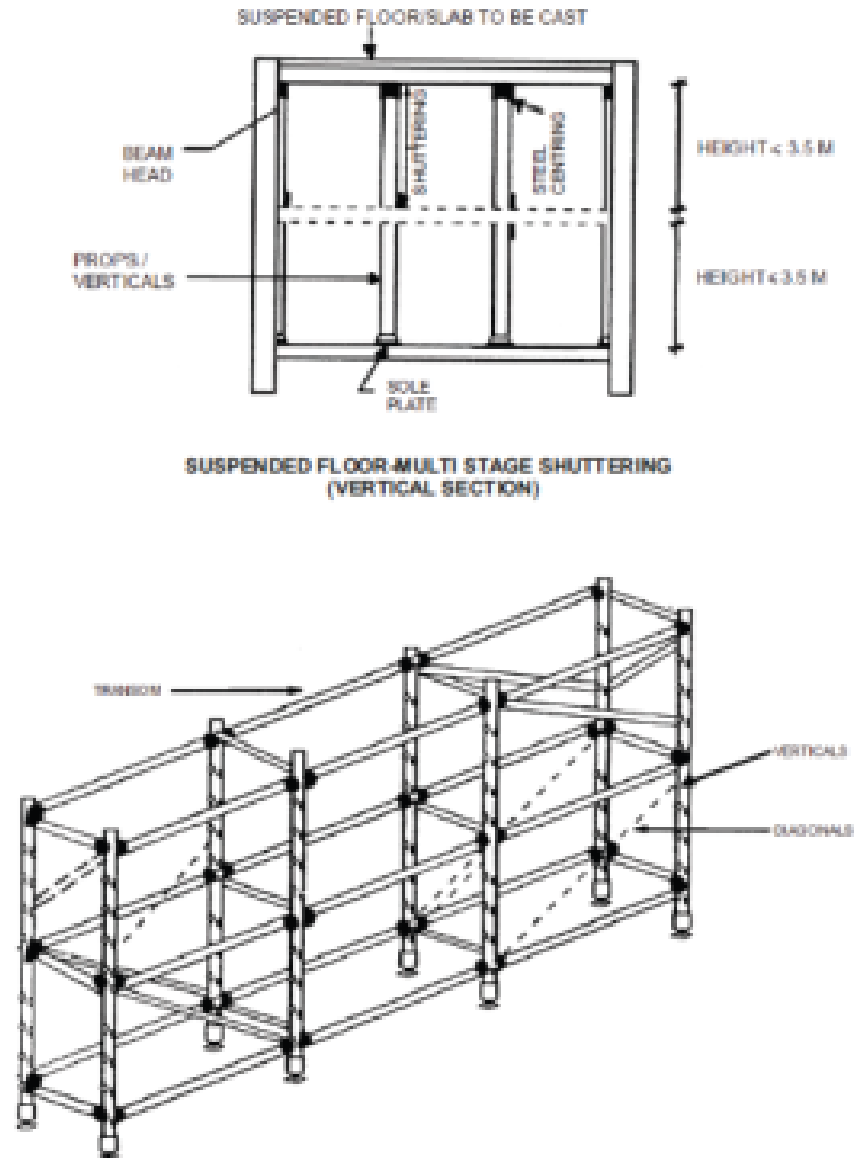


Figure 14.6 : Typical Details of Multi Stage Shuttering

All Members are of Steel

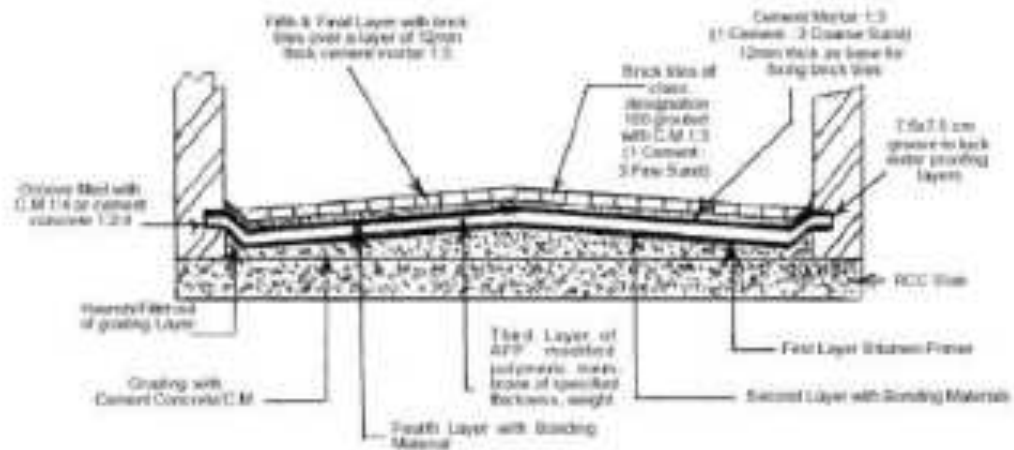


Figure 14.7 : Five Course Water Proofing Treatment with APP Modified Polymeric Membrane

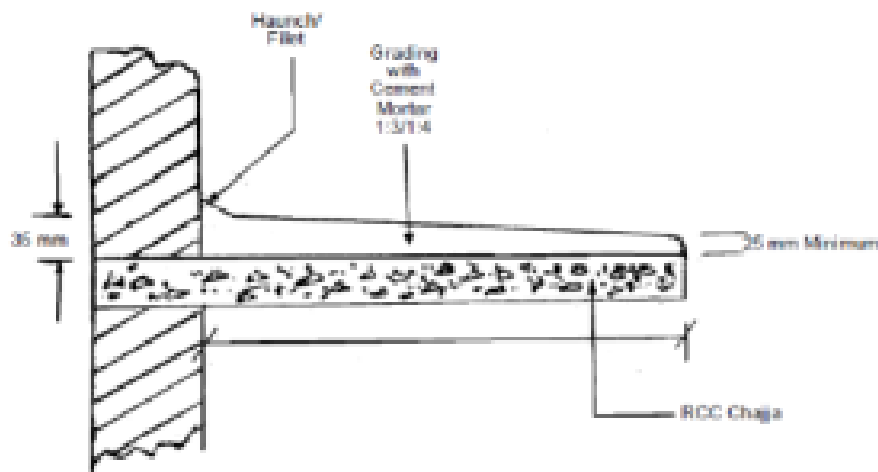
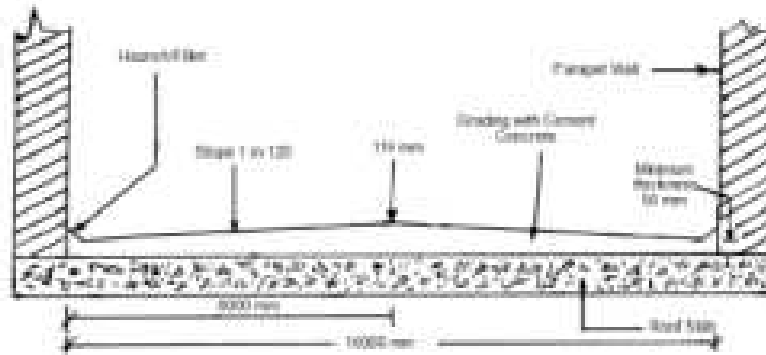
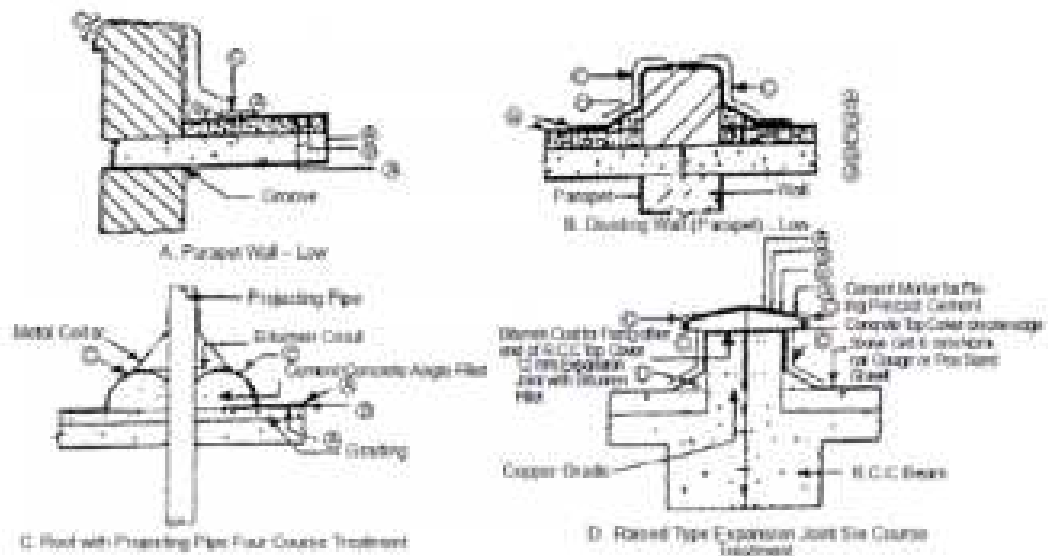


Figure 14.8 : Grading Chajja with Cement Mortar 1:3/1:4



### Figure 14.9 : Grading Roof Slab with Cement Concrete

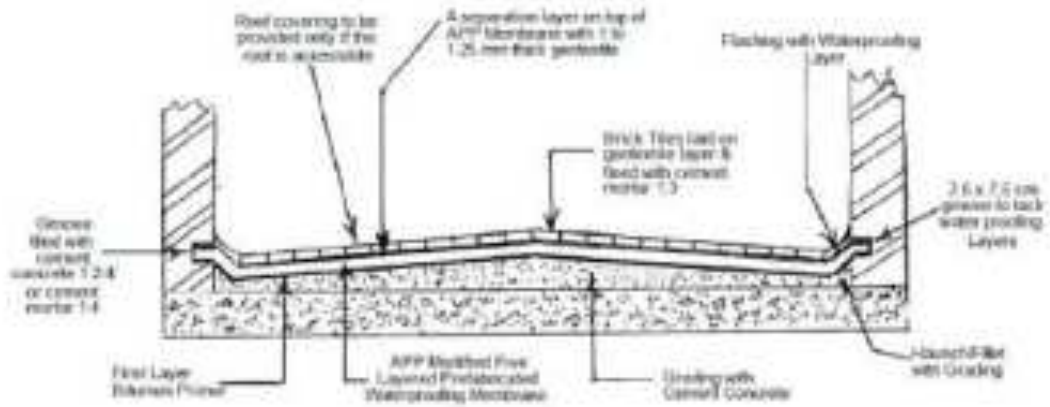
**Sub Head : Repairs to Buildings**  
**Clause : 14.49.1.7**



### Figure 14.10 : Water Proofing

Diagrams Not to Scale  
All dimensions are in mm

**Sub Head : Repairs to Buildings**  
**Clause : 14.51**



**Figure 14.11 : Five Layer Water Proofing Treatment with APP Modified Prefabricated Membrane**





# DISMANTLING AND DEMOLISHING

DEMOLISHING



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#### LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	IS No.	Subject
1.	IS 1200 (Pt – XVIII)	Method of Measurements of Building and Civil Engineering Works (Part –XVIII) Demolition and Dismantling
2.	IS 4130	Demolition of Buildings–Code of Safety



## 15 DISMANTLING AND DEMOLISHING

### 15.0 TERMINOLOGY

- i. **Deconstruction** – Means a selective demolition in which salvage, reuse and recycling of demolished structure is maximized. The term ‘Dismantling’ implies carefully separating the parts without damage and removing. This may consist of dismantling one or more parts of the building as specified or shown on the drawings.
- ii. **Demolition** - The term ‘Demolition’ implies breaking up. This shall consist of demolishing whole or part of work either manually or using mechanical force (various equipment) or by implosion using explosion, including all relevant items as specified or shown on the drawings.

### 15.1 GENERAL

This chapter relates to buildings only.

#### 15.1.1 Precautions

- 15.1.1.1 All materials obtained from dismantling or demolition shall be the property of the Corporation unless otherwise specified and shall be kept in safe custody until they are handed over to the Engineer-in-Charge/ authorized representative.
- 15.1.1.2 The demolition shall always be well planned before hand and shall generally be done in reverse order of the one in which the structure was constructed. The operations shall be got approved from the Engineer-in-Charge before starting the work. Due care shall be taken to maintain the safety measures prescribed in IS 4130 and construction and demolition waste management rules 2016 shall be followed.
- 15.1.1.3 Necessary propping, shoring and or under pinning shall be provided to ensure the safety of the adjoining work or property before dismantling and demolishing is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions and necessary scaffolding with suitable double scaffolding and proper cloth covering shall also be provided, as directed by the Engineer-in-Charge. It shall be ensured that no dust is generated while demolishing. Demolition Rules – 2016 shall be followed.
- 15.1.1.4 Necessary steps shall be taken to keep noise and dust nuisance to the minimum. All work needs to be done under the direction of Engineer-in- Charge. Helmets, goggle, safety belts etc., should be used whenever required and as directed by the Engineer-in-Charge. The demolition work shall be proceeded wit in such a way that it causes the least damage and nuisance to the adjoining building and the public. Barricading shall be provided as per NGT guidelines.
- 15.1.1.5 Dismantling shall be done in a systematic manner. All materials which are likely to be damaged by dropping from a height or by demolishing roofs, masonry etc. shall be carefully removed first. Chisels and cutters may be used carefully as directed. The dismantled articles shall be removed manually or otherwise, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer-in-Charge.
- 15.1.1.6 Where existing fixing is done by nails, screws, bolts, rivets, etc., dismantling shall be done by taking out the fixing with proper tools and not by tearing or ripping off.
- 15.1.1.7 Any serviceable material, obtained during dismantling or demolition, shall be separated out and stacked properly as directed by the Engineer-in-Charge within a lead of 50 meters. All unserviceable materials, rubbish etc. shall be disposed offat authorized locations by urban local bodies as directed by the Engineer-in-Charge.



- 15.1.1.8** The contractor shall maintain/disconnect existing services, whether temporary or permanent, wherever required by the Engineer-in-Charge.
- 15.1.1.9** No demolition work should be carried out at night especially when the building or structure to be demolished is in an inhabited area.
- 15.1.1.10** Appropriate screens shall be placed where necessary to prevent injuries due to falling pieces.
- 15.1.1.11** Water spray shall be used to reduce dust while tearing down plaster from brick work.
- 15.1.1.12** Safety belts shall be used by labourers while working at higher level to prevent falling from the structure. Wherever, possible mechanized parking working platform shall be used.
- 15.1.1.13** First-aid equipment shall be made available at all demolition works of any magnitude.

## **15.2 RECOMMENDATIONS FOR DEMOLITION OF CERTAIN SPECIAL TYPES AND ELEMENTS OF STRUCTURES**

- 15.2.1** Roof Trusses If a building has a pitched roof, the roof structure should be removed to wall plate level by hand method. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively.
  - 15.2.1.1** Temporary bracing should be added, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts.
  - 15.2.1.2** On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from making outward movement.
- 15.2.2** Heavy Floor Beams Heavy bulks of timber and steel beams should be supported before cutting at the extremities and should then be lowered to a safe working place.
- 15.2.3** Jack Arches Where tie rods are present between main supporting beams, these should not be cut until after the arch or series of arches in the floor have been removed. Particular care should be exercised and full examination of this type of structure undertaken before demolition is commenced (see Fig. 15.1). The floor should be demolished in strips parallel to the span of the arch. rings (at right angles to the main floor beams).
- 15.2.4 Brick Arches**
  - 15.2.4.1** Expert advice should be obtained and at all stages of the demolition, the closest supervision should be given by persons fully experienced and conversant in the type of work to ensure that the structure is stable at all times.
  - 15.2.4.2** As much dead load as possible may be removed provided it does not interfere with the stability of the main arch rings but it should be noted that the load- carrying capacity of many old arches relies on the filling between the spandrels. On no account should the restraining influence of the abutments be removed before the dead load of the spandrel fill and the arch rings are removed.
  - 15.2.4.3** The normal sequence of demolition is as shown in Fig. 15.2-A, namely:
    - (a) Remove spandrel in filling down to the springing line,
    - (b) Remove the arch. rings and
    - (c) Remove the abutment.
  - 15.2.4.4** Special temporary support shall be provided in the case of skew bridges.



- 15.2.4.5** A single span arch. can be demolished by hand by cutting narrow segments progressively from each springing parallel to the span of the arch until the width of the arch has been reduced to a minimum which can then be collapsed (see Fig. 15.2B).
- 15.2.4.6** Where it is impossible to allow debris to fall to the ground below, centering designed to carry the load should be erected and the arch demolished progressively. The design of the centering should make appropriate allowance for impact.
- 15.2.4.7** Where deliberate collapse is feasible the crown may be broken by the demolition ball method working progressively from edges to the centre (see Fig. 15.2C).
- 15.2.4.8** Collapse of the structure can be effected in one action by the use of explosives. Charges should be inserted into boreholes drilled in both arch and abutments. This method is the most effective for demolition of tall viaducts.
- 15.2.4.9** In multi-span arches before individual spans are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for a single span, care being taken to demolish the spandrels down to the springing line as the work proceeds (see Fig. 15.2D). Where explosives are used it is preferable to ensure the collapse of the whole structure in one operation to obviate the chance of leaving unstable portions standing.

#### **15.2.5 Cantilevers (Not part of a Framed Structure)**

A cantilever type of construction depends for its stability on the super imposed structure. Canopies, cornices, staircases and balconies should be demolished or supported before the tailing down load is removed.

#### **15.2.6 In-situ Reinforced Concrete**

- 15.2.6.1** Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.
- 15.2.6.2** Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.
- 15.2.6.3** Demolition should be commenced by removing partitions and external non- load bearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability.
- 15.2.6.4** Where hard demolition methods are to be used, the following procedures should be used.
- a)** Reinforced Concrete Beams - For beams, a supporting rope should be attached of preferably at two or three locations to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be cut in such a way as to allow the beam to be lowered under control to the floor (see Fig. 15.3A).
  - b)** Reinforced Concrete Columns - For columns, the reinforcement should be exposed at the base after estraining guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control. (see Fig. 15.3B for sequence of operations).
  - c)** Reinforced Concrete Walls Reinforced concrete walls should be cut into strips and demolished as for columns (Fig. 15.3C).

### **15.3 MEASUREMENTS**

- 15.3.1** All work shall be measured net in the decimal system, as fixed in its place, subject to the following limits, unless otherwise stated hereinafter.
- a)** Dimensions shall be measured correct to a cm.



- b) Areas shall be worked out in sqm correct to two places of decimal.
- c) Cubical contents shall be worked out to the nearest 0.01 cum.

**15.3.2** Parts of work required to be dismantled and those required to be demolished shall be measured separately.

**15.3.3** Measurements of all work except hidden work shall be taken before demolition or dismantling and no allowance for increase in bulk shall be allowed.

**15.3.4** Specifications for deduction for voids, openings etc. shall be on the same basis as that adopted for new construction of the work.

**15.3.5** Work executed in the following conditions shall be measured separately.

- (a) Work in or under water and/or liquid mud
- (b) Work in or under foul position.

**15.3.6 Roofs**

- (a) Roof coverings generally including battens boarding, mats, bamboo jaffari or other subsidiary supports shall be measured in square metres except lead sheet roof covering which shall be measured in quintals (15.2.3) and stone slab roof covering which shall be measured in cubic metres.
- (b) Ridges, hips and valleys shall be girthed and included with the roof area. Corrugated or semi corrugated surfaces shall be measured flat and not girthed.
- (c) Mud phuska on roofs shall be measured in cubic metres.
- (d) Lead sheets in roofs shall be measured in quintals and hips, valleys, flashings, lining to gutter etc. shall be included in this weight.
- (e) R.B. or R.C.C. roofs shall be measured as specified in 15.3.11.
- (f) Supporting members, such as rafters, purlins, beams joists, trusses etc. of wood shall be measured in cubic metres and steel or iron sections, in quintals.

**15.3.7 Ceiling**

- a) The stripping of ceilings shall be measured in square metres.
- b) Dismantling of supporting joists, beams, etc. shall be measured in cubic metres or in quintals as specified in 15.3.6(vi).
- c) Height above floor level, if it exceeds 3.5 m shall be paid for separately.

**15.3.8 Flooring and Pavings**

Dismantling of floors (except concrete and brick floors) shall be measured in square metres. Supports such as joints, beams etc. if any shall be measured as per 15.3.6(vi). Concrete and bricks paving shall be measured as per 12.3.9.

**15.3.9 Concrete and Brick Roofs and Suspended Floors**

Demolition of floors and roofs of concrete or brick shall be measured in cubic metres. Beams cantilevers or other subsidiary supports of similar materials, shall be included in the item. In measuring thickness of roofs provided with water proofing treatments with bitumen felts, the thickness of water proofing treatment shall be ignored.

**15.3.10 Walls and Piers**



**15.3.10.1** Taking down walls and independent piers or columns of brick, stone or concrete shall be measured, in cubic metres. All copings, corbels, cornices and other projections shall be included with the wall measurements.

**15.3.10.2** In measuring thickness of plastered walls, the thickness of plaster shall be ignored.

**15.3.10.3** Ashlar face stones, dressed stone work, pre-cast concrete articles, etc. if required to be taken down intact shall be so stated and measured separately in cubic metres.

**15.3.10.4** Cleaning bricks stacking for measurements including all extra handling and removal and disposing off the rubbish as stated shall be enumerated in thousand of cleaned bricks.

**15.3.10.5** Cleaning stone obtained from demolished/dismantling stone masonry of any description including ashlar facing dressed stone work, stone slabs or flagging and pre-cast concrete blocks including all extra handling and disposing off the rubbish as stated shall be measured in cubic meters of cleaned stone.

**15.3.10.6** Honey comb works or cavity walls of bricks stone or concrete shall be measured as solid.

#### **15.3.11 Reinforced Concrete and Brick Work**

Reinforced concrete structures and reinforced brick roofs and walls shall be measured in cubic meters and if reinforcement is required to be salvaged, it shall be so stated. Where reinforcement is required to be separated, scraped and cleaned, the work shall be measured separately in quintal of salvaged steel.

#### **15.3.12 Partitions, Trellis Work etc.**

Partitions or light walls, of lath and plaster, trellis work, expanded metal, thin concrete or terracotta slabs and other similar materials including frame work if any shall be measured in square meters stating the over all thickness.

#### **15.3.13 Wood Work**

All wood work including karries average 40 sq cm or over in section, shall be measured in cubic meters, while that under 40 sq cm in section, in running meters. Ballies shall be measured in running meters.

Boarding including wooden chajjas and sun shades along with supports shall be measured in square meters in its plane stating the thickness.

#### **15.3.14 Steel and Iron Work**

- i. All steel and iron work shall be measured in quintals. The weight shall be computed from standard tables unless the actual weight can readily be determined.
- ii. Riveted work, where rivets are required to be cut, shall be measured separately.
- iii. Marking of structural steel required to be re-erected shall be measured separately.
- iv. In framed steel items, the weight or any covering material or filling such as iron sheets and expanded metal shall be included in the weight of the main article unless such covering is not ordered to be taken out separately.

#### **15.3.15 Doors and Windows**

Dismantling of doors, windows, clerestory windows, ventilators etc. (wood or metal) whether done separately or along with removal of wall by making recess in the wall shall be enumerated. Those exceeding 3 sqm each in area shall be measured separately. The item shall include removal of chowkhats architraves, holdfasts and other attachments. If only shutters are to be taken out it shall be measured separately.

#### **15.3.16 Pipes and Sewer Lines**





- i. Water pipe lines including rain water pipes with clamps and specials, sewer lines (salt glazed ware or concrete) etc. shall be described by their internal diameter and length measured in running metres inclusive of joints (The measurement shall be taken along the centre line of the pipes and fittings).
- ii. If the joints, special and fittings etc. are required to be separated, it shall be so stated and enumerated.
- iii. Pucca drains shall be measured under relevant items.
- iv. Valve cistern, public fountain platform, fire hydrants, etc. shall be enumerated.
- v. Manholes and inspection chambers shall be enumerated stating the size and depth of manhole/inspection chamber. They shall be classified into different groups depending upon the depth, in unit of half and one metre depth. The depth of the manhole shall be the distance between the top of manhole cover and invert level of the drain.
- vi. Ventilating shafts, gully traps, flushing cisterns and other appurtenant items of work shall be enumerated.

#### **15.3.17 Posts or Struts**

Posts or struts (wood, steel or RCC) section including taking out embedded portion shall be measured in running meters.

#### **15.3.18 Fencing Wire Mesh**

Fencing wire mesh of any type with frame work shall measured in square metres. If the frame work is required to be separated and wire mesh put into rolls, it shall be so stated.

#### **15.3.19 Glazing**

Taking out any portion of serviceable glass except polished plate, from old sashes, skylights, etc. (any thickness, weight or size) raking out old putty, etc. shall be measured in square meters. Irregular circular panes shall be measured as rectangle or square enveloping the same. The width and height being measured correct to the nearest 0.5 cm.

#### **15.3.20 Road Work**

- i. Different types of road surfaces shall be measured separately.
- ii. Road surfaces metalling or soling (base) shall be measured in square meters.
- iii. Concrete paving shall be measured as in 15.3.8 or 15.3.9 as the case may be.

### **15.4 RATES**

The rate shall include the cost of all labour involved and tools used in demolishing and dismantling including scaffolding. The rate shall also include the charges for separating out and stacking the serviceable material properly and disposing off unserviceable material within a distance of 50 meters.

The rate shall also include for temporary shoring for the safety of portions not required to be pulled down, or of adjoining property, and providing temporary enclosures or partitions, where considered necessary.

## DEMOLITION OF JACK ARCHES

Sub Head : Dismantling and Demolition  
Clause : 15.2.4

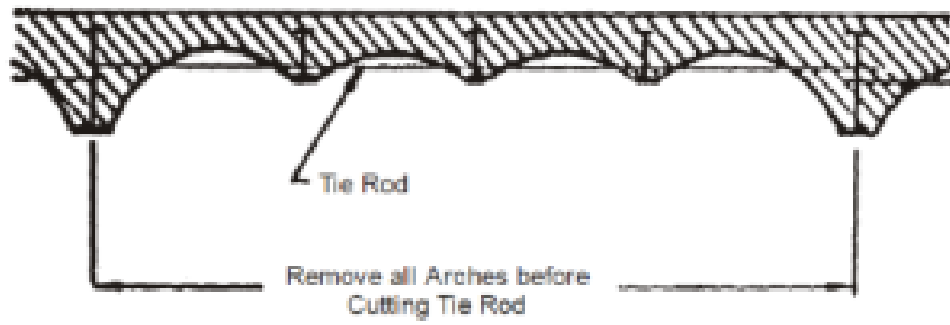


Figure 15.1 : Demolition of Jack Arches

## DEMOLITION OF MASONRY AND BRICKWORK ARCHES

Sub Head : Dismantling and Demolition

Clause : 15.2.4 and 15.2.5

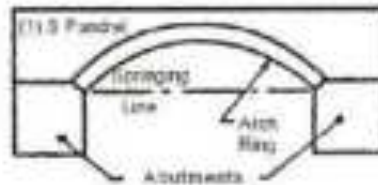


Fig. 15.2A

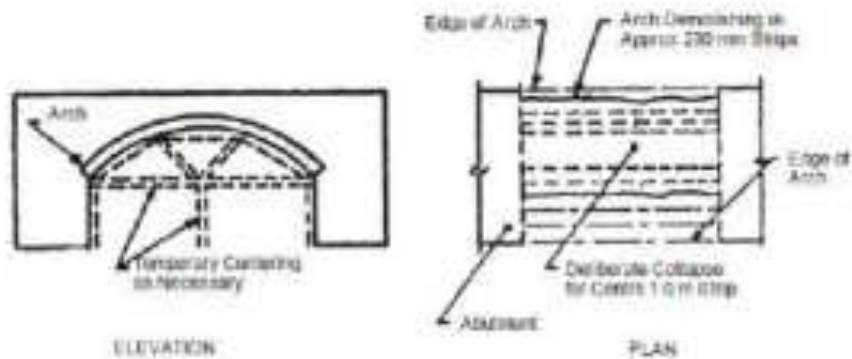


Fig. 15.2B

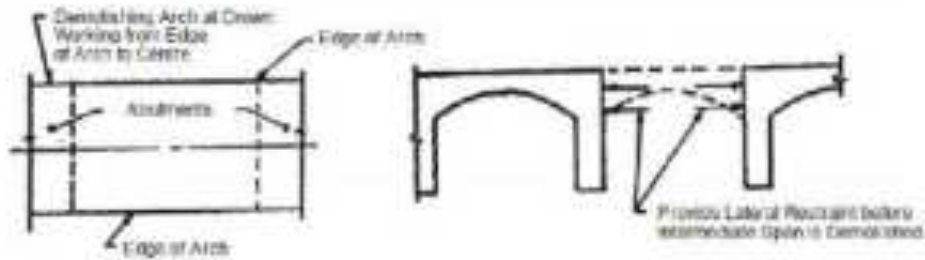


Fig. 15.2C

Fig. 15.2D

Figure 15.2 : Demolition of Masonry and Brick Work Arches

Note: Order of Demolition

## HAND DEMOLITION OF IN-SITU CONCRETE STRUCTURE

Sub Head : Dismantling and Demolition  
Clause : 15.2.7.4

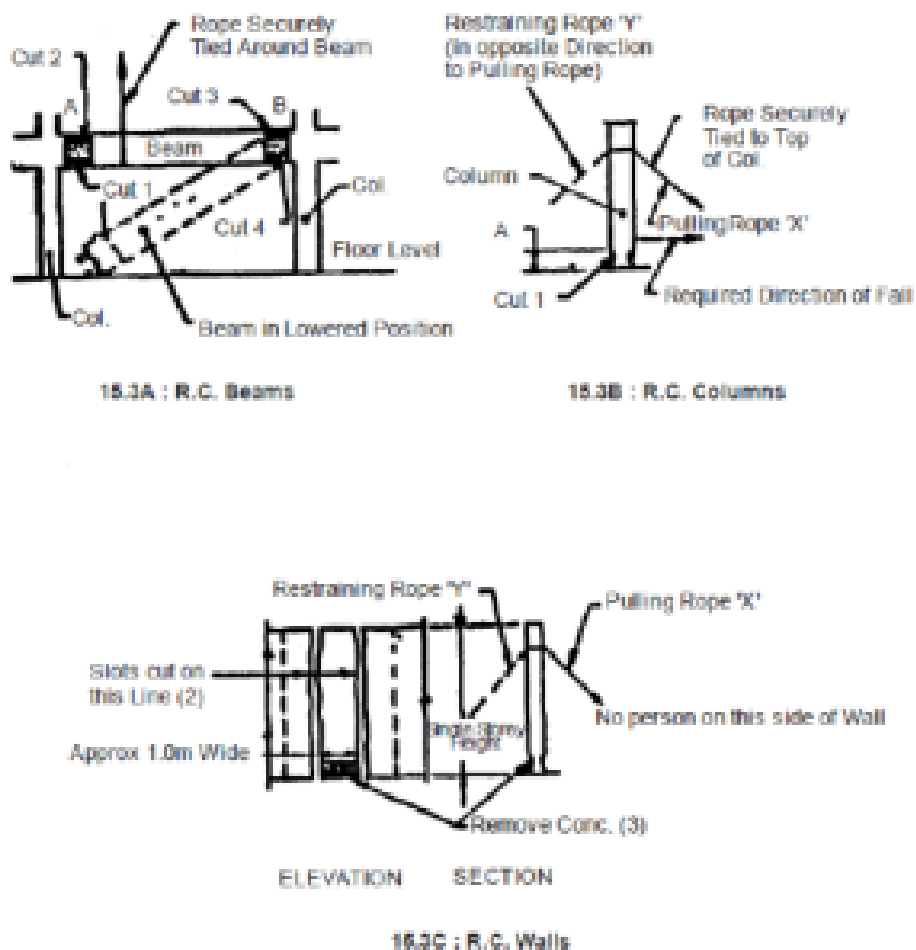


Figure 15.3 : Hand Demolition of In Situ Concrete Structure



## ROAD WORKS



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### LIST OF MANDATORY TESTS

Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
1) Co arse Aggregate	16.1.1	Los Angeles Abrasion Value or	Laboratory	IS 2386 (Part IV)	Per 200 m <sup>3</sup>
		Aggregate Impact Value			
		Specific gravity, Water absorption & Density	Laboratory	IS 2386 (Part III)	
		Combined Flakiness and Elongation Indices	Field	IS 2386 (Part I)	Per 100 m <sup>3</sup>
	16.1.1 Table 16.2	Size and grading of aggregate	Field	IS 2386 (Part I)	Per 100 m <sup>3</sup>
2) Fin e Aggregate	16.1.2	Deleterious materials	Field	IS 2386 (Part II)	As required by the Engineer- in- Charge.
		Specific gravity, Water absorption & Density	Laboratory	IS 2386 (Part III)	
		Size and grading of aggregate	Field	IS 2386 (Part I)	
3) Bitumen	16.1.5	As prescribed in IS 73 or IRC: SP53, IS:15462	Laboratory	As prescribed in IS 73	As required by the Engineer- in- Charge.
4) Embankme nt under (O.M.C. conditions)	16.3.1	(a) Moisture content	Laboratory Field	IS 2720 (Part II) IS 2720 (Part XXVIII)	250 m <sup>3</sup>
		(b) Density			250 m <sup>3</sup>
	16.3.4.4	c) Control test on borrow pits.			
		(i) Gradation	Laboratory	IS 2720 (Part IV)	One to two tests per 8000 m <sup>3</sup>
		(ii) Plasticity	Laboratory	IS 2720 (Part V)	-do-



Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
		(iii) Proctor Test	Laboratory	IS 2720 (Part VIII)	-do-
		(iv) Deleterious content	Laboratory	IS 2386 (Part II)	As required by the Engineer-in- Charge
		(v) Moisture contents	Laboratory	IS 2720 (Part II)	250 m3
5) Prime Coat / Tack Coat / Fog Spray	16.65	(i) Quality of Binder	Laboratory	IS:73	Number of samples per lot and tests as per IS:73, IS:217 and IS:8887 as applicable
		(ii) Binder temperature for application	Field		At regular close intervals
		(iii) Rate of spread of Binder	Field		Three tests per day
6) Seal Coat / Surface Dressing	16.35	(i) Quality of binder	Laboratory	IS:73	Same as mentioned under Serial No. 5
		(ii) Aggregate Impact Value or Los Angeles Abrasion Value	Laboratory	IS:2386 (Part IV)	One test per 200 cum of each source and whenever there is change in the quality of aggregate
		(iii) Combined Flakiness Index and Elongation Index	Field	IS:2386 (Part I)	One test per 100 cum of aggregate for each source and whenever there is change in the quality of aggregate
		(iv) Stripping value of aggregates (Immersion	Laboratory	IS:6241	One test of each source and whenever there is change in the
		Tray Test)			quality of aggregate
		(v) Water absorption of aggregates	Laboratory	IS:2386 (Part III)	-- do --
		(vi) Grading of aggregates	Field	IS:2386 (Part I)	Two tests per day
		(vii) Soundness (Magnesium and Sodium Sulphate)	Laboratory	IS:2386 (Part V)	One test for each source and whenever there is change in the quality of aggregate
		(viii) Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	Field		At regular intervals



Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
		(ix) Rate of spread of materials	Field		Same as mentioned under Serial No. 5
		(x) Percentage of fractured faces (When gravel is used)	Field		One test per 100 cu.m of aggregate
7) Bitumen Macadam	16.32 & 16.47	(i) Quality of binder	Field	IS 73	Same as mentioned under Serial No. 5
		(ii) Aggregate Impact Value Los Angeles Abrasion Value	Laboratory	IS 2386 (Part IV)	Same as mentioned under Serial No. 6
		(iii) Combined Flakiness Index and Elongation Index	Laboratory	IS 2386 (Part I)	One test per 350 cu.m for each source
		(iv) Stripping value of aggregates	Laboratory	IS 6241	Same as mentioned under Serial No. 6
		(v) Water absorption of aggregates	Field or Laboratory	IS 2386 (Part III)	Same as mentioned under Serial No. 6
		(vi) Deleterious material	Field	IS:2386 (Part II)	Once in the month
		(vii) Grading of aggregates	Field	IS 2386 (Part I)	Same as mentioned under Serial No. 6
		(viii) Soundness (Magnesium and Sodium Sulphate)	Laboratory	IS:2386 (Part V)	Same as mentioned under Serial No. 6
		(ix) Binder content	Laboratory		Two test per day per plant
		(x) Control of temperature of binder and aggregate for mix and of the mix at the time of laying and rolling	Field		Same as mentioned under Serial No. 6
		(xi) Density of Comp layer	Laboratory	IS 2386 (Part III)	One test per 700 sq.m area
		(xii) Rate of spread of Mixed materials	Field		At regular intervals.
8) Dense Bituminous Macadam /	16.48	(i) Quality of binder	Laboratory	IS:73	Number of samples per lot and tests as per IS:73 or IRC:SP:53, IS:15462



Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
Bituminous Concrete		(ii) Aggregate Impact Value / Los Angeles Abrasion Value	Laboratory	IS:2386 (Part IV)	One test per 350 cu.m of aggregate for each sour and whenever there is change in the quality of aggregate
		(iii) Flakiness and Elongation Indices	Laboratory	IS:2386 (Part I)	One test per 350 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
		(iv) Soundness test (Sodium or Magnesium Sulphate test)	Laboratory	IS:2386 (Part V)	One test for each source and whenever there is change in the quality of aggregate
		(v) Water absorption of aggregates	Laboratory	IS:2386 (Part III)	One test for each source and whenever there is change in the quality of aggregate
		(vi) Plasticity Index	Laboratory	IS:2386 (Part V)	One test for each source and whenever there is change in the quality of aggregate
		(vii) Mix grading	Laboratory		One set for individual constituent and mixed aggregate from dryer for each 400 tonnes of mix subject to minimum of two tests per day per plant
		(viii) Stability and voids analysis of mix including theoretical maximum specific of loose mix	Laboratory		Three tests for stability, flow value, density and void contents for each 400 tonnes of mix subject to minimum of two tests per day per plant.
		(ix) Moisture Susceptibility of mix (AASHTO T283)	Laboratory		One test for each mix type whenever there is change in the quality or source of coarse of fine aggregate
		(x) Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	Field		At regular intervals
		(xii) Binder content	Laboratory		One set for each 400 tonnes of mix subject to minimum of two tests per day per plant



Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
		(xii) Rate of spread of mix material	Field		After every 5th truck load
		(xiii) Density of compacted layer	Laboratory		One test per 700 sq.m area
9) Slurry seal and Micro surfacing		(i) Quality of aggregate sand equivalent value water absorption soundness test (Sodium / Magnesium Sulphate Test)	Laboratory		One per source / site
		(ii) Quality of Emulsion	Laboratory		One per lot of 20 t as per IS:8887
		(iii) Aggregate Moisture	Laboratory		Two per day
		(iv) Aggregate Gradation	Field	IS:2386 (Part I)	Two per day at site
		(v) Binder Content	Laboratory		Two per lane per Km
		(vi) Calibration of Machine	Laboratory		Once per Project
		(vii) Quantity of Slurry (By weight of aggregate)	Field		Daily (Travel time of Machine)
10) Mastic asphalt		(i) Quality of binder	Laboratory		Same as mentioned under serial No. 8
		(ii) Aggregate Impact Value and Los Angeles Abrasion Value	Laboratory	IS:2386 (Part IV)	Same as mentioned under serial No. 8
		(iii) Combined Flakiness and Elongation Indices	Field	IS:2386 (Part I)	Same as mentioned under serial No. 8
		(iv) Stripping value	Laboratory	IS:6241	Same as mentioned under serial No. 6
		(v) Deleterious material	Field	IS:2386 (Part II)	One in a month
		(vi) Grading of aggregates	Field	IS:2386 (Part I)	Two tests per day per plant on the individual constituent and mixed aggregates from the dryer



Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
		(vii) Water absorption of aggregates	Laboratory	IS:2386 (Part III)	Same as mentioned under serial No. 8
		(viii) Soundness (Magnesium Sulphate / Sodium Sulphate)	Laboratory	IS:2386 (Part V)	Same as mentioned under serial No. 8
		(ix) Binder content	Laboratory		Two test per day per plant
		(x) Control of temperature of binder and aggregate for mixing and of the mix at the time of laying and rolling	Field		At regular close intervals
		(xi) Rate of Spread of Mixed Material	Field		Regular control through check of layer thickness
		(xii) Hardness number	Laboratory		Minimum two tests per day
11) Recycled Material		Grading of aggregate	Field	IS:2386 (Part I)	Two tests per day
12) Cold Mixes			Laboratory		All tests as per S. No. 8
13) Quality of Modified Binder			Laboratory		Number of samples per lot and tests as per IS:15462
14) Geo textiles			Laboratory		The requirements of Section 700 of MORTH Specification shall apply
15) Granular Sub Base (GSB)	16.62	(i) Gradation	Field	IS:2386 (Part I)	One test per 400 cu.m.
		(ii) Atterberg limits	Laboratory	IS:2720 (Part V)	One test per 400 cu.m.
		(iii) Water absorption	Laboratory		One test per 400 cu.m.
		(iv) Density of compacted layer	Laboratory		One test per 1000 cu.m.
		(v) Deleterious constituents	Field	IS:2386 (Part II)	As required
		(vi) Soundness	Field	IS:2386 (Part V)	Same as mentioned under serial No. 8
		(vii) CBR	Laboratory		As required



Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
16) Lime / Cement Stabilised Soil Sub- base		(i) Quality of lime / Cement	Laboratory		One test for each consignment subject to a minimum of one test per 5 tonnes
		(ii) Lime / Cement content	Laboratory		Regularly, through procedural checks
		(iii) Degree of pulverization	Laboratory		Periodically as considered necessary
		(iv) CBR or Unconfined Compressive Strength Test on a set of 3 specimens	Laboratory		As required
		(v) Moisture content prior to compaction	Laboratory		One set of two tests per 500 sq.m.
		(vi) Density of compacted layer	Laboratory		One set of two tests per 500 sq.m.
		(vii) Deleterious constituents	Field		As required
17) Water Bound Macadam	16.7wet mix	(i) Aggregate Impact Value	Laboratory	IS:2386 (Part IV)	One tests per 1000 cu.m of aggregate
		(ii) Grading of aggregate	Field	IS:2386 (Part I)	One test per 250 cu.m
		(iii) Combined Flakiness and Elongation Indices	Laboratory	IS:2386 (Part I)	One tests per 500 cu.m of aggregate
		(iv) Atterberg limits of binding material	Laboratory	IS:2386 (Part IV)	One test per 50 cu.m of binding material
		(v) Atterberg limits of screenings	Laboratory	IS:2720 (Part 5)	One tests per 100 cu.m of aggregate
		(vi) Water absorption of aggregate	Laboratory	IS:2386 (Part III)	Once in a month
		(vii) Deleterious material	Field	IS:2386 (Part II)	As required, once in a month
18) Wet Mix Macadam	16.63	(i) Aggregate Impact Value	Laboratory	IS:2386 (Part IV)	One tests per 1000 cu.m of aggregate
		(ii) Grading of aggregate	Field	IS:2386 (Part I)	One tests per 200 cu.m of aggregate





Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
		(iii) Combined Flakiness and Elongation Indices	Laboratory	IS:2386 (Part I)	One tests per 500 cu.m of aggregate
		(iv) Atterberg limits of portion of aggregate passing 425 micron sieve	Laboratory	IS:2720 (Part V)	One tests per 200 cu.m of aggregate
		(v) Density of compacted layer	Field		One set of three tests per 1000 sq.m.
		(vi) Water absorption of aggregate	Laboratory	IS:2386 (Part III)	Once in a month
		(vii) Deleterious material	Field	IS:2386 (Part II)	As required, once in a month
19) Cement concrete pavement under controlled conditions	16.37.19	Coarse aggregate	Laboratory	IS 2386 (Part I)	Before approval of the quarry and every sub-sequent change in the source of supply and one test per 100 cum.
		i. Flakiness Index			
		ii. Impact Value	-do-	IS 2386 (Part IV)	-do-
		iii. Loss Angles abrasion Value	-do-	-do-	-do-
		iv. Deleterious material	-do-	IS 2386 (Part II)	Before approval of the quarry and at every subsequent change in the source of supply
		v. Moisture content	-do-	IS 2386 (Part III)	Regularly as required subject to a minimum of one test per day
		Fine Aggregate			
		i. Silt content	Field	As per IOCL Civil Specifications Vol. I.	One test per 15 cum.
		ii. Gradation of sand	-do-	IS 2386 (Part II)	-do-
		iii. Deleterious material	-do-	IS 2386 (Part II)	Before approval of the quarry and at every subsequent change in the source of supply



Material/ work	Clause / Para No.	Test	Field/ Laboratory	Test Procedur e	Frequency of Testing
		iv. Moisture content	-do-	IS 2386 (Part III)	Regularly as required subject to a minimum of two tests per day
		v. Mix Aggregate	Field	IS 2386 (Part I)	One test per 15 cum of concrete
		vi. Flexural strength	Laboratory	IS 526	One test consisting of 8 specimen for 30 cum. of concrete
20) Concrete Interlocking Paver Block	16.57	i. Visual Inspection	Field/Laborat ory	IS 15658	4 (16) <sup>2)</sup>
		ii. Dimensions	Field/Laborat ory	IS 15658	4 (16) <sup>2)</sup>
		iii. Thickness of wearing layer <sup>3)</sup>	Field/Laborat ory	IS 15658	4 (16) <sup>2)</sup>
		iv. Water absorption	Field/Laborat ory	IS 15658	3
		v. Compressive Strength	Laboratory	IS 15658	4 (16)
		vi. Tensile Spitting strength	Laboratory	IS 15658	4 (16)
		vii. Flexural strength/ breaking load	Laboratory	IS 15658	4 (16)
		viii. Abrasion resistance	Laboratory	IS 15658	4 (16)
		ix. Freeze-thaw durability	Laboratory	IS 15658	3

**Note:**

The required number of blocks shall be sampled from each batch of the consignment of blocks up to a quantity of 25000 blocks.

<sup>1)</sup> The number within brackets is the number to be sampled to avoid secondary sampling from the batch if on the basis of the conformity criteria, additional blocks are required to be tested to assess conformity.

<sup>2)</sup> These blocks may be used for subsequent tests.



## LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	IS No.	Subject
1.	IS 73	Specification for paving bitumen
2.	IS 164	Ready mixed paint for road marking
3.	IS 217	Specification for cut back bitumen
4.	IS 8112	Specification for 43 grade ordinary Portland Cement
5.	IS 278	Specification for galvanized steel barbed wire for fencing
6.	IS 334	Glossary of terms relating to bitumen and tar
7.	IS 383	Specification for coarse and fine aggregate from natural sources for concrete
8.	IS 460	Specification for test sieves
9.	IS 516	Method of test for strength of concrete
10.	IS 702	Specification for industrial bitumen
11.	IS 712	Specification for building limes
12.	IS 1195	Specification for bitumen mastic for flooring
13.	IS 1199	Methods of sampling and analysis of concrete
14.	IS 1203	Method of testing tar and bituminous material, determination of penetration
15.	IS 1205	Method of testing tar and bituminous material determination of softening point
16.	IS 1208	Method of testing tar and bituminous material determination of ductility
17.	IS 1212	Method of testing tar and bituminous material determination of loss of heating
18.	IS 1216	Method of testing tar and bituminous material determination of solubility in carbon-di-sulphide, trichloroethylene
19.	IS 1834	Specification for hot applied sealing compound for joint in concrete
20.	IS 1838 (Pt.1)	Specification for performed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type/ bitumen impregnated fibre)
21.	IS 2386 (Pt.I)	Method of test for aggregate for concrete particle size and shape
22.	IS 2386 (Pt. II) 1963	Method of test for aggregate for concrete estimation of deleterious materials and organic impurities
23.	IS 2386 (Pt.III)	Method of test for aggregate for concrete specific gravity, density, voids, absorption and bulking
24.	IS 2386 (Pt. IV)	Method of test for aggregate for concrete mechanical properties
25.	IS 2720 (Pt. V)	Method of test for soil: Determination of liquid and plastic limit.
26.	IS 2720 (Pt. VII)	Methods of test for soils: part VII determination of water content dry density relation using light compaction
27.	IS 2720 (Pt. XXVIII)	Method of test for soil: determination of dry density of soils in place, by sand replacement method



Sl. No.	IS No.	Subject
28.	IS 3812	Specification for fly ash for use as pozzolana and admixture
29.	IS 5317	Specification for bitumen mastic for bridges decking and roads
30.	IS 5640	Method of test for determining aggregate impact value of soft coarse aggregates
31.	IS 6241	Method of test for determination of stripping value of road Aggregates
32.	IS 15658	Precast Concrete Blocks for Paving- Specification



### LIST OF IRC STANDARDS

Sl. No.	IS No.	Subject
1.	IRC 10	Recommended practice for borrow pits for road embankments constructed by manual operation
2.	IRC 29	Specification for bituminous concrete for road pavements
3.	IRC 36	Recommended practice for construction of earth embankments for road works
4.	IRC 60	Tentative guidelines for the use of lime flyash concrete as pavement base of sub base
5.	IRC 63	Guidelines for the use of Interlocking Concrete Block Pavement
6.	IRC 88	Recommended practice for lime flyash stabilized soil base/ sub base in pavement construction
7.	IRC 107	Tentative specification for bitumen mastic wearing courses
8.	IRC 109	Guidelines for Wet Mix Macadam



## 16 ROAD WORK

### 16.0 TERMINOLOGY

#### **Asphalt**

A natural or artificial mixture in which bitumen is associated with mineral matter. The word 'Asphalt' should always be qualified by indication of its origin or nature.

#### **Asphalt Mastic**

An intimate mixture of mineral fillers, well graded sand and/or stone chippings with a hard grade of bitumen, cooked and laid hot manually by means of wooden float. The mixture settles to a coherent, void less and impermeable solid or semi-solid mass under normal temperature condition.

#### **Binder**

The binder shall be an appropriate type of bituminous materials complying with the relevant Indian Standard (IS) as defined in the appropriate clauses of these specifications or as otherwise specified herein. The choice of binder shall be stipulated in the contract or by the Engineer-in-charge.

#### **Bitumen**

A non crystalline solid or viscous material, having adhesive properties derived from petroleum either by natural or refinery processes and substantially soluble in carbon disulphide. Bitumen shall be paving bitumen of viscosity grade complying with Indian Standard Specifications for "Paving bitumen" IS:73:2006 of grade appropriate for the traffic and climatic conditions of the Project Highway. The heavily trafficked roads in hot areas may find harder grade bitumen more appropriate while pavements in mountainous regions subject to sub-zero temperatures during winter months carrying relatively lower traffic loads subject to the phenomenon of "Frost Heave" may find less viscous bitumen resistant to fatigue and cold cracking more appropriate.

#### **Bitumen-Cutback**

Bitumen, the viscosity of which has been reduced by a volatile diluent when blended with kerosene or naptha type diluent or fuel oil, is called, medium or rapid or slow curing cut backs respectively.

#### **Bitumen-Emulsion**

A liquid product in which a substantial amount of bitumen is suspended in a finely divided condition in an aqueous medium containing an emulsifier and stabiliser. The emulsion is termed 'Anionic' when the bitumen particles are negatively charged and the aqueous phase is alkaline. The emulsion is termed 'cationic' when the particles are positively charged and the aqueous phase is acidic.

#### **Bitumen Mastic Filler**

Inorganic mineral material all of which will pass through specified IS sieve used in admixture with solid or semi-solid bituminous material.

#### **Road Tar**

A product obtained by treating at high temperature coal tar in such a manner that it conforms to a specification which defines its suitability for road construction.

#### **Tar**



A viscous material having adhesive properties and resulting from the distinctive distillation of certain type of organic material. The term Tar should be preceded by the name of the material from which it is produced e.g. coal, shale, peat, vegetable matter and its mode of production shall be indicated.

#### Flash point

The lowest temperature at which the vapour of a substance can be ignited in air by a flame under specified conditions of test. The substance itself does not continue to burn.

#### Tack Coat

It shall consist of application of a single coat of low viscosity liquid bituminous material to an existing road surface preparatory to further bituminous construction.

#### Bitumen concrete (Asphaltic concrete)

A well graded mixture of high quality aggregates with designated proposition of bitumen, hot mixed, hot laid and hot rolled into a uniform dense mass with specified design criteria.

#### Ductility

The property by which a material can be drawn out without breaking, for bitumen it is measured by the distance in centimetres to which it will elongate before breaking, when two ends of a briquette specimen of the material of the specified form and cross-section are pulled apart under water at a specified speed and temperature.

#### Viscosity

The property of a liquid by which it resists flow due to internal friction and is measured by the ratio of the shearing stress to the rate of shear.

### 16.1 MATERIALS

#### 16.1.1 Aggregate Coarse

Coarse aggregate as specified in the item shall be either crushed/broken stone, crushed slag, over burnt (Jhama) brick aggregate or one of the naturally occurring aggregates such as kanker or laterite of suitable quality as stated hereinafter and approved by the Engineer-in-Charge.

The stone aggregate shall conform to the physical requirements set forth in Table 16.1. The type and size range of the aggregate shall be specified in the contract. If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part-5).

**TABLE 16.1**

**Physical Requirements of Coarse Aggregate for Water Bound Macadam for Sub-Base / Base Courses**

S. No	Test	Test method	Requirements
1.***	Los Angeles Abrasion value or Aggregate impact value	IS 2386 (Part-4) IS 2386 (Part-4) or IS 5640*	40% (Max.) 30% (Max.)
2.	Combined flakiness and Elongation Indices (Total)**	IS 2386 (Part-1)	35% (Max.)

\*Aggregates which get softened in presence of water shall be tested for impact value under wet conditions in accordance with IS:5640.



\*\* The requirements of flakiness index and elongation index shall be enforced only in case of crushed/broken stone and crushed slag.

\*\*\* In case water bound macadam is used for sub-base, the requirements in respect of Los Angeles Value and Aggregate Impact Value shall be relaxed to 50 percent and 40 percent maximum respectively.

The coarse aggregate shall conform to one of the gradings given in Table 16.2 as specified. For crushable type of aggregates such as brick metal, kankar and laterite, grading shall not be regarded as very important, but the material should generally be within the specified range.

**TABLE 16.2**

**Grading Requirements of Coarse Aggregate for W.B.M.**

<i>Grading No.</i>	<i>Size Range</i>	<i>IS Sieve Designation</i>	<i>Percent by weight passing the sieve</i>
1	90 mm to 45 mm	125 mm	100
		90 mm	90 – 100
		63 mm	25 – 60
		45 mm	0 – 15
		22.4 mm	0 – 5
2	63 mm to 45 mm	90 mm	100
		63 mm	90 – 100
		53 mm	25 - 75
		45 mm	0 – 15
		22.4 mm	0 – 5
3	53 mm to 22.4 mm	63 mm	100
		53 mm	95 – 100
		45 mm	65 – 90
		22.4 mm	0 – 10
		11.2 mm	0 - 5

**Note:** The compact thickness for a layer with Grading 1 shall be 100 mm while for layer with other Gradings i.e. 2 & 3, it shall be 75 mm.

**16.1.1.1 Overburnt (Jhama) Brick Aggregates:** Brick aggregate shall be made from over-burnt bricks and dense brick bats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dust, dirt and other objectionable and deleterious materials.

**16.1.1.2 Crushed or Broken Stone:** When crushed or broken stone is specified as the coarse aggregate, it shall be hard, durable and free from excess of flat, elongated, soft, disintegrated particles, dirt and other objectionable matter. The total quantity of such deleterious material including clay lumps, soft fragment, foreign material etc. shall not exceed 5% of the weight of the aggregate.

**16.1.1.3 Crushed Slag:** Crushed slag shall be made from air-cooled blast furnace slag. It shall be of angular shape, reasonably uniform in quality and density and generally free from thin, elongated and soft pieces, dirt or other deleterious materials. The weight of the crushed slag shall not be less than 11.2 kN per cubic





metre (1120 kg per cubic metre) and the percentage of glossy material shall not be more than 20. Water absorption of slag shall not exceed 10% (IS 2386 Pt.III).

**16.1.1.4 Kankar:** Kankar shall be tough, having a blue almost opalescent fracture. It shall not contain any clay in the cavities between nodules.

**16.1.1.5 Laterite:** Laterite shall be hard, compact, heavy and of dark colour. The light coloured sandy laterite as well as those containing much ochreous clay shall be rejected.

#### 16.1.2 Aggregate-Fine

The fine aggregate shall be the fraction passing 2.8 mm sieve and retained on 90 micron sieve. It shall consist of crusher run screenings, natural sand or a mixture of both. These shall be clean, hard, durable, uncoated, dry and free from injurious, soft or flaky pieces and organic or deleterious substance.

The contents of organic and deleterious materials shall not exceed the limits specified in Table 16.3.

**TABLE 16.3**

	<i>Uncrushed</i>	<i>Crushed</i>
Coal and lignite	1%	1%
Clay lumps	1%	1%
Material passing through 75 microns (I.S.S.) Sieve	3%	3%
Shale	1%	1%

The sum of the percentages of all deleterious material shall not exceed 5%. Tests for estimation of deleterious materials and organic impurities shall be done as per IS 2386 (Pt. II).

#### 16.1.3 G.I. Barbed Wire

The barbed wire shall be of galvanised steel as specified and it shall conform to IS 278. The sampling criteria is given in Table 16.4. The wire shall be manufactured from steel by any process and shall not contain sulphur and phosphorous exceeding 0.065 per cent. The galvanised steel barbed wires shall be of two types: Type A (Lowa Type) and Type B (Glidden Type).

**Type A (Lowa Type):** The barbs shall have four points and shall be formed by twisting two point wires, each two turns, tightly around both line wires making altogether four complete turns.

**Type B (Glidden Type):** The barbs shall have four points and shall be formed by twisting two point wires, each two turns, tightly around one line wire making altogether four complete turns.

**Details of G.I. Barbed wire** - The galvanised steel barbed wire shall be of the size designations given in Table 13.4.

**TABLE 16.4**

Size Designat ion	Nominal dia. of wire				Mass of completed Barbed Wire		Distance between two barbs	No. of lays between the two consecuti ve barbs
	Line Wire		Point Wire					
	Nom	Tol	Nom	Tol	Max	Min		
	(mm)	(mm)	(mm)	(mm)	(g/m)	(g/m)	(mm)	(mm)
1.	2.50	± 0.08	2.50	± 0.08	155	136	75 ± 12	2 to 7
2.	2.50	± 0.08	2.50	± 0.08	120	108	150 ± 12	2 to 7



3.	2.50	$\pm 0.08$	2.00	$\pm 0.08$	125	108	$75 \pm 12$	2 to 7
4.	2.50	$\pm 0.08$	2.00	$\pm 0.08$	103	89	$150 \pm 12$	2 to 7
5.	2.24	$\pm 0.08$	2.00	$\pm 0.08$	106	97	$75 \pm 12$	2 to 7
6.	2.24	$\pm 0.08$	2.00	$\pm 0.08$	85	78	$150 \pm 12$	2 to 7

Note: The mass in g/m shall be obtained by dividing the total mass of the reel by the linear length in metres.

The number of lays between the two consecutive barbs shall vary between 2 to 7.

The barbed wire shall be formed by twisting together two line wires, one or both containing the barbs. The size of the line and point wires and barb spacings shall be as specified. The permissible deviation from the nominal diameter of the line wire and the point wire shall not exceed  $\pm 0.08$  mm. The line and point wires shall be circular in section, free from scales and other defects and shall be uniformly galvanised. The line wire shall be in continuous lengths and shall not contain any welds other than those in the rod before it is drawn. The distance between two successive splices shall not be less than 15 metres. It shall have the tensile properties as specified in Table 16.5.

**TABLE 16.5**

**Tensile Properties**

<i>Size of Line Wire</i>	<i>Tensile Strength of line wire</i>	<i>Minimum Breaking Load of Completed Barbed Wire</i>
mm	kgf/sq. mm	kgf
2.50	40 to 60	375
2.24	40 to 60	300

The number of reels to be selected at random for this purpose shall be in accordance with Table 16.6.

**TABLE 16.6**

**Sampling Criteria**

<i>No. of Reels in the Lot</i>	<i>No. of Reels to be selected</i>
Up to 25	3
26 to 50	4
51 to 150	5
151 to 300	7
301 and above	10

#### 16.1.4 Binding Material

Binding materials to prevent ravelling of water bound macadam construction shall consist of a fine grained material possessing plasticity index value of 4 to 9 when the water bound macadam is to be used as a wearing course, and 4 to 6 when W.B.M. is being adopted as a sub-base/base course with bituminous surfacing on top of it. The plasticity index shall be determined in accordance with IS 2720 (Pt. V). The quantity of binding material used in each layer shall be as per direction of Engineer-in- Charge. Application of binding material may be dispensed with the approval of Engineer-in-Charge, where screenings consisting of crushable type material like moorum or gravel are used. Where earth cut for



sub-grade formation is used as binder with the approval of Engineer-in-Charge, no separate payment shall be made for collection of this binder material.

### 16.1.5 Bitumen Straight Run

A range of grades, from a very soft to a very hard consistency, can be produced by varying the temperature and the rate of flow during distilling process. It shall conform to IS 73. Grades of bitumen for different uses is given in Table 16.7.

**TABLE 16.7**  
**Bitumen Grades**

Grade		Temperature to which it shall be heated
I.	FOR PAINTING (Surface Dressing)	
	1. Paving bitumen from Assam Petroleum A 90	177 deg. C to 190 deg. C
	2. Paving bitumen from other sources 80/100 - S90	177 deg C to 190 deg. C
	3. Bitumen emulsion min. 50% bitumen content- RS grade IS 8837	(Cold application)
	4. Cut backs RC-3 (rapid curing) IS 217	—do—
II.	FOR PREMIX CARPETING	
	1. Paving asphalt 30/40 S-35 or 80/100 S-90	149 deg. C to 177 deg. C
	2. Bitumen Emulsion min. 60% bitumen contents RS grade IS 8837	(Cold application)
	3. Cut back MC (medium curing) IS 4545	(Cold application)
III.	FOR ASPHALTIC CONCRETE STRAIGHT RUN BITUMEN 60/70 (S-65) CONFORMING TO IS 73	150 deg. C to 177 deg. C

Note: For premix carpeting with paving asphalt, extra shall be paid if solvent is used.

### 16.1.6 Bricks

Bricks shall be of class designation 75 unless otherwise stated. The specifications of bricks shall be as sub head brick work as detailed in subhead 6.0, IOCL Civil Specification 2023.

### 16.1.7 Filler

The filler, where specified, shall be an inert material, the whole of which passes through a 710 micron sieve, atleast 90 per cent passing through a 180 micron sieve and not less than 70 per cent passing through a 90 micron sieve. The filler shall be cement, stone dust, hydrated lime, lime stone dust, flyash or any other non-plastic mineral matter approved by the Engineer-in-Charge.

**TABLE 16.8**  
**Aggregate Gradation including Filler**

Sieve designation	Percent by weight passing the sieve	
	For 25 mm thickness	For 20 mm thickness



20.0 mm	100	-
12.5 mm	75-100	100
10.0 mm	60-85	75 – 100
4.75 mm	35-55	35 – 55
2.36 mm	20-35	20 – 35
600 micron	10-22	10 – 22
300 micron	6-16	6 – 16
150 micron	4-12	4 – 12
75 micron	2- 8	2 - 8

#### 16.1.8 Flyash

Flyash shall conform to IS 3812

#### 16.1.9 Lime

Lime shall be of specifications as directed by Engineer-in-Charge.

#### 16.1.10 Moorum

It shall be obtained from pits of weathered disintegrated rocks. It should preferably contain silicious material and natural mixture of clay of calcarious origin. The size of moorum shall not be more than 20 mm.

#### 16.1.11 Posts, Rails and Pales

These shall be of standard size and length of posts being 1.8 m, rails 2.25 m and pales 1.25 m unless otherwise specified. A tolerance of 12 mm in length and 3 mm in other dimensions shall be permissible. These shall be cast in cement concrete 1:1 ½ 3 (1 cement : 1 ½ coarse sand : 3 graded stone aggregate 12.5 mm nominal size) with slots and reinforced with tor steel bars of diameters 10 mm in the case of posts and pales and 8 mm in the case of rails or as directed and finished with cement mortar 1:2 (1 cement : 2 fine sand). The specifications for R. C. C. work shall apply.

For the whole of their length below the top of the rail the paling shall have a projecting dovetail shape at the back which shall fit into dovetail grooves in each of the rails. That part of the palings projecting above the top rail shall be left square to prevent the dropping right through the rails. The posts, rails and pales shall be free from cracks, twists and such other defects.

#### 16.1.12 Posts and Struts—R.C.C.

All posts and struts shall be of standard size, the length of posts being 1.8 m or as specified and that of struts being minimum of 2.0 m. These shall be cast in cement concrete 1:1 ½ :3 (1 cement : 1 ½ coarse sand : 3 graded stone aggregate 12.5 mm nominal size) reinforced with 10 mm diameter tor steel bars as directed and finished smooth with cement mortar 1:2 (1 cement: 2 fine sand). The specifications for R.C.C. work shall apply. The posts and struts shall be free from cracks, twists and such other defects. G.I. staples on wooden plugs or 6 mm bar nibs will be provided as directed by Engineer-in-Charge while casting the posts. Quantity of RCC post, struts, Rails and Pales to be measured in cubic content.

#### 16.1.13 Premoulded Joint Filler

It shall conform to IS 1838, the thickness shall be 20 mm or 25 mm as specified and shall be of the maximum available standard length. During the casting of the slab the premoulded joint filler shall be



placed accurately in position against the finished end of concrete slab. The filler shall remain 20 mm below the top surface of the pavement and shall extend upto the subgrade.

#### 16.1.14 Red Bajri

This shall be disintegrated rock dark red in colour consisting of coarse grains, free from mica, dust and other foreign matter.

#### 16.1.15 Screenings

Screening to fill voids in the coarse aggregate shall generally consists of the same material as the coarse aggregate. However, where permitted, predominantly non-plastic material such as moorum or gravel (other than river borne rounded material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

As far as possible screenings shall conform to the gradings set-forth in Table 16.9. Screenings of type A shall be used with coarse aggregate of grade I of Table 16.2. Screenings of type A or B as specified shall be used with coarse aggregates of grading 2. Type B screenings shall be used with coarse aggregates of grading 3. The use of screenings may be omitted in the case of soft aggregates such as brick metal, kankar and laterite. For screenings like moorum or gravel the gradings given in Table 16.9 shall not be binding.

**TABLE 16.9**  
**Grading for Screenings**

<i>Grading Classification</i>	<i>Size Screenings of</i>	<i>IS Designation Sieve</i>	<i>Percent by Weight Passing Sieve</i>
A	13.2 mm	13.2 mm	100
		11.2 mm	95 -100
		5.6 mm	15 - 35
		180 micron	0 – 10
B	11.2 mm	11.2 mm	100
		9.5 mm	80-100
		5.6 mm	50 - 70
		180 micron	05 - 25

#### 16.1.16 Sealing Compound

After the curing period is over the joint portion above the filler board shall be cleaned thoroughly as directed by the Engineer-in-Charge. The joints shall be filled with hot applied sealing compound. Grade A (Normal) for concrete constructions other than those which are subjected to spillage of kerosene or other heavy petroleum oils and Grade B (Jet fuel resistant) for concrete constructions of runways for jet air crafts, conforming to IS 1834.

#### 16.1.17 Soil

Soil having a plasticity index (PI) between 5 and 20 shall be suitable. Atleast one test for 200 cubic metre of soil for determining P.I. shall be conducted.

#### 16.1.18 Stones



These shall be clean, hard, sound and durable stones, free from decay and weathering. They shall be in blocks and hammer dressed on all sides. The size of pitching stones shall be approximately 22.5 cm in depth and not less than 15 cm in any other direction.

#### 16.1.19 Stone Chippings For Surface Dressing/Painting

The stone chipping shall consist of fairly cubical fragment of clean, hard, tough and durable rock of uniform quality throughout. These shall be obtained by crushing stone river gravel (shingle) or other approved materials. Rounded gravel shall be used only if specifically permitted by the Engineer-in-Charge. The chipping shall be free of elongated or falky pieces, soft or disintegrated stone, salt, alkali, vegetable matter, dust and adherant coatings. They shall conform to the quality requirements of Table 16.10.

However, the total quantity of such deleterious material including clay lumps, soft fragments, foreign material shall not exceed 5% of the weight of the aggregate. The aggregate shall be got tested to ensure the requirements specified in Table 16.10.

**TABLE 16.10**

**Physical Requirements of Aggregates for Surface Dressing**

Sl. No.	Test	Test method	Requirements
1.	Los Angles Abrasion Value	IS 2386 (Part-4)	40% (Max.)
2.	Aggregate Impact Value*	IS 2386 (Part-4)	30% (Max.)
3.	Flakiness Index	IS 2386 (Part-1)	25% (Max.)
4.	Stripping Value	IS 6241	25% (Max.)
5.	Water Absorption	IS 2386 (Part-3)	1% (Max.)

\* Aggregates may satisfy requirements of either of the two tests.

#### 16.1.20 Stones for Kerb and Channels (Fig. 16.12)

Kerb and channel stones are provided on roads having raised berms for foot path etc. These shall be of selected hard stone, sound, durable free from laminations and other structural defects. The length of each kerb and channel stone shall be not less than 49.5 cm except that 29.5 cm long stones shall be permitted for closures and for curves. The other dimensions shall be 30 x 20 cm for kerb stones and 30 x 10 cm for channel stones, unless specified otherwise. Kerb and channel stones shall be chisel dressed on exposed surface and edges. The dimensions of the exposed faces of kerb and channel stones shall be of sizes as specified with a tolerance of 10 mm in width and depth. In the case of kerb stones a tolerance of 5 cm shall be allowed in the dimensions of unexposed back and bottom faces and in the case of channel stones a tolerance of 10 mm shall be allowed in thickness.

#### 16.1.21 Boundary Stone (Fig. 16.4)

The boundary stones shall be of either hard stone or sound and durable quality or precast R.C.C. These shall be in blocks of size 15 × 15 × 90 cm unless directed otherwise by the Engineer-in-Charge. A tolerance of 12.5 mm shall be permitted in the specified size. In the case of boundary stones of hard stone, the upper 30 cm shall be chisel dressed on all the four sides and on the top.

The R.C.C. boundary stones shall be cast in cement concrete 1 : 1 ½ : 3 (1 cement : 1 ½ coarse sand : 3 graded stone aggregate 20 mm nominal size), reinforced with 10 mm diameter tor steel bars or as directed and finished smooth with cement mortar 1 : 3 (1 cement : 3 fine sand ). The specifications for R.C.C. work shall apply.

#### 16.1.22 Kilometer stone (Fig.16.7): DELETED



## 16.2 SUB-GRADE: PREPARATION AND CONSOLIDATION

**16.2.0** In sub-grade composed of clay, fine sand or other soils that may be forced up into the coarse aggregate during rolling operation, an insulation layer of suitable thickness of granular materials or over size brick aggregate not less than 10 cm thick shall be provided for blanketing the sub-grade, which shall be paid for separately, unless otherwise specified in the agreement.

In slushy soils or in areas that are water logged, special arrangements shall be made to improve the sub-grade and the total pavement thickness shall be designed after testing the properties of the sub-grade soil. Necessary provision for the special treatment required shall be made in the project and paid for separately.

### 16.2.1 Preparation of Sub-Grade

The surface of the formation for a width of sub-base, which shall be 15 cm more on either side of base course, shall first be cut to a depth equal to the combined depth of sub-base and surface courses below the proposed finished level (due allowance being made for consolidation). It shall then be cleaned of all foreign substances. Any ruts or soft yielding patches that appear due to improper drainage conditions, traffic hauling or from any other cause, shall be corrected and the sub-grade dressed off parallel to the finished profile.

### 16.2.2 Consolidation

The sub-grade shall be consolidated with a power road roller of 8 to 12 tonnes. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass (the roller shall pass a minimum of 5 runs on the sub grade). All undulations in the surface that develop due to rolling shall be made good with material or quarry spoils as the cases may be and the sub-grade is rerolled.

### 16.2.3 Surface Regularity

The finished surface shall be uniform and conform to the lines, grades and typical cross section shown in the drawings, when tested with the template and straight edge, the variation shall be within the tolerances specified in Table 16.11.

**TABLE 16.11**

**Permissible Tolerances of Surface Evenness of Sub Grade**

<i>Longitudinal profile maximum permissible undulation when measured with a 3 metre straight edge</i>	<i>Cross profile maximum permissible variation from specified profile when measured with a camber template</i>
24 mm	15 mm

Where the surface irregularity of the sub grade falls outside the specified tolerances, the contractor shall be liable to rectify these with fresh material or quarry spoils as the case may be, and the sub-grade rerolled to the satisfaction of Engineer-in-Charge.

### 16.2.4 Measurements

The length and width shall be measured correct to a cm. The area shall be worked out in square metre, correct to two places of decimal.

### 16.2.5 Rate

The rate for preparation and consolidation of sub grade shall include the cost of materials and labour involved for all the operations mentioned in above unless otherwise specified.

## 16.3 EMBANKMENT CONSTRUCTION (UNDER OPTIMUM MOISTURE CONDITIONS)





- 16.3.1** In the case of earth work consolidated under optimum moisture conditions each layer of earth shall be carefully moistened to give field moisture content of about +1% to -2% of the optimum moisture content (OMC). The OMC shall be determined according to IS 2720 (Pt. VIII) Methods of Tests for Soils. Each layer shall then be compacted by rolling with 8 to 10 tonnes power road roller and a sheep foot roller if required. The required amount of water shall be added during consolidation to keep the moisture content of the soil at the optimum as per test. The density to be achieved for each layer of the material shall not be less than 95% of the density obtained in the laboratory (Proctor Method).
- 16.3.2** Each compacted layer shall be tested in the field for density and accepted before the operations for next layer are begun.
- 16.3.3** Control on compaction in the field shall be exercised through frequent moisture content and density determinations. A systematic record of these shall be maintained. At all times during construction the top of the embankment shall be maintained at such cross fall as will shed water and prevent ponding.
- 16.3.4** Density Measurement and Acceptance Criteria
- 16.3.4.1** One measurement of density shall be made for each 500 sqm of compacted area or for a smaller area as decided by the Engineer-in-Charge. Each measurement shall consist of atleast 5 density determinations tests and the average of these 5 determinations shall be treated as the field density achieved. The determination of density shall be as per IS 2720 (Pt. XXVIII).
- 16.3.4.2** In general the control at the top 40 cm thickness of the formation shall be more strict with density measurements being done at the rate of one measurement for 250 sqm of compacted area. Further for the determination of the mean density the number of tests in one measurement shall not be less than 10 and the work will be accepted if the mean dry density equals or exceeds the specified density.
- 16.3.4.3** When density measurements reveal any soft areas in the embankment, the Engineer-in-Charge shall direct that these be compacted further. If in-spite of that the specified compaction is not achieved the material in the soft areas shall be removed and replaced by approved materials and compacted to the satisfaction of the Engineer-in-Charge.
- 16.3.4.4** Control Tests on Borrow Material
- 16.3.4.5** Soil suitable for consolidation under O.M.C. conditions should preferably have the following characteristics:
- |  |     |
|--|-----|
| (a) Minimum percentage of clay                   | 10% |
| (b) Liquid limit                                 | 14  |
| (c) Plasticity index                             | 4   |
| (d) Percentage of silt should not exceed         | 50% |
| (e) Peat, muck and organic soils are unsuitable. |     |
- 16.3.4.6** The Engineer-in-Charge may, however, relax these requirements taking into account availability of materials, cost of transportation and other relevant factors.
- 16.3.4.7** Various test required to be conducted on the borrow material with their recommended frequency are indicated below. All the test need not be stipulated on every project. Depending upon site condition etc. only some may be found necessary at a particular project. The frequency of testing indicated refers generally to the minimum number of tests to be conducted. The rate of testing must be stepped up as found necessary depending upon the variability of the materials and compaction methods employed at a project.
- a) *Gradation*: At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.





- b) *Plasticity*: At least one test for each kind of soil. Usual rate of testing 1 to 2 tests per 8000 cum of soil.
- c) *Proctor Tests*: At the rate of 1 to 2 tests per 8000 cum of soil.
- d) *Deleterious Contents*: As required.
- e) *Moisture contents*: One test for every 250 cum of soil.

**16.3.4.8 Measurements:** The filling shall be measured and quantity of earth work computed from cross sections of filling or the embankment. No deduction shall be made for voids.

**16.3.4.9** Rate shall include the cost of all operations described above including operation mentioned into the extent applicable.

## **16.4 SUPPLYING AND STACKING OF MATERIALS**

### **16.4.1 Aggregates/Red Bajri**

**16.4.1.1** The item of work shall specify stone aggregate/brick aggregate/red bajri etc., as the case may be.

**16.4.1.2 Stacking:** Ground where stacks are proposed to be made shall be cleared, levelled or dressed to a uniform slope and all lumps, depressions etc. shall be removed. The stacked metal shall be free from vegetation and other foreign matter. Coarse aggregates stack shall be made at places as directed by the Engineer-in-Charge. All rejected stone metal shall be removed from the site.

The aggregate shall be stacked in convenient units of one metre top width, 2.2 m bottom width, 60 m height and length in multiples of 3 m for new roads. Where berm width is limited or for repair works it shall be stacked in units of 40 cm top width 1.4 m bottom width, 50 cm height and length in multiples of 3 m. Template of steel shall be used for making the stacks and shall always be kept at site for check measurements. The Engineer-in-Charge may permit stacking in different sizes and height ranging between 45 to 75 cm for new roads and 40 to 60 cm for repair work, in case the site conditions so demand. In a particular reach of road as decided by the Engineer-in-Charge, the quantity of stacked material shall be comparable to the theoretical quantity required for W.B.M. to be laid in that reach.

The stacks shall be uniformly distributed along the road and shall be numbered serially. The number plate shall be planted on each stack, which shall remain in position until the stack is used in the work. A register showing daily consumption of stacks shall be maintained at site of work. The collection of stone metal shall be for completed length of one km (for each layer of W.B. macadam) or as directed by the Engineer-in-Charge in writing.

**16.4.1.3 Measurements:** Length, breadth and height shall be measured correct to a cm. The total quantity so arrived shall be reduced by 7.5% to arrive at the net quantity for payment, in cases of aggregates. No such reduction shall be made in case of fine aggregate i.e. Red Bajri & screening etc. as defined under clause 16.1.1 to 16.1.2.

### **16.4.2 Binder**

**16.4.2.1 Stacking:** Specified binder shall be brought to the site of work in the sealed original containers. Binder brought in damaged containers shall not be allowed. The material shall be stacked in fenced enclosures, as directed by the Engineer-in-Charge, on one side of the roadway. The material shall be purchased from reputed firms or their authorised dealer. All the drums brought to site shall be serially numbered and used in the same order. The materials shall be brought in at a time in adequate quantities to suffice for the whole work or for atleast a fortnight's work.

For major bituminous road works, supply of bitumen in bulk may be taken for economical reasons, or if the contingencies of the work so require. Sufficient storage arrangement shall be made at site for atleast ten days requirement.



Materials shall be kept in the joint custody of the contractor and the representative of the Engineer-in-Charge. The empty containers shall not be removed from the site of work, till the relevant item of work has been completed and permission obtained from the Engineer-in-Charge. A few drums may be removed before completion of work for heating bitumen and mixing aggregates etc. with the permission to the Engineer-in-Charge. Empty drums required to be returned to stores shall be in good condition. Recovery rate for non- return of the empty drums or for the damaged drums shall be as decided by the Engineer-in-Charge.

**16.4.2.2 Measurements:** The materials shall be recorded as per standard weights of different type of container as intimated by manufacturers. The material shall be weighed where containers are found leaking.

**16.4.2.3 Rate:** The rate shall include the cost of all labour and materials involved in all the operations described above.

#### **16.4.3 Moorum/Stone Chippings/Good Earth**

**16.4.3.1** The item of work shall specify moorum/stone chippings/Good Earth as the cases may be.

**16.4.3.2 Stacking:** Ground where stacks are proposed to be made, shall be dressed to a uniform slope and all lumps, depressions etc. shall be removed. Sample of moorum shall be got approved from the Engineer-in-Charge, before the material in bulk is brought to site. Moorum/Good Earth shall be stacked in convenient units of one cubic metre in between aggregate stacks in each length of 100 m as per requirement. The stacks shall be made with wooden boxes open at both ends and of  $2 \times 2 \times 0.25$  m dimensions. These shall always be kept at site for stacking and check measurement. The stacks shall be uniformly distributed along the road. The supply of moorum shall be completed for the entire work or for a complete length of one km or as directed by the Engineer-in-Charge in writing.

**16.4.3.3 Measurements:** Length and breadth of boxes shall be measured correct to a cm. Volume shall be calculated in cubic metres, correct to two places of decimal.

**16.4.3.4 Rate:** The rate shall include the cost of all materials and labour involved in all the operations described above.

### **16.5 EARTHWORK IN ROAD CONSTRUCTION**

**16.5.1** Earthwork connected with road construction fall broadly into three categories.

- a) Earthwork in cutting including borrow pits.
- b) Earthwork in fillings in embankments (without optimum moisture conditions).
- c) Earthwork in fillings in embankments (under optimum moisture conditions).

**16.5.2** Detailed specifications relating to Earthwork already described in subhead Earth Work, IOCL Civil Specification, 2023 so far as the various options in the earthwork for road construction as indicated below shall be applicable.

- a) Site clearance
- b) Setting out and making profile
- c) Blasting operations
- d) Excavation in all kinds of soils
- e) Excavation in ordinary/hard rock
- f) Earthwork in filling
- g) Measurements



- h) Rates
- i) Surface excavation
- j) Rough excavation and filling

**16.5.3** In addition to the above, there are certain special requirements of earthwork for road constructions, especially in embankments and excavations from borrow pits. These shall broadly conform to.

- a) IRC: 36 Recommended practice for construction of earth embankments for road works.
- b) IRC: 10 Recommended practice for borrow pits for road embankments by manual operations.

Excavation from borrow pits shall conform to provisions in para 3 of IRC: 10 and the road embankment shall generally conform to section, slopes and location of borrow pits as per Fig. given in Specifications.

## **16.6 EMBANKMENT CONSTRUCTION (WITHOUT OPTIMUM MOISTURE CONDITIONS)**

**16.6.1** In addition to what is described in 16.5 above, the following shall apply : materials used in embankments shall be earth moorum, gravel, a mixture of these or any other material approved by the Engineer-in-Charge. Such materials shall be free of logs, stumps, roots, rubbish or any other ingredient likely to deteriorate or affect the stability of the embankment. The work shall be so planned and executed that the best available materials are saved for the top portion of the embankment. Highly expansive clays exhibiting marked swell and shrinkage properties may be deposited only at the bottom of the embankment and no such material shall be placed nor permitted to remain in the top 500 mm portion of the embankment below the sub-grade.

### **16.6.2 Preparation of Foundations**

The foundations of the embankment shall be ploughed to a depth of 15 to 25 cm. All clods shall be broken into fine earth and the area roughly levelled. The surface shall then be well watered before the earth work is started.

### **16.6.3 Source of Supply**

**16.6.3.1** The material used in embankment shall be obtained either from cutting high ground or from borrow pits as directed by the Engineer- in-Charge. In case of road embankments, the borrow pits may be excavated along the sides of the road so as to form road side drains with proper slopes and sections. The clear berm width between the toe of the bank and the inner edge of the borrow pits shall be specified by the Engineer-in-Charge but it shall not be less than 5 metres after making due allowance for future development.

**16.6.3.2** Borrow pits shall be rectangular in shape with one side parallel to the centre line of the road. If on road land, these shall be dug as near the boundary as possible. Borrow pits shall not be dug continuously. Ridges of not less than 8 metres width should be left at intervals not exceeding 300 metres. Small drains should be cut through the ridges to facilitate drainage. Borrow pits shall be well drained. The bed level of the borrow pits, shall, as far as possible, slope down progressively towards the nearest cross drain, if any and shall not be lower than the bed of the cross drain. Borrow pits shall not be dug within 0.8 km of towns or villages. If unavoidable these shall not exceed 30 cm in depth and shall be drained.

**16.6.3.3** Where it becomes necessary to borrow filling materials from temporarily acquired cultivable lands the depth of borrow pits shall not exceed 45 cm. The top soil to a depth of 15 cm shall be stripped and stacked aside. Thereafter soil shall be dug out to a further depth not exceeding 30 cm and used in forming the embankment. The top soil shall then be spread back on the land.

**16.6.3.4** In case of flood and marginal banks, earth shall be obtained from borrow pits on the river side of the banks. No borrow pit shall be excavated on the land side of the bank, unless permitted by the Engineer



-in-Charge in writing depending upon the depth of borrow pits and height of embankment. However the minimum berm width between the toe of the bank and the edge of the borrow pits on the river side shall be 15 metres and that between the toe of the bank and the edge of the borrow pits on the land side 25 metres.

- 16.6.3.5** Guide-banks shall be constructed from material obtained from excavation for laying stone aprons and further borrow pits excavated if necessary, according to the directions of the Engineer-in- Charge.

#### **16.6.4 Earth Filling and Compactions**

- 16.6.4.1** Before commencement of filling the toe lines of the embankment shall be marked by pegs driven into the ground at 15 metres intervals and by continuous nicking (daf balings) to indicate the limits of the side slopes. Bamboo and string profiles shall be erected at every 60 metres interval in straight reaches and 15 metres apart in curved portions.

- 16.6.4.2** Embankment material shall be laid in 20 cm layers which shall be continuous and parallel to the finished grade. The placing of earth fill shall be done in the full width of embankment including slopes, and the section of formation shall be kept slightly sloping away from the centre to avoid pools of water forming due to rain. The height of filling in different sections shall be uniform as far as possible. All clods shall be broken while the earth is being placed. Organic matter of any kind shall be removed and disposed off as directed by the Engineer-in-Charge.

- 16.6.4.3** Joining of old and new embankments shall be done by stepping in an overall slope of about 1 to 5.

- 16.6.4.4** Each layer of earth shall be adequately watered to aid compaction.

- 16.6.4.5** If the material delivered to the road bed is too wet it shall be dried by aeration and exposure to the sun, till the moisture content is acceptable for compaction. It shall then be rolled with roller of minimum 1/2 tonne weight, not less than 5 times, till it gets evenly and densely consolidated with wooden or steel rammers of 7 to 10 kg weight having a base of 20 cm square or 20 cm diameter. The labour for ramming shall be atleast one rammer to six diggers. Every third layer of earth and the top most layer shall be well consolidated with a power roller of minimum 8 tonnes weight, rolled not less than 5 times, till the soil behaves as an elastic material and gets compressed only elastically under the load of roller.

- 16.6.4.6** *Dressing:* The embankment shall be dressed neatly to the required level as per designed section and grade, after it has been completed and thoroughly consolidated. The top and slopes shall be protected from any damage and maintained, till the work is completed and handed over to the Engineer- in-Charge.

#### **16.6.5 Embankment Around Structures**

- 16.6.5.1** To avoid interference with the construction of abutments, wing walls or return walls of culvert/bridge structure, the contractor shall at points to be determined by the Engineer-in -Charge suspend work on embankments forming approaches to such structures, until such time as the construction of the latter of sufficiently advanced to permit the completion of approaches without the risk of interference of damage to the bridge works.

- 16.6.5.2** Unless directed otherwise, the filling around culverts, bridges and other structures upto a distance of twice the height of the embankment shall not be done. The fill material shall not be placed against any abutment or wing wall unless permission has been given by the Engineer-in-Charge but in any case not until the concrete or masonry has been in position for 14 days. The embankment shall be brought up simultaneously in equal layers on each side of the structure to avoid displacement and unequal pressure. The sequence of work in this regard shall be got approved from the Engineer-in- Charge.

- 16.6.5.3** Where the provision of any filter medium is specified behind the abutment, the same shall be laid in layers simultaneously with the laying of fill material. The material used for filter material shall conform to



the requirements for filter medium as specified. Payment for providing filter material shall be made separately under relevant items.

- 16.6.5.4** Where it may be impracticable to use power roller or other heavy equipment, compaction shall be carried out by mechanical tampers or other methods approved by the Engineer-in-Charge. Care shall be taken to see that the compaction equipments does not hit or come too close to any structural member so as to cause any damage to it.

#### **16.6.6 Earth Work for Widening Existing Road Embankment**

- 16.6.6.1** When an existing embankment is to be widened and its slope is steeper than 4:1 continuous horizontal benches each at least 0.3 metre wide, shall be cut into the old slope for ensuring adequate bond with the fresh embankment material to be added. The material obtained from cutting of benches could be utilised in the widening of the embankment. However, when the existing slope against which the fresh material is to be placed is flatter than 4:1 the slope surface may only be ploughed or scarified instead of resorting to benching.

- 16.6.6.2** Where the width of the widened portion is insufficient to permit the use of standard rollers compaction shall be carried out with the help of sheep's foot roller mechanical tampers or other approved equipment. End dumping of material from trucks for widening operations shall be avoided except in difficult circumstances when the extra width is too narrow to permit the movement of any other type of hauling equipment.

#### **16.6.7 Cutting**

Where the formation level of the road is lower than the ground level, cutting shall be done up to formation level. Side slopes except in rock cutting shall be evenly and truly dressed.

- 16.6.7.1 *Disposal of Surplus Earth:*** Earth from cutting shall be utilized for filling in embankment as directed by the Engineer-in- Charge. Earth not required for embankment shall be disposed off as directed by the Engineer -in-Charge. The area where the surplus earth is disposed off shall be levelled and neatly dressed. When the surplus earth is disposed off at a distance of more than 50 metres the extra lead shall be paid for.

- 16.6.7.2 *Measurements:*** The quantity of earth work shall be calculated by measuring the volume of earth excavated from the borrow pits and shall be done as specified where it is not possible or convenient to take measurements from cutting the filling shall be measured and the quantity of earth work computed from cross sections of the filling. The quantity of earth work so computed shall be reduced by 5% to arrive at the quantity for payment. For the purpose of taking measurements of earth work in cutting or embankment, ground levels of the area shall be recorded as specified in 16.5.

- 16.6.7.3 *Rate:*** It includes the cost of all the operations described above. The lead and lift for depositing the earth or disposal of unsuitable material shall be as described in the description of item. It also includes the Sub Head 2.0 Earth Work.

### **16.7 WATER BOUND MACADAM WITH STONE AGGREGATE**

#### **16.7.1 Water Bound Macadam with Stone Aggregate**

Stone aggregate of specified size is used. This is a standard sub base/base and is used where stone aggregate is available at reasonable rates. This consists of clean crushed coarse aggregate mechanically interlocked by rolling and voids thereof filled with screening and binding material with the assistance of water, laid on a prepared sub grade, sub-base, base or existing pavement as the case may be. Water bound macadam may be used as a sub base, base course or surfacing course.

#### **16.7.2 Approximate Quantities of Materials**



Quantities of coarse aggregate, screening and binding material required to be stacked for 100 mm approximate compacted thickness of W.B.M. for 10 sqm shall be as per table 16.12 for stone aggregate of the size 90 mm to 45 mm. For stone aggregate of other size, 63 mm to 45 mm and 53 mm to 22.4mm quantity of coarse aggregate and stone screening for 75 mm approximate compacted thickness of WBM base for 10 sqm. shall be as per Table 16.13.

**TABLE 16.12**

Coarse Aggregate			Stone Screenings		Binding Material
Classification	Size Range	Loose Quantities	Grading/classification and size	Loose Quantity	Quantity
Grading 1	90 mm to 45 mm	1.21 cum to 1.28 cum	Type A 13.2 mm	0.27 cum to 0.30 cum	0.08 cum to 0.10 cum

Note: Net quantity = Loose quantity measured in stacks minus 7.5%.

**TABLE 16.13**

Coarse Aggregate				Stone Screenings		
Classification	Size Range	Compacted Thickness	Loose Qtr.	Grading Classification & Size	For WBM Sub-base/Base Course (Loose Quantity)	For WBM surface course (Loose Quantity)
Grading 2	63-45 mm	75 mm	0.91 to 0.96 m <sup>3</sup>	Type A 13.2 mm	0.12 cum to 0.15 cum	0.10 cum to 0.12 cum
-Do-	-do-	-do-	-do-	Type B 11.2 mm	0.20 cum to 0.22 cum	0.16 cum to 0.18 cum
Grading 3	53-22.4 mm	75 mm	-do-	Type B 11.2 mm	0.18 cum to 0.21 cum	0.14 cum to 0.17 cum

\* Note:

1. The quantity of metal measured in stacks and reduced by 7.5% to calculate net quantity.
2. The above mentioned quantities should be taken as a guide only for estimation of quantities for construction etc.

**16.7.3** The quantity of binding material required for 75 mm (approximate) compacted thickness will be 0.09 cum/10 sqm in the case of W.B.M. base course and 0.13 cum/10 sqm when the W.B.M. is to function as a surface course.

#### **16.7.4 Preparation of Foundation**

In the case of an existing unsurfaced road, where new materials is to be laid, the surface shall be scarified and reshaped to the required grade, camber and shape as necessary. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials,





before spreading the aggregate for W.B.M. Where the existing surface over which the sub base of W.B.M. is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degree C to the central line of the carriageway before the W.B.M. is laid.

#### **16.7.5 Provision of Lateral Confinement of Aggregates**

Before starting with W.B.M. construction, necessary arrangements shall be made for lateral confinement of aggregates. One method is to construct side shoulders in advance to a compacted layer of the W.B.M. coarse (Fig.16.1). Inside edges may be trimmed vertical and the included area cleaned off all spilled materials thereby setting the stage for spreading the coarse aggregate. The practice of laying W.B.M. after excavating a trench section in the finished formation must be completely avoided.

#### **16.7.6 Spreading Aggregate**

The coarse aggregate shall be spread uniformly and evenly upon the prepared base in required quantities with a twisting motion to avoid segregation. In no case shall these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed base be permitted. The aggregates shall be spread uniformly to proper profile by using templates placed across the road six metres apart. Where specified, approved mechanical devices may be used to spread the aggregates uniformly. The levels along the longitudinal direction upto which the metal shall be laid, shall be first obtained at site to the satisfaction of Engineer-in-Charge, and these shall be adhered to.

The surface of the aggregate spread shall be carefully trued up and all high or low spots remedied by removing or adding aggregate as may be required. The W.B.M. sub-base shall be normally constructed in layer of 100 mm compacted thickness and W.B.M. base shall be normally constructed in layers of 75 mm compacted thickness. No segregation of large or fine particles shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material.

The coarse aggregate shall normally not be spread in lengths exceeding three days average work ahead of the rolling and blending of the proceeding section.

#### **16.7.7 Rolling**

Immediately following at spreading of the coarse aggregate, it shall be compacted to the full width by rolling with either the three- wheel- power -roller of 8 to 10 tonnes capacity or an equivalent vibratory roller. Initially, light rolling is to be done, which shall be discontinued when the aggregate is partially compacted with sufficient void space in them to permit application of screenings.

The rolling shall begin from the edges with the roller running forward and backward and adding the screenings simultaneously until the edges have been firmly compacted. The roller shall then progress gradually from the edges to the centre, parallel to the centre line of the road and overlapping uniformly each preceding rear wheel track by one half width and shall continue until the entire area of the course has been rolled by the rear wheel. Rolling shall continue until the road metal is thoroughly keyed with no creeping of metal ahead of the roller. Only slight sprinkling of water may be done during rolling, if required. On superelevated curves, the rolling shall proceed from the lower edge and progress gradually continuing towards the upper edge of the pavement.

Rolling of sub base shall not be done when the sub-grade is soft or yielding or when the rolling causes a wave like motion in the sub-base or sub-grade. When rolling develops irregularities that exceed 12 mm when tested with a three-metre straight edge, the irregular surface shall be loosened and then aggregate added to or removed from it as required and the area rolled until it gives a uniform surface conforming to the desired cross-section and grade. The surface shall also be checked transversely by template for



camber and any irregularities corrected in the manner described above. In no case shall the use of screenings to make up depressions be permitted.

#### 16.7.8 Application of Screenings

After the coarse aggregate has been lightly rolled to the required true surface, screenings shall be applied gradually over the surface to completely fill the interstices. Dry rolling shall be continued while the screenings are being spread so that the jarring effect of the roller causes them to settle into the voids of the coarse aggregates. The screenings shall not be dumped in piles on the coarse aggregate but shall be spread uniformly in successive thin layers either by the spreading motion of the hand, shovels or a mechanical spreader.

The screenings shall be applied at a slow rate (in three or more applications) so as to ensure filling of all voids. Rolling and brooming shall continue with the spreading of the screenings. Either mechanical brooms or hand brooms or both may be used. In no case shall the screenings be applied, so fast and thick as to form cakes, ridges on the surface making the filling of voids difficult, or to prevent the direct bearing of the roller on the coarse aggregates. The spreading, rolling and brooming of screenings shall be performed on sections which can be completed within one day's operation and shall continue until no more screenings can be forced into the voids of the coarse aggregate. Damp and wet screenings shall not be used under any circumstances.

#### 16.7.9 Sprinkling and Grouting

After spreading the screening and rolling the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screening into the voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued and additional screenings applied where necessary until the coarse aggregates are well bonded and firmly set for the entire depth and until a grout has been formed of screenings and water that will fill all voids and form a wave of grout ahead of the wheels of the roller. The quantity of water to be used during the construction shall not be excessive so as to cause damage to the sub-base or sub-grade.

#### 16.7.10 Application of Binding Material

After the application of screenings and rolling, a suitable binding material shall be applied at a uniform and slow rate in two or more successive thin layers. After each application of binding material, the surface shall be copiously sprinkled with water and the resulting slurry swept in with hand brooms or mechanical brooms or both so as to fill the voids properly. The surface shall then be rolled by a 8-10 tonne roller, water being applied to the wheels in order to wash down the binding material that may get stuck to the wheels. The spreading of binding material, sprinkling of water, sweeping with brooms and rolling shall continue until the slurry that is formed will, after filling the voids form a wave ahead of wheels of the moving roller.

#### 16.7.11 Setting and Drying

After final compaction of the course, the road shall be allowed to cure overnight. Next morning defective spots shall be filled with screenings or binding material, lightly sprinkled with water, if necessary and rolled. No traffic shall be allowed till the macadam sets.

#### 16.7.12 Surface Evenness

The surface evenness of completed W.B.M. sub -base in the longitudinal and transverse directions shall be as specified in Table 16.14 for sub base with stone aggregate of size 90-45 mm and above.

**TABLE 13.14**

	Longitudinal profile measured with a 3 metre straight edge	Cross profile
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Size of Coarse aggregates	Maximum permissible undulation	Max. No. of Undulations permitted in any 300 m length exceeding		Max. permissible undulation when measured with a camber template
		15 mm	10 mm	
90-45 mm & above	15 mm	-	30	12 mm

The longitudinal profile shall be checked using a 3 meter long straight edge and graduated wedge at the middle of each traffic lane along a line parallel to the Centre line of the road. The transverse profile shall be checked with adjustable template at intervals of 10 meters. For base with stone aggregate of size 63 to 45 mm and 53 to 22.4 mm surface evenness to be as per Table 16.15.

**TABLE 16.15**

Size of Coarse aggregates	Longitudinal profile measured with a 3 metre straight edge			Cross profile
	Maximum permissible undulation	Max. No. of Undulations permitted in any 300 m length exceeding		Max. permissible undulation when measured with a camber template
		15 mm	10 mm	
63-45 mm and 53-22.4 mm	12 mm	-	30	8 mm

The longitudinal profile shall be checked with a three metre long straight edge and graduated wedge at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with adjustable templates at intervals of 10 metres.

#### **16.7.13 Rectification of Defective Construction**

Where the surface irregularity of the W.B.M. sub-base course exceeds the tolerances specified in Table 16.14 or where the course is otherwise defective due to sub grade soil mixing with the aggregates, the layer to its full thickness shall be scarified over the affected area, reshaped with added material or removal and replaced with fresh materials as applicable, and recompact. The area treated in the aforesaid manner shall not be less than 10 sqm. In no case shall depressions be filled up with screenings and binding materials.

#### **16.7.14 Measurements**

The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from



the left and right edges at a cross section taken at 100 metre interval or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal. The cubical contents shall be compared with net quantity of stone aggregates paid (that is stacked quantity – 7.5%). If the cubical contents are within ( $\pm$ ) 5% of the paid net stacked quantity of stone aggregates, the work shall be treated as acceptable. If the cubical contents is short of net stacked quantity by more than 5% then the payment shall be restricted to the quantities derived from cubical content.

#### **16.7.15 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above, except cost of stone aggregate, kankar moorum, screenings and bajri, for which separate payments shall be made. Where W.B.M. is to be laid over an existing road, scarifying and consolidation of the aggregate received from scarifying shall be paid for separately.

#### **16.8 WATER BOUND MACADAM WITH BRICK AGGREGATE (OVERBURNT (JHAMA) BRICK AGGREGATE): DELETED**

#### **16.9 BAJRI PATHS: DELETED**

#### **16.10 BRICK EDGING**

##### **16.10.1 Edging**

Trenches of specified width and depth shall first, be made along the edges of the wearing course of the road to receive the bricks. The bed of trenches shall be compacted to a firm and even surface and then the bricks shall be laid with its length at right angle or parallel to the side of the road depending upon the width of edging as specified in the item. The bricks shall be abutting against the wearing course, true to line, gradient and in camber with the finished road surface at the edge.

##### **16.10.2 Finishing**

Berms and road edges shall be restored with excavated earth and consolidated by manually. All surplus earth including rubbish etc. shall be disposed off as directed by the Engineer-in-Charge.

##### **16.10.3 Measurements**

Length of the finished work shall be measured in running metres along the edges of the road correct to a cm.

##### **16.10.4 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above.

#### **16.11 SCARIFYING METALLED (WATER BOUND) SURFACE: DELETED**

#### **16.12 DRY STONE PITCHING**

##### **16.12.1 Stones**

These shall be clean, hard stones, free from decay and weathering. They shall be in block and hammer dressed on all sides. The size of the pitching stones shall be approximately 22.5 cm.in depth and not less than 15 cm. in any other direction.

##### **16.12.2 Preparation of surface**

The sides and bottom of earth work to be pitched, shall be brought to the required slope and gradient and shall be compacted to a firm and even surface.

##### **16.12.3 Pitching**



Pitching shall be of 22.5 depth unless specified otherwise. Profiles shall be put up by means of pegs and strings or by placing stones, at intervals of not more than 15 cm. Stones shall then be laid closely in position in between the profile and firmly embedded with joints staggered and with exposed faces true to line, gradient and in uniform slope throughout.

Cross bands of approximately 22.5 cm. width through bond stones equal to the full depth of pitching shall be provided at an interval of approximately 3 metres centre to centre both longitudinally and transversely.

The interstices between adjacent stones shall be filled in with stones of proper size, well driven in with crow bars to ensure tight packing and complete filling of all interstices. Such filling shall be carried on simultaneously with the placing in position of the large stones and shall in no case be permitted to fall behind. Final wedging shall be done with the largest sized chip practicable, each chip being well driven home with a hammer so that no chip is possible of being picked up or removed by hand.

#### **16.12.4 Measurements**

The measurements shall be taken in sqm. The area of pitching for drains shall be calculated by multiplying the perimeter (bed width plus side slopes) by the length of the pitching. The length, width and side slope shall be measured correct to a cm.

#### **16.12.5 Rate**

The rate shall include the cost of the materials and labour involved in all the operations described above, except pitching stone, if specified, shall be paid for separately.

### **16.13 BRICK PITCHING**

**16.13.1** Bricks shall be all second class designation 75 unless otherwise specified. The specification of bricks shall be as per SH 6.00 (Masonry work) IOCL Civil Specification 2023.

#### **16.13.2 Preparation of Surface**

The sides and bottom of earth work to be pitched, shall be brought to the required slope and gradients and shall be compacted to a firm and even surface.

#### **16.13.3 Pitching**

Pitching shall be 10 cm. in depth or in multiples of 10 cm. as specified. Profiles shall first be put up by means of pegs and strings or by placing bricks at intervals not more than 15 cm. Bricks shall then be laid in parallel rows breaking bond or Herring –bone bond pattern as directed. In the case of drains, bricks shall be laid on bed width in parallel rows breaking bond and on sides in either of the above manner. At the top, the toe and at every 3 m. intervals, brick courses shall be laid with bricks on ends. All bricks shall be laid closely in position and firmly embedded, true to line, gradient and in uniform slope through out pitching work.

#### **16.13.4 Measurements**

Para 16.12.4 shall apply, except that the measurements of the dry pitching 10 cm. deep for the drains shall be taken by adding 10 cm. on either side to the perimeter of the drain so as to allow for the top 20 cm. courses. In this case the perimeter of the drain (bed width plus sides slopes) plus 20 cm. multiplied with the length of the pitching shall give the area of the pitching in sqm.

#### **16.13.5 Rate**

The rate shall include the cost of material and labour involved in all the operations described above.

### **16.14 CUTTING W.B.M. ROADS AND MAKING GOOD**

#### **16.14.1 Cutting**



All road crossings shall be cut in half the width at a time and repaired, unless otherwise permitted by the Engineer-in-Charge. Cutting shall be straight and uniform in width. Soling stone and aggregate obtained from cutting macadam shall be stacked separately, clear of the road surface. Aggregate shall be screened. Stones of size below 20 mm and with rounded edges shall be discarded and disposed.

#### **16.14.2 Making Good**

**16.14.2.1** After the trenches have been filled in with excavated earth in layers of 15 cm thickness, watered, well consolidated with heavy iron rammers and brought to sub grade level, soling stone obtained from cutting shall be laid as per existing soling and consolidated with heavy iron rammers. Where the earth consolidation is well done, no settlement need occur subsequently, for this excess watering should be avoided.

**16.14.2.2** New aggregate 50 mm nominal size or as required, shall be added to old aggregate and spread over to a depth of 7.5 cm as specified in 16.7.6. This shall then be consolidated with hand roller or heavy iron rammers, as directed, first with light sprinkling then with sufficient application of water till the aggregate has become adequately consolidated and does not get displaced. All undulations shall be loosened by hand picking, surplus aggregate removed from high spots and depressions filled with surplus and new aggregate and the surface compacted again. When thoroughly consolidated, kankar moorum and red bajri, freshly collected shall be spread over it in 12 mm layer and consolidated with hand roller or heavy iron rammers, with sufficient application of sufficient water till a uniform surface is obtained.

**16.14.2.3** The finished surface shall be in camber and left a little higher than the adjoining road surface to allow for any settlement on drying.

**16.14.2.4 Measurement:** Length and width of cutting shall be measured correct to a cm. The area shall be calculated in square metre, correct to two places of decimal.

**16.14.2.5 Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

#### **16.14.3 Cutting Bituminous Roads and Making Good**

**16.14.3.1** Cutting, making good and measurements shall be as specified in 16.14.1 except the top bituminous surface shall be finished as per the existing surface or as directed by the Engineer-in-Charge. The item shall include cutting and restoration of W.B.M. portion as well as Bitumen portion.

**16.14.3.2 Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

#### **16.15 CUTTING BAJRI PATHS AND MAKING GOOD: DELETED**

#### **16.16 FENCING WITH G.I. BARBED WIRE AND RCC POSTS (FIG. 16.9)**

**16.16.1 Materials:** R.C.C. posts and struts shall be as specified in 16.1.12. G.I. Barbed wire shall be as per IS 278.

**16.16.2 Spacing of Posts and Struts:** The spacing of between posts shall be three metres centre to centre, unless otherwise specified, or as directed by the Engineer-in-Charge to suit the dimensions of the area to be fenced. Every 15th, last but one end post and corner posts shall be strutted on both sides and end posts on one side only.

**16.16.3 Fixing of Posts and Struts:** Pits 45 x 45 cm and 75 cm deep or as directed shall first be excavated true to line and level to receive the posts. In the case of struts, pits 70 x 45 x 75 cm deep or as directed shall be excavated to suit the inclination of the strut so that it is surrounded by concrete by not less than 15 cm at any point. The pits shall be filled with a layer of 15 cm thick cement concrete 1:3:6 (1 cement: 3 fine sand: 6 graded stone aggregate 40 nominal size). The posts and struts shall then be placed in the pits,



the posts projecting 1.2 m or to the specified height above ground, true to line and position. The cement concrete 1:3:6 shall be filled in upto 15 cm for posts and 25 cm for struts below ground level at the base of the concrete so that the posts are embedded in the cement concrete block of size 45 x 45 x 60 cm and strut in block of size 70 x 45 x 50 cm. The concrete in foundations shall be watered for at least 7 days to ensure proper curing. The remaining portions of pits shall be filled up with excavated earth and the surplus earth disposed off as directed by the Engineer-in-Charge and site cleared.

#### **16.16.4 Fixing G.I. Barbed Wire**

The barbed wire shall be stretched and fixed in specified number of rows and two diagonals. The bottom row shall be 14 cm above ground and the rest at 12.5 cm centre to centre. The diagonals shall be stretched between adjacent posts from top wire of one post to the bottom wire of the second post. The diagonal wires will be interwoven with horizontal wires by fixing the odd- rows of wires first, then the diagonal cross wires and lastly the even rows of wires. The barbed wire shall be held to the R.C.C. posts by means of G.I. staples fixed to wooden plugs or G.I. binding wire tied to 6 mm barnibis fixed while casting the posts. Turn buckles and straining bolts shall be used at the end posts, if so specified.

#### **16.16.5 Measurements**

Total length of G.I. barbed wire shall be measured in running meter correct to a cm.

#### **16.16.6 Rate**

The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of posts, struts, turn buckle, straining bolts and excavation and concrete in foundations for which separate payments shall be made under respective items.

### **16.17 G.I. BARBED WIRE FENCING WITH ANGLE IRON POSTS**

#### **16.17.1 Materials**

G.I. Barbed wire shall be as per IS 278 and angle iron shall be as per subhead – 10.00 steel work of IOCL Civil Specification 2023. The angle shall be of size 40 × 40 × 6 mm.

#### **16.17.2 Spacing of Posts and Struts**

The spacing of posts shall be 3.00 m centre to centre, unless otherwise specified or as directed by the Engineer-in-Charge to suit the dimensions of the area to be fenced. Every 15th, last but one end posts and corner post shall be strutted on both sides and end post on one side only.

#### **16.17.3 Fixing of Posts and Struts**

This shall be as per 16.16.3. In addition, angle iron post at bottom shall be split and banded at right angle in opposite direction for 10 cm length to get proper grip.

#### **16.17.4 Fixing G.I. Barbed Wire**

The barbed wire shall be stretched and fixed in specified number of rows and two diagonals. The bottom row should be 14 cm above ground and the rest at spacing of 2.5 cm centre to centre. The diagonal shall be stretched between adjacent posts from the top wire of one post to the bottom wire of 2nd post. The diagonal wire will be inter woven with horizontal wires by fixing the odd rows of wires first, then the diagonal cross wires and lastly even rows of wires. The barbed wire shall be held by tearing the holes of 10 mm dia in the post and tied with G.I. wire, turn buckles and straining bolts shall be used at the end post, if so specified.

#### **16.17.5 Measurements**

This shall be as per 16.16.5.

#### **16.17.6 Rates**



The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of post struts turn buckle straining bolts and excavation and concrete in foundation for which separate payments shall be made under respective item. Angle iron post shall be paid as per similar item of subhead Steel work of IOCL Civil Specification 2023. No extra payment shall be made for making holes in angle and nothing shall be deducted on account of holes.

## **16.18 WELDED STEEL WIRE FABRIC FENCING WITH RCC POSTS**

### **16.18.1 Materials**

RCC posts and struts shall be as specified in 16.1.12. Welded steel wire fabric will conform to IS 4948 and shall be of rectangular mesh 75 × 25 mm size weighing not less than 7.75 kg/sqm

**16.18.2** Fixing of RCC posts and struts shall be as described in 16.16.3.

**16.18.3** Steel wire fabric 90 cm wide will be fixed to the posts by means of G.I. staple on wooden plugs or tied to 6 mm bar ribs with binding wire. The steel fabric shall be fixed to leave 15 cm clearance at the bottom and top of the posts.

### **16.18.4 Finishing**

The steel wire fabric shall be painted with two or more coats of approved shade of enamel paint over a coat of steel primer as for new work.

### **16.18.5 R.C.C. Posts, Rails and Pales (Fig. 16.10)**

**16.18.5.1 Materials:** R.C.C. posts, rails and pales shall be as described in 16.1.11 & 16.1.12.

**16.18.5.2 Spacing of Posts:** The spacing of post shall be as specified, or as directed by the Engineer- in-Charge to suit the dimensions of the area to be fenced.

**16.18.5.3 Fixing Posts:** Pits 45 x 45 cm and 70 cm deep or as directed shall first be excavated true to line and level to receive the posts.

**16.18.5.4 Fixing Rails and Pales:** The rails shall be slotted into the slots left in the posts, while the pales shall be simply dovetailed into the rails. The pales shall be fixed by pouring a little grout of 1.2 mix (1 cement : 2 fine sand) into the dovetails. The fencing shall be so erected that on completion is truly in line and level and top of the fence shall then follow approximately the profile of the ground.

### **16.18.6 Measurements**

Fencing to be measured in square metre correct to two places of decimal after taking length and width of the finished work in metre.

### **16.18.7 Rates**

As per item No. 16.16.6.

## **16.19 ENGRAVING LETTERS IN HARD STONES (FIG. 16.5 & 16.6): DELETED**

## **16.20 BOUNDARY STONES (HARD STONE) (FIG. 16.4): DELETED**

## **16.21 PRECAST RCC BOUNDARY STONE (FIG. 16.4)**

**16.21.1** RCC Boundary stones shall be manufactured as per standard design or as specified in item and directed by Engineer-in-Charge. These shall be of reinforced cement concrete 1:1 ½ : 3 (1 cement : 1 ½ coarse sand : 3 graded stone aggregate 20 mm nominal size), 90 cm high and 15 cm dia at the top and 20 cm. dia at bottom with necessary steel reinforcement as per standard design or as directed by the Engineer-in-Charge. The precast RCC Stones shall be finished smooth with cement mortar 1:3 (1 cement : 3 fine sand).



**16.21.2** Spacing, fixing, measurements and rate shall be as described in 16.20.

## **16.22 KILOMETERS STONES (FIG. 16.7): DELETED**

## **16.23 SURFACE DRESSING ON NEW SURFACE WITH HOT BITUMEN ONE COAT**

**16.23.1** This type of treatment shall consist of cleaning the existing water bound macadam kankar or gravel surfaces and applying one coat of hot bitumen on the prepared base, blinding it with stone chippings of 12.5 mm nominal size and consolidation with a road roller. This type of treatment is normally done for a road with light density rubber tyred traffic and roads for temporary construction. This treatment is also done on existing water bound macadam before applying the final surface treatment. In the latter case, after applying a coat of painting the road is thrown open to traffic till the road is consolidated. The final treatment is then given after making good the undulations etc. in the road surface.

**16.23.2** Preparation of surface (Repairs and Cleaning) shall be as specified under 16.24.2(a).

**16.23.3** Applying binder, blinding, consolidation, surface finishing, measurements and rates shall be as specified under 16.24 except that binder shall be applied at the rate of 2.25 kg per sqm and stone chippings of size 13.2 mm at 1.65 cum per 100 sqm unless otherwise specified.

## **16.24 SURFACE DRESSING ON NEW SURFACE USING HOT BITUMEN TWO COATS**

**16.24.0** This consists of the application of two coats of surface dressing each coat consisting of a layer of bituminous binder sprayed on a base prepared previously, followed by a cover of stone chippings properly rolled to form a wearing course. The existing water-bound macadam, kankar or gravel surface shall be cleaned thoroughly before application of bituminous binder. The work shall be carried out only when the atmospheric temperature in shade is 16 deg C or above. No bituminous material shall normally be applied when the road surface or material is damp, when the weather is foggy or rainy, or during dust storms.

### **16.24.1 Materials**

Binder shall be as specified and shall conform to Table 16.7 and stone chippings shall conform to grading as the Table 16.17. Unless otherwise specified or directed by the Engineer -in- Charge the quantities of materials shall be as specified in Table 16.17. A proper record will be kept to ensure that the daily out-turn of work is co-related with the quantity of bitumen used.

**TABLE 16.17**

Type of coat	Stone Chipping			Bitumen Quantity
	Nominal Size	Specification	Quantity	
First Coat	13.2 mm	100 per cent passing through IS sieve 22.4 mm square mesh and retained on IS Sieve 11.2 mm square mesh	1.5 cum/100 sqm	1.8 kg per sqm
Second coat	11.2 mm	100 per cent passing through IS sieve 13.2 mm square mesh and retained on IS sieve 5.6 mm square mesh	1.0 cum/100 sqm	1.1 kg per sqm

### **16.24.2 First Coat**

#### **a) Preparation of Surface**

*Repairs:* Pot holes or patches and ruts in the water bound macadam base or surface course which is to be surface treated, shall be repaired by removal of all loose and defective material by cutting in





rectangular patches and replacement with suitable material. For the purpose of repairs the area of pot holes shall be taken upto 0.75 sqm and depth upto 5 cm. All pot holes, patches and ruts upto 2.5 cm deep shall be repaired and brought to level with premix and properly consolidated while those of depths greater than 2.5 cm shall be repaired with similar specifications as adopted originally.

**Cleaning:** Prior to the application of the binder, all dust, dirt, caked mud, animal dung, loose and foreign material etc. shall be removed 30 cm on either side, beyond the full width to be treated, by means of mechanical sweepers and blowers, if available or otherwise with wire brushes, small picks, brooms etc. The material so removed shall be disposed off as directed by the Engineer-in-Charge.

For a water bound macadam surface, the interstices between the road metal shall be exposed upto a depth of about 10 mm by means of wire brushes. The surface shall then be brushed with soft brooms to remove all loose aggregate. Finally the traces of fine dust which get accumulated while brushing shall be thoroughly removed from the surface by blowing with gunny bags.

The prepared surface shall be closed to traffic and maintained fully clean till the binder is applied.

#### **b) Applying Binder (Hot Bitumen)**

The binder shall be heated in a boiler to a temperature as specified under Table 16.7 for the grade used and maintained at the temperature, the use of a thermometer being essential.

The binder shall be applied evenly to the clean dry surface by means of a pressure sprayer at the rate specified. The binder shall be applied longitudinally along the length of the road and never across it. The edges of the binder surface shall be defined by wire or a rope stretched in position.

Heating in cut out drums and pouring from perforated tins, cans and such other methods shall not be permitted. Except in the case of petty works and repairs with the specific approval of the Engineer-in-Charge.

Excessive deposits of binder caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

#### **c) Blinding or Spreading Stone Chippings**

Immediately after the binder is applied and while it is still hot, stone chippings free from dust and in a dry and clean state shall be spread evenly over the surface at the rate specified above. Spreading shall be done preferably by means of a mechanical gritter, otherwise manually with a twisting motion to avoid segregation which otherwise shall have to be removed by brushing the excess stone chippings over the surface into hungry spots to obtain a uniform surface, free from waviness, depressions and other irregularities. The surface shall be checked by means of a camber board laid across the road and a three metre straight edge laid parallel to the centre line of the road, and undulations if any shall be corrected by addition or removal of blindage till a surface free from undulation is obtained.

If a uniform surface is assured at this stage, the completed surface should be normally free from undulations and unevenness.

#### **d) Consolidation of Blindage**

Immediately following the application of the stone chippings and light brooming, the road surface shall be compacted by a power roller of 6 to 8 tonnes, starting at edges and working towards the centre (or to the outside edge in case of superelevated curve). Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The roller shall be worked or started and stopped without jerks and shall not be stopped or reversed each time at the same location to cause displacement of stone and other irregularities. Consolidation shall be considered complete when the stone chippings are firmly embedded.





Generally five to six trips shall be made for thorough compaction of the surface or as may be specified by the Engineer-in-Charge. Along kerbs, manholes and all places not accessible to the roller, compaction shall be secured by means of steel rammers or hand rollers.

### **16.24.3 Second Coat**

**Cleaning the Road Surface:** The surface shall be examined and any loose material and foreign matter shall be removed by brooming or blowing off by fanning with gunny bags, care being taken not to loosen the blinding already set.

**Applying Binder (Hot Bitumen):** The second coat of binder shall be applied immediately after the blinding has been set and the surface has been cleaned. The binder shall be applied at the specified rate in the manner specified for the first coat 16.24.2(b).

**Blinding or Spreading Stone Chippings:** Immediately after the second application of binder, the stone chippings shall be spread at the specified rate in the manner described in 16.24.2(c).

**Consolidation of Blinding:** The specifications described in 16.24.2(d) shall apply. Further the prepared finished surface shall be protected from traffic for 24 hours or such period as may be specified by the Engineer-in-Charge.

### **16.24.4 Surface Finishing**

The finished surface shall be uniform and conform to the lines, grades and typical cross-sections shown in the drawings.

**16.24.5** The finished surface shall be thrown open to traffic on the following day. Controlling traffic shall be done by suitable methods like barricading posting of watchman etc.

### **16.24.6 Measurements**

The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal. For record purposes, the measurement for binder and stone chippings shall be taken as specified in

16.4.2 and 16.4.3 before they are actually used on the work. Premeasurements of materials taken for record purposes shall simply serve as a guide and shall not form the basis for payment.

### **16.24.7 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above, except for repairs described under 16.24.2.

## **16.25 SURFACE DRESSING ON OLD SURFACE WITH HOT BITUMEN ONE COAT**

**16.25.1** This treatment consists of cleaning old painted surfaces and applying a coat of hot bitumen on the prepared base, blinding with stone chippings and consolidation with road roller.

### **16.25.2 Materials**

Binder shall be as specified and conform to Table 16.7 stone chipping shall conform to grading given Table 16.17 for 11.2 mm. Unless otherwise specified or directed by the Engineer-in-Charge stone Chippings of 11.2 mm nominal size shall be used @ 1.5 cum per 100 sqm area and bitumen @ 1.95 kg per square metre area. A proper record shall be kept to ensure that the daily turn out of work is correlated with the quantity of bitumen used.

**16.25.3** Preparation of Surface (Repairs and cleaning) shall be as specified under 16.24.2.

**16.25.4** Applying binder, Blinding, Consolidation, Surface Finishing, Measurement and Rate shall be as specified under 16.24 except that the binder and chippings shall be applied at the rate specified above.



## **16.26 SURFACE DRESSING ON NEW SURFACE WITH BITUMEN EMULSION-ONE COAT**

**16.26.0** This treatment consists of cleaning the existing water bound macadam, kankar gravel or stabilized base and other black top surfaces, applying a coat of bitumen emulsion at atmospheric temperature, blinding it with stone chippings including consolidation with a road roller.

This type of treatment is normally applied under damp conditions and for minor repair works during rainy season for roads with medium density, rubber tyred traffic such as service roads. This treatment is also done on existing water bound macadam before applying the final surface treatment. In the latter case, the road is consolidated. The final treatment is then given after making good the undulations depressions etc. in the road surface.

### **16.26.1 Materials**

Binder shall be as specified and shall conform to RS grade IS 8837. Stone chipping of 13.2 mm size shall conform to Table 16.17. Unless otherwise specified or directed by the Engineer-in-Charge 13.2 mm stone chippings shall be used @ 1.5 cum per 100 sqm area and bitumen @ 1.95 kg/sqm area. A proper record shall be kept to ensure that the daily out turn of work is correlated with the quantity of bitumen used.

### **16.26.2 Preparation of Surface**

The specification described in 16.24.2 (a) shall apply except that the binder used for patch repairs etc. shall be bitumen emulsion.

### **16.26.3 Applying Binder**

The specification described in 16.24.2 (b) shall apply except that bitumen emulsion is not heated in boilers but it shall be spread at atmospheric temperature at the specified rate. In case the road surface is very dry the surface shall be very lightly sprinkled with water just before applying the binder.

**16.26.4** Blinding including consolidation, Measurements and Rate shall be as specified under 16.24 except that the stone chippings shall be spread at the specified rate immediately after the bitumen emulsion on application breaks i.e. changes colour from brown to black.

## **16.27 SURFACE DRESSING ON OLD SURFACE WITH BITUMEN EMULSION-ONE COAT**

**16.27.1** This treatment consists of cleaning old painted surfaces and applying a coat of bitumen emulsion on the prepared base, blinding with stone chippings and consolidation with a road roller. This type of treatment is normally done under damp conditions.

### **16.27.2 Materials**

Binder shall be as specified and shall conform to RS grade IS 8837. Unless otherwise specified or directed by the Engineer- in-Charge 11.2 mm the stone chippings shall be used @ 1.10 cum per 100 sqm area and bitumen @ 1.22 kg per sqm area. A proper record shall be kept to ensure that the daily out turn of work is correlated with the quantity of bitumen used.

**16.27.3** Preparation of surface shall be as specified in 16.24.2 (a) except that the binder used for patch repairs etc. shall be bitumen emulsion.

**16.27.4** Applying binder, bitumen emulsion, blinding or Spreading to it including consolidation of blindage, measurement etc. shall be as specified under 16.24 except for preparation of surface and that the binder and stone chippings shall be used at the rates prescribed in 16.26.1.

## **16.28 TACK COAT OF HOT STRAIGHT RUN BITUMEN**

**16.28.1** The rate of application of binder which shall be as specified and which shall conform to 16.1.5 shall depend on the surface on which the premix carpet is to be laid.

a) 0.75 kg/sqm on W.B.M. surface.



b) 0.50 kg/sqm on existing black topped surface.

#### 16.28.2 Materials

**Bitumen:** This shall be straight-run bitumen of penetration value 80/100 conforming to IS 73 specifications.

#### 16.28.3 Preparation of Surface

#### 16.28.4 Cleaning

Prior to the application of bitumen, all vegetation, loose sealing compound, caked mud, animal dung, dust, dirt and foreign material shall be removed from the entire surface of the pavement and from existing dummy, construction and expansion joints (wherever existing) by means of mechanical sweepers and blowers, otherwise with steel wire brushes, small picks, brooms or other implements as approved by the Engineer-in-Charge. The material so removed shall be disposed off as directed by the Engineer-in-Charge.

#### 16.28.5 Weather and Seasonal Limitations

The tack coat shall not be applied nor any bitumen work done during rainy weather or when the surface is damp or wet or when the atmospheric temperature in the shade is not more than 160 deg. C.

#### 16.28.6 Application of Tack Coat

**16.28.6.1 Heating:** Bitumen shall be heated in a boiler to a temperature of 165 deg. C to 175 deg. C and maintained at that temperature. Temperature shall be checked at regular intervals with the help of a thermometer.

**16.28.6.2 Application of Bitumen:** Hot bitumen shall be applied evenly to the clean, dry surface by means of a pressure sprayer at specified rate. Even and uniform distribution of bitumen shall be ensured. Bitumen shall be applied longitudinally along the length of the pavement and never across it. Excessive deposits of bitumen caused by stopping or starting of the sprayer or through leakage or any other reason shall be suitably rectified.

#### 16.28.7 Measurements

Length and breadth shall be measured correct to a cm, along the surface of pavement. Area shall be worked out in sqm correct to two places of decimal.

#### 16.28.8 Rate

Rate shall include the cost of all materials and labour involved in all the operations described above.

### 16.29 TACK COAT WITH BITUMEN - EMULSION

#### 16.29.1 Scope

The work shall consist of the application of single coat of low viscosity liquid bituminous material to existing bituminous, cement concrete or primed granular surface preparatory to the superimposition of a bituminous mix, as specified in the contract or as instructed by the Engineer-in-Charge.

#### 16.29.2 Materials

The binder used for tack coat shall be either cationic bitumen emulsion (RS1) complying with IS:8887 or suitable low viscosity paving bitumen of VG 10 grade conforming to IS:73. The use of cutback bitumen RC:70 as per IS:217 shall be restricted only for sites at sub-zero temperatures or for emergency applications as directed by the Engineer-in-Charge. The type and grade of binder for tack coat shall be as specified in the contract or as directed by the Engineer-in-Charge.

#### 16.29.3 Construction



#### 16.29.3.1 Equipment

The tack shall be applied by a self propelled or towed bitumen pressure sprayer, equipped for spraying the material uniformly at specified rate. Hand spraying shall not be permitted except in small areas, inaccessible to the distributor, or narrow strips, shall be sprayed with a pressure hand sprayer, or as directed by the Engineer-in-Charge.

#### 16.29.4 Preparation of Base

The surface on which the tack coat is to be applied shall be clean and free from dust, dirt and any extraneous material, and be otherwise prepared in accordance with the requirements. The granular or stabilized surfaces shall be primed as per Para 16.65 clause (priming coat) immediately before the application of the tack coat, the surface shall be swept clean with a mechanical broom, and high pressure air jet, or by other means as directed by the Engineer-in-Charge.

##### 16.29.4.1 Application of Tack Coat

The application of tack coat shall be at the rate specified in Table 16.17A and it shall be applied uniformly. If rate of application of tack coat is not specified in the contract, then it shall be the rate specified in Table 16.17A. No dilution or heating at site RS1 bitumen emulsion shall be permitted. Paving bitumen if use for tack coat shall be heated to appropriate temperature in bitumen boilers to achieve viscosity less than 2 poise. The normal range of spraying temperature for a bituminous emulsion shall be 20 C to 70 C and for cutback, 50 C to 80 C. The method of application of tack coat will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed or forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

**Table 13.17A**

**Rate of application of tack coat**

Type of Surface	Rate of Spray of Binder in Kg per sq.m
Bituminous surfaces	0.20-0.30
Granular surfaces treated with primer	0.25-0.30
Cement concrete pavement	0.30-0.35

##### 16.29.4.2 Curing of Tack Coat

The tack coat shall be left to cure until all the volatiles have evaporated before any subsequent construction is started. No plant or vehicles shall be allowed on the tack coat other than those essential for the construction.

##### 16.29.4.3 Measurement of Payment

Tack coat shall be measured in terms of surface area of application in square metres.

##### 16.29.4.4 Rate

The contract unit rate for tack coat shall be payment in full for carrying out the required operations including for all components i.e. labour, equipments and machinery as described above.

#### 16.30 PREMIX CARPET WITH HOT BITUMEN

This type of treatment is normally applied on roads where the motor traffic is of medium intensity, but bullock cart traffic is fairly heavy. This treatment is suitable for district roads and for internal and service road in colonies. The consolidated thickness of this type of treatment shall be 2 cm or 2.5 cm as specified.



This treatment consists of applying a tack coat on the prepared base followed immediately by spreading aggregates pre-coated with specified binder to camber and consolidated. Premix carpet shall not be laid during rainy weather or when the base course is damp or wet or, when the atmospheric temperature in the shade is not more than 16oC.

#### 16.30.1 Preparation of Surface

This shall be done as described in 16.26.

#### 16.30.2 Materials

Grading of stone chipping shall be as per Table 16.17. Binder shall be as specified and shall conform to Table 16.7. Quantities of materials shall be as given in Table 16.18. A proper record shall be kept to ensure that the daily out turn of work is correlated with the quantity of bitumen used.

**TABLE 16.18**

Consolidated thickness of premix carpet	Binder Hot Bitumen	Stone Chippings	
		(in cum/100 sqm) 13.2 mm size	11.2 mm size
2.00 cm	(52 kg/cum of 13.2 mm size and 56 kg per cum of 11.2 mm	1.8	0.90
2.50 cm	-Do-	2.25	1.12

#### 16.30.3 Tack Coat

The rate of application of binder for tack coat shall be as specified. The rate will be depending upon the surface on which the premix carpet is to be laid i.e. water bound macadam surface or existing black topped surface. Tack coat shall be applied as described in 16.28.

#### 16.30.4 Preparation of Premix

The aggregate shall be dry and suitably heated to temperature as directed by Engineer-in-Charge before these are placed in the mixer to facilitate mixing with the binder. Mixers of approved type shall be employed for mixing the aggregates with the bituminous binder.

The binder shall be heated to the temperature appropriate to the grade of bitumen approved by the Engineer-in-Charge, in boilers of suitable design avoiding local overheating and ensuring a continuous supply.

The aggregates shall be dry and suitably heated to a temperature as directed by Engineer-in- Charge before these are placed in the mixer. After about 15 seconds of dry mixing, the heated binder shall be distributed over the aggregates at the rate specified.

The mixing of binder with chippings shall be continued until the chippings are thoroughly coated with the binder. The mix shall be immediately transported from the mixer to the point of use in suitable vehicles or wheel barrows. The vehicles employed for transport shall be cleaned and be covered over in transit if so directed.

#### 16.30.5 Spreading and Rolling

The premixed material shall be spread on the road surface with rakes to the required thickness and camber or distributed evenly with the help of a drag spreader, without undue loss of time. The camber shall be checked by means of camber boards and inequalities evened out. As soon as sufficient length of bituminous material has been laid, rolling shall commence with 6 to 9 tonne power rollers, preferably of smooth wheel tandon type, or other approved plant power roller. Rolling shall begin at the edges and



progress towards the centre longitudinally. Except on the super elevated portions rolling shall progress from the lower to upper edge, parallel to the centre line of the pavement. The consolidated thickness shall not at any place be less than the specified thickness by more than 25%. However, the average thickness shall not be less than that specified in the item.

When the roller has passed over the whole area once, any high spots or depressions which become apparent shall be corrected by removing or adding premixed materials. Rolling shall then be continued until the entire surface has been rolled to compaction and all the roller marks eliminated. In each pass of the roller, preceding track shall be overlapped uniformly by at least 1/3 width. The roller wheels shall be kept damp to prevent the premix from adhering to the wheels and being picked up. In no case shall fuel/lubricating oil be used for this purpose.

Rollers shall not stand on newly laid material as it may get deformed thereby. The edges along and transverse of the carpet, laid and compacted earlier shall be cut to their full depth so as to expose fresh surface which shall be painted with a thin surface coat of appropriate binder before the new mix is placed against it.

Further, the prepared finished surface shall be protected from traffic for 24 hours or such period as may be directed by the Engineer-in-Charge.

#### 16.30.6 Surface Finishing

The surface regularity both in longitudinal and transverse directions shall be within the tolerances specified in Table 16.19.

**TABLE 16.19**

Longitudinal profile Max. permissible undulation when measured with 3 M straight edge	Cross profile Max. permissible variation from specified profile when measured with a camber template
10 mm	6 mm

The longitudinal profile shall be checked during rolling with a three metres long straight edge and graduated wedge at the middle of each traffic lane along the road. Similarly the transverse profile shall be checked with adjustable templates at intervals of 10 metres.

#### 16.30.7 Rectification

Where the surface irregularity fall outside the specified tolerances limit the contractor shall be liable to rectify it to the satisfaction of Engineer-in-Charge by adding fresh material and recompacting to specifications where the surface is low. Where the surface is high the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications.

#### 16.30.8 Measurements

The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal.

For record purposes, the measurement for binder and stone chippings shall be taken as specified in 16.4.2.2 and 16.4.3.2 before they are actually used on the work. Premeasurements of the materials taken for record purposes shall simply serve as a guide and shall not form the basis for payment.

#### 16.30.9 Rate

The rate shall include the cost of materials, machinery and labour involved in all the operations described above for the particular item, except for the cost of Repairs described under para 16.24.2(a).



### 16.31 PREMIX CARPET WITH BITUMEN EMULSION

This type of work is not ordinarily recommended but may be done in case of urgent repairs under damp conditions.

#### 16.31.1 Materials

Binder shall be as specified and shall conform to RS grade as per IS 8837 grading of 11.2 mm stone chipping shall be as per Table 16.17. Quantities of bitumen emulsion and stone chippings shall be as specified in Table 16.20. A proper record shall be kept to ensure that the daily out turn of work is correlated with the quantity of bitumen used.

**TABLE 16.20**

**Bitumen Emulsion**

Consolidated thickness of premix Carpet	Bitumen Emulsion	Stone Chippings
	For Carpet in kg/cum of chippings	cum per 100 sqm
2 cm	96	2.4 (11.2 mm nominal size)
2.5 cm	96	3.0 (11.2 mm nominal size)

**16.31.2** Preparation of surface and binder application shall be as specified under 16.26 except that the rate of application of bitumen for tack coat shall be 0.75 kg per sqm on water bound macadam surface and 0.5 kg per sqm on black topped surface.

**16.31.3** Preparation, spreading, consolidating mix, surface finishing, measurements and rate shall be as specified under 16.30 except that the bitumen emulsion shall not be heated but it shall be poured over the aggregate at atmospheric temperature at the correct rate before spreading on the road surface. The rolling shall commence 24 hours after spreading the mixture. The surface shall be protected by a suitable device such as barricading and posting of watchmen for closing the traffic.

### 16.32 BITUMINOUS PENETRATION MACADAM

#### 16.32.0 Scope

The work shall consist of construction of one or more layers of compacted crushed coarse aggregates with alternate applications of bituminous binder and key aggregates in accordance with the requirements of these specifications to be used as a base course on roads, subject to the requirements of the overall pavement design, in conformity with the lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-Charge. Thickness of an individual course shall be 50 mm or 75 mm or otherwise as specified.

#### 16.32.1 Materials

**16.32.1.1 Bitumen:** The binder shall be paving bitumen of specified penetration grade conforming to IS 73 or approved cutback satisfying the requirement of IS 217 or 454 as specified in item. The actual grade of bitumen or cutback to be used shall be as specified in item or as directed by the Engineer-in-charge.

**16.32.1.2 Aggregates:** The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm IS sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious matter. Where the contractors selected source of aggregate have poor affinity for bitumen, as a condition for approval of the source, the bitumen shall be treated with approved anti-stripping agents, as per the manufacturers recommendations, without





additional payment. Before approval of the source the aggregate shall be tested for stripping. The coarse aggregate shall conform to Table 16.31. The coarse and key aggregates shall conform to the grading given in Table 16.21.

**16.32.1.3 Quantities of Material:** The quantities of materials used for this work shall be as specified in Table 16.21.

## 16.32.2 Construction Operations

**16.32.2.1 Weather and Seasonal Limitations:** Laying shall be suspended while free standing water is present on the surface to be covered, or during rains, fog and dust storm. After rain, the bituminous surface, tack coat shall be blown off with a high pressure of air jet to remove excess moisture, or the surface left to dry before laying shall start. Laying of bituminous mixture shall not be carried out when the air temperature at the surface on which it is to be laid is below 10°C.

**16.32.2.2 Equipment:** A mechanical broom, compressor, self propelled or trailed bitumen heater/distributor, mechanical aggregate spreader and 8 to 10 tonne smooth steel wheel roller or vibrating roller are required for the preparation of Penetration Macadam.

**16.32.2.3 Preparation of the Base:** The base on which the Penetration Macadam Course is to be laid shall be prepaid, shaped and compacted to the specified lines, grades and sections as appropriate or directed by Engineer-in-Charge. A prime coat, where specified shall be applied over the base as directed by the Engineer-in-charge.

**16.32.2.4 Spreading Coarse Aggregate:** The coarse aggregate shall be dry and clean and free from dust, and shall be spread uniformly and evenly at the rate specified in Table 16.21. It shall be spread by a self-propelled or tripper tail mounted aggregate spreader capable of spreading aggregate uniformly at the specified rates over the required widths. The surface of the layer shall be carefully checked with camber templates to ensure correct line and level and cross fall. The spreading shall be carried out such that the rolling and penetrating operations can be completed on the same day. Segregated aggregates or aggregates contaminated with foreign material shall be removed and replaced.

**TABLE 16.21**

**Composition of Penetration Macadam**

IS Sieve Designation (mm)	Cumulative percent by weight of total aggregate passing			
	For 50 mm compacted Thickness		For 75 compacted Thickness	
	Coarse Aggregate	Key Aggregate	Coarse Aggregate	Key Aggregate
(1)	(2)	(3)	(4)	(5)
63	-	-	100	-
45	100	-	58-82	-
26.5	37-72	-	-	100
22.4	-	100	5-27	50-75
13.2	2-20	50-75	-	-
11.2	-	-	-	5-25
5.6	-	5-25	-	-
2.8	0-5	0-5	0-5	0-5





Approx. Loose Aggregate quantities cm/m <sup>2</sup>	0-06	0.015	0.09	0.018
Binder Quantity (Penetration Grade) (1) (Kg/m <sup>2</sup> )	As specified in item		As specified in item	

Note: (1) If cutback bitumen is used, adjust binder quantity such that the residual bitumen is equal to the values in this table.

**16.32.2.5 Compaction:** After the spreading of course aggregates, dry rolling shall be carried out with an 8-10 tonne smooth steel wheel roller. After initial dry rolling the surface shall be checked with a crown and 3 metre straight edge. The surface shall not vary more than 10 mm from the template or straight edge. All surface irregularities exceeding the above limit shall be corrected by removing or adding aggregate as required the rolling shall continue until the compacted coarse aggregate has a firm surface, true to cross-section shown on the plans and has a texture that will allow free and uniform penetration of the bitumen material.

Compaction shall be done as per following procedure.

Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the centre longitudinally except that on super elevated and unidirectional cambered uni-directional cambered portions, it shall progress from the lower to the upper edge parallel to the centre line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8-10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8-10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a type pressure of at least 5.6 kg/sqcm. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers.

Where compaction is to be determined by density of cores the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperature above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used.

Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic-tyred roller, at least the nominal width of 300 mm.

In portions with super-elevated and uni-directional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge.



Rollers should move at a speed of not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing. The wheels of rollers shall be kept moist with water and the spray system provided with the machined shall be in good working order, to prevent the mixture from adhering to the wheels. Only sufficient moisture to prevent adhesion between the wheels of rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

After initial dry rolling, the surface shall be checked with a crown template and a 3 metre straight-edge. The surface shall not vary more than 10mm from the template or straight-edge. All surface irregularity exceeding the above limit shall be corrected by removing or adding aggregates as required.

The rolling shall continue until the compacted coarse aggregate has a firm surface true to the cross section shown on the plans and has a texture that will allow free and uniform penetration of the bitumen material.

**16.32.2.6 Application of Bituminous Material:** After the coarse aggregate has been rolled and checked, the bituminous binder shall be applied at the rate given in Table 16.21, at a temperature directed by Engineer-in-Charge.

At the time of applying the binder, the aggregates shall be surface dry for the full depth of the layer.

In certain circumstances, depending on the type and size of aggregate used, the Engineer-in-Charge may direct the placing of a bed of clean sand or quarry fines, not exceeding 10 mm in thickness, on the prepared foundation before placing the coarse aggregate. The sand or fine material shall be slightly wetted, just sufficient for it to slurry up during the compaction process. Where cut back is used, if flooding of the binder occurs it should be applied in two operations, or as directed by the Engineer-in-charge.

**16.32.2.7 Application of Key Aggregates:** Immediately after the first application of bitumen, the key aggregates, which shall be clean, dry and free from dust shall be spread uniformly over the surface by means of an approved mechanical spreader or by approved manual methods at the rate specified in Table 16.21.

Where directed by the Engineer-in-charge, the surface shall be swept and the quantity of key aggregate adjusted to ensure uniform application, with all the surface voids in the coarse aggregate being filled without excess. The entire surface shall then be rolled with a 8- 10 tonnes smooth steel wheel roller (or vibrating roller operating in non-vibratory mode) in accordance with the procedure specified in above para 16.32.2.5.

### 16.32.3 Surface Finish and Quality Control

The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH specifications.

### 16.32.4 Surfacing

The penetration Macadam shall be provided with a surfacing (binder/wearing course) within a maximum of forty-eight hours. If there is to be any delay, the penetration macadam shall be covered by a seal coat as specified and directed by Engineer-in-charge. The seal coat in such cases shall be considered incidental to the work and shall not be paid for separately.

### 16.32.5 Arrangements for Traffic

During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of Engineer-in-Charge.

### 16.32.6 Measurement for Payment



Penetration Macadam base course shall be measured as finished work in square metres.

#### 16.32.7 Rate

The rate includes the cost of all materials, labours and equipment involved in all the operations described above.

### 16.33 BITUMEN MASTIC WEARING COURSES

#### 16.33.1 Definition

The bitumen mastic is an intimate homogeneous mixture of mineral fillers and well graded fine and coarse aggregates with a hard grade bitumen, cooked and laid hot, troweled and floated by means of a wooden float. The mixture settles to a coherent, voidless and impermeable solid mass under normal temperature conditions.

The bitumen mastic is normally used as a wearing course. Over the mastic laid surface, hard stone chips pre-coated with bitumen are grafted or spread and rolled to provide a skid resistant surface.

Bitumen mastic is used as a wearing course in different situation of heavy duty road pavements. However, use of this material is not recommended in places where abundant fuel oil dripping is expected on the pavement surfaces like bus depots, fuel filling and service stations etc.

#### 16.33.2 Materials

**16.33.2.1** The bitumen shall be industrial bitumen conforming to IS 702 of grade 85 /25 or suitable consistency satisfying the requirements of physical properties as given in Table 16.22.

**TABLE 16.22**

**Physical Properties of Bitumen**

S.No.	Characteristics	Requirements	Method of Test
1.	Penetration at 25 deg. C in 1/10 mm	15 ± 5	IS 1203
2.	Softening point (R&B)	65 ± 10	IS 1205
3.	Ductility at 27 deg.C (Minimum in cms.)	3	IS 1208
4.	Loss on heating, per cent (Maximum)	2	IS 1212
5.	Solubility in trichloroethylene per cent by mass (minimum)	95	IS 1216
6.	Ash (mineral matter) %age by mass	1.0	IS 1217

**16.33.2.2 Coarse Aggregates:** The coarse aggregates shall consist of clean, hard, durable, crushed rock free of disintegrated pieces, organic and other deleterious matter and adherent coatings. They shall be hydrophobic, of low porosity, and satisfy the physical requirements set forth in Table 16.23.

**TABLE 16.23**

**Physical Requirements of Coarse Aggregates for Bitumen Mastic**

S. No	Test	Test Method	Acceptance Criteria
1.	Los Angeles Abrasion Value or	IS 2386 (Pt.IV) -do-	40% (Max.) or 30% (Max.)



	<i>Aggregate impact value</i>		
2.	<i>Flakiness Index</i>	<i>IS 2386 (Pt.I)</i>	<i>30% (Max)</i>
3.	<i>Stripping Value</i>	<i>IS 6241</i>	<i>25% (Max)</i>
4.	<i>Soundness</i>		
	<i>(i) Loss with Sodium Sulphate 5 cycles</i>	<i>IS 2386 (Pt.V)</i>	<i>12% (Max)</i>
	<i>(ii) Loss with Magnesium Sulphate 5 cycles</i>	<i>-do-</i>	<i>18%(Max)</i>
5.	<i>Water Absorption</i>	<i>IS 2386 (Pt.III)</i>	<i>2% (Max)</i>
6.	<i>Retained tensile strength</i>	<i>-</i>	<i>80% (Min)</i>

The percentage and grading of the coarse aggregates to be used in the bitumen mastic depending upon the thickness of the finished course shall be as in Table 16.24. The minimum and maximum thickness of the bitumen mastic for wearing course shall be 25 mm and 50 mm respectively except for footpaths of bridges where it shall be 20 mm and 25 mm respectively.

**TABLE 16.24**

**Grading and Percentage of Coarse Aggregates for Bitumen Mastic in Wearing Course and Footpath**

S. No	Type of work	Grading of coarse aggregate		Thickness of finished mastic surface course	Percentage of coarse aggregates (mm)
		IS Sieve	%age passing IS sieve		
1.	Wearing course for road pavement and bridge decks	19 mm	100	(a) 25-40	(a) 30-40
		13.2 mm	88-96	or	or
		2.36 mm	0-5	(b) 41-50	(b) 40-50
2.	Footpaths	6.7 mm	100	20-25	15-30
		600 micron	0.15		

**16.33.2.3 Fine Aggregates:** The fine aggregates shall consist of crushed hard rock or natural sand or a mixture of both. The grading of fine aggregates inclusive of filler material passing 75 micron shall be as given in Table 16.25.

**TABLE 16.25**

**Grading of Fine Aggregate I/C Filler**

Passing IS Sieve	Retained on IS Sieve	% age by Weight
2.36 mm	600 micron	0-25
600 micron	212 micron	10-30
212 micron	75 micron	10-20



75 micron	—	30-50
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**16.33.2.4 Filler:** The filler shall be limestone powder passing 75 micron and shall have a calcium carbonate content of not less than 80 per cent when determined in accordance with IS 1514.

### 16.33.3 Equipment for Bitumen Mastic

**16.33.3.1** There are two ways of preparing a mastic. The conventional method is by using a mastic cooker which is dealt with in this specification. The other method using fully mechanized units needed for large scale work, as is generally practiced in Germany (Gussasphalt), may form the subject of a separate document.

**16.33.3.2** Mastic cooker are very similar to tar boilers. These are insulated tanks mounted on wheeled chassis. The heating of the bitumen and material is generally done by oil fired burners. Mastic cookers have compartments. The central and main compartment is used for heating bitumen and for preparing the mix. The side pockets or compartments are meant for pre-heating of the coarse and fine aggregates. Since heating is by oil fired burners, the temperature can be easily controlled by controlling the flames or supply of the fuel.

**16.33.3.3** Mastic cookers of various capacities ranging from 1/2 tonne to 3 tonne are used depending on the amount of work involved. These are not being marketed commercially because it is not a common specification but can be easily got made from manufactures of tar boilers.

Fig. 16.13 indicates the broad details of equipment and components of cooker presently in common use.

**16.33.3.4** Apart from mastic cooker, the following equipments are required for transportation and laying.

- Wheel barrows and flat mortar pans (for short distance haul) and small dumpers (for long distance haul).
- Wooden trowels, heavy wooden floats, suitable hand tools gauge, straight edge and hand level.
- Angle irons, required to contain the mastic in desired width and thickness.

### 16.33.4 Manufacture of Bitumen Mastic

The manufacture of bitumen mastic involves different stages. Initially the filler alone shall be heated to a temperature of 175 deg. C to 210 deg. C in mechanically agitated mastic cooker and half the required quantity of bitumen heated at 175 deg. C to 180 deg. C added. They shall be mixed and cooked for one hour. After that the fine aggregates and the balance bitumen at 175 deg. C to 180 deg. C shall be added to that mixture in the cooker and heated upto 175 deg. C to 200 deg. C and further mixed for another one hour. In the final stage, the coarse aggregates shall be added and heating of mix shall continue for another one hour. Thus a total period of minimum three hours will be needed to prepare the mastic. During mixing and cooking, care shall be taken to ensure that the contents in the cooker are at no time heated to a temperature exceeding 210 deg. C.

**16.33.4.1** In case the material is not required for immediate use, the bitumen mastic with filler, fine aggregates and bitumen shall be cast into blocks each weighing about 25 kg. The bitumen mastic blocks (without coarse aggregates) shall show on analysis a composition with the limits as given in Table 16.26. These blocks when intended to be used subsequently shall be transported to site, broken into pieces of size not exceeding 60 mm cube and remelted in the cooker at a temperature ranging from 175 deg. C. to 210 deg. C thoroughly incorporating the requisite quantity of coarse aggregates as indicated in Table 16.26 and mixed continuously for at least an hour. Mixing shall be continued until the laying operations are completed so as to maintain the coarse aggregates in suspension. At any stage the temperature during the process of mixing shall not exceed 210 deg. C.

**TABLE 13.26**



### Composition of Bitumen Mastic Blocks without Coarse Aggregates

IS Sieve		% age by weight	
Passing	Retained	Minimum	Maximum
2.36 mm	600 micron	0	22
600 micron	212 micron	4	30
212 micron	75 micron	8	18
75 micron	-	25	45
Bitumen content		14	17

#### 16.33.5 Hardness Number

The hardness number of bitumen mastic shall be determined at 25 deg. C in accordance with IS 5317 and with the method specified in Appendix D of IS 1195. It shall conform to the following requirements:

- (1) Without coarse aggregates at 25 deg. C      60-80
- (2) With coarse aggregates at 25 deg. C      10-20

#### 16.33.6 Laying the Bitumen Mastic

**16.33.6.1 Preparation of the Base:** The base on which bitumen mastic is to be laid shall be prepared, shaped and conditioned to the specified levels, grade and camber as directed. If the existing surface is too irregular and wavy, it shall be made good by providing a corrective course of bituminous concrete mix as per IRC:29. The surface shall be thoroughly swept clean and made free of dust and other deleterious matter. Spots rich in binder shall be scrapped and repaired. Under no circumstances the bitumen mastic sheet be spread on a base containing a binder which will soften under high application of temperature. If any such spot exists, the same shall be cut out and repaired before the bitumen mastic is laid. To receive and contain the mastic, angle irons of sizes 25 or 50 mm are placed at required spacing till finish of the job.

**16.33.6.2 Transportation of Mix:** When the bitumen mastic, duly prepared including addition of coarse aggregates at the manufacturing point, is to be transported over a long distance and delivered to the laying site, arrangements for transport shall be made in a towed mixer transporter with adequate provision for heating and stirring so as to keep the aggregates and filler suspended in the mix till the time of laying. However, for small works and where the laying site is near the manufacturing point, the mix can be transported in wheel barrows/flat mortar pans. To prevent the molten material from sticking to the wheel barrows/pans, the inside of the transport may be sprinkled with a minimum quantity of inorganic fine material like limestone dust. However, cement, ash or oil shall not be used.

#### 16.33.6.3 Laying of Mix

**16.33.6.3.1** The bitumen mastic shall be discharged into containers sprinkled with limestone dust or provided with lime-wash. The bitumen mastic shall be deposited directly on the prepared base immediately in front of the spreader where it is spread uniformly by means of wooden floats to the required thickness. The mix shall be laid in one metre widths confined between standard angle irons of size 25 mm to 50 mm to receive and contain the mastic of required thickness. The temperature of the mix at the time of laying shall be 175 deg. C. In case blowing takes place while laying the bitumen mastic, the bubbles shall be punctured while the mastic is hot and the surface made good. Since mastic asphalt is an expansive material, extreme care shall be taken while fixing the angle irons and their level checked with instrument at suitable intervals.





**16.33.6.3.2 Laying Bitumen Mastic Surfacing Over Old Existing Bridge Deck:** Before laying bitumen mastic over old existing bridge deck, the existing cross fall/camber, expansion joint members and water drainage spouts shall be carefully examined for their proper functioning in the bridge deck structure and any deficiency found shall first be removed. Loose elements in the expansion joint shall be firmly secured. The cracks in the concrete surface, if any, shall be repaired and filled up properly or replaced by new concrete of specified grade before laying the bitumen mastic over bridge deck.

**16.33.6.3.3 Laying over New Bridge Deck:** New concrete bridge deck which is not in camber/cross fall shall first be provided with required camber and cross fall by suitable concrete or bituminous treatment. In case of laying over concrete surface, following measures shall be taken:

- For proper bond with new concrete deck, surface shall be roughened by means of stiff broom or wire brush and it shall be free from ridges and troughs.
- A thin bituminous tack coat (with bitumen of grade 80/100) shall be applied on the concrete deck before pouring mastic. The quantity of bitumen for tack coat shall not exceed 5-6 kg per 10 sqm.
- On surface in longitudinal slope, after applying tack coat, chicken-mesh reinforcement of 1.5 mm dia steel wire with hexagonal or rectangular openings of 20-25 mm shall be placed and held properly in position on the concrete surface before pouring mastic.

#### 16.33.7 Joints

All construction joints shall be properly and truly made. These joints shall be made by warming the existing bitumen mastic by the application of an excess quantity of hot bitumen mastic which afterwards shall be trimmed off to make it flush with surface on the either side.

#### 16.33.8 Surface Finish

The bitumen mastic surfacing has got a very fine texture which on initial laying provides very little resistance to skidding. Therefore, the bitumen mastic after spreading and while still hot and in plastic condition shall be spread over with bitumen precoated fine grained hard stone chips/aggregates of approved quality of 13.2 mm size complying with quality requirement as per Table 16.27 depending upon the thickness of mastic, using bitumen at the rate of 2 to 3 percent of S-65 or S-90 grades and aggregates at the rate of 0.005 cum (1/200 cum) per 10 sqm. and at a spacing of 10 cm c/c in both directions and pressed into the surface when the temperature of bitumen mastic is between 80 deg. C. and 100 deg. C. Such precoated aggregates when laid should protrude 2 to 4 mm over the mastic surface. Flakiness index of stone aggregates used for anti-skid measures shall be less than 25 per cent. The addition of 2% filler complying with Table 16.28/16.30 may be required to enable the quantity of bitumen to be held without draining.

**TABLE 16.27**

Sl.N o.	Name of Test	I.S.Code	Acceptance Criteria
1.	Grain size analysis	IS 2386 Part I	Max. 5% passing IS sieve 75 microns
2.	Flakiness or elongation Index	IS 2386 Part IV	Max. 30% *
3.	Los Angeles Abrasion Value	-do-	Max. 30%
4.	Polished Stone Value	B.S. 812 (Part 114)	Min. 55
5.	Soundness Sodium Sulphate	IS 2386 (Part V)	Max. 12% Max. 18%



	<i>Magnesium Sulphate</i>		
6.	<i>Water absorption</i>	<i>IS 2386 Part III</i>	<i>Max. 2%</i>
7.	<i>Coating and stripping of bitumen aggregate mixture</i>	<i>IS 6241</i>	<i>Min retained coating 95%</i>
8.	<i>Water sensitivity retained tensile strength</i>	<i>AASHTO T 283</i>	<i>Min. 80% **</i>

The elongation test to be done only on non-flaky aggregate to the sample.

\*\* This test is only required if the maximum retained coating in the stripping test is less than 95%.

**TABLE 16.28**

<i>Sl. No.</i>	<i>IS Sieve (MM)</i>	<i>Cumulative percent passing by weight of total aggregate</i>
1.	0.6	100
2.	0.3	95-100
3.	0.075	85-100

The traffic may be allowed after completion of work when the bitumen mastic has cooled down to the ambient temperature.

### **16.33.9 Controls**

**16.33.9.1** Sieve analysis of each type of the aggregate used shall be made at least once a day to see that the gradation of the aggregates follows the original gradation as approved. Additional tests shall be carried out in case of variation in grading or receipt of supply of material from new source. The number of samples to be tested per day would depend upon the bulk supply of aggregates made in a day at the plant site. Physical properties such as aggregate impact values, flakiness index, water absorption etc. shall be determined at the rate of one test for every 25-50 cum of aggregates or as directed by the Engineer at site.

**16.33.9.2** Two sets of tests shall be carried out on each lot of supply of bitumen for checking penetration and softening point as per IS 1203 and IS 1205.

**16.33.9.3** For filler material calcium carbonate content and fineness shall be tested at the rate of one set of tests for each consignment subject to a minimum of one set of test per 5 tonne or part thereof.

**16.33.9.4** It shall be ensured that the aggregates are not wet before heating, otherwise it would affect the output adversely. During heating the aggregate temperature shall be recorded periodically to see that it does not exceed the limits prescribed.

**16.33.9.5** Material in block form shall be sampled by taking approximately equal amount in pieces, from not less than six blocks chosen at random. The total weight of specimen to be tested shall not be less than 5 kg. In case the preparation of the mix is at site, then at least one sample of every 10 tonne of bitumen mastic discharged from the mastic cooker or at least one sample for each cooker per day shall be collected and following tests done:

- Two specimens each of 10 cm dia or 10 cm square and 2.5 cm thick shall be prepared and tested for hardness number.
- Bitumen shall be extracted from about 1000 gm of the mastic sample and bitumen content determined as specified in Appendix C of IS 1195.





- c) A sieve analysis of the aggregates after the bitumen is extracted, shall be done and the gradation determined according to the procedure laid down in IS 2386 (Pt.I).

**16.33.9.6** The temperature of the bitumen mastic at the time of laying shall not exceed 210 deg. C and shall not be less than 175 deg. C.

**16.33.9.7** The longitudinal profile of the finished surface shall be tested with a straight edge 3 m long and transverse profile with a camber template while the mastic laid is still hot. Irregularities greater than 4 mm in the longitudinal and transverse profile shall be corrected by picking up the mastic in full depth and full area of the affected panel and relaying.

**16.33.9.8** Bitumen mastic shall not be laid on a damp or wet surface or when the atmospheric temperature in the shade is 15 deg. C or less.

**16.33.9.9 Measurements**

The length & breadth of the area where bitumen mastic wearing course of specified thickness has been provided shall be measured correct to a centimeter and the area shall be calculated in square metres correct to two decimal places.

**16.33.9.10 Rate**

The rate per square metre shall include cost of all the operations described above including anti-skid treatment mentioned in para 16.33.1 above.

**16.34 BITUMINOUS SHEET WITH HOT BITUMEN**

This type of treatment is normally done for garden paths, driveways, footpaths and playgrounds and roads. The treatment is also useful in providing a thin wearing course over existing cement concrete roads. This is sometimes capable of standing with very heavy traffic. This can also be used over worn out cement concrete pavements, the concrete surface is roughened before laying the binder coat. It is also useful as a corrosion resistant flooring in shade and godowns for storing salt, fertilizer etc. This treatment consists of a mixture of coarse sand and stone chippings with bituminous binder, spread and consolidated to a specified thickness on prepared surface after the application of a tack coat.

The consolidated thickness of this type of treatment shall be 2.5 cm or 4 cm, as specified. The work shall be carried out only when the atmospheric temperature in shade is 16 deg. C or above. No bituminous material shall normally be applied when the road surface or material is damp or when the weather is foggy or rainy, or during dust storms. Bitumen of specified grade and consistency to be used.

**16.34.1 Quantities of Materials**

The quantities of materials shall be as specified in Table 16.29.

**TABLE 16.29**

Consolidated thickness of bituminous sheet	Bitumen			Stone chippings cum/100 sqm	Coarse sand cum/100 sqm
	Kg/sqm of surface area (For Tack Coat)	Kg/sqm of stone chipping	Kg/sqm of sand		
2.5 cm	0.75	56	128	1.65*	1.65
4 cm	0.75	56	128	2.6*	2.6

\* 60% 12.5 mm Nominal size and 40% 10 mm Nominal size



A proper record shall be kept to ensure that the daily turn out of work is correlated with the quantity of bitumen used as per proforma prescribed in Appendix A.

**16.34.2** Preparation of surface and application of binder (tack coat) shall be as specified under 16.28.2 to 16.30.5.

Preparation of Mix, laying and Consolidation

**16.34.3** Para 16.30.4 and 16.30.5 shall generally apply except that the mixing shall be done in two stages. Stone aggregate of the correct standard size and in the proportion shown in table 16.29 shall be fed into the mixer to which 2/3 rd of the total specified quantity of bitumen heated to the appropriate temperature shall be added. When the stone metal is well coated, the sand in the specified proportion and then the balance 1/3rd quantity of total bitumen shall be fed into the mixer. Mixing shall be continued until a homogeneous mix is produced and all particles are uniformly coated with bitumen.

Any high spots or depressions which become apparent shall be corrected by addition or removal of premixed materials. The rolling shall continue until the maximum consolidation to the satisfaction of Engineer-in -Charge is obtained. The wheels of the roller shall be moistened with gunny bags to prevent the mixture from sticking to the wheel while rolling.

**16.34.4** Surface finishing and rectification shall be as specified under 16.30.6 and 16.30.7.

#### **16.34.5 Permitting Traffic**

Traffic shall be allowed on the road after a lapse of 24 hours to 48 hours after laying, as decided by the Engineer-in-Charge.

#### **16.34.6 Measurements**

The length and width of the finished work shall be measured correct to a cm along the finished surface of the road. The area shall be calculated in square metre, correct to two places of decimal.

For record purposes measurements for binder, stone aggregate, stone chippings and sand as described under 16.3 shall be taken before they are actually used on the work. Premeasurements shall simply serve as a guide and shall not form the basis for payment. The thickness of surface treatment shall be the ruling criterion for payment.

#### **16.34.7 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above.

### **16.35 SEAL COAT**

#### **16.35.1 Scope**

This work shall consist of the application of a seal coat for sealing the voids in a bituminous surface laid to the specified levels, grade and cross fall (camber).

#### **16.35.2 Seal coat shall be of either of the two types specified below:**

- a) Liquid seal coat comprising of an application of all layer of bituminous binder followed by a cover of stone chips.
- b) Premixed seal coat comprising of a thin application of the aggregate premixed with bituminous binder.

#### **16.35.3 Materials**

**16.35.3.1 Binder:** The binder and its quantity shall be a penetration bitumen of a suitable grade as specified in the item or as directed by the Engineer-in-charge.

**16.35.3.2 Stone Chips for Item 16.41 of D.S.R. 2007 of Seal Coat:** The stone chips shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They should be free of



soft or disintegrated stone, organic or other deleterious matter. Stone chips shall be of 6.7 mm size defined as 100 per cent passing through 11.2 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cubic metre per 100 square metre area. The stone chips shall satisfy the quality requirements in Table 16.31 bituminous except that the upper limit for water absorption value shall be 1 per cent.

**TABLE 16.30**

Sl. No.	I.S. Sieve (mm)	Cumulative % passing by weight of total aggregate
1.	0.6	100
2.	0.3	95-100
3.	0.075	85-100

**TABLE 16.31**

Sl. No.	Name of Test	I.S. Code	Acceptance Criteria
1.	Grain size analysis	IS 2386 Part I	Max 5% passing IS sieve 75 micron
2.	Flakiness and elongation Index	IS 2386 (Part IV)	Max 30%
3.	Los Angeles Abrasion Value	IS 2386 (Part IV)	Max 30%
4.	Polished stone value	B.S. 812 (part 114)	Min 55%
5.	Soundness	IS 2386 (Part V)	
	(a) Sodium sulphate		Max 12%
	(b) Magnesium sulphate		Max 18%
6.	Water absorption	IS 2386 (Part III)	Max 2%
7.	Coating and stripping of Bitumen aggregate mixture	IS 6241	Min retained coating 95%
8.	Water sensitivity retained tensile strength	AASHTOT 283	Min 80%

The elongation test to be done only on non-flaky aggregate on the sample.

\*\* This test is only required if the minimum retained coating in the stripping test is less than 95%.

**16.35.3.3 Fine Aggregate:** The aggregate shall be sand or grit and shall consist of clean, hard durable, uncoated dry particles and shall be free from dust, soft or flaky/elongated material, organic matter or other deleterious substances. The aggregate shall pass 2.36 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cubic metres per 100 square metres area. Stones or fine aggregate shall be used as specified in item.

#### 16.35.4 Construction Operations

**16.35.4.1** Weather and Seasonal Limitations: Ref. Item No. 16.32.2.1.



**16.35.4.2 Preparation of Surface:** The seal coat shall be applied immediately after laying the bituminous course which is required to be sealed. Before application of seal coat materials, the surface shall be cleaned free of any dust or other extraneous matter.

**16.35.4.3 Construction of Seal Coat with Stone Chips:** Bitumen shall be heated to 150oC - 163oC and sprayed at the rate specified on the dry surface in a uniform manner with a self-propelled mechanical sprayer

**16.35.4.4** Immediately after the application of binder, stone chips which shall be clean and dry, shall be spread uniformly at the rate specified on the surface preferably by means of a self –propelled or towed mechanical grit spreader so as to cover the surface completely. If necessary, the surface shall be brushed to ensure uniform spread of chips. Immediately after the application of the cover material, the entire surface shall be rolled with a 8-10 tonne smooth wheeled steel roller, 8-10 tonne static weight vibratory roller, or other equipment approved by the Engineer after laying trials if required. Rolling shall commence at the edges and progress towards the centre except in super elevated and unidirectional cambered portions where it shall proceed from the lower edge to the higher edge. Each pass of the roller shall uniformly overlap not less than one-third of the track made in the proceeding pass. While rolling is in progress, additional chips shall be spread by hand in necessary quantities required to make up irregularities. Rolling shall continue until all aggregate particles are firmly embedded in the binder and present a uniform closed surface.

**16.35.4.5 Construction of Seal Coat with Premixed Fine Aggregate:** A mixer of appropriate capacity and type approved by the Engineer-in-charge shall be used for preparation of the mixed material. The plan shall have separate dryer arrangements for heating aggregate.

The binder shall be heated in boilers of suitable design, approved by the Engineer-in-Charge to the temperature appropriate to the grade of bitumen or as directed by the Engineer-in -Charge. The aggregates shall be dry and suitably heated to a temperature between 150oC and 165oC or as directed by the Engineer-in-charge before these components are placed in the mixer. Mixing of binder with aggregates to the specified proportions shall be continued until the latter are thoroughly coated with the former.

The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed. As soon as a sufficient length has been covered with the premixed material, the surface shall be rolled with an 8-10 tonne smooth-wheeled roller. Rolling shall be continued until the premixed material completely seals the voids in the bituminous course and a smooth uniform surface is obtained.

#### **16.35.5 Opening to Traffic**

In the case of seal coat with premixed fine aggregate traffic may be allowed soon after final rolling when the premixed material has cooled down to the surrounding temperature. In the case of seal coat with stone chips traffic shall not be permitted to run on any newly sealed area until the following day. In special circumstances, however, the Engineer-in-charge may open the road to traffic immediately after rolling, but in such case traffic speed shall be rigorously limited to 16 km. per hour until the following day

#### **16.35.6 Measurement for Payment**

Seal coat, for both items shall be measured as finished work over the area specified to be covered, in square metres at the thickness specified in the item.

#### **16.35.7 Rate**

The rate for seal coat shall be cost of all materials, labour and equipment involved in operation described above.

### **16.36 CEMENT CONCRETE PAVEMENT UNDER ORDINARY CONDITIONS**



Specifications of item 16.37 to be followed except that cement concrete of grade 1:2:4 or specified otherwise to be prepared and compacted.

## 16.37 CEMENT CONCRETE PAVEMENT UNDER CONTROLLED CONDITIONS

### 16.37.1 Materials

#### 16.37.1.1 Cement

Cement used on work shall be as per sub head cement concrete of this Civil Specification document.

**16.37.1.2 Water:** Water used on work shall conform to SH: cement concrete of this specification document.

**16.37.1.3 Coarse Aggregate:** These shall be crushed or broken from hard stones obtained from approved quarry. These shall be clean strong, durable of fairly cubical shape and free from soft, friable, thin elongated and laminated disintegrated pieces. These shall also be free from dirt, organic deleterious and any other foreign matter and adherent coatings and shall satisfy the physical requirements laid down in para 16.37.19 under quality control.

**16.37.1.4 Fine Aggregate:** This shall be coarse sand conforming to IOCL Civil Specification.

**16.37.1.5 Grading of Mixed Aggregates:** The grading of all aggregates (coarse and fine aggregates) to be used in the work shall be determined in the laboratory. The coarse and fine aggregates shall be mixed in suitable proportions so that the grading of the mixed aggregates shall be in the range indicated in Table 16.32.

**TABLE 16.32**

<i>I.S. Sieve Size (IS 460)</i>	<i>% age passing by weight</i>
45 mm	100
22.4 mm	55 - 60
11.2 mm	45 - 50
5.6 mm	35 - 40
2.8 mm	30 - 35
1.4 mm	20 - 25
710 microns	15 - 20
355 microns	10 - 14
180 microns	2 - 5

### 16.37.2 Mix Design

**16.37.2.1** The mix shall be approved by Engineer-in- Charge so as to obtain the following mean strength that exceeds the minimum specified flexural strength by 1.64 times the designed standard deviation.

Minimum works beam

Flexural strength at 28 days = 300 kg/sqm. for M-30 or specified in item

Designed standard deviation = 60 kg/sqm. for M-30 or for specified grade(s)

Design flexural strength at 28 days =  $300 + 60 \times 1.64$

Water cement ratio by weight =  $398.4 \text{ kg/sqm. } (f + 1.64 s)$  say 400 kg.

Water cement ratio by weight = 0.5



Minimum slump not more than 25 mm

**16.37.2.2** For the purpose of tendering the contractor shall base his rate on the assumption that the quantity of cement used for one cum. of finished concrete shall be 340 kg. or M - 30. If the actual quantity of cement required to be used as a result of the laboratory test is different from that assumed above, necessary adjustment in the cost due to short cement used shall be made on the basis of issue rate of cement including storage charges plus 2.5% for handling charges. However, under no circumstances the quantity of cement to be used shall either exceed 350 kg./cum or fall below 330 kg. per cum of finished concrete.

### **16.37.3 Statistical Field Check**

**16.37.3.1** Samples of concrete shall be taken at the mixer and works beams, made, cured and tested in accordance with IS 1199 and IS 516.

**16.37.3.2** When a mix is used for the first time, it is important to get a large number of results, as soon as possible, in order to establish the level of control and then suitability of the mix proportions. A sample of concrete shall be taken at random on eight separate occasions during each of the first five days of using that mix. From each sample two beams shall be made one for test at 7 days and the other for test at 28 days.

**16.37.3.3** The work beam results shall be examined both individually and in consecutive (but not overlapping) sets of four, for which the average and the range of each set is calculated. The mix proportions shall be modified to increase the strength, if in the first ten consecutive (but not overlapping) sets any of the following conditions are not satisfied.

- a) Each sample has a test strength not less than the minimum specified strength i.e. 30 kg/sq. cm. (or otherwise specified in item).

OR

- b) Not more than two individual results (Not more than one of first twenty) of the 40 beams tests shall fall below the minimum work beam strength but they shall not be less than 80% of the specified beam strength of 30 kg./sq. cm (or otherwise specified in item) or the minimum specified strength minus 1.35 times the standard deviation whichever is greater.

No value of the range in any set shall exceed 3 times the designed standard deviation.

The average for all samples (10 sets) shall not be less than the minimum specified strength i.e. 30 kg/sq. cm (or otherwise specified in item) plus 1.64 times the designed standard deviation 60 kg./sq.cm M-30.

**16.37.3.4** If either of these conditions (16.37.3.3 I or 16.37.3.3 II) are not satisfied, the mix shall be modified and the procedure described above shall be repeated till results satisfying the above criterias are obtained.

**16.37.3.5** Subsequently samples shall be taken at the rate of one for every 30 cubic metre of concrete laid. Eight beam specimen shall constitute one sample. A set of 4 specimen shall be tested after 7 days and another set of 4 specimen shall be tested after 28 days. These test results shall be checked individually and in sets of four as the work progresses. If at any stage it is found that either of conditions 16.43.4.3,I or 16.4.3,II are not satisfied, the overall average and the standard deviation of the previous consecutive 40 beam test results including the non-complying set shall be calculated. If the overall average strength minus 1.64 times the standard deviation is more than the specified beam strength (30 kgm/sq.cm) (or otherwise specified in item) the concrete shall be accepted. But if it is less than the concrete work corresponding to these 40 beams tests shall be rejected and the mix proportion shall be modified forth with for further work. The rejected work shall be replaced by the contractor immediately at his own cost and expense.

The statistical field checks described in 16.37.3.1 to 16.37.3.2 are meant to control the quality of concrete. The standard of acceptance of concrete shall be governed by the provision of para 16.37.3.3 to 16.37.3.5.



#### 16.37.4 Slump Test

The test shall be carried out as per IS 1199. A slump test shall be carried out at each mixer at least one in fifty batches mixed or more frequently if directed by the Engineer-in-Charge. Any batch from which slump test is being made shall not be transferred to the place of laying till the slump test has been completed. Not only the batch which gives a slump in excess of that specified shall be rejected but the concrete already laid immediately preceding the batch tested upto the nearest last transverse joint may be rejected by the Engineer-in-Charge or his subordinate, if he is satisfied that such preceding batches were substandard in this respect. The decision of the Engineer-in-Charge in this respect shall be final and binding on the contractor. Such rejected concrete shall be removed by the contractor immediately and replaced with proper slump concrete at his cost and expense.

#### 16.37.5 Steel Forms

**16.37.5.1** All side forms shall be of mild steel. The steel forms shall be of M.S. Channel sections and their depth shall be equal to the thickness of the pavement.

**16.37.5.2** The side forms shall have a length of at least 3.0 metres except on curves of less than 4.5 metres radius where shorter lengths may be used. When set to grade and stacked in place the maximum deviation of the top surface of any section from a straight line shall not exceed 3 mm. The method of connection between sections shall be such that the joint formed shall be free from play or movement in any direction. The use of bent, twisted or worn out forms shall not be permitted. At least three stake pockets for bracing pins or stakes shall be provided for each 3.0 M length of forms. Bracing and supports must be ample to prevent the springing of forms under pressure of concrete or weight or thrust of the machinery (like screed vibrator) operating on the forms. Support to the forms shall be sufficiently rigid to hold them in position during the entire operation of laying and compacting and finishing and that they shall not at any time deviate more than 3 mm from straight edge 3 metres in length. Forms which show a variation from the required rigidity of the alignment and levels shown on the plans shall be reset or removed as directed. The length and number of pins or stakes shall be such as to maintain the forms at the correct line and grade.

**16.37.5.3** The supply of forms shall be sufficient to permit their remaining in place for at least 12 hrs. after the concrete has been placed or longer, if in the opinion of the Engineer-in-Charge, it is necessary.

**16.37.5.4** The top line of the forms is not to vary from the correct level or alignment and the levels and alignment of the forms are to be checked and corrected as necessary immediately prior to the placing of concrete. The top edges and faces of the forms are to be carefully cleaned and maintained in clean condition.

**16.37.5.5** While removing the steel forms, care shall be taken to withdraw them gradually, any damage to the bull nosed edges shall be made good while the concrete is still green.

#### 16.37.5.6 Setting of Forms

- a) Setting of forms shall be according to the slab plan subject to the approval of Engineer-in-Charge and concreting shall not commence until the setting of forms is approved.
- b) Forms shall be set for at least 50 metres in advance of the point where the concrete is being laid and shall not be removed until at least 12 hrs. of placing of the concrete or longer if in the opinion of Engineer-in-Charge is necessary.
- c) After setting, the working faces shall be thoroughly oiled by using approved oil before concrete is placed against them.
- d) The pavement joints of overlay layer would overlap with the joints of underlay cement concrete.

#### 16.37.6 Batching and Mixing





As detailed in SH: 5 of reinforced cement concrete work of IOCL Civil Specifications 2023.

#### **16.37.7 Placing of Concrete**

As detailed in SH: 5 of reinforced cement concrete work of IOCL Civil Specifications 2023.

#### **16.37.8 Compaction of Concrete**

**16.37.8.1** Compaction shall be carried out by electrically (or) diesel operated needle and screed vibrators as stipulated hereafter. Needle vibrator should be used all over the area for obtaining initial compaction of concrete. These should be of diameter not less than 4.5 cm. If the vibrator are pneumatic the pressure must not be below 4 kg/sq.cm. If electrically operated, they should have a minimum frequency of 3500 impulses per minute.

**16.37.8.2** There should be at least three needle vibrators working in any bay. A vibrating screed consisting of a steel or timber section weighing not less than 15 kg. per metre with a tamping edge of not less than 7 cm width and having a vibrator mounted thereon shall follow needle vibrators to obtain full compaction. The face of the wooden tamping edge of the screed shall be lined with M.S. Plate rigidly fixed by means of counter sunk screw. Where screed vibrators are used for compaction, a standby unit shall always be maintained ready for use, should the other one go out of order. Where electrically driven vibrators are employed, a standby diesel pneumatic unit shall be kept ready for use in case of power failure. At the discretion of the Engineer-in-Charge, for compaction at edges and joints, vibrators may be supplemented by hand tamping and rodding for securing satisfactory results. Under no circumstances, honey combing of concrete at joints or elsewhere shall be permitted.

**16.37.8.3** When using screed vibrator for compaction it should not be dragged over the concrete. During the initial passes it shall be lifted to the adjacent forward position in short steps, subsequently, it shall be slowly slid over the surface with its axis slightly tilted away from the direction of sliding and the operation repeated until a close, dense surface is obtained.

**16.37.8.4** Concreting shall be carried out in one operation between the expansion joints and construction joints without any break at the dummy joints.

**16.37.8.5** Concrete shall be deposited on the base as near the joints as possible without touching them. It shall then be shoveled against the sides, maintaining equal pressure and deposited approx. 50 mm higher than the depth of the joints, care being taken that it is worked well around the joints. The concrete shall not be dumped from the bucket directly upon or against the joints.

**16.37.8.6** Workmen shall not be allowed to walk on freshly laid concrete and proper cat walk shall be provided with independent supports beyond concreting bays.

#### **16.37.9 Finishing of Concrete**

**16.37.9.1** During compaction, any low or high spots shall be made up by adding or removing concrete. After longitudinal floating has been completed but while concrete is still plastic, the slab surface shall be tested for trueness with a 3 m straight edge. Any depressions or high spots showing departure from the true surface shall be immediately rectified. High spots shall be cut down and refinished. Depressions shall be enlarged to about 8-10 cm and filled up with fresh concrete, compacted and finished.

**16.37.9.2** The straight edge testing the refloating is to continue until the entire surface:

- a) is free from observable departure from the straight edge,
- b) conforms to the required levels and across section, and
- c) shall conform to the specified surface when the concrete has hardened.

**16.37.9.3** The foregoing work is to be carried out while the concrete is still plastic and workable.





#### **16.37.10 Belting**

**16.37.10.1** Just before concrete becomes non-plastic, the surface shall be belted with a two ply canvas belt not less than 20 cm wide and at least 1 metre longer than the width of the slab. Hand belts shall have suitable handles to permit controlled uniform manipulation. The belt shall be operated with short strokes transversed to the centre line of the pavement and with rapid advance parallel to the centre line.

#### **16.37.11 Brooming**

**16.37.11.1** After belting and as soon as the surplus water, if any, has risen to the surface, the pavement shall be given a broom finish with an approved steel or fiber broom not less than 45 cm wide. The broom shall be pulled gently over the surface of the pavement from edge to edge. Adjacent strokes shall be slightly overlapped. Brooming shall be perpendicular to the centre line of the pavement and so executed that the corrugations formed shall be uniform in character and width and not more than 1.5 mm deep.

**16.37.11.2** Brooming shall be completed before the concrete reaches such a stage that the surface is likely to be torn or unduly roughened by the operation. The broomed surface shall be free from porous or rough spots, irregularities, depressions, and small pockets such as may be caused by accidental disturbing of particles of coarse aggregates embodied near the surface. The brooming shall be of uniform pattern all through.

**16.37.11.3** *Edging* : After belting/brooming has been completed but before the initial setting of concrete, the edges of the slab shall be carefully finished with an edger of 6 mm radius, and the pavement edges shall be left smooth and true to line.

#### **16.37.12 Honey Combing**

**16.37.12.1** The side forms shall not be removed until 12 hours or such longer period as the Engineer-in-Charge may decide after the laying of concrete.

**16.37.12.2** As soon as the side forms are removed, any minor honey combed area shall be filled with mortar composed of one part of cement and two parts of fine aggregate. Major honey combing areas or segregated concrete or other defective work or areas damaged by removal of the forms or concrete damaged by rain or due to any other reason whatsoever shall be considered as defective work and shall be removed and replaced by the contractor at his own expense. The total area of honey combed surface shall not exceed 4 per cent of the area of the slab side. However, no individual honeycomb patch shall exceed 0.1 sqm. Engineer-in-Charge's decision as to whether the concrete is defective or not shall be final and binding.

#### **16.37.13 Surface Accuracy**

**16.37.13.1** After the concrete has sufficiently hardened after about 12 hours and not later than 24 hours, the surface shall be tested again for high spots. All high spots shall be marked and those exceeding 3 mm shall be ground down immediately. Care shall be taken to see that the grinding does not in any way damage the concrete surface. The final surface finish is to be such that when tested with a profilograph/roughness indicator/or a 3 metre long straight edge or an equivalent mechanical unevenness indicator placed anywhere within the same or adjoining slab in any direction on the surface, there shall be no variation greater than 3 mm.

If the surface irregularity exceeding 3 mm still remains despite grinding as per para 16.37.13.2 the concrete shall be removed to its full depth. The area of concrete to be removed shall be complete slab between the nearest joints, where the defective slab is less than 4.5 metres from the expansion joint, the whole area upto the expansion joint shall be removed to the full depth. The concrete so removed shall not be reused in the work. Fresh concrete shall be laid in the manner already de-scribed in above paras



and shall again be subject to test for surface accuracy and other quality control measures. Nothing extra shall be paid on this account.

Every slab shall bear an impression not exceeding 3 mm in depth comprising the number allotted to the slab and the date on which it is laid. This impression shall be formed by the contractor when the concrete is green so as to leave permanent mark on setting.

#### **16.37.13.2 Initial Curing**

Immediately after completion of the finishing operations, the surface of the pavement shall be entirely covered with wetted burlap, cotton or jute mats. The mats used shall be of such length (or width) that as laid they shall extend at least 45 cm beyond the edges of the slab. The mats shall be placed so that the entire surface and both edges of the slab are completely covered. This covering shall be placed as soon as, in the judgment of the Engineer- in-Charge the concrete has set sufficiently to prevent damage to the surface prior to being placed, the mats shall be thoroughly saturated with water and shall be placed with the wettest side down. The mats shall be so placed and weighed down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained full wetted and in position for 24 hours after the concrete has been placed or until the concrete is sufficiently hard to be walked on without suffering damage. Water shall be gently sprayed so as to avoid damage to the fresh concrete. If it becomes necessary to remove a mat for any reason, the concrete slab shall not be exposed for a period of more than half an hour.

Worn burlap or burlap with holes shall not be permitted. Burlap reclaimed from previous use other than curing concrete shall be thoroughly washed prior to use for curing purposes. If burlap is obtained in strips, shall be laid to overlap by at least 150 mm.

#### **16.37.14 Burlap shall be placed from suitable bridges. Walking on freshly laid concrete to facilitate placing burlap shall not be permitted.**

#### **16.37.15 Final Curing**

Upon the removal of the burlaps, the slab shall be thoroughly wetted and then cured as follows:-

All joints shall be filled with filler in order to prevent the edges of joints from getting damaged and entry of clay materials into the joints during final curing. Exposed edges of the slab shall be banked with a substantial berm of earth. Upon the slab shall then be laid a system of transverse and longitudinal dykes of clay about 50 mm high immediately covered with a blanket of sandy soil free from stones to prevent the drying up and cracking of clay. The rest of slab shall then be covered with sufficient sandy soil so as to produce a blanket of earth not less than 40 mm deep after wetting. The earth covering shall be thoroughly wetted while it is being placed on the surface and against the sides of the slab and kept thoroughly saturated with water for 21 days and thoroughly wetted down during the morning of the 22nd day and shall thereafter remain in place until the concrete has attained the required strength and permission is given by the Engineer-in-Charge. Thereafter the covering shall be removed and the pavement cleaned and swept. If the earth covering becomes displaced during the curing period, it shall be replaced to the original depth and resaturated.

Contractor shall appoint chowkidars at his expense to prevent workmen, cattle, etc., straying on the pavement concrete.

Concrete shall not be subjected to any load or weight of any plant until at least 28 days after laying.

#### **16.37.16 Construction Joints**

Construction joints shall be provided as shown in the drawing and also at places where concreting is stopped due to unforeseen circumstances. The joints shall be straight and vertical through the full thickness of the slab. While concrete in adjacent bay is still green, flats of suitable size shall be drawn



along the edge and a groove of size 10 mm × 25 mm deep shall be neatly formed and finished. The edges of the groove shall be full nosed. After curing of concrete is complete, this groove shall be thoroughly cleaned of all sand dust and shall be perfectly dried and filled with hot poured sealing compound conforming to grade B of IS 1834. Before filling with sealing compound the faces of concrete of the joint shall be coated with primer of approved brand to a depth of 25 mm at the rate of 2.6 liters per 10 square meters. Bitumen emulsion shall not be used as primer.

#### **16.37.17 Dummy Joints**

The joints shall be 10 mm wide and shall extend vertically from the surface of the slab to a depth equal to 1/3rd of the thickness of the slab but not less than 4 cm in any case. The joint may be formed by depressing into the soft but compacted concrete a high tensile M.S. or other approved Tee of flat bar of depth not less than required depth of the joint plus 25 mm. The bar used for forming the groove shall be coated with soft soap or other suitable lubricant to facilitate its removal when the steel Tee or flat is removed joints shall be neatly formed with proper tools and mortar/fine material from the slab itself. No additional cement mortar (rich or otherwise) shall be used.

Cutting or sawing by a saw mounted on a movable frame and driven mechanically shall also be permitted as a method for making the joint. In this case the width may be reduced to 6 mm. any other method for making joints can be followed with the prior approval of the Engineer-in-Charge.

In all cases, except where cutting is done with saw, the joint edges shall be bullnosed. Care should be taken to see that the edges of the grooves are not damaged.

The grooves shall be filled with hot poured sealing compound conforming to Grade B of IS:1834. Prior to filling with sealing compound, the joints shall be cleaned by compressed air and primed with Shalijet primer or equivalent at the rate specified in Para 16.37.16.1

All joints shall be sealed as soon as practicable after 28 days of casting of cc pavement. Joints shall be sealed flush with the adjacent pavement surface in summer and 3-4 mm below finished concrete surface in winter. The pavement shall be opened to traffic only after joint sealing over the entire pavement. To prevent tackiness or pickup under traffic, the exposed surfaces of the sealing compound shall be dusted with hydrated lime, if directed by Engineer-in-Charge, for which nothing extra shall be paid to the contractor.

In case of sudden rain or storm, the work can be concluded at the dummy joints but these will then be formed as construction joints.

Before sealing of joints, it may be ensured that the groove extends fully across the bay between consecutive longitudinal joints, in the case of transverse joints and is continuous in the case of longitudinal joints. Any concrete or other foreign matter must be removed from the groove.

#### **16.37.18 Concreting during Rains**

To prevent damage to freshly laid concrete during monsoon, or sudden rains, the contractor shall provide an adequate supply of tarpaulins or other water proof covering material. Any concrete damaged by rain shall be removed and replaced by the contractor at his own cost as directed by the Engineer-in-Charge.

#### **16.37.19 Quality Control**

The following quality control tests shall be carried out at frequencies specified against each as in Table 16.33.

**TABLE 13.33**

S.No	Test	Test Method	Frequency	Acceptance Criteria
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1	2	3	4	5
(i)	<b>COARSE AGGREGATE</b>			
(a)	Flakiness index	IS 2386 (Pt.I)	Before approval of the quarry and at every subsequent change in the source of supply and one test per 100 cum of aggregates	Not more than 15%
(b)	Impact value	IS 2386 (Pt. IV)	-do-	Not more than 30%
(c)	Los angles abrasion value.	IS 2386 (Pt.IV)	-do-	Not more than 40%
(d)	Deleterious materials.	IS 2386 (Pt.II)	Before approval of the quarry and at every subsequent change in the source of supply	As per table 1 of IS 383
(e)	Moisture content.	IS 2386 (Pt.III)	Regularly as required subject to a min. one test per day	-do-
(ii)	<b>FINE AGGREGATES</b>			
(a)	Silt content.	IOCL Civil Specifications 2023, SH: CC	One test per 15 cum	Not more than 8%
(b)	Gradation of sand	IS 2386 (Pt.I)	-do-	Fineness modulus between 2.5 to 3.9
(c)	Deleterious materials.	IS 2386 (Pt.II)	Before approval of the quarry and at every subsequent change in the source of supply	As per table 1 of IS 383
(d)	Moisture content.	IS 2386 (Pt.III)	Regularly as required subject to a min. 2 test/day	-do-
(iii)	<b>MIXED AGGREGATES</b>			
(a)	Grading	IS 2386 (Pt. I)	1 test per 15 cum	As per para 16.37.1.5
(iv)	Slump test of concrete	IS 1199	At least once in 50 batches at each mixer or more frequently if directed by the Engineer-in-Charge	Not more than 25 mm
(v)	Flexural strength	IS 516	One test of sample consisting of eight specimens for every 30 cum of concrete	As per para 16.37.3.5.
(vi)	Surface accuracy	As prescribed	Regularly	As per para 16.37.13

#### 16.37.20 Equipments



**16.37.20.1** Equipments shall be provided by the contractor in the field testing laboratory. Nothing extra shall be paid to him on this account. Records as required shall be maintained at site. All tests details in support of mix design shall be maintained as part of records of the contract and shall be signed both by the contractor and the Engineer-in-Charge. The contractor shall provide all labour, materials and equipment required for all tests to be carried out at his own cost.

**16.37.20.2** The Engineer-in-Charge reserves the right to test any part of concrete laid regarding quality soundness, compactness, thickness, strength and finish of the concrete, at any time before the expiry of the "Defect liability period" notwithstanding that necessary tests had been carried out and found satisfactory at the time of execution.

**16.37.20.3** All defective unsound sub-standard work and concrete of sub-standard strength and quality etc. as established vide paras 16.37.3 shall be rejected and shall be replaced by the contractor at his own expense in the manner as detailed in para 16.37.3. Where due to operational or any other reason such replacement does not become possible (decision of Engineer-in-Charge in this respect being final and binding on the contractor), the cost of removal and replacement of such rejected work shall be recovered from the contractor whether such rejected work is subsequently replaced by the Government or not.

#### **16.37.21 Defects Liability Period**

**16.37.21.1** This period shall be reckoned in the case of this work as one year from the date of completion of work and it shall be the liability of the contractor to repair, strengthen or reconstruct any portion of the work which has shown damage or any defect, arising out of any bad workmanship or defective material used in the work during this period. In the case of this rectification not being commenced by the contractor within 7 days from the date of notice from the Engineer-in-Charge and completed expeditiously the Engineer-in-Charge reserves the right to get the repair work executed at the risk and cost of the contractor.

#### **16.37.22 Measurements**

**16.37.22.1** For the purpose of ascertaining the quantity of concrete in the pavement, thickness shall be measured by means of a scale correct to the nearest 2 mm. The thickness of the concrete pavement slabs shall be taken on either side of the pavement at each dummy joint at four corners of the slab immediately after removal of the side forms. In case the average thickness of the slab exceeds the specified thickness, payment shall be restricted to the specified thickness.

The dimensions of each slab of pavement shall be measured as follows to the nearest 5 mm.

##### **a) Length**

- i. Between the end of a pavement to the centre line of the expansion joints.
- ii. Between the centre lines of consecutive expansion joints.

##### **b) Width**

- i. Between the edge of a pavement and the centre line of the construction joints.
- ii. Between the centre lines of construction joints and expansion joints.
- iii. Between the centre lines of consecutive construction joints.

**Note:** The quantity of concrete in the pavement slab shall be worked out by multiplying the area of the slab and its average thickness or specified thickness whichever is less. No deduction shall be made for any joints in the concrete slab.

Measurements of concrete slabs shall be recorded jointly by the Engineer-in-Charge or his authorised subordinate and the contractor or his authorised agent.



### 16.37.23 Rate

The rate of the item for concrete in pavement shall include the cost of all materials and labour including charges for machinery tools & plants required in all the operations described above. The rate also includes all cost of setting up the laboratory at site and carrying out the quality control measures/tests enumerated above by the contractor at his own cost in the presence of Engineer-in-Charge or his authorized representative and submission of test results on completion of tests to the Engineer-in-Charge thereof.

### 16.38 HARD CRETE

Hard crete of approved quality and brand to be used. It shall be mixed in ratio and method as recommended by manufacturer and approved by Engineer-in-charge in cement concrete for laying in paramount. Quantity shall be measured in litre used in cement concrete. Hardcrete to be brought in sealed container and proper record of quantity be maintained. Empty containers of hardcrete shall not be removed from site with but prior permission of Engineer-in-Charge.

### 16.39 EXPANSION JOINT

#### 16.39.0 Materials

**Premoulded Joint Filler in Expansion Joint:** It shall conform to IS 1838 (Pt. I). The thickness shall be 25 mm with tolerance 1.5 mm. and shall be of the maximum available standard length not less than one lane width. The filler board shall be positioned vertically with the prefabricated joint assemblies along the line of the joint within tolerance of  $\pm 10$  mm from the intended line of the joint. The depth of board shall be 25 mm less than thickness of slab within a tolerance of  $\pm 3$ mm so that the top of the board shall be below the surface or will not impend the passage of the finishing straight edge or oscillating beam of the paving machine.

Bitumine **Hot Sealing Compound:** The joint sealing compound shall be fuel and heat resistant type complying to grade B of IS 1834. It shall be capable of adhering to the concrete without cracking, spalling and disintegration.

### 16.40 CONSTRUCTION PROCEDURE

**16.40.1** Expansion joints shall be provided as shown in the drawing and as per directions of Engineer-in- Charge. All joints shall be constructed true to line with their faces perpendicular to the surface of the pavement. The joint shall be 20 mm wide. The depth of the non-extruding filler pad shall be 25 mm less than the depth of the concrete slab.

**16.40.2** Before the provision of expansion joint, the face of the already laid concrete slab shall be painted with primer at the rate of 2.6 liters per 10 square metres. The expansion pad shall be properly cut to shape and shall then be placed in position abutting the painted face of the already laid concrete slab. The adjacent slab shall then be concreted. The face of the pad against which the new concrete slab is to be laid shall also be painted with primer before laying the concrete, while concreting a neat groove of size 20 mm x 25 mm as per drawing shall be formed on top of the pad taking care that the edges are absolutely straight and that the groove so made does not get filled with any material like concrete, mortar and other rubbish.

**16.40.3** Before the curing process is started, the top of expansion joint shall be filled with bitumen sand mixture in order to ensure that no foreign material used in curing enters into the joint. This filling shall be removed before filling the joints with sealing compound.

**16.40.4** For sealing the joints following operations shall be carried out:

- a) The joints are cleared of any foreign matter to the full depth upto the top of expansion pad with steel spatula.





- b) The joints are blown with compressed air.
- c) Cleaning is done with Kerosene oil.
- d) Priming is done with spray gun @ 2.6 liters per 10 sqm of the surface to be primed.
- e) The primer is allowed to dry completely before pouring the sealing compound.
- f) The sealing compound grade 'A' is heated to the required temperature ranging between 155 deg. C to 165 deg. C or to the temperature range specified by the manufacturer. Over heating shall be avoided. Pouring shall be done from vessel with spout in such a manner that the material will not get spilled on the exposed surface of the concrete, any excess filler on the surface of the pavement shall be removed immediately and the pavement surface cleaned.
- g) The filling shall be worked into the joints with hot flats to ensure escape of trapped air.
- h) The filling is then ironed with hot iron. It is recommended that while in summer the joints may be sealed flush with the //directed by Engineer-in-Charge (Nothing extra shall be paid for the same).

**16.40.5 Measurements:** The measurement of the specified depth of joint shall be recorded in metres correct to two places of decimals.

#### **16.40.6 Rate**

Rate for the item shall include the cost of all materials, plant, machinery and labour involved in all operations described above, including all cartages and lifts.

### **16.41 PAINTING ROAD/ RUNWAYS MARKINGS**

#### **16.41.1 Materials**

**16.41.1.1** Special Road marking paint of approved brand and manufacture shall be used. The paint shall conform to IS 164. Ready mixed paint as received from the manufacturer shall be used without adding any admixture.

**16.41.1.2** During work, if the consistency of the paint gets thick and thinning becomes necessary it shall be done by use of thinner of the approved brand of paint recommended by the manufacturer and with the approval of the Engineer-in-Charge.

**16.41.1.3** The paint shall be brought to the site of work by the contractor in original sealed containers. The material shall be brought in one lot in adequate quantity to suffice for the entire work. The material shall be kept in the joint custody of the contractor and the Engineer-in-Charge. The empty container shall not be removed from the site of work, till the work has been completed and permission obtained from the Engineer-in-Charge.

#### **16.41.2 Preparation of Surface**

The surface shall be thoroughly cleaned and free from dust. All the dirt, scales, oil and grease shall be thoroughly removed before painting is started. The prepared surface shall be inspected and approved by the Engineer-in-Charge before painting is commenced.

#### **16.41.3 Application**

**16.41.3.1** Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its original container. The paint shall be continuously stirred in the smaller container while applying to runway surface so that its consistency is kept uniform.

**16.41.3.2** The painting shall be applied evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area over with paint, brushing the surface hard for the first time over and then brushing alternatively in opposite direction, two or three times and then finally brushing lightly



in a direction at right angle to the same. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

**16.41.3.3** Each coat shall be allowed to dry out thoroughly before the next coat is applied.

**16.41.3.4** Earlier applied coat shall be cleaned off dust before the next coat is laid.

**16.41.3.5** No left over paint shall be put back into the stock tins. When not in use, the containers shall be kept properly closed.

**16.41.3.6** No hair marks from the brush or clogging of paint puddles shall be left on the work.

**16.41.3.7** The surface shall ordinarily not be painted until it has dried up completely. Trial patches of paint shall be laid at intervals to check if drying is satisfactory.

**16.41.3.8** The runway marking shall be done in accordance with the drawing unless otherwise instructed by the Engineer-in-Charge.

#### **16.41.4 Brushes and Containers**

**16.41.4.1** After work, the brushes shall be completely cleaned of paint by rinsing with turpentine. A brush in which paint has dried up is spoiled and shall on no account be reused for painting work. On no account kerosene oil shall be used for washing the brush.

**16.41.4.2** When the paint has been used, the containers shall be washed with turpentine and wiped dry with soft clean cloth so that they are clean, and can be used again.

#### **16.41.5 Measurement**

Length and breadth shall be measured correct to a cm. Area shall be worked out in square metre, correct to two places of a decimal.

#### **16.41.6 Rate**

Rate shall include cost of all materials, tools and labour involved in all the operations described above including all cartages and lifts.

### **16.42 PAINTING ROAD SURFACE (WITH READY MIXED ROAD MARKING PAINT)**

Specifications of item no. 16.41 to be followed except that road surface to be painted with ready mixed road marking paint of approved brand instead of paint of superior make.

### **16.43 LIME FLY ASH STABILISED SOIL SUB BASE: DELETED**

### **16.44 PRECAST LIME FLY ASH CONCRETE BLOCKS: DELETED**

### **16.45 CONCERTINA COIL FENCING**

**16.45.1 Material:** Angle iron post & strut shall be as specified in 16.18.

Concertina coil fencing shall be dia 610 mm (having 15 nos round per 6 metre length), spring core (2.5 mm thick) wire of high tensile strength of 165 kg./sq.mm with tape (0.52 mm thick) and weight 43.478 gm/metre.

**16.45.2 Spacing of Posts & Struts:** The spacing of posts shall be 2.4 m or 3.00 m apart centre to centre, unless otherwise specified or as per Engineer-in -Charge to suit the dimension of the area to be fenced. Every 15th last but one end posts and corner posts shall be strutted on both sides and end posts on one side only.

**16.45.3 Fixing of Posts and Struts:** As specified in the 16.17.3.





**16.45.4** Fixing Concertina coil fencing shall be fixed on angle iron shaped with 9 horizontal reinforced barbed tape (RBT) stud tied with GI staples and GI clips to retain horizontal including necessary bolts or GI barbed wire tied to angle iron all complete as per directions of Engineer-in-Charge with reinforced barbed tape.

#### **16.45.5 Measurements**

The length of fencing shall be measured correct to a cm. for finished work.

#### **16.45.6 Rate**

The rate shall include the cost of labour and materials involved in all the operation described above but excluding the cost of M.S. angle and excavation and concrete in foundation for which separate payment shall be made under respective items.

### **16.46 DENSE GRADED BITUMINOUS MACADAM (DBM)**

#### **16.46.1 Scope**

Dense Bituminous Macadam (DBM) for use mainly but not exclusively, for in base/binder and profile corrective courses. DBM is also used as road base material. This work shall consist of construction in a single or multiple layers of DBM on a previously prepared base or sub-base. The thickness of a single layer shall be 50 mm to 100 mm.

#### **16.46.2 Material**

**16.46.2.1 Bitumen:** The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, or as otherwise specified in the item. The type and grade of bitumen to be used shall be specified in the item of Contract. Where modified bitumen is specified, it shall conform to the requirements of IRC: SP:53 and IS:15462.

Section criteria for viscosity grade bitumen, based on highest and lowest daily mean temperatures at a particular site are given in Table 16.40A.

Selection criteria for modified bitumen shall be in accordance with IRC: SP53.

**16.46.2.2 Coarse Aggregates:** The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on the 2.36 mm IS Sieve. They shall be clean, hard, durable, or cubical shape, free from dust and soft or friable matter, organic or other deleterious substance. Before approval of the source, the aggregates shall be tested for stripping. The aggregates shall satisfy the physical requirements specified in Table 16.35, for dense bituminous macadam.

Where crushed gravel is proposed for use as aggregate, not less than 90% by weight of the crushed material retained on the 4.75 mm IS Sieve shall have at least two fractured faces.

**16.46.2.3 Fine Aggregates:** Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm IS Sieve and retained on the 75 micron sieve. These shall be clean, hard, durable, dry and free from dust and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand upto 50 percent of the fine aggregate may be allowed in base courses.

The fine aggregate shall have a sand equivalent value of not less than 50 when tested in accordance with the requirements of IS 2720 (Part 37).

The plasticity index of the fraction passing the 0.425 mm IS Sieve shall not exceed 4, when tested in accordance with IS 2720 (Part 5).

**TABLE 16.35**

#### **Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam**



Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis <sup>7</sup>	Max 5% passing 0.075mm sieve.	IS:2386 Part 1
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS:2386 Part 1
Strength	Los Angeles Abrasion Value Or Aggregate Impact Value	Max 35% Max 27%	IS:2386 Part 4
Durability	Soundness either: Sodium Sulphate or Magnesium Sulphate	Max 12% Max 18%	IS:2386 Part 5
Water Absorption	Water Absorption	Max 2%	IS:2386 Part 3
Stripping	Coating and stripping of Bitumen aggregate Mix	Minimum retained coating 95%	IS:6241
Water sensitivity	Retained Tensile Strength**	Min 80%	AASHTO 283

\* To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.

\*\* If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement.

**16.46.2.4 Filler:** Filler shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer-in-Charge. The filler shall be graded within the limits indicated in Table 16.36.

**TABLE 16.36**  
**Grading Requirements for Mineral Filler**

<i>Is Sieve (mm)</i>	<i>Cumulative per cent passing by weight of total aggregate</i>
0.6	100
0.3	95-100
0.075	85-100

The filler shall be free from organic impurities and have a plasticity index not greater than 4. The Plasticity Index requirements shall not apply if filler is cement or lime. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 16.35, then 2 percent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly.

**16.46.2.5 Aggregate Grading and Binder Content:** When tested in accordance with IS 2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in Table 16.37 for dense bituminous macadam. To avoid gap grading the combined aggregate grading shall not vary from the low limit on one sieve to the high limit on the adjacent sieve.



**TABLE 16.37**

**Composition of Dense Graded Bituminous Macadam Pavement Layers**

Mix Designation	Grading 2
Nominal aggregate size*	26.5 mm
Layer Thickness	50-75 mm
IS Sieve <sup>1</sup> (mm)	Cumulative % by weight of total aggregate passing
37.5	100
26.5	90-100
19	71-95
13.2	56-80
4.75	38-54
2.36	28-42
0.3	7-21
0.075	2-8
Bitumen content percent by mass of total mix (Marshall method)	Min 4.5** or as specified in the item
Bitumen grade	As specified in item or directed otherwise.

\* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

\*\* Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30° C or lower and lowest daily air temperature is – 10 ° C or lower, the bitumen content may be increased by 0.5 percent.

**16.46.2.6** Bitumen content indicated in Table 16.37 is the minimum quantity. The quantity shall be determined in accordance with the Mix Design. Para 16.46.3

**16.46.3 Mix Design**

The bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS-2.

The Fines to Bitumen (F/B) ratio by weight of total mix shall range from 0.6 to 1.2.

**16.46.3.1 Requirement** for the Mix: The mix shall meet the requirements as given in Table 16.38.

**TABLE 16.38**

**Requirements for Dense Bituminous Macadam**

Properties	Viscosity Grade Paving Bitumen	Modified bitumen		Test Method
		Hot climate	Cold climate	
Compaction level	75 blows on each face of the specimen			
Minimum stability (kN at 60° C)	9.0	12.0	10.0	AASHTO T245



Marshall flow (mm)	2 – 4	2.5 - 4	3.5 - 5	AASHTO T245
Marshall Quotient Stability Flow	2 – 5	2.5 - 5		MS-2 and ASTM D2041
% air voids	3 – 5			
% Voids Filled with Bitumen (VFB)	65 – 75			
Coating of aggregate particle	95% Min.			IS:6241
Tensile Strength ratio	80% Min.			AASHTO T283
% Voids in Mineral Aggregate (VMA)	Minimum percent voids in mineral aggregate (VMA) are set out in Table 16.40			

**TABLE 16.39**

**Minimum Percent Voids in Mineral Aggregate (VMA)**

<i>Nominal Maximum Particle size<sup>1</sup> (mm)</i>	<i>Minimum VMA, Percent Related to Design Percentage Air voids</i>		
	3.0	4.0	5.0
26.5	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Note: Interpolate minimum voids in the mineral aggregate (VMA) for designed percentage air voids values between those listed.

**16.46.3.2 Binder Content:** The binder content shall be optimized to achieve the requirements of the mix set out in Table 16.38. The binder content shall be selected to obtain 4 percent air voids in the mix design. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2.

Where maximum size of the aggregate is more than 26.5 mm, the modified Marshall method using 150 mm diameter specimen described in MS-2 and ASTM D 5581 shall be used. This method requires modified equipment and procedures. When the modified Marshall test is used, the specified equipment and procedures. When the modified Marshall test is used, the specified minimum stability values in Table 16.39 as above shall be multiplied by 2.25 and the minimum flow shall be 3 mm.

**16.46.3.3 Job Mix Formula :** The contractor shall inform the Engineer-in-Charge in writing, at least 21 days before the start of the work, of the job mix formula proposed for use in the works, and shall give the details of Source and location of all materials, their sizes, grading, binder type and percentage by weight of total mix, Coarse aggregate / Fine aggregate / Mineral filler as percentage by weight of total aggregate including mineral filler and Mixing temperature and compacting temperature and test results.



While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer-in-Charge for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer-in-Charge.

Job mix formula shall be revised if there is a change in source of material and be got approved by Engineer-in-Charge.

**16.46.3.4 Plant Trials – Permissible Variation in Job Mix Formula:** Once the laboratory job mix formula is approved, the Contractor shall carry out plant trials at the mixer to establish that the plant can be set up to produce a uniform mix conforming to the approved job mix formula. The permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used shall be within the limits as specified in Table 16.40.

**TABLE 16.40**

**Permissible Variations in the Actual Mix from the Job Mix Formula**

<i>Description</i>	<i>Permissible Variation</i>	
	<i>Base/Binder Course</i>	<i>Wearing Course</i>
Aggregate passing 19 mm sieve or larger	± 8%	± 7%
Aggregate passing 13.2 mm, 9.5 mm	± 7%	± 6%
Aggregate passing 4.75 mm	± 6%	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 5%	± 4%
Aggregate passing 0.3 mm, 0.15 mm	± 4%	± 3%
Aggregate passing 0.075 mm	± 2%	± 1.5%
Binder content	± 0.3%	± 0.3%
Mixing temperature	± 10°C	± 10°C

**16.46.3.5 Laying Trials:** Once the plant trials have been successfully completed and approved, the Contractor shall carry out laying trials, to demonstrate that the proposed mix can be successfully laid and compacted.

#### **16.46.4 Construction Operations**

**16.46.4.1 Preparation of Base:** The base on which DBM is to be laid shall be prepared, shaped and compacted to the required profile as appropriate or as directed by the Engineer-in-charge. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air, in locations where mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer-in-charge.

**16.46.4.2 Tack Coat:** Where the material on which the dense bituminous macadam is to be laid is either bitumen bound layer or primed granular layer, tack coat shall be applied as specified, in accordance with the provisions of para 16.29, or as directed by the Engineer-in-Charge.

**16.46.4.3 Mixing and Transportation of the Mixture:** The provisions are as specified in the para 16.47.3.3 shall apply. Table 16.41A gives the mixing laying and rolling temperature for dense mixes using viscosity grade bitumen. In case of modified bitumen, the temperature of mixing and compaction shall be higher



than the mix with viscosity grade bitumen. The exact temperature depends upon the type and amount of modifier used and shall be adopted as per the recommendations of the manufacturer. In order to have uniform quality, the plant shall be calibrated from time to time.

**16.46.4.4 Spreading:** The provisions are as specified in the para 16.47.3.5 shall apply. The paver finisher shall be fitted with electronic sensor device.

**16.46.4.5 Rolling / Compaction & Joints:** The provisions are as specified in the para 16.47.3.6 and 16.47.3.7 shall apply, as modified by the approved laying trials. The compaction process shall be carried out by the same plant, and using the same method, as approved in the laying trials, which may be varied only with the express approval of the Engineer-in-charge in writing.

**16.46.5 Opening to Traffic:** The newly laid surface shall not be open to traffic for at least 24 hours after laying the completion of compaction, without the approval of the Engineer-in-Charge in writing, on the surface until the DBM layer has cooled to the ambient temperature.

**16.46.6 Surface Finish and Quality Control of Work:** The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH Specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH Specifications.

**16.46.7 Arrangement for Traffic:** During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of the Engineer-in-charge.

#### **16.46.8 Measurement**

Dense Bituminous Macadam shall be measured as finished work in cubic meters, correct to two places of decimal.

#### **16.46.9 Rate**

The rate includes the cost of all material, labour, machineries and equipments in all the operations described above.

### **16.47 BITUMINOUS MACADAM**

#### **16.47.1 Scope**

This work shall consist of construction in a single course having 60 mm to 100 mm thickness or in multiple courses of compacted crushed aggregates premixed with a bituminous binder on a previously prepared base to the requirements of these Specifications. Since the bituminous macadam is an open-graded mix, there is a potential that it may trap water or moisture vapour within the pavement system. Therefore, adjacent layer (shoulders) should have proper drainage quality to prevent moisture-induced damage to the BM.

#### **16.47.2 Material**

**16.47.2.1 Bitumen:** The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, or as otherwise specified in the item. The type and grade of bitumen to be used shall be specified in the Contract. The type and grade of bitumen to be used would depend upon the climatic conditions and the traffic. Guidelines for selection of bitumen are given in Table 16.40A.

**Table 16.40A**

#### **Selection Criteria For Viscosity-Graded (VG) Paving Bitumen Based On Climatic Conditions**

Lowest Daily Mean Air Temperature °C	Highest Daily Mean Air Temperature, °C		
	Less than 20°C	20 to 30°C	More than 30°C



More than -10°C	VG-10	VG-20	VG-30
-10°C or lower	VG-10	VG-10	VG-20

**16.47.2.2** Coarse Aggregates - same as 16.46.2.2 excepting strength which shall be max 40% for Los Angeles Abrasion Value and Aggregate Impact Value of max 30%.

**16.47.2.3** Fine Aggregates: Same as 16.46.2.3.

**16.47.2.4** Proportioning of Material:

The combined aggregate grading shall not vary from the lower limit on one sieve to the higher limit on the adjacent sieve to avoid gap grading. The aggregate may be proportioned and blended to produce a uniform mix complying with the requirements in Table 16.41. The bitumen content and appropriate thickness are as per Table 16.41.

**TABLE 16.41**  
**Composite of Bituminous Macadam**

Mix Designation	Grading 2
Nominal maximum aggregate size*	19 mm
Layer Thickness	50-75 mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing
26.5	100
19	90-100
13.2	56-88
4.75	16-36
2.36	4-19
0.3	2-10
0.075	0-8
Bitumen content** percent by mass to total mix	3.4** or as specified in the item
Bitumen grade	As specified in item or directed otherwise

\* Nominal maximum aggregate size is the largest specified sieve size upon which any of the aggregate material is retained.

\*\* Corresponds to specific gravity of the Aggregate being 2.7. In case aggregates have specific gravity more than 2.7, bitumen content can be reduced proportionately. Further, for regions where highest daily mean air temperature is 30° C or lower and lowest daily mean air temperature is – 10° C or lower, the bitumen content may be increased by 0.5 percent.

**16.47.2.5** Aggregate Grading and Binder Content: When tested in accordance with IS 2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and added filler for the particular mixture shall fall within the limits shown in Table 16.41 for bituminous macadam.

### **16.47.3 Construction Operation**

**16.47.3.1** Preparation of the Base: The base on which bituminous macadam is to be laid shall be prepared, shaped and compacted to the required profile as appropriate, and a prime coat, shall be applied as specified, in





accordance with the provisions or as directed by the Engineer-in-charge. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air, in locations where mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer-in-charge.

**16.47.3.2 Tack Coat:** Where the material on which the bituminous macadam is to be placed is bitumen bound surface, a tack coat shall be applied as specified, in accordance with Para 16.29, or as directed by the Engineer-in-Charge.

**16.47.3.3 Mixing and Transportation of the Mixture:** Pre-mixed bituminous materials, shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures are given in Table 16.41A of these Specifications; the difference in temperature between the binder and aggregate should at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time. The essential features of the hot mix plants are given in Annex. A of IRC:27.

If a continuous type mixing plant is used, the Contractor must demonstrate by laboratory analysis that the cold feed combined grading is within the grading limits specified for that bituminous bound material. In the case of a designed job mix, the bitumen and filler content shall be derived using this combined grading.

Bituminous materials shall be transported in clean insulated vehicles, and unless otherwise agreed by the Engineer, shall be covered while in transit or awaiting tipping. Subject to the approval of the Engineer, a thin coating of diesel or lubricating oil may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

**TABLE 16.41A**

**Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree Celsius)**

Bitumen Viscosity Grade	Bitumen Temperature	Aggregate Temperature	Mixed Material Temperature	Laying Temperature	*Rolling Temperature
VG-40	160-170	160-175	160-170	150 Min.	100 Min.
VG-30	150-165	150-170	150-165	140 Min.	90 Min.
VG-20	145-165	145-170	145-165	135 Min.	85 Min.
VG-10	140-160	140-165	140-160	130 Min.	80 Min.

\* Rolling must be completed before the mat cools to these minimum temperatures.

**16.47.3.4 Cleaning of Surface:** The surface on which the bituminous work is to be laid shall be cleaned of all loose and extraneous matter by means of a mechanical broom and air jet. or any other approved equipment/ method as specified in the contract. The use of a high pressure air jet from a compressor to remove dust or loose matter shall be available full time on the site, unless otherwise specified in the Contract.

**16.47.3.5 Spreading:** Prior to spreading the mix, the base shall be prepared by carrying out the required operation. Except in areas where a mechanical paver cannot get access, bituminous materials shall be spread, leveled and tamped by an approved self-propelled paving machine equipped with an electronic sensing device. The essential features of the paver finisher shall conform to Annex A of IRC:27. As soon as possible after arrival at site, the materials shall be supplied continuously to the paver and laid without delay.





The rate of delivery of material to the paver shall be regulated to enable the paver to operate continuously. The travel rate of the paver, and its method of operations, shall be adjusted to ensure an even and uniform flow of bituminous material across the screed, free from dragging, tearing and segregation of the material. In areas with restricted space where a mechanical paver cannot be used, the material shall be spread, raked and leveled with suitable hand tools by experienced staff, and compacted to the satisfaction of the Engineer-in-charge.

The minimum thickness of material laid in each paver pass shall be in accordance with the minimum values given in the relevant parts of these Specifications. When laying binder course or wearing course approaching an expansion joint of a structure, machine laying shall stop 300 mm short of the joint. The remainder of the pavement up to the joint, and the corresponding area beyond it, shall be laid by hand, and the joint or joint cavity shall be kept clear of surfacing material.

Bituminous material, with a temperature greater than 145°C, shall not be laid or deposited on bridge deck waterproofing systems, unless precautions against heat damage have been approved by the Engineer-in-charge.

**16.47.3.6 Rolling / Compaction:** Bituminous materials shall be laid and compacted in layers which enable the specified thickness, surface level, regularity requirements and compaction to be achieved.

Compaction of bituminous materials shall commence as soon as possible after laying. Compaction shall be substantially completed before the temperature falls below the minimum rolling temperatures stated in the relevant part of these Specifications. Rolling of the longitudinal joints shall be done immediately behind the paving operation. After this, rolling shall commence at the edges and progress towards the center longitudinally except that on super elevated and unidirectionally cambered portions, it shall progress from the lower to the upper edge parallel to the center line of the pavement. Rolling shall continue until all roller marks have been removed from the surface. All deficiencies in the surface after laying shall be made good by the attendants behind the paver, before initial rolling is commenced. The initial or breakdown rolling shall be done with 8 – 10 tonnes dead weight smooth-wheeled rollers. The intermediate rolling shall be done with 8 – 10 tonnes dead weight or vibratory roller or with a pneumatic tyred roller of 12 to 15 tonnes weight having nine wheels, with a tyre pressure of at least 5.6 kg/sqcm or 0.56 MPa. The finish rolling shall be done with 6 to 8 tonnes smooth wheeled tandem rollers. Rolling shall be continued until the specified density is achieved, or where no density is specified, until there is no further movement under the roller.

Where compaction is to be determined by density of cores the requirements to prove the performance of rollers shall apply in order to demonstrate that the specified density can be achieved. In such cases the Contractor shall nominate the plant, and the method by which he intends to achieve the specified level of compaction and finish at temperatures above the minimum specified rolling temperature. Laying trials shall then demonstrate the acceptability of the plant and method used.

Bituminous materials shall be rolled in a longitudinal direction, with the driven rolls nearest the paver. The roller shall first compact material adjacent to joints and then work from the lower to the upper side of the layer, overlapping on successive passes by at least one-third of the width of the rear roll or, in the case of a pneumatic-tyred roller, at least the nominal width of 300 mm.

In portions with super elevated and unidirectional camber, after the edge has been rolled, the roller shall progress from the lower to the upper edge.

Rollers should move at a speed of not more than 5 km per hour. The roller shall not be permitted to stand on pavement which has not been fully compacted, and necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing. The wheels of rollers shall be kept moist with water, and the spray system provided with the machine shall be in good working order, to prevent the mixture from adhering to the wheels. Only



sufficient moisture to prevent adhesion between the wheels of rollers and the mixture should be used. Surplus water shall not be allowed to stand on the partially compacted pavement.

**16.47.3.7 Joints:** Where joints are made, the material shall be fully compacted and the joint made flush in one of the following ways:

- a. All joints shall be cut vertical to the full thickness of the previously laid mix. All loosened material shall be discarded and the vertical face coated with a suitable viscosity grade hot bitumen, or cold applied emulsified bitumen. While spreading the material along the joint the material spread shall overlap 25 mm to 50 mm on the previously laid mix beyond the vertical face of the joint. The thickness of the loose overlap material should be approximately a quarter more than the final compacted thickness. The overlapped mix shall be dragged back to the hot lane so that the roller can press the small excess into the hot side of the joint to obtain a high joint density.
- b. By using two or more pavers operating in echelon, where this is practicable, and in sufficient proximity for adjacent widths to be fully compacted by continuous rolling

All longitudinal joints shall be offset at least 300 mm from parallel joints in the layer beneath or as directed, and in a layout approved by the Engineer-in-charge. Joints in the wearing course shall coincide with either the lane edge or the lane marking, whichever is appropriate. Longitudinal joints shall not be situated in wheel track zones.

**16.47.3.8 Opening to Traffic:** The newly laid surface shall not be open to traffic for at least 24 hours after laying the completion of compaction, without the approval of the Engineer-in-Charge in writing.

**16.47.3.9 Surface Finish and Quality Control of Work:** The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH Specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH Specifications.

**16.47.3.10 Arrangement for Traffic:** During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of the Engineer- in-charge.

**16.47.4 Measurement:** Bituminous Macadam shall be measured as finished work in cubic meters correct to two places of decimal.

**16.47.5 Rate:** The rate includes the cost of all material, labour, machineries and equipments in all the operations described above.

## **16.48 DENSE BITUMINOUS CONCRETE**

### **16.48.1 Scope**

Dense Bituminous Concrete (DBC) is used in wearing and profile corrective courses. This work shall consist of construction in a single layer of bituminous concrete on a previously prepared bituminous bound surface. A single layer in a single layer shall be 30 mm / 40 mm / 50 mm thick.

### **16.48.2 Materials**

**16.48.2.1 Bitumen:** The bitumen shall be viscosity grade paving bitumen complying with the Indian Standard Specification IS:73, or as otherwise specified in the item. The type and grade of bitumen to be used shall be specified in the item of Contract. Where modified bitumen is specified, it shall conform to the requirements of IRC:SP:53 and IS:15462.

Section criteria for viscosity grade bitumen, based on highest and lowest daily mean temperatures at a particular site are given in Table 16.40A.

Selection criteria for modified bitumen shall be in accordance with IRC:SP53.



**16.48.2.2 Coarse Aggregates:** Same as specified in para 16.46.2.2 excepting strength which shall be max 30% for Los Angeles Abrasion Value and Aggregate Impact Value of max 24%. Where crushed gravel is proposed for use as aggregate, not less than 95 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

**16.48.2.3 Fine Aggregates:** The fine aggregates shall be all as specified in para 16.46.2.3.

**16.48.2.4 Filler:** Filler shall be generally as specified in para 16.46.2.4.

**16.48.2.5 Aggregate Grading and Binder Content:** When tested in accordance with IS 2386 part 1 (wet grading method), the combined grading of the coarse and fine aggregates and added filler shall fall within the limits shown in Table No. 16.42 for grading 1 or 2 specified in the contract.

**TABLE NO. 16.42**  
**Composition of Bituminous Concrete Pavement Layers**

<i>Grading</i>	<i>1</i>	<i>2</i>
Nominal aggregate size*	19 mm	13.2 mm
Layer Thickness	50 mm	30-40 mm
IS Sieve <sup>1</sup> (mm)	Cumulative % by weight of total aggregate passing	
45	-	-
37.5	-	-
26.5	100	-
19	90-100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Min. 5.2* or as specified in the item	Min. 5.4** or as specified in the item
Bitumen grade	Specified in item or directed otherwise	Specified in item or directed otherwise

\* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

\*\* Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest



daily mean air temperature is 30° C or lower and lowest daily air temperature is – 10 ° C or lower, the bitumen content may be increased by 0.5 percent.

### 16.48.3 Mix Design

The bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS-2.

The Fines to Bitumen (F/B) ratio by weight of total mix shall range from 0.6 to 1.2.

**16.48.3.1** Requirements for the Mix: Same as specified in Para 16.46.3.1 shall apply.

**16.48.3.2** Binder Content: Same as specified in para 16.46.3.2.

**16.48.3.3** Job Mix Formula: The procedure for formulating the job mix formula shall be generally as specified in Para 16.46.3.3.

**16.48.3.4** Plant Trials – Permissible Variation In Job Mix Formula: The requirements for plant trials shall be as specified in Para 16.46.3.4 and permissible limit for variation as given in Table 16.43.

**TABLE 16.43**

**Permissible Variations in the Plant Mix from the Job Mix Formula**

<i>Description</i>	<i>Permissible Variation</i>
Aggregate passing 19 mm sieve or larger	± 7%
Aggregate passing 13.2 mm, 9.5 mm	± 6%
Aggregate passing 4.75 mm	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	± 4%
Aggregate passing 0.3 mm, 0.15 mm	± 3%
Aggregate passing 0.075 mm	± 1.5%
Binder content	± 0.3%
Mixing temperature	± 10°C

**16.48.3.5** Laying Trials: The requirements for laying trials be as specified in Para 16.46.3.5. The compacted layers of bituminous concrete (BC) shall have a minimum field density equal to or more than 92 percent of the average theoretical maximum specific gravity (Gmm) obtained on the day of compaction in accordance with ASTM D2041.

### 16.48.4 Construction Operations

**16.48.4.1** Preparation of Base: The base on which DBC is to be laid shall be prepared, shaped and compacted to the required profile as appropriate or as directed by the Engineer-in-charge. The surface shall be thoroughly swept clean by a mechanical broom, and the dust removed by compressed air, in locations where mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer-in-charge.

**16.48.4.2** Tack Coat: Where the material on which the bituminous macadam is to be placed is bitumen bound surface, a tack coat shall be applied as specified, in accordance with Para 16.29, or as directed by the Engineer-in-Charge.



**16.48.4.3** Mixing and Transportation of the Mixture: The provisions are same as specified in Para 16.47.3.3 shall apply.

**16.48.4.4** Spreading: The provisions are same as specified in Para 16.47.3.5 shall apply.

**16.48.4.5** Rolling / Compaction: The provisions are same as specified in Para 16.47.3.6 shall apply.

**16.48.5 Opening to Traffic:** The newly laid surface shall not be open to traffic for at least 24 hours after laying the completion of compaction, without the approval of the Engineer-in-Charge in writing.

**16.48.6 Surface Finish and Quality Control of Work:** The surface finish of the completed construction shall conform to the requirements of section 900 of MORTH Specifications. For control of the quality of materials supplied and the works carried out the relevant provisions of Section 900 of MORTH Specifications.

**16.48.7 Arrangement for Traffic:** During the period of construction, arrangements for traffic shall be made in accordance with the provisions of specification and as per direction of the Engineer-in-charge.

#### **16.48.8 Measurement**

Dense Bituminous Concrete shall be measured as finished work in cubic meters, correct to two places of decimal.

#### **16.48.9 Rate**

The rate includes the cost of all material, labour, machineries and equipments in all the operations described above.

### **16.49 RETRO REFLECTIVE SIGN BOARD**

#### **16.49.0 General**

The colour, configuration, size and location of all the traffic signs for highways other than Express ways shall be in accordance with the code of practice for road signs, IRC:67 or as shown on the drawings. For expressways, the size of the signage, letters and their placement shall be as specified in the contract drawings and relevant specifications or as directed by the Engineer-in-Charge.

#### **16.49.1 Materials**

##### **16.49.1.1 Concrete**

Concrete shall be of M-25 grade.

##### **16.49.1.2 Reinforcing steel**

Reinforcing steel shall confirm to the requirement of IS 1786 unless otherwise specified.

##### **16.49.1.3 Bolts Nuts and Washers**

High strength bolts shall confirm to IS 1367 whereas precision bolts, nuts etc. shall confirm to IS 1364.

##### **16.49.1.4 Plates and Supports**

Plates and support sections for the sign posts shall confirm to IS 226 and IS 2062 or any other stated IS specification.

##### **16.49.1.5 Substrata**

The substrate shall be either aluminium sheeting or aluminium composite material (ACM) confirming to following sub-sections.

###### **16.49.1.5.1 Aluminium**



Aluminium sheets used for sign boards shall be of smooth, hard and corrosion resistant aluminium alloy confirming to IS 736 material designation 24345 or 1900.

#### 16.49.1.5.2 Aluminium composite materials

- i. The Aluminum Composite Material (ACM), used as the substrate for signage application shall have a thickness of at least 4.0mm (excluding coating thickness).
- ii. The ACM shall be composed of thermoplastic core of 'Low Density Polyethylene' (LDPE) of 3.0mm thickness sandwiched between two thick sheets of aluminium, of 3003 grade and H- 18 temper and minimum thickness of 0.5mm each. The retro reflection sheeting must be applied on the top surface with aluminium surface with recommended surface preparation from sheeting manufactures.
- iii. A fluorocarbon coating may be applied over the exposed surface of aluminum to ensure corrosion resistance and weather proof and thus shall confirm to relevant ASTM.
- iv. The ACM shall have a high-surface energy coating on the top surface, over which the retro reflective sheeting shall be applied.
- v. When measured after 24 hrs after application, the 90 peel-adhesion strength of the top surface of ACM with the retro reflective sheeting applied on it using a 2kg roller as per ASTM D3330 shall be at least 1.5 kg-f.
- vi. The front surface shall have no other coating other than the high-surface energy coating and shall be protected with a self-adhesive peel-off film. The retro reflective sheeting shall be applied only on the top surface with high-surface energy coating.
- vii. On the back surface, it shall have a polyester based service coating preferably grey in color to protect against possible corrosion and to avoid undesired glare from the rear side of the sign.
- viii. The mechanical properties of 4mm ACM and that of its aluminium skim shall confirm to the requirement given in table 16.44 below. When tested accordance with the test methods mentioned against each of them.

**Table 16.44**

#### **Specification for Aluminium Composite Material (ACM)**

S. No.	Description	Specification for 4mm	
		Standard Test	Acceptable Value/Results
<b>A</b>	<b>Physical Tests for ACM</b>		
1	Over all thickness of ACM	Measurement	4mm (Tolerance + 0.2mm)
2	Aluminium Skin thickness (each side)	Measurement	0.5mm (Tolerance +/- 0.03mm)
3	Panel weight (ACM)	Measurement	5.5 Kg/m <sup>2</sup> (+ 5%)
<b>B</b>	<b>Mechanical Properties of ACM</b>		
1	Peel off strength with retro reflective sheeting. (Drum Peel Test)	ASTM D903	Min. 4 N/mm
2	Tensile strength	ASTM E638	Min. 40 N/mm <sup>2</sup>
3	0.2% Proof Stress	ASTM E638	Min. 34 N/mm <sup>2</sup>
4	Elongation	ASTM E638	Min. 6%



5	Flexural strength	ASTM C393	Min. 130 N/mm <sup>2</sup>
5	Shear strength with punch shear test	ASSTM D732	Min. 18 N/mm <sup>2</sup>
<b>C</b>	<b>Properties of Aluminium skin</b>		
1	Tensile strength (Rm)	ASTM E8	Min. 150 N/mm <sup>2</sup>
2	Modules of elasticity	ASTM E8	Min 70000 N/mm <sup>2</sup>
3	Elongation	ASTM E8	Min. 2%
4	0.2% proof stress	ASTM E8	Min. 110 N/mm <sup>2</sup>
<b>D</b>	<b>Properties of High surface energy coating</b>		
1	(90 deg) Peel adhesion strength of Retroreflective sheeting on ACM surface with high-surface energy coating	ASTM D330	Min. of 1.5 kgf i.e. Equal to or more than that with surface prepared aluminium

#### 16.49.1.5.3 Performance Certificate

Requisite performance certificate from the manufacturer of the ACM stating compliance with ACM technical specification as per Table 16.44 above shall be submitted by the contractor to the Engineer- in-Charge.

#### 16.49.1.6 Retro- Reflective Sheeting (Type-XI Prismatic Grade sheeting):

(AS per IRC 67-2012 Clause 6.7)

The retro reflective sheeting used on the signs shall consist of white or coloured sheeting having a smooth outer surface which has the property of retro reflection over its entire surface. It shall be weather resistant and exhibit colour fastness. It shall be new and unused and show no evidence of cracking, scaling, and pitting, blistering, edge lifting or curling and shall have negligible shrinkage or expansion. A certificate of having the sheeting tested for coefficient of retro reflection, daytime colour and luminance, shrinkage, flexibility, liner removal, adhesion, impact resistance, specular gloss and fungus resistance, 3 years outdoor weathering and its having passed these tests shall be obtained from International / Government Laboratory / Institute by the manufacturer of the sheeting and in case the certificate is obtained from international agency, it should also be obtained from Indian agency within 3 years of launching of product by the manufacture in abroad. Alternatively, a certificate conforming to ASTM Specification (D 4956-09) on artificial accelerated weathering requirements from a reputed laboratory in India can be accepted provisionally. In such a situation, the Employer/ Client, if so desires, could seek for a performance guarantee which would be released after receipt of certificate meeting the requirement of three years outdoor weathering of the sheeting.

Retro-reflective sheeting is typically manufactured as a cube corner. The reflective sheeting shall be retro-reflective sheeting made of micro prismatic retro-reflective material. The retro-reflecting surface after cleaning with soap and water and in dry condition shall have minimum co-efficient of retro reflection (determined in accordance with ASTM D4956-09) confirming to IRC:67 Table 6.9.

When totally wet, the sheeting shall not show less than 90 per cent of the values of retro-reflection. At the end of 10 years the sheeting shall return at least 80 per cent of its original retro-reflectance.

**16.49.1.7 Adhesives:** The sheeting shall have a pressure-sensitive adhesive of the aggressive- tack type requiring no heat, solvent or other preparation for adhesion to a smooth clean surface, in a manner recommended by the sheeting manufacturer and approved by Engineer-in-Charge. The adhesive shall be protected by an easily removable liner (removable by peeling without soaking in water or other solvent) and shall be suitable for the type of material of the base plate used for the sign. The Adhesive shall form a durable





bond to smooth, corrosion and weather resistant surface of the base plate such that it shall not be possible to remove the sheeting from the sign base in one piece by use of sharp instrument. The sheeting shall be applied in accordance with the manufacturers specifications.

#### **16.49.2 Installation**

**16.49.2.1** Surface to be reflectorised shall be effectively prepared to receive the retro- reflective sheeting. The Aluminium / ACP sheeting shall be de-greased either by acid or hot alkaline etching and all scale/dust removed to obtain a smooth plain surface before the application of retro-reflective sheeting. Complete sheet of the material shall be used on the signs except where it is unavoidable. Sheeting with heat-activated adhesives may be spliced with an overlap not less than 5 mm or butted with a gap not exceeding 0.75 mm. The material shall cover the sign surface evenly and shall be free from twists, cracks and folds.

**16.49.2.2** Sign posts, their foundations and sign mountings shall be so constructed as to hold these in a proper and permanent position against the normal storm wind load or displacement by vandalism. Normally, sign with an area upto 0.9 sq.m shall be mounted on a single post and for greater area two or more supports shall be provided. Sign supports shall be as specified in item or as per directions of Engineer-in-Charge. The work of foundation shall conform to relevant specification as specified.

**16.49.2.3** Backside of aluminium sheet portion shall be painted with two coats of epoxy paint. Any part and support frame with two or more coats of synthetic enamel paint.

#### **16.49.3 Performance Certificate**

Requisite performance certificate from the manufacturer of the ACM stating compliance with ACM technical specification as per Table 16.44 above shall be submitted by the contractor to the Engineer- in-Charge.

#### **16.49.4 Warranty and Durability**

The Contractor shall obtain from the manufacturer a ten year warranty as per IRC:67 for satisfactory performance including stipulated retro-reflectance of the retro-reflective sheeting, the screen printed areas and cut out sheeting and cut out durable transparent overlay film and submit the same to the Engineer-in-Charge.

Processed and applied in accordance with recommended procedures, the reflective material shall be weather resistant and following cleaning, shall show no appreciable discoloration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified minimum reflective intensity values when subjected to accelerated weathering of 1000 hours, using type E or EH Weather meter (AASHTO Designation M 268).

#### **16.49.5 Measurement**

These shall be measured in square meters upto two place of decimal.

#### **16.49.6 Rate**

The rate includes the cost of materials labour and equipments involved in all the operations described above except 16.49.1.1 to 16.49.1.4.

### **16.50 RETRO REFLECTIVE OVERHEAD SIGNAGE**

#### **16.50.1 General**

Overhead signs may be used in lieu of, or as an adjunct to, ground signs where the situation so warrants for proper information and guidance of the road user.





The support system should be properly designed based on sound engineering principles, to safely sustain the dead load, live load and wind load on the completed sign system. For this purpose, the overhead signs shall be designed to withstand a wind loading of 150 kg/m<sup>2</sup> normal to the face of the sign and 30 kg/m<sup>2</sup> transverse to the face of the sign. In addition to the dead load of the structure, walkway loading of 250kg concentrated live load shall also be considered for the design of the overhead sign structure.

#### **16.50.2 Height**

Overhead signs shall provide a vertical clearance of not less than 5.5 m over the entire width of the pavement and shoulders except where a lesser vertical clearance is used for the design of other structures. The vertical clearance to overhead sign structures or supports need not to be greater than 300 mm in excess of the minimum design clearance of other structures.

#### **16.50.3 Lateral Clearance**

**16.50.3.1** The minimum clearance outside the usable roadway shoulder for expressway sign mounted at the road side or for overhead sign supports either to the right or left side of the roadways shall be 1.80 m. This minimum clearance of 1.80 m shall also apply outside of an unmountable kerb. Where practicable, a sign should not be less than 3 m from the edge of the nearest traffic lane.

**16.50.3.2** Where a median is 3.6 m or less in width, consideration should be given to spanning over both roadways without a central support. Where overhead sign supports cannot be placed at a safe distance away from the line of traffic or in an otherwise protected site, they should either be so designed as to minimize the impact forces or protect motorists adequately by a physical barrier or guard rail of suitable design.

#### **16.50.4 Number of Signs at an Overhead Installation**

In no case should there be more than three signs displayed at any one location, including regulatory or warning signs, either on the overhead structure or on its support.

#### **16.50.5 Materials for Overhead Sign and Support Structures**

**16.50.5.1** Aluminium alloy or galvanized steel to be used as truss design supports shall conform to relevant IS. These shall be of sections and type as per structural design requirements as shown on the plans.

**16.50.5.2** Plates and support sections for sign posts shall conform to IS 226 and IS 2062.

**16.50.5.3** The overhead signs shall be reflectorised with high intensity retro-reflective sheeting of encapsulated lens type.

#### **16.50.6 Size, Locations, etc of Signs**

**16.50.6.1** The size of the signs, letter and their placement shall be as specified in the Contract drawings and specifications as per direction of Engineer-in-Charge.

#### **16.50.7 Installation**

**16.50.7.1** The supporting structure and signs shall be fabricated and erected as per details given in the plans.

**16.50.7.2** Sign posts, their foundations and sign mountings shall be so constructed as to hold sign in a proper and permanent position to adequately resist swaying in the wind or displacement by vandalism.

**16.50.7.3** The work of construction of foundation for sign supports including excavation and backfill, forms, steel reinforcement, concrete and its placement shall conform to the relevant specifications given in this specification.

**16.50.7.4** The structures shall be erected with the specified camber and in such a manner as to prevent excessive stresses, injury and defacement.



**16.50.7.5** Brackets shall be provided for mounting signs of the type to be supported by the structure. For better visibility, they shall be adjustable to permit mounting the sign faces at any angle between a truly vertical position and three degree from vertical. This angle shall be obtained by rotating the front lower edge of the sign forward. All brackets shall be of a length equal to the heights of the signs being supported.

**16.50.7.6** Before erecting support structures, the bottom of each base plate shall be protected with an approved material which will adequately prevent any harmful reaction between the plate and the concrete.

**16.50.7.7** The end supports shall be plumbed by the use of levelling nuts and the space between the foundation and base plate shall be completely filled with an anti-shrink grout.

**16.50.7.8** Anchor bolts for sign supports shall be set to proper locations and elevation with templates and carefully checked after construction of the sign foundation and before the concrete has set.

**16.50.7.9** All nuts on aluminium trusses, except those used on the flanges, shall be tightened only until they are snug. This includes the nuts on the anchor bolts. A thread lubricant shall be used with each aluminium nut.

**16.50.7.10** All nuts on galvanized steel trusses, with the exception of high strength bolt connections, shall be tightened only to a snug condition.

**16.50.7.11** Field welding shall not be permitted.

**16.50.7.12** After installation of signs is completed; the sign shall be inspected by the Engineer. If specular reflection is apparent on any sign, its positioning shall be adjusted by the Contractor to eliminate or minimize this condition.

#### **16.50.8 Measurement**

These shall be measured in sq.meter upto two place of decimal.

#### **16.50.9 Rate**

The rate includes the cost of materials, labour and equipments involved in all the operations described above.

### **16.51 ROAD MARKINGS STRIPS**

The colour width and layout of road markings shall be in accordance with the Code of Practice for Road Markings with paints, IRC : 35, and as specified in the drawings or as directed by the Engineer- in-Charge.

#### **16.51.1 Materials**

Road markings shall be of ordinary road marking paint (retro-reflective), hot applied thermoplastic compound as specified in the item.

#### **16.51.2 Hot Applied Thermoplastic Road Marking**

General

- (i) The thermoplastic material shall be homogenously composed of aggregate, pigment, resins and glass reflectorizing beads.
- (ii) The thermoplastic compound shall be screeded/extruded on to the pavement surface in a molten state by suitable machine capable of controlled preparation and laying with surface application of glass beads at a specific rate. Upon cooling to ambient pavement temperature, it shall produce an adherent pavement marking of specified thickness and width and capable of resisting deformation by traffic.
- (iii) The thermoplastic material shall conform to ASTM D36/BS-3262-(Part I).



- (iv) The material shall meet the requirements of these specifications for a period of one year. The thermoplastic material must also melt uniformly with no evidence of skins or unmelted particles for the one year storage period. Any material not meeting the above requirements shall be replaced by the manufacturer/supplier/Contractor.
- (v) Marking : Each container of the thermoplastic material shall be clearly and indelibly marked with the following information:
  - 1. The name, trade mark or other means of identification of manufacturer.
  - 2. Batch number
  - 3. Date of manufacture
  - 4. Colour (White or yellow)
  - 5. Maximum application temperature and maximum safe heating temperature.
- (vi) Sampling and Testing: The thermoplastic material shall be sampled and tested in accordance with the appropriate ASTM/BS method. The Contractor shall furnish to the Engineer-in-Charge a copy of certified test reports from the manufacturers of the thermoplastic material showing results of all tests specified herein and shall certify that the material meets all requirements of this Specification.

#### **16.51.3 Preparation**

- (i) The material shall be melted in accordance with the manufacturer's instructions in a heater fitted with a mechanical stirrer to give a smooth consistency to the thermoplastic material to avoid local overheating. The temperature of the mass shall be within the range specified by the manufacturer, and shall on no account be allowed to exceed the maximum temperature stated by the manufacturer. The molten material should be used as expeditiously as possible and for thermoplastic material which has natural binders or is otherwise sensitive to prolonged heating, the material shall not be maintained in a molten condition for more than 4 hours.
- (ii) After transfer to the laying equipment, the material shall be maintained within the temperature range specified by the manufacturer for achieving the desired consistency for laying.

#### **16.51.4 Properties of Finished Road Marking**

- a. The stripe shall not be slippery when wet.
- b. The marking shall not lift from the pavement in freezing weather.
- c. After application and proper drying, the stripe shall show no appreciable deformation or discolouration under traffic and under road temperatures upto 60oC.
- d. The marking shall not deteriorate by contact with sodium chloride, calcium chloride or oil drippings from traffic. The stripe or marking shall maintain its original dimensions and position. Cold ductility of the material shall be such as to permit normal movement with the road surface without chopping or cracking.
- e. The colour of yellow marking shall conform to IS Colour No. 356 as given in IS 164.

#### **16.51.5 Application**

Marking shall be done by fully /semi automatic paint applicator machine fitted with profile shoe, glass beads dispenser, propane tank heater and profile shoe heater, driven by experienced operator as specified in item. For locations where painting cannot be done by machine, approved manual methods shall be used with prior approval of the Engineer-in-charge. The Contractor shall maintain control over traffic while painting operations are in progress so as to cause minimum inconvenience to traffic compatible with protecting the workmen.



The thermoplastic material shall be applied hot either by screeding or extrusion process. After transfer to the laying apparatus, the material shall be laid at a temperature within the range specified by the manufacturer or otherwise directed by the Engineer-in-Charge for the particular method of laying being used. The paint shall be applied using a screed or extrusion machine.

The pavement temperature shall not be less than 10°C during application. All surfaces to be marked shall be thoroughly cleaned of all dust, dirt, grease, oil and all other foreign matter before application of the paint.

Thermoplastic paint shall be applied in intermittent or continuous lines of uniform thickness of at least 2.5 mm unless specified otherwise. Where arrows or letters are to be provided, thermoplastic compound may be hand-sprayed.

The minimum thickness specified is exclusive of surface applied glass beads.

The finished lines shall be free from ruggedness on sides and ends and be parallel to the general alignment of the carriageway. The upper surface of the lines shall be level, uniform and free from streaks.

#### **16.51.6 Measurements for Payment**

The painted markings shall be measured in sq. metres of actual area marked (excluding the gaps, if any) correct upto the two places of decimal.

**16.51.7** The rate include the cost of all materials, labour and equipments required in all the above operations.

#### **16.52 KERB CHANNEL OF CEMENT CONCRETE**

Base: The base of the channel to be of the 75 mm compacted thick dry brick ballast 40 mm nominal size well rammed and consolidated and grouted with fine sand.

Kerb channel shall be provided in cement concrete of specified grade. These shall be cast in-situ of specified size as given in the item. Top surface of channel to be finished smooth.

Measurements: Cement concrete channel shall be measured in metre of length of the completed channel correct upto two places of decimal.

Rate: The rate includes the cost of all the materials, labours and tools required in all the operations described above.

#### **16.53 75 MM THICK COMPACTED BED OF DRY BRICK BALLAST: DELETED**

#### **16.54 POST DELINEATORS**

**16.54.1** The role of delineators is to provide visual assistance to drivers about alignment of the road ahead, especially at night. Delineators are particularly effective in the case of complex locations involving changes in horizontal / vertical geometry and doing severe weather condition such as heavy rain, fog or snow. Normally reflectors are used on the delineators for better night time visibility. Road delineators may have a circular, rectangular or triangular cross-section, however the side facing the traffic should not be less than 10 cm wide.

In board sense, Delineators stands for any device or treatment whose aim is to outline the road way.

#### **16.54.2 Material:**

The design, materials to be used and the location of the road delineators shall conform to recommended practice for road delineators, IRC:79, and to relevant drawings and as directed by the Engineer-in-charge.

The delineators are to be made of Acrylonitrile Butadiene Styrene (ABS) body fitted with 2 No. 100 mm dia of highly reflective reflectors are mounted on M.S. pipe of 65 mm dia or of size specified otherwise, duly powder coated of minimum 40 microns thickness anti-rust and anti-theft, installed as per direction of



Engineer-in-charge. Road delineators may have a circular, rectangular or triangular cross-section, however the side facing the traffic should not be less than 10 cm wide.

#### **16.54.3 Dimensions:**

Height of the delineator should be not less than 800 mm above ground. Width not less than 100 mm. Not more than 300 mm below the ground while being installed.

#### **16.54.4 Placement and spacing:**

As a general rule, delineators posts should be erected at the edge of the usable shoulders, and in the case of kerbed sections at a distance of 0.6 to 1.5 m from the kerb face. On hill roads they may be placed either on the parapet or at the edge of the shoulders.

The delineator should be so positioned that the reflectorised face is perpendicular to the direction of travel.

#### **Warranty:**

The contractor shall obtain a two years warranty for satisfactory performance including stipulated retro-reflectance of the retro-reflective sheeting and submit the same to the Engineer-in-charge.

#### **16.54.5 Measurement**

The measurement shall be made in numbers of delineators fixed at site.

#### **16.54.6 Rate**

The rate includes the cost of all the material, labour and equipment required in all the operations described above.

### **16.55 EXCAVATING HOLES UPTO 0.10 CUM**

The specifications of sub head earth work of Specifications to be followed for this item.

### **16.56 FACTORY MADE RCC PAVEMENT SLAB**

Precast RCC slab casted with the cement concrete of M-30 or specified otherwise grade of size specified in item made of approved brand and manufacturer to be used.

Specification of cement concrete base, bed cement mortar and RCC to be of the sub head cement concrete, mortar and RCC of the specification to be followed.

### **16.57 FACTORY MADE CEMENT CONCRETE INTERLOCKING PAVER BLOCK**

#### **16.57.1 General**

The construction of block pavement involves preparation of subgrade, sub-base and base course layers, bedding sand and finally the laying of blocks. The block paving can be done entirely by manual labour. However, for efficient construction work, the work force has to be properly trained for this specialized job. Paving can also be done by mechanical means.

#### **16.57.2 Preparation of Subgrade**

This is the foundation layer on which the block pavement is constructed. Like in conventional pavements the water table should be at a minimum depth of 600 mm below the subgrade. Subgrade should be compacted in layers of 150 or 100 mm thickness as per IRC:36-2010.

The prepared subgrade should be graded and trimmed to a tolerance of  $\pm 20$  mm of the design levels, and its surface evenness should have a tolerance of within 15 mm under a 3 m straight edge.

The following types of material shall be considered unsuitable for subgrade construction.



- a. Material from swamps, marshes and bogs.
- b. Peat, log, stump and perishable material; any soil that classifies as OL, OI, OH, or Peat in accordance with IS 1498.
- c. Material is susceptible to spontaneous combustion
- d. Material in frozen condition
- e. Clay having liquid limit exceeding 50 and plasticity index exceeding 25
- f. Expansive soil e.g. Black cotton soil

The detail procedure for preparation of subgrade is mentioned in section.

**Note:**

Capillary Cut off: At locations where the water table is high and the soil has potential for rapid and relatively great migration of moisture by capillarity, a granular layer, impervious membrane or barrier of another approved medium shall be inserted at a suitable level by way of a cut-off, so that the moisture is not able to rise to the subgrade level. For details about the suitable types of capillary cut-offs, and their provision, refer to IRC 34 "Recommendations for Road Construction in Waterlogged Areas" and relevant clause in Section 300 of MORTH Specifications.

### 16.57.3 Base Course

The commonly used material considered suitable for base courses are unbound crushed rock, water-bound macadam, wet mix macadam, cement bound crushed rock/ granular material, and lean cement concrete. For heavy duty block pavement, lean concrete base must be provided.

In broad terms, wherever the subgrade is weak (having a CBR value below 5) use of bound granular material like, cement treated crushed rock, requiring a relatively thinner base, should be preferred while for high strength subgrades, unbound crushed rock can be used. The climatic and environmental factors also need to be considered during the choice of a base material.

### 16.57.4 Sub-Base Course

Generally, a sub base is warranted where commercial traffic is expected. The quality of sub base material is inferior to the base materials and includes natural gravels, cement treated gravels and sands and stabilized subgrade materials. The quality of sub base materials should be in conformance with IRC 37 or MoRTH specification. Constructing layers to proper level and grade is very essential to maintain the level and surface regularity of the block pavement.

### 16.57.5 Bedding and Joint Filling Sand

#### 16.57.5.1 Bedding Sand:

- a. Single-sized or gap graded sands or sands with excessive amount of fines or plastic fines shall not be used. The shape of sand particles should preferably be angular type rather than rounded, since the sharp sands possess higher strength and resist the migration of sand from under the block to less frequently trafficked areas. Even though sharp sands are relatively more difficult to compact than rounded sands, the use of sharp sands should be preferred for the more heavily trafficked pavements. The bedding sand should be free of deleterious materials.
- b. The bedding sand layer shall be from either a single source or blended to achieve the following grading:

IS Sieve Size	Percent Passing
9.52 mm	100
4.75 mm	95-100
2.36 mm	80-100
1.18 mm	50-95
600 micron	25-60



300 micron	10-30
150 micron	0-15
75 micron	0-10

- c. The thickness of the sand bed after compaction should be in the range of  $30 \pm 5$  mm, whereas, in the loose form it can be 30 to 50 mm. It is preferable to restrict the compacted thickness to  $30 \pm 5$  mm to reduce the risk of any localized pre compaction, which would affect the final block surface level. Bedding sand should not be used to fill-up local depressions on the surface of a base or sub-base. The depressions should be repaired in advance before placing sand.

Sand to be used should be uniformly in loose condition and should have a uniform moisture content. Best moisture content is that when sand is neither too wet nor too dry and have a value about 4 per cent by weight. Requirement of sand for a day's work should be prepared and stored in advance and covered with tarpaulin or polythene sheets.

The processed sand is spread with the help of screed boards to the required thickness. The screed boards are provided with nails at 2-3 m apart which when dragged gives the desired thickness. The length of nail should take into account the surcharge to be provided in the uncompacted thickness. Alternatively, the screed can be dragged on edge strips kept on both sides as guide. Asphalt paver can be employed in large projects. The sand is subsequently compacted with plate vibrators weighing 0.6 tones or more. Level checks shall be carried out on a grid pattern to establish that the desired level is achieved. Local correction can be done either by removing or adding extra sand followed by levelling and compacting the layer. There will be some settlement of sand after the blocks are placed and compacted, which must be allowed for, while fixing the level of sand bed.

#### 16.57.5.2 Joint filling sand:

The gaps in between two paving blocks (typically about 2-3 mm wide) need to be filled by sand, relatively finer than the bedding sand. The desired gradation for the joint tilling sand is as under:

IS Sieve Size	Percent Passing
2.36 mm	100
1.18 mm	90-100
600 micron	60-90
300 micron	30-60
150 micron	15-30
75 micron	0-10

It is necessary to restrict the fines (silt and/or clay) to 10 per cent, since excessive fines make joint filling very difficult. Similarly, it is not advisable to use cement in the joint tilling sand which will not only make it difficult to completely fill the joints but would also adversely affect the desired flexibility characteristics of the paving block layer. The joint filling sand should be as dry as possible; otherwise complete filling of joints will be difficult. To overcome the problem of efflorescence on the surface of paving block layer, the joint filling sand should be washed to remove soluble salts.

#### 16.57.6 Interlocking Paver Block





**16.57.6.1** Factory made precast paver block of M-40 or otherwise specified grade to be used. Paver blocks to be of approved brand and manufacturer and of approved quality. Minimum strength as prescribed by manufacturer and as per direction of Engineer-in-Charge for the grade specified to be tested as per method mentioned in specification of subhead cement concrete of Civil Specification 2023.

**16.57.6.2** The desired engineering properties of bedding/joint filling sand layer beneath the block, the base course and sub-base materials are also described.

Traffic and Road Type	Types of Layers	Subgrade CBR (%)		Grade of Block
		Above 10	5-10	
• Cycle Tracks, Pedestrian Footpaths	Block Thickness	60 mm	60 mm	M-30
	Sand Bed	30±5 mm	30±5 mm	
	Granulated Subbase	200 mm	200 mm	
• Commercial Traffic Axle Load Repetitions less than 10 msa • Residential Streets	Block Thickness	60-80 mm	60-80 mm	M-40
	Sand Bed	30±5 mm	30±5 mm	
	WBM/WMM Base	250 mm	250 mm	
	Granulated Subbase	200 mm	250 mm	
• Commercial Traffic Axle Load Repetitions 10-20 msa • Collector Streets, Industrial Streets, Bus and Truck Paring Areas	Block Thickness	80-100 mm	80-100 mm	M-40
	Sand Bed	30±5 mm	30±5 mm	
	WBM/WMM Base	250 mm	250 mm	
	Granulated Subbase	200 mm	250 mm	
• Commercial (Container yard and seaport) Axle Load Repetitions 20-50 msa • Arterial Streets	Block Thickness	100-120 mm	100-120 mm	M-50
	Sand Bed	30±5 mm	30±5 mm	
	WBM/WMM Base	250 mm	250 mm	
	or WBM/WMM Base and DLC over it*	150 mm 100 mm	150 mm 100 mm	
	Granulated Subbase	200 mm	250 mm	

**Notes:**

1. Thickness of layers given above are in mm
2. Granular sub-base should have at least 150 mm layer at bottom.
3. If the subgrade soil has a CBR of less than 5 %, it should be improved by suitable stabilisation technique to bring the CBR value to 5%.

**16.57.6.3 Physical Requirement**

The physical requirements of paver blocks are categorized into two groups, namely:

- a. Obligatory requirements shall be for ensuring durability of pavements constructed with paver blocks as well as obtaining better levels of service in block paving work, and
- b. Optional requirements shall be as per specific demands of the purchaser. These are described below.

**Obligatory Requirements**





- i. Visual Inspection
- ii. Dimensions and Tolerances
- iii. Thickness of Wearing Layer
- iv. Water Absorption
- v. Compressive Strength
- vi. Abrasion Resistance

#### Optional Requirements

- i. Tensile Splitting Strength
- ii. Flexural Strength/Breaking Load
- iii. Freeze-Thaw Durability
- iv. Colour and Texture

#### Note:

Test procedure is mentioned in IS 15658:2006

**Table 16.57A Recommended Dimensions and Tolerance for Paver Blocks**

SI No	Dimension	Measurement Method, Ref to IS 15658:2006	Recommended Values	Tolerance Limit for Paver Block	
				Thickness < 100 mm	Thickness > 100 mm
(1)	(2)	(3)	(4)	(5)	(6)
i)	Width, W	Annex B	To be specified by manufacture	± 2 mm	± 3 mm
ii)	length, L	Annex B	To be specified by manufacture	± 2 mm	± 3 mm
iii)	Thickness, T	Annex B	50 to 120 mm	± 3 mm	± 4 mm
iv)	Aspect Ratio, (L/T)	Annex B	Maximum: 4.0	+ 2	+ 2
v)	Arris/chamfer	Annex B	Minimum: 5 Maximum: 7	± 1 mm	± 1 mm
vi)	Thickness of wearing layer	6.2.3	Minimum: 6 mm	+ 2 mm	+ 2 mm
vii)	Plan Area, $A_{sp}$	Annex B	Maximum: 0.03 m <sup>2</sup>	+ 0.001 m <sup>2</sup>	+ 0.001 m <sup>2</sup>
viii)	Wearing surface area, $A_{sw}$	Annex B	Minimum 75 percent of Plan Area	-1 percent	-1 percent
ix)	Squareness	Annex B	Nil	± 2	± 3

#### 16.57.6.4 Laying of Blocks

Blocks can be laid generally by manual labour but mechanical aids hand-pushed trolleys can expedite the work.

Normally, laying should commence from the edge strip and proceed towards the inner side. When dentated blocks are used, the laying done at two fronts will create problem for matching joints in the middle. Hence, as far as possible, laying should proceed in one direction only, along the entire width of the area to be paved.

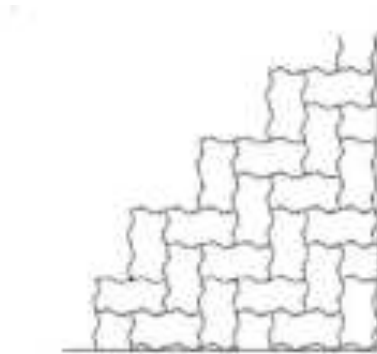
While locating the starting line, the following should be considered:



On a sloping site, start from the lowest point and proceed uphill on a continuous basis, to avoid downhill creep in incomplete areas.

#### **16.57.6.5 Bonds or Patterns of Laying Blocks**

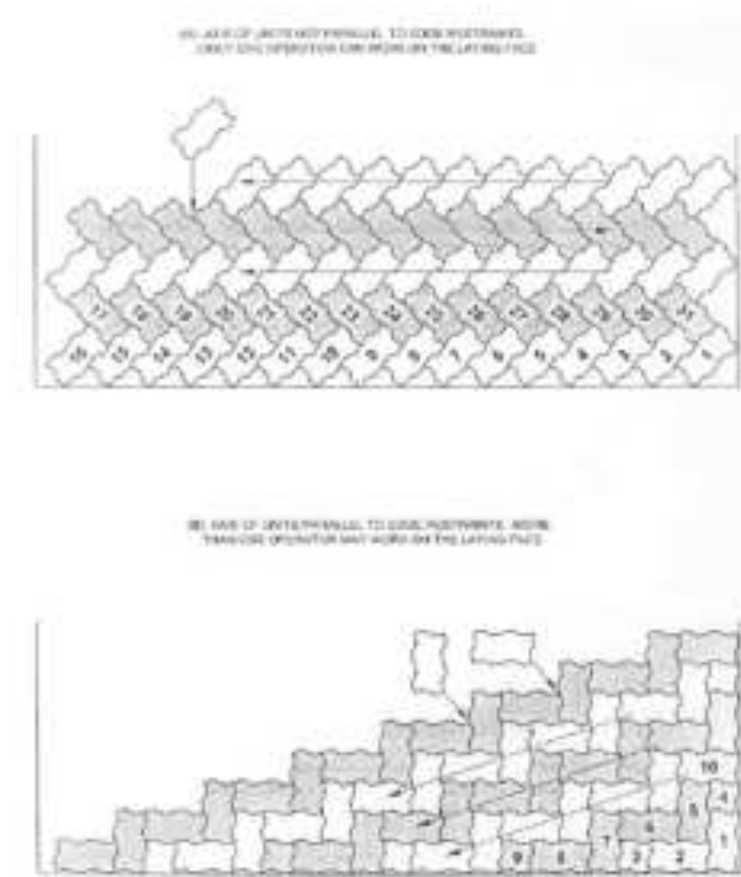
The blocks can be placed to different bonds or patterns depending upon choice. In case of Retail Outlet, the Herringbone bond shall be used. The typical layout of these bonds are given in Fig. below.



#### **16.57.6.6 Establishing the Laying Pattern**

In relation to the starting line, the blocks should be placed at the correct angle to achieve the final orientation as required by the laying pattern. If the edge restraint is straight and suitably oriented, the first row of blocks can abut it. For irregular-shaped and unfavourably oriented edge restraints, a string line should be established a few rows away to position the first row.

With the help of gauges, the joint width specification (2 to 3 mm) should be checked in the first few square metres, where it should be ensured that the block alignment is correct. The laying patterns and face should be established (Fig. below) to permit fast and easy laying without the necessity of forcing a block between previously positioned blocks. To start with, full blocks should be used; only subsequently, cutting and in-filling at edges be permitted. Under no circumstances should the blocks be forced or hammered into the bedding sand at this stage of laying. For cutting paving blocks, hydraulic or mechanical block cutters, or power saws are used. Cut units less than 50 mm minimum dimension should not be used, as these are difficult to cut accurately and can be dislodged under traffic. Where space does not permit use of a larger segment, use premixed concrete or a sand-cement mortar instead. The control over alignment, laying pattern and joint widths can be maintained by the use of chalked string lines, at about 5 m intervals.



#### 16.57.6.7 Methods of Construction of Block Pavement

##### a. Manual methods

In the traditional manual method, the sand is roughly screeded and a skilled worker (called a pavior) levels the sand and then embeds the block using a hammer; he works backwards so as to have a continuous view of the completed pavement in order to obtain a good finish. A pavior, along with an assistant, can lay 50 to 75 m<sup>2</sup> of paving per day. An alternative to the above method, the block layers (generally unskilled labourers) work on the completed surface, moving forward. For optimum output, it is advantageous to select an easy fitting block shape, with the desirable size being that which can be easily accommodated in the worker's hand; in addition, the blocks should be chamfered for easy handling and their weight should preferably be less than 4 kg.

The output of finished pavement varies widely with training of workmen, over a wide range from a low of 20 to a high of 120 m<sup>2</sup>/man-day. The higher outputs being for industrial hard standings where intrusion like manholes, etc. are minimal. To keep up the speed of work, it is important to maintain an adequate supply of paving blocks to the laying site for manual paving. Ordinarily, hand pushed trolleys are adequate for the purpose, but for large projects employing a number of laying teams, use of powered trolleys is preferable.

care must be taken to see that paving blocks are not tightly butted against each other, otherwise there could be non-uniformity in the laying patterns and the blocks may spall or even crack. Joint widths of 2 to 3 mm can be maintained if, when laying a paving unit, it is held lightly against the face of an adjacent laid unit and allowed to vertically slide into position. Since each workman may produce slightly different joint



widths, it is desirable to rotate workmen along the workplace, and also periodically interchange the personnel laying and transporting blocks. The average joint width can be measured and checked, by determining statistically the representative values of average length and breadth of blocks at the project site and then obtaining average distance between joints, say 40 blocks apart; or it can be done by measuring joint widths directly, using a calibrated, hardened steel mandrel which is forced into joints at a series of randomly selected location, to obtain a statistically representative figure.

**b. Mechanised methods**

Mechanised laying requires the use of specialised equipment for transporting and placing clusters of paving blocks. The size of paving block cluster suitable for paving, is usually 0.3 to 0.5 m<sup>2</sup> in area for hand-operated equipment. For fully mechanised equipment, the cluster surface area can be upto about 1.2 m<sup>2</sup>. These clusters are designed to maintain a joint space of about 3 mm between blocks, when clamped together. Since the blocks are placed in separate clusters, there exists the possibility of damage if joints between adjacent clusters run uninterrupted throughout the pavement. To overcome this problem, clusters may be arranged so that the joints are periodically staggered both along and across the cluster axis or link blocks are installed by hand across these joints. Mechanised laying must be coordinated with the manufacturer, so that the blocks are delivered stacked on pallets in the required pattern; in some cases, spacing ribs may be cast on the sides of blocks to preserve the required joint spacing.

**16.57.7 Compaction**

For compaction of the bedding sand and the blocks laid over it, vibratory plate compactors are used over the laid paving units; at least two passes of the vibratory plate compactor are needed. Such vibratory compaction should be continued till the top of each paving block is level with its adjacent blocks. It is not good practice to leave compaction till end of the day, as some blocks may move under construction traffic, resulting in the widening of joints and corner contact of blocks, which may cause spalling or cracking of blocks. There should be minimal delay in compaction after laying of paving blocks to achieve uniformity of compaction and retention of the pattern of laying; however, compaction should not proceed closer than 1 m from the laying face, except after completion of the pavement.

During vibratory compaction of the laid blocks, some amount of bedding sand will work its way into the joints between them. The extent of sand getting worked up into the joints will depend on the degree of pre-compaction of sand and the force applied by the block compactor. Standard compactors may have a weight of about 90 kg, plate area of about 0.3 m<sup>2</sup> and apply a centrifugal force of about 15 kN, while heavy duty compactors may weigh 300-600 Kg, have a plate area of about 0.5-0.6 m<sup>2</sup> and apply a centrifugal force of 30-65 kN.

Where the bedding sand has been pre-compacted and for heavily trafficked block pavements, heavy duty compactors should be used. After compaction by vibratory plate compactors, some 2 to 6 passes of a vibratory roller (with rubber coated drums or those of static weight less than 4 tonnes and nominal amplitude of not more than 0.4 mm) will further help in compaction of bedding sand and joint tilling.

**16.57.8 Measurement & Rates**

Area provided with paver block to be measured in sqm. correct upto two places of decimal. The rate includes the cost of the material, labour, tools etc. required in all the operations described above.

**16.58 KERB STONE (PRECAST)**

**16.58.1 Laying**

**16.58.1.1** Trenches shall first be made along the edge of the wearing course of the road to receive the kerb stones of cement concrete of specified grade. The bed of the trenches shall be compacted manually with steel



rammers to a firm and even surface and then the stones shall be set in cement mortar of specified proportion.

**16.58.1.2** The kerb stones with top 20 cm. wide shall be laid with their length running parallel to the road edge, true in line and gradient at a distance of 30 cm. from the road edge to allow for the channel and shall project about 12.5 cm. above the latter. The channel stones with top 30 cm. wide shall be laid in position in chamber with finished road surface and with sufficient slope towards the road gully chamber. The joints of kerb and channel stones shall be staggered and shall be not more than 10 mm. Wherever specified all joints shall be filled with mortar 1:3 (1 cement : 3 coarse sand) and pointed with mortar 1:2 (1 cement: 2 fine sand) which shall be cured for 7 days.

**16.58.1.3** The necessary drainage openings of specified sizes shall be made through the kerb as per drawings or as directed by the Engineer-in-Charge for connecting to storm water drains.

#### **16.58.2 Finishing**

Berms and road edges shall be restored and all surplus earth including rubbish etc. disposed off as directed by the Engineer-in-charge. Nothing extra shall be paid for this.

#### **16.58.3 Measurements**

It shall be measured in cubic meters with Length of the finished work (for specified width and height of stone) shall be measured in running metre along the edge of the road correct to a cm.

#### **16.58.4 Rate**

The rate shall include the cost of all the materials and labour involved in all the operations described above.

### **16.59 G.I. CHAIN LINK FABRIC FENCING**

#### **16.59.1 Material**

G.I. Chain link fabric fencing of required width in mesh size 50 x 50 or 25 x 25 mm or specified otherwise of approved brand and made of specified dia GI wire PVC coated of specified thickness / or not as specified in item of required colour or shade to be used.

**16.59.1.1** Fixing: GI chain link shall be stretched and fixed in specified width, strengthening with 2 mm dia wire or nuts bolts & washers as required to be done complete as per the direction of Engineer- in-Charge.

**16.59.1.2** Measurements: The length and width shall be measured correct to a cm. The area shall be calculated in square metre, correct to two places of decimal.

**16.59.2** The rate shall include the cost of material and labour involved in all the operations described as above.

### **16.60 SUPPLYING AND STACKING OF HARD STONE (FOR STONE PITCHING)**

Hard stone hammer dressed having no side less than 15 cm. with minimum depth of 20 cm. of the specification as mentioned in subhead – stone work of Specification to be used.

Specification for supplying, stacking and measurement to be same as for item no. 16.3.

### **16.61 VACUUM DEWATERED CEMENT CONCRETE PAVEMENT**

**16.61.1** Cement concrete to be compacted by screed board vibrator of the type approved by Engineer- in-Charge and by vacuum dewatering process complete as per directions of Engineer-in-charge.

#### **16.61.2 Measurements**

It shall be measured in cubic meteres correct to two place of decimal.

#### **16.61.3 Rate**



The rate shall include the cost of material, labour and machinery involved in all the operations described above.

## 16.62 GRANULAR SUB BASE

### 16.62.1 Scope

This work shall consist of laying and compacting well-graded material on prepared subgrade in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as sub-base or lower sub-base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross-sections shown on the drawings or as directed by the Engineer-in-charge.

### 16.62.2 Materials

**16.62.2.1** The material to be used for the work shall be natural sand, crushed gravel, crushed stone, crushed slag or combination thereof depending upon the grading required. Use of materials like brick metal, Kankar and crushed concrete shall be permitted in the lower sub-base. The material shall be free from organic or other deleterious constituents and shall conform to the grading given in Table 16.44 and physical requirement given in Table 16.45. Gradings III and IV shall preferably be used in lower sub-base. Grading V and VI shall be used as a sub-base-cum-drainage layer. The grading to be adopted for a project shall be as specified in the Contract. Where the sub-base is laid in two layers as upper sub-base and lower sub-base, the thickness of each layer shall not be less than 150 mm.

**16.62.2.2** If the water absorption of the aggregate determined as per IS: 2386 (Part 3); if this value is greater than 2 per cent, the aggregate shall be tested for Wet Aggregate Impact Value (AIV) (IS: 5640). Soft aggregates like Kankar, Brick ballast and laterite shall also be tested for Wet AIV (IS: 5640).

**TABLE No. 16.44**

**GRADING FOR GRANULAR SUB-BASE MATERIALS**

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	--	--	--	100	--
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55-90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	--	--	35-65	55-75
4.75 mm	25-55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20-40	30-50	--	--	10-20	10-25
0.85 mm	--	--	--	--	2-10	--
0.425 mm	10-15	10-15	--	--	0-5	0-8
0.075 mm	<5	<5	<5	<5	--	0-3

**TABLE No. 16.45**

**PHYSICAL REQUIREMENTS FOR MATERIALS FOR GRANULAR SUB-BASE**



Aggregate Impact Value (AIV)	IS:2386 (Part 4) or IS:5640	40 Maximum
Liquid Limit	IS:2720 (Part 5)	Maximum 25
Plasticity Index	IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)	IS:2720 (Part 5)	Minimum 30 unless otherwise specified in the Contract

### 16.62.3 Construction Operations

#### 16.62.3.1 Preparation of Sub-Grade:

The surface of the sub grade to receive the Granular Sub-base shall be prepared to the specified lines and crossfall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80 – 100 kN smooth wheeled roller until firm surface is obtained if necessary by sprinkling water. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for GSB.

Where the existing surface over which the sub base of GSB is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the GSB is laid.

#### 16.62.3.2 Spreading and compacting:

The sub-base material of grading specified in the Contract and water shall be mixed mechanically by a suitable mixer equipped with provision for controlled addition of water and mechanical mixing. So as to ensure homogenous and uniform mix. The required water content shall be determined in accordance with IS:2720 (Part 8). The mix shall be spread on the prepared sub-grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer-in-charge.

Moisture content of the mix shall be checked in accordance with IS:2720 (Part 2) and suitably adjusted so that, at the time of compaction, it is from 1 to 2 per cent below the optimum moisture content (OMC).

Immediately after spreading the mix, rolling shall be done by an approved roller. If the thickness of the compacted layer does not exceed 100 mm, a smooth wheeled roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional crossfall or on super elevation. For carriageway having crossfall on both sides, rolling shall commence at the edges and progress towards the crown.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. During rolling, the grade and crossfall (camber) shall be checked and any high spots or depressions, which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent of the maximum dry density for the material determined as per IS : 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction





planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re-compacted.

#### 16.62.4 Measurements

Granular sub-base shall be measured as finished work in position in cubic metres. The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre interval or less as decided by the Engineer-in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal. The protection of edges of granular sub-base extended over the full formation as shown in the drawing shall be considered incidental to the work of providing granular sub-base and as such no extra payment shall be made for the same.

#### 16.62.5 Rate

The Contract unit rate for granular sub-base shall be payment in full for carrying out the required operations including all labour, tools, equipments, machinery and incidentals to complete the work to the specifications as described above.

### 16.63 WET MIX MACADAM (WMM) SUB-BASE/BASE

#### 16.63.1 Scope

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared subgrade/sub-base/base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer-in-charge.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub- base course may be increased to 200 mm upon approval of the Engineer-in-charge.

#### 16.63.2 Materials

##### 16.63.2.1 Aggregates

##### 16.63.2.1.1 Physical requirements

Coarse aggregates shall be crushed stone. If crushed gravel/shingle is used, not less than 90 per cent by weight of the gravel/shingle pieces retained on 4.75 mm sieve shall have at least two fractured faces. The aggregates shall conform to the physical requirements set forth in Table 16.46 below.

If the water absorption value of the coarse aggregate is greater than 2 per cent, the soundness test shall be carried out on the material delivered to site as per IS:2386(Part-5).

**TABLE 16.46**

#### **PHYSICAL REQUIRMENTS OF COARSE AGGREGATES FOR SUB-BASE/BASE COURSES**

SI No	Test	Test Method	Requirement
1.	Los Angeles Abrasion value or	IS:2386 (Part-4)	40 per cent (Max.)
	Aggregate impact value	IS:2386 (Part-4) or IS:5640	30 per cent (Max.)





2.	Combined Flakiness and Elongation indices (Total)	IS:2386 (Part-1)	35 per cent (Max)*
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\* To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The value of flakiness index and elongation index so found are added up.

#### 16.63.2.1.2 Grading requirements:

The aggregates shall conform to the grading given in Table 16.47 below.

**TABLE 16.47**  
**GRADING REQUIREMENTS OF AGGREGATES FOR WET MIX MACADAM**

IS Sieve Designation	Per cent by weight passing the IS sieve
53.00 mm	100
45.00 mm	95-100
26.50 mm	---
22.40 mm	60-80
11.20 mm	40-60
4.75 mm	25-40
2.36 mm	15-30
600.00 micron	8-22
75.00 micron	0-5

Materials finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be well graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

### 16.63.3 Construction Operations

#### 16.63.3.1 Preparation of base:

The surface of the sub grade / sub base / base to receive the Wet Mix Macadam shall be prepared to the specified lines and crossfall (Camber) as necessary and made free of dust and other extraneous materials. Any ruts or soft yielding places shall be corrected in an approved manner and rolled with 80-100 KN smooth wheeled roller until firm surface is obtained if necessary by sprinkling water. Weak places shall be strengthened, corrugations removed and depressions and pot holes made good with suitable materials, before spreading the aggregate for WMM.

Where the existing surface over which the sub base of WMM is to be laid is black topped, to ensure effective internal drainage, furrows 50 mm x 50 mm (depth of furrows increased to reach bottom of bituminous layer where necessary) at one metre intervals shall be cut in the existing bituminous surface at 45 degrees to the central line of the carriageway at one metre intervals in the existing road before the WMM is laid.

#### 16.63.3.2 Provision of lateral confinement of aggregates:



While constructing wet mix macadam, arrangement shall be made for the lateral confinement of wet mix. This shall be done by laying materials in adjoining shoulders along with that of wet mix macadam layer.

#### **16.63.3.3 Preparation of mix:**

Wet Mix Macadam shall be prepared in an approved mixing plant of suitable capacity having provision for controlled, addition of water and forced/positive mixing arrangement like pugmill or pan type mixer of concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Optimum moisture for mixing shall be determined in accordance with IS:2720 (Part-8) after replacing the aggregate fraction retained on 22.4 mm sieve with material of 4.75 mm to 22.4 mm size. While adding water, due allowance should be made for evaporation losses. However, at the time of compaction, water in the wet mix should not vary from the optimum value by more than agreed limits. The mixed material should be uniformly wet and no segregation should be permitted.

#### **16.63.3.4 Spreading of mix:**

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub- base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher.

The paver finisher shall be self-propelled of adequate capacity with the following features:

- (i) Loading hoppers and suitable distribution system. So as to provide a smooth uninterrupted material flow for different layer thickness from the tipper to the screed.
- (ii) Hydraulically operated telescopic screed for paving width upto 8.5 metre and fixed screed beyond this. The screed shall have tamping and vibrating arrangement for initial compaction of the layer.
- (iii) Automatic leveling control system with electronic sensing device to maintain mat thickness and cross slope of mat during laying procedure. In exceptional cases where it is not possible for the paver to be utilized mechanical means like motor grader may be used with the prior approval of the Engineer-in-charge. The motor grader shall be capable of spreading the material uniformly all over the surface.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate may be required. The layer may be tested by depth blocks during construction. No segregation of larger and fine panicles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

The Engineer-in-charge may permit manual mixing and / or laying of Wet Mix Macadam, where small quantity of WMM is to be executed. Manual mixing / laying in inaccessible / remote locations and in situations where use of machinery is not feasible can also be permitted. Were manual mixing / laying is intended to be used, the same shall be done with the approval of the Engineer-in-charge.

#### **16.63.3.5 Compaction:**

After the mix has been laid to the required thickness, grade and crossfall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, a smooth wheel roller of 80 to 100 kN weight may be used. For a compacted single layer upto 200 mm, the compaction shall be done with the help of vibratory roller of minimum static weight of 80 to 100 kN with an arrangement for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of the roller shall not exceed 5 km/h.



In portions having unidirectional cross fall/superelevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one-third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and crossfall. In no case should the use of unmixed material be permitted to make up the depressions.

Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part-8)

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompacted.

**16.63.3.6 Setting and drying:** After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

#### **16.63.4 Opening to Traffic**

No vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

#### **16.63.5 Surface Evenness**

All work perform shall confirm to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer-in-charge, subject to the permitted tolerances described herein after.

##### **16.63.5.1 Horizontal Alignment**

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriage way as constructed shall be correct within a tolerance of  $\pm 10$  mm there from. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be  $\pm 25$  mm.

##### **16.63.5.2 Surface Levels**

The levels of the Sub-base / base course as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer-in-charge beyond the tolerances mentioned as below:



## TOLERANCES IN SURFACE LEVELS OF WMM

### Sub-base

- |     |                   |         |
|-----|-------------------|---------|
| (a) | Flexible pavement | ± 10 mm |
| (b) | Concrete pavement | ± 06 mm |

### Base course flexible pavement

- |      |                                 |         |
|------|---------------------------------|---------|
| (a)  | Bituminous Base / Binder Course | ± 06 mm |
| (b)  | Granular                        |         |
| (i)  | Machine laid                    | ± 10 mm |
| (ii) | Manually laid                   | ± 15 mm |

For checking compliance with the above requirement for sub-base / base courses, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely.

The longitudinal profile shall be checked with a 3 metre long straight edge / moving straight-edge as desired by the Engineer-in-charge at the middle of each traffic lane along a line parallel to the centre line of the road.

### 16.63.6 Measurements

Wet Mix Macadam shall be measured as finished work in position in cubic metres. The length and breadth shall be measured to the nearest centimetre. The depth of consolidated layer shall be computed to nearest half centimetre by taking average of depths at the centre and at 30 cm from the left and right edges at a cross section taken at 100 metre interval or less as decided by the Engineer- in-Charge by making small pits. The consolidated cubical contents shall be calculated in cubic metres correct to two places of decimal.

### 16.63.7 Rates

The contract unit rate for Wet Mix Macadam shall be payment in full for carrying out the required operations including all labour, tools, equipments machinery and incidentals to complete the work to the specification as described above.

## 16.64 REFLECTIVE PAVEMENT MARKERS (RPM) OR ROAD STUDS

### 16.64.1 Scope

The work shall cover the providing and fixing of reflective pavement marker (RPM) or road stud, a device which is bonded to or anchored within the road surface, for lane marking and delineation for night-time visibility, as specified in the Contract.

### 16.64.2 Material

**16.64.2.1** Plastic body of RPM/road stud shall be moulded from ASA (Acrylic Styrene Acrylonitrile) or HIPS (Hi-impact Polystyrene) or Acrylonitrile Butadiene Styrene (ABS) or any other suitable material approved by the Engineer. The markers shall support a load of 13.635 kg tested in accordance with ASTM D 4280.



**16.64.2.2** Reflective panels shall consist of number of lenses containing single or dual prismatic cubes capable of providing total internal reflection of the light entering the lens face. Lenses shall be moulded of merthyl methacrylate conforming to ASTM D 786 or equivalent.

#### **16.64.3 Design**

The slope or retro-reflecting surface shall preferably be  $35 \pm 5^\circ$  to base and the area of each retro-reflecting surface shall not be less than 13.0 sq.cm.

#### **16.64.4 Optical Performance**

##### **16.64.4.1 Unidirectional and Bi-directional Studs.**

Each reflector or combination of reflectors on each face of the stud shall have a Coefficient of Luminous Intensity (C.I.L.), as specified in Table 16.48.

**TABLE NO 16.48**  
**Minimum C.I.L. values for Road Studs**

Entrance Angle	Observation Angle	C.I.L. in mcd/lx		
		White	Amber	Red
0° U 5° L&R	0.3°	220	110	44
0° U 5° L&R	0.5°	120	60	24

#### **16.64.5 Tests**

**16.64.5.1** Co-efficient of luminance intensity can be measured by procedure described in ASTM E 809 "Practice for Measuring Photometric Characteristics" or as recommended in BS:873-Part 4 : 1973.

#### **16.64.6 Fixing of Reflective Markers or Road Studs or Cats Eyes.**

##### **16.64.6.1 Requirements**

The enveloping profile of the head of the stud shall be smooth and the studs shall not present any sharp edges to traffic. The reflecting portions of the studs shall be free from crevices or ledges where dirt might accumulate. Marker height shall not be less than 10 mm and shall not exceed 20 mm, and its width shall not exceed 130 mm. The base of the marker shall be flat within 1.3 mm. If the bottom of the marker is configured, the outermost faces of the configurations shall not deviate more than 1.3 mm from a flat surface. All road studs shall be legibly marked with the name, trade mark or other means of identification of the manufacturer.

##### **16.64.6.2 Placement**

The reflective marker shall be fixed to the road surface using the adhesives and the procedure recommended by the manufacturer. No nails shall be used to affix the marker so that they do not pose safety hazard on the roads. Regardless of the type of adhesive used, the markers shall not be fixed if the pavement is not surface dry and on new asphalt concrete surfacing until the surfacing has been opened to traffic for a period of not less than 14 hours. The portions of the highway surface, to which the marker is to be bonded by the adhesive, shall be free of dirt, curing compound, grease, oils, moisture, loose or unsound layers, paint and any other material which would adversely affect the bond of the adhesive.

The adhesive shall be placed uniformly on the cleaned pavement surface or on the bottom of the of the marker in a quantity sufficient to result in complete coverage of the area of contract of the marker with no voids present and with a slight excess after the marker has been lightly pressed in place. For epoxy



installations, excess adhesive around the edge of the marker, excess adhesive on the pavement and adhesive on the exposed surfaces of the markers shall be immediately removed.

#### 16.64.6.3 Warranty and Durability

The contractor shall submit a two year warranty for satisfactory field performance including stipulated retro-reflectance of the reflecting panel, to the Engineer-in-charge. In addition, a two year warranty for satisfactory infield performance of the finished road marker shall also be given by the contractor who carries out the work of fixing of reflective road markers. In case the markers are displaced, damaged, get worn out or lose their reflectivity compared to stipulated standards, the contractor would be required to replace all such markers within 15 days of the intimation from the Engineer-in-charge, at his own cost.

#### 16.64.7 Measurement

The measurement of reflective road markers or road studs shall be made in numbers supplied and fixed at site.

#### 16.64.8 Rates

The rates include the cost of all the material, labour, tools and equipments required in all the operation described above.

### 16.65 PRIME COAT OVER GRANULAR BASE

#### 16.65.1 Scope

This work shall consist of the application of a single coat of low viscosity liquid bituminous material to a porous granular surface preparatory to the superimposition of bituminous treatment or mix.

#### 16.65.2 Materials

**16.65.2.1** Primer: The primer shall be cationic bitumen emulsion SS1 grade conforming to IS:8887 or medium curing cutback bitumen conforming to IS:217 or as specified in the contract.

**16.65.2.2** Quantity of SS1 grade bitumen emulsion for various types of granular surface shall be as given in Table 16.49 or as specified in the item of contract.

**Table 16.49**

**Quantity of Bitumen Emulsion for various types of Granular Surfaces**

Type of Surface	Rate of Spray (kg/sqm)
WMM/WBM	0.7-1.0
Stabilized soil bases/Crusher Run Macadam	0.9-1.2

**16.65.2.3** Cutback for primer shall not be prepared at the site. Type and quantity of cutback bitumen for various types of granular surface shall be as given in Table 16.50.

**Table 16.50**

**Type and Quantity of Cutback Bitumen for various types of Granular Surface**

Type of Surface	Type of Cutback	Rate of Spray (kg/sq.m)
WMM/WBM	MC 30	0.6-0.9



Stabilized soil bases/Crusher Run Macadam	MC 70	0.9-1.2
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**16.65.2.4** The correct quantity of primer shall be decided by the Engineer-in-Charge and shall be such that it can be absorbed by the surface without causing run-off of excessive primer and to achieve desired penetration of about 8-10mm.

### **16.65.3 Construction**

#### **16.65.3.1 Equipment**

The primer shall be applied by a self propelled or towed bitumen pressure sprayer equipped for spraying the material uniformly at specified rates and temperatures. Hand spraying shall not be allowed except in small areas, inaccessible to the distributor, or in narrow strips where primer shall be sprayed with a pressure hand sprayer, or as directed by the Engineer-in-Charge.

#### **16.65.3.2 Preparation of Road Surface**

The granular surface to be primed shall be swept clean by power brooms or mechanical sweepers and made free from dust. All loose material and other foreign material shall be removed completely. If soil/moorum binder has been used in the WBM surface, part of this should be brushed and removed to a depth of about 2 mm so as to achieve good penetration.

#### **16.65.3.3 Application of Bituminous Primer**

After preparation of the road surface the primer shall be sprayed uniformly at the specified rate as per item of contract. The method for application of the primer will depend on the type of equipment to be used, size of nozzles, pressure at the spray bar and speed of forward movement. The contractor shall demonstrate at a spraying trial, that the equipment and method to be used is capable of producing a uniform spray, within the tolerances specified.

No heating or dilution of SS1 bitumen emulsion and shall be permitted at site. Temperature of cutback bitumen shall be high enough to permit the primer to be sprayed effectively through the jets of the spray and to cover the surface uniformly.

#### **16.65.3.4 Curing of Primer and Opening to Traffic**

A primed surface shall be allowed to cure for at least 24 hours or such other higher period as is found to be necessary to allow all the moisture/volatiles to evaporate before any subsequent surface treatment or mix is laid. Any unabsorbed primer shall first be blotted with a light application of sand, using the minimum quantity possible. A primed surface shall not be opened to traffic other than that necessary to lay the next course.

### **16.65.4 Measurement for Payment**

Prime coat shall be measured in terms of surface area of application in square metres.

#### **16.65.5 Rate**

The contract unit rate for prime coat shall be payment in full for carrying out the required operations i/c all equipments, labour and machinery as described above.

**APPENDIX A****BITUMEN REGISTER**  
(Clause 16.24 to 16.31, 16.32, 16.33)

Name of Work:

Name of Contractor:

<i>Receipts</i>			<i>Issues</i>					
<i>Date of receipt</i>	<i>Quantity received</i>	<i>Progressive total</i>	<i>Date of issue</i>	<i>Quantity of Bitumen issued</i>	<i>Total issue</i>	<i>Daily Balance in hand</i>	<i>Contractor's initial</i>	<i>Junior Engineer's initial</i>
1	2	3	4	5	6	7	8	9

Daily Comparison of Issues with Requirements

<i>Item of work for which issued</i>	<i>Approx. quantity of work done on each day</i>	<i>Theoretical requirement of bitumen for work done on each day</i>	<i>Assistant Executive Engineer/Assistant Engineer</i>	<i>Executive Engineer</i>
10	11	12	13	14





## APPENDIX B

### DETERMINATION OF IN-SITU DENSITY OF ASPHALTIC CARPET OR BITUMINOUS MACADAM BY SAND POURING DEVICE

The metallic tray of the field density unit is kept on a level spot of the surface and a hole 10 cm in dia, is cut to the entire thickness of the carpet. All materials removed from the hole are carefully collected and weighed.

A known weight of dry standard sand, passing 710 micron I.S. Sieve and retained on 355 micron

I.S. sieve, is taken in the sand pouring cylinder. The cylinder is kept directly over the hole and the shutter of the cylinder is released without any jerk and closed when the hole is filled with the sand. The quantity of the residual sand in the cylinder as well as the quantity filling the cone of the cylinder are weighed.

The in-situ density of the carpet is calculated as follows:-

$$\text{Density: } \frac{A.d}{W-(W_1+W_2)}$$

- Where A = Weight of the materials removed from the carpet hole.  
W = Initial weight of the sand taken in the cylinder.  
W<sub>1</sub> = Weight of the sand filling the cone of cylinder.  
d = Bulk density, gm per cc of the sand.  
W<sub>2</sub> = Weight of sand remaining in the cylinder.



## APPENDIX C

### LIST OF MINIMUM EQUIPMENT TO BE PROVIDED IN THE FIELD TESTING LABORATORY BY THE CONTRACTOR AT HIS OWN COST.

#### Concrete Section

##### 1. Sieve Analysis of stone ballast

- (a) Sets of I.S. Sieves of sizes 63 mm, 45 mm, 22.4 mm, 11.2 mm, 5.60 mm. etc.

##### 2. Sieve analysis of sand

- (a) Sets of I.S. sieves of sizes 2.36 mm, 1.18 mm, 600 micron, 355 micron and 180 micron.

##### 3. Silt content of sand

- (a) Graduated glass cylinders 500 C.C. capacity.

##### 4. Bulkage of sand

- (a) Graduated glass cylinders 500 C.C. capacity.

##### 5. Slump test.

- (a) Slump cones.
- (b) Slump rods 3/8" dia. 24" long bullet pointed.
- (c) Steel plates 24" x 24"
- (d) Steel scales.

##### 6. For making beam specimens for flexural strength.

- (a) Beam moulds.
- (b) Tamping rods.

##### 7. Testing flexural strength of concrete:-

- (a) 100 ton capacity compressive strength testing i/c hand operated in two numbers with flexure test attachment.

##### 8. Other miscellaneous items.

- (a) Physical balance with set of weights.
- (b) Pan balances.
- (c) Spring balances.



- (d) Glass measuring jar.
- (e) Beakers.
- (f) Towels, glass plates etc.

## PROVISION FOR LATERAL CONFINEMENT OF AGGREGATES

Sub Head : Road Work  
Clause : 16.7.5

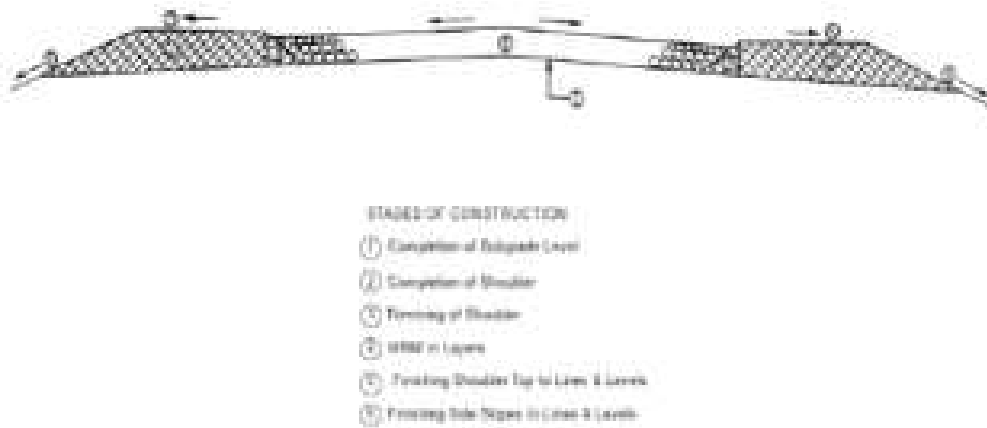


Figure 16.1 : Provision for Lateral Confinement of Aggregate

Drawing not to scale  
All dimensions are in mm

## BARBED WIRE FENCING (WITH R.C.C. POST)

Sub Head : Road Work

Clause : 16.16

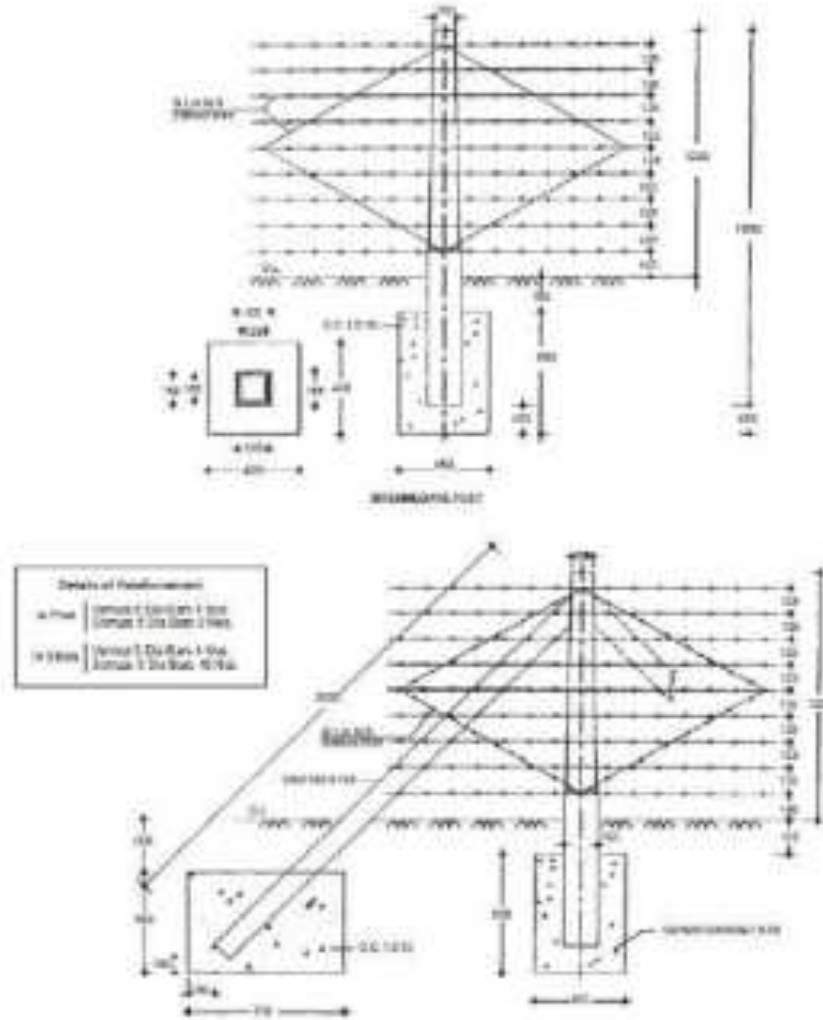


Figure 16.9 : Barbed Wire Fencing

1. In case of end post one strut shall be omitted.
2. Drawing not to Scale
3. All dimensions are in mm.

## FENCING WITH R.C.C. POST RAILS, PALES

Sub Head : Road Work

Clause : 16.18.6

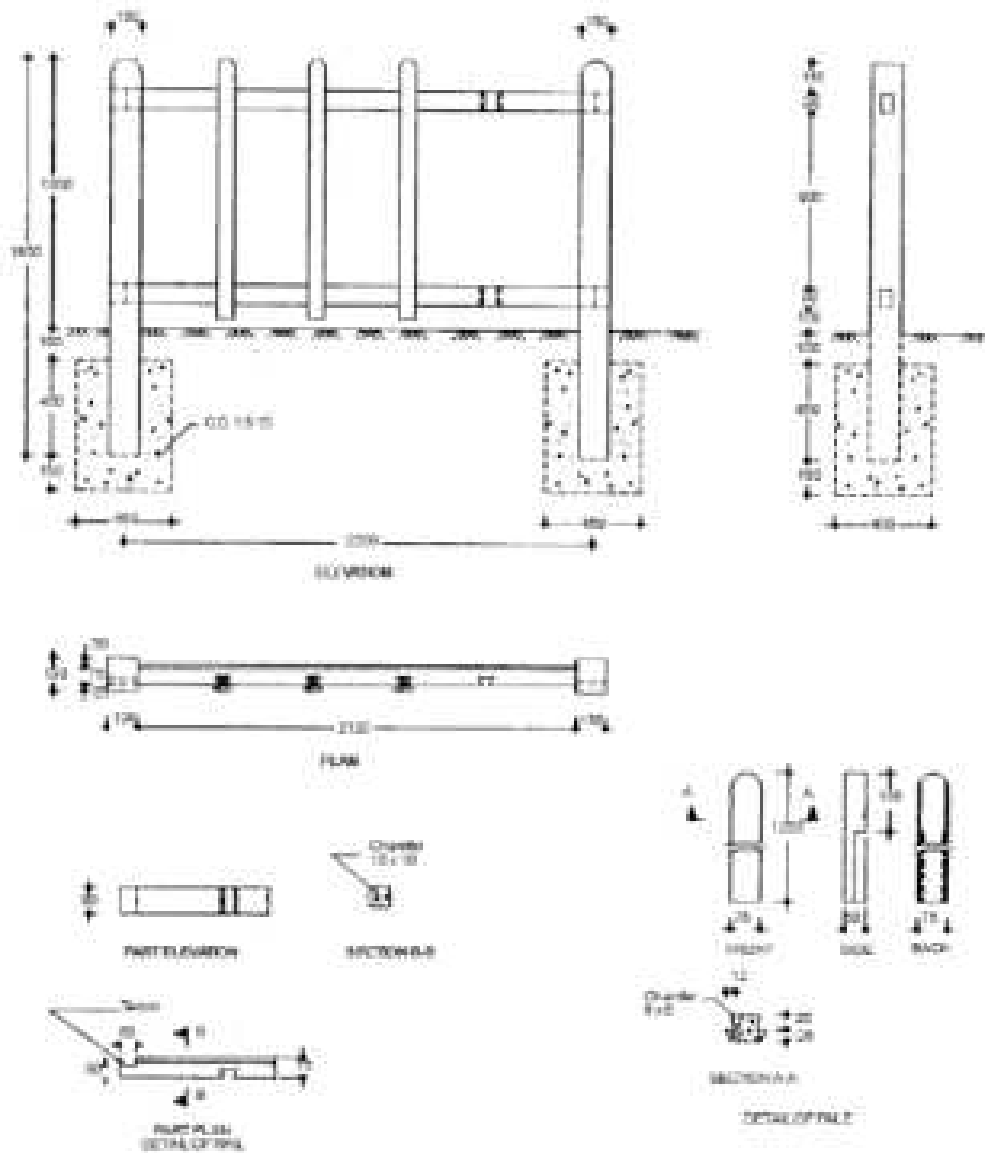


Figure 16.10 : Fencing with R.C.C. Post Rails, Pales

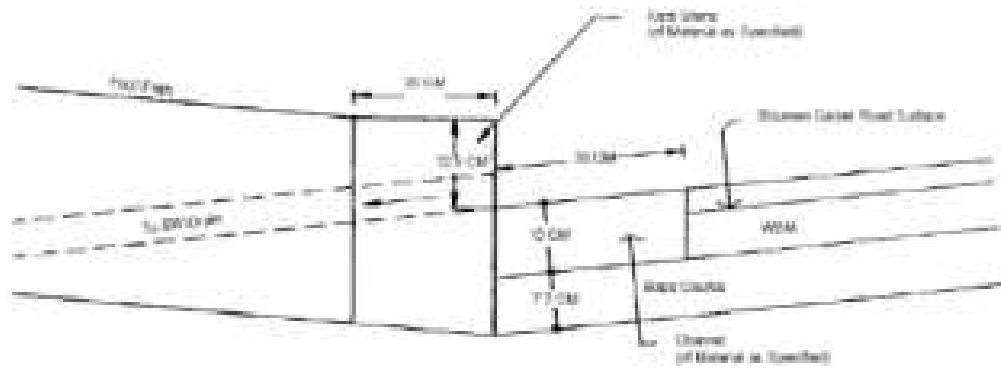
Drawing not to Scale  
All dimensions are in mm



## KERB & CHANNEL STONES

**Sub Head : Road Work**

**Clause : 16.1.20**



**Figure 16.12 : Kerb & Channel Stones**

Drawing not to Scale  
All dimensions are in mm

## BROAD DETAILS OF COOKER FOR BITUMEN MASTIC IN WEARING COURSES

Sub Head : Road Work

Clause : 16.33.3

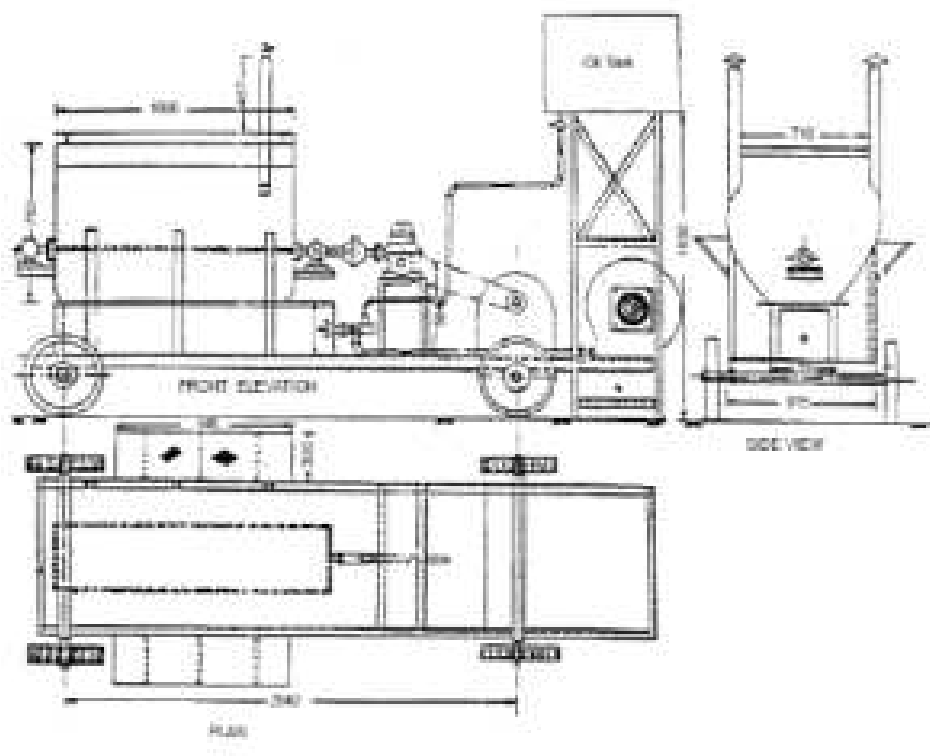


Figure 16.13 : Broad Details of Cooker for Bitumen Mastic in Wearing Courses

Drawing not to Scale.  
All dimensions are in mm





## SANITARY INSTALLATIONS



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## LIST OF BUREAU OF INDIAN STANDARDS (BIS) CODES

S. No.	IS No.	Subject
1.	IS 771 (Pt.1)	Specification for glazed fire clay sanitary appliances: Part 1: General requirements.
2.	IS 771 (Pt.-2)	Specification for glazed fire clay sanitary appliances: Part 2: Specific requirements of kitchen and laboratory sink.
3.	IS 772	Specific action for general requirements for enameled cast iron sanitary appliances.
4.	IS 774	Flushing cisterns for water closets and urinals (Other than plastic cistern)- Specifications.
5.	IS 1300	Phenolic moulding materials. - Specifications
6.	IS 13983	Providing and fixing stainless steel sink
7.	IS 1570 (Part-5)	Schedule for Wrought steel (Stainless Steel and heat resisting steels)
8.	IS 1703	Water fittings- copper alloy float valves (horizontal plunger type) - Specification.
9.	IS 1729	Cast iron /Ductile Iron Drainage Pipes and pipe fittings for Over ground non-pressure pipe line Socket and Spigot Series.
10.	IS 1795	Specification for pillar taps for water supply purposes.
11.	IS 1865	Iron casting with spheroidal or nodular graphite
12.	IS 2267	Polystyrene moulding and extrusion materials - Specifications
13.	IS 2326	Specification for Automatic Flushing Cisterns for Urinals (Other than plastic cisterns)
14.	IS 2548 (Part-1)	Plastic seats and covers for water closets Part 1: Thermo set seats and covers - Specifications
15.	IS 2548 (Part-2)	Plastic seats and covers for water closets Part 2: Thermoplastic seats and covers.- Specifications
16.	IS 2556	Vitreous sanitary appliances (vitreous china) -Specifications
17.	IS 2556 (Part-1)	Part-1: General requirements.
18.	IS 2556 (Part-2)	Part-2: Specific requirements of wash-down water closets.
19.	IS 2556 (Part-3)	Part-3: Specific squatting pans.
20.	IS 2556 (Part-4)	Part-4: Specific requirements of wash basins.
21.	IS 2556 (Part-5)	Part-5: Specific requirements of laboratory sinks.
22.	IS 2556 (Part-6)	Part-6: Specific requirements of Urinals & Partition plates
23.	IS 2556 (Part-7)	Part-7: Specific requirements of accessories for sanitary appliances
24.	IS 2556 (Part -14)	Part-14: Specific requirements of integrated squatting pans.



S. No.	IS No.	Subject
25.	IS 2556 (Part -15)	Part-15: Specific requirements of universal water closets.
26.	IS 2556 (Part -16)	Part-16: Specific requirements of wash down wall mounted water closets
27.	IS 2963	Specification for Copper alloy waste fittings for wash basins and sinks.
28.	IS 3076	Specification for low density polyethylene pipes for potable water supplies.
29.	IS 3389	Urea formaldehyde moulding materials. - Specifications
30	IS 3989	Specification for centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes fittings and accessories.
31.	IS 4827	Specification for electroplated coating of nickel and chromium on copper and copper alloys.
32.	IS 4984	Specification for high density polyethylene pipes for potable water supplies.
33.	IS 4985	Unplasticised P.V.C. pipes for potable water supply – Specifications.
34	IS 7231	Plastic flushing cisterns for water closets and urinals – Specifications.
35	IS 13983	Stainless steel sinks for domestic purposes –Specifications.
36	IS 15905	Centrifugally Cast Iron Hubless pipes & fittings



## 17 SANITARY INSTALLATIONS

### 17.0 TERMINOLOGY

#### **Antisiphon Pipe (Fig. 17.1)**

A ventilating pipe connected to or close to the outlet side of a trap seal.

#### **Automatic Flushing Cistern (Fig. 17.3)**

A flushing cistern arranged to discharge its content by siphonage at regular intervals, determined by the rate at which water is fed into the cistern.

#### **Ball Cock (Fig. 17.3)**

A faucet opened or closed by the fall or rise of a ball floating in the surface of water.

#### **Ball Valve (Fig. 17.3)**

A simple non return valve consisting of a ball resting on a cylindrical seat within a fluid passageway.

#### **Bell Mouth (Fig. 17.3)**

An expanded rounded entrance to a pipe or orifice.

#### **Bend**

Length of pipe bent or cast into an angle shape.

#### **Bib Tap**

A tap with a horizontal inlet and nozzle bent to discharge in a downward direction.

#### **Blister**

A raised portion of the surface protruding not more than one millimeter above the surface and not greater than 3 mm in its greatest dimension.

#### **Box Union**

A device for joining two threaded pipes.

#### **Branch (Fig. 17.1)**

A special form of vitrified sewer and cast iron pipe used for making connections to a sewer or water main. The various types are called T, Y, T-Y, double Y, and V branches, according to their respective shapes.

Any part of piping system other than a main.

#### **Caulking**

The process of driving, pouring or forcing lead, oakum, plastic or other material into a joint to make it leak proof.

The material used in the caulking process.

#### **Caulked Joint**

A spigot and socket joint in which the jointing material is compacted by means of caulking tool and hammer.

#### **Chase**

A continuous recess in wall, floor or ceiling for the purpose of holding pipes and conduits.

**Cistern (Fig. 17.3)**

A fixed container for water in which the water is at atmospheric pressure. The water is usually supplied through a ball valve.

**Collar**

A pipe-fitting in the form of sleeve for jointing the spigot ends of two pipes in the same alignment.

**Cowl (Fig. 17.1)**

A hood on the top of a vent pipe or soil stack.

**Craze or Crazing**

Fine cracks in the glaze.

**Cross**

A pipe fitting used for connecting four pipes at right angles.

**Fittings**

Coupling, flange, branch, bend, tee, elbow, union, waste with plug, P or S trap with vent, ferrule, stop tap, bib tap, pillar tap, globe tap, ball valve, cistern, storage tank, baths, water closets, boiler geyser, pumping set with motor and accessories, metre, hydrant valve and any other article used in connection with water supply, drainage and sanitation.

**Float Valve (Fig. 17.3)**

A valve in which the closure to an opening such as a plug or gate, is actuated by a float to control the flow into a tank.

**Flush Bend**

A bend located at the bottom of low level flushing cistern for the purpose of flushing pedestal type water closet and similar fixture.

**Flushing Cistern (Fig. 17.3)**

A cistern provided with a device for rapidly discharging the contained water and used in connection with a sanitary appliance for the purpose of cleaning the appliance and carrying away its contents into a drain.

**Gasket**

A piece of compressible material used to make a joint between two flat surfaces.

**Oakum**

Hemp or old hemp rope soaked in oil to make it water proof.

**One Pipe System (Fig. 17.1)**

In this a single soil waste pipe conveys both soil and waste directly to the building drain.

**Pinhole**

A hole in the body, less than 1.5 mm, in its maximum dimension.

**Reducer**

A pipe-fitting with inside threads larger at one end than at the other. All such fittings having more than one size are reducers because of the custom of stating the larger size first.

**Single Stack System (Fig. 17.1)**





This is the name given to a simplified one pipe system wherein all ventilation pipes are omitted. The stack itself is made to cater (or provide) for all the vent requirements by restricting the flow into the stack to certain predetermined limits.

**Sink (Fig. 17.7)**

A shallow fixture, ordinarily with a flat bottom, that is usually used in kitchen or in connection with the preparation of food, laboratory purposes and for certain industrial processes.

**Socket**

The female part of spigot and socket joint.

**Soil Pipe**

A pipe which conveys to drain the discharge from a water closet or urinals. In 'One pipe' and 'single stack' system the soil pipe also conveys to a drain the discharges from bath, wash basins, sinks and similar appliances.

**Speck**

Area of the finished surface with contrasting colour less than one millimeter maximum dimension.

**Spigot**

The male part of a spigot and socket joint.

**Spigot and Socket Joint**

Joint in which the end of the one pipe enters the enlarged end of the next pipe.

**Stack**

A main vertical discharge or ventilating pipe.

**Trap**

A fitting or device so designed and constructed as to provide, when properly vented, a liquid seal which will prevent the back passage of air without materially affecting the flow of sewage or waste water through it.

**Two Pipe System (Fig. 17.1)**

In this, the soil pipe conveys discharges from water closets, urinals, and similar soil appliances directly to the drainage system and the waste pipe conveys waste from ablutionary and culinary appliances to the drainage system directly or through a trapped gully where desired.

**Union A**

pipe fitting used for joining the ends of two pipes neither of which can be turned.

**Valve**

A device used for controlling the flow of liquid in a line of pipe.

**Ventilating Pipe (Vent Pipe)**

The pipe which provides a safe outlet into the atmosphere for the foul gases in the drain or sewer.

**Warpage**

Distortion of original shape during manufacturing process.

**Water Seal**



The depth of water which should be removed from a fully charged trap before air can pass through the trap.

### **Waste Pipe**

A pipe used to convey liquid waste not containing human excreta.

### **Waste Stack**

A vertical pipe used to convey liquid waste not containing human excreta.

## **17.1 APPLIANCES AND FITTINGS**

**17.1.0** All vitreous sanitary appliances (Vitreous China) shall conform to IS 2556 (Part-I) general requirements.

### **17.1.1 Flushing Cisterns (Fig. 17.3)**

The flushing cisterns shall be automatic or manually operated high level or low level as specified, for water closets and urinals. A high level cistern is intended to operate with minimum height of 125 cm and a low level cistern with a maximum height of 30 cm between the top of the pan and the under side of the cistern. Cisterns shall be of following type (i) Vitreous China (IS 774) for Flushing type (ii) Automatic Flushing Cistern (IS 2326) and (iii) Plastic cisterns (IS 7231).

**17.1.1.1 Vitreous Chine Cisterns:** The thickness of the body including cover shall be not less than 6 mm for vitreous China cisterns. The outlet of each syphon or stand pipe shall be securely connected to the cistern by means of lock nut. The cistern shall be free from manufacturing faults and other defects affecting their utility. All working parts shall be designed to operate smoothly and efficiently. Cistern shall be mosquito proof. A cistern shall be considered mosquito proof only if there is no clearance anywhere which would permit a 1.6 mm wire to pass through in the permanent position of the cistern i.e. in the flushing position or filling position.

The breadth of a low level cistern, from front to back shall be such that the cover or seat, or both, of water closet pan shall come to rest in a stable position when raised.

The cistern shall be supported on two cast iron brackets of size as approved by the Engineer-in-Charge and embedded in cement concrete 1:2:4 block 100 x 75 x 150 mm. These shall be properly protected by suitable impervious paint. Alternatively the cisterns shall have two holes in the back side above the overflow level for screwing into the wall, supplemented by two cast iron wall supports. A 5 litres cistern, however, may be supported by larger brackets cast on the body of the cistern.

The cistern shall have a removable cover which shall fit closely on it and be secured against displacement. In designs where the operating mechanism is attached to the cover this may be made in two sections, but the section supporting the mechanism shall be securely bolted or screwed to the body. The outlet fitting of each cistern shall be securely connected to the cistern. The nominal internal diameter of cistern outlet shall be not less than  $38 \pm 1$  mm for low level cisterns respectively. The length of the outlet of the cistern shall be  $37 \pm 2$  mm.

Ball valve shall be of screwed type 15 mm in diameter and shall conform to IS 1703. The float shall be made of polyethylene as specified in IS 9762. (The design shall permit the cistern to fill in rapidly and close effectively when the level of water reaches the working water level.)

In the case of manually operated cisterns the siphonic action of the flushing cistern shall be capable of being rapidly brought into action by the operating lever but shall not self siphon or leak. When tested according to IS 774 the discharge rate shall be  $10 \pm 0.5$  litre in 6 seconds and  $5 \pm 0.5$  litre in 3 seconds for cisterns of capacities 10 litre and 5 litre respectively. The cisterns shall be so designed that there is not appreciable variation in the force of flush during the discharge of the required quantity of water. The cistern



shall have a discharge capacity of 5 & 10 litres as specified. When required to give a full flush, they shall respectively discharge 5 litres and 10 litres with variation of  $\pm 0.5$  litres.

The flush pipe shall be of (a) medium quality galvanised iron having internal diameter of  $38 \pm 1$  mm for low level cistern. The flush pipe shall be of suitable length with bends etc. as required for fixing it with front or back inlet W.C. Pan. (b) Polyethylene pipes low density conforming to IS 3076 or high density

Unplasticised PVC pipes. For high density polyethylene and unplasticised PVC pipes, the outside diameter of the pipes shall be 40 mm. When PVC plumbing pipes are used the outside diameter of the pipe shall be 40 mm for high level cisterns and 50 mm for low level cisterns.

In case of low level cistern the flush pipe shall be a vertical pipe 30 cm long and having a nominal internal dia  $38 \pm 1$  mm (except plastic flush pipes).

#### **Over Flow Pipe**

- a) GI overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non-corrodible mosquito proof brass cover having 1.25 mm dia perforation, screwed in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water closet or soil pipe without being detected.

The invert of the overflow pipe in the case of high level and low level cisterns shall be 19 mm minimum above the working water level. In case of overflow due to any reason water should drain out through the over flow pipe and not through the siphon pipe.

- b) The plastic overflow pipes shall be manufactured from high density polyethylene conforming to IS 4984 or unplasticised P.V.C. conforming to IS 4985.

**Inlet and Overflow Holes:** The cistern shall be provided with inlet and overflow holes, situated one at each end which shall be capable of accommodating an overflow pipe of not less than 20 mm nominal bore and a 15 mm size ball valve. The holes shall be cleanly cast or drilled and the adjacent surfaces shall be smooth.

#### **17.1.1.2 PVC Cisterns:** Plastic flushing cisterns for WC and Urinals shall be as per IS 7231.

The materials for manufacturing various components of the flushing cisterns shall conform to the requirements given in Table 17.1 below:

**TABLE 17.1**

**Materials for Various Components of Flushing Cisterns**

Sl. No.	Component(s)	Material	Conforming to
(1)	(2)	(3)	(4)
1	Cisterns	High density polyethylene (HDPE) Or Polystyrene, high impact Or Polypropylene Or Acrylonitrile-butadiene-styrene (ABS) Or Glass Fibre reinforced plastic (GRP)	IS 7328  IS 2267



2	Flush pipe	Steel tube, seamless or welded, medium or light, completely protected inside and outside by hot-dip galvanizing, electroplating or vitreous enamelling Or Lead pipe Or Copper alloy tube Or High density polyethylene pipe Or Unplasticised PVC plumbing pipe	IS 1239 ((Part 1)  IS 404 (Part 1)  IS 407  IS 2501
3.	Cover	Same material as that of the body	
4.	Chain	Hot-dip galvanized steel wires Or Inter-locked non-ferrous metal Or Any other corrosion resistant material	-
5.	Overflow pipe	High density polyethylene Or Unplasticised PVC Or Any other corrosion-resistant material	IS 4984 IS 4985
6.	Siphon/Valve	High density polyethylene Or Polystyrene, high impact Or Polypropylene Or Acrylonitrile- butadiene-styrene Or Glass fibre reinforced plastic (GRP)	IS 7328
			IS 2267
			-
			-
7.	Operating Mechanism / Lever	Non-ferrous metal or any other corrosion resistant material	-
8.	Float valve	Water fittings-Copper Alloy Float Valves (Horizontal Plunger type) Plastic equilibrium float valve for cold water services	IS 1703 IS 12234 IS 13049



		Diaphragm type (plastic body) float operated valves for cold water services	
9.	Polyethylene float for float valve	As specified in IS 9762	
10.	Coupling nut and lock-nut	Non-ferrous metal, Or Hot-dip galvanised steel Or Hot-dip galvanised malleable iron Or Any other non-corrosive metal Or Injection-moulded HDPE/polyacetal Or Any other non-corrosive metal or Injection moulded HDPE/ Polyacetal	

Talc as filler, if used shall not exceed 20%.

Note: Where the requirements for the material of any component or the relevant Indian Standard designation for any material are not specified, these shall be as directed by the Engineer-in- Charge.

The thickness of the body including cover at any point shall not be less than 2 mm for GRP, and not less than 3 mm for other plastic materials. The cistern shall be free from manufacturing faults and other defects affecting its utility. All working parts shall be designed so as to operate smoothly and efficiently. The cistern shall be mosquito-proof. It shall be deemed to be mosquito proof only when there is no clearance anywhere in it which would permit a 1.6 mm diameter wire to pass through. The outlet of each siphon or stand pipe or flush valve shall be securely connected to the cistern by means of a lock nut. In the case of plastic siphon, it shall be provided with suitable means of ensuring and maintaining watertight and airtight joint to the cistern.

The cistern shall be provided with a removable cover which shall fit closely and shall be secured against displacement. In designs, where the operating mechanism is attached to the cover, the cover may be made in two sections, the section supporting the mechanism being securely fixed or booked to the body.

The flush pipe (except plastic flush pipe) shall have an internal diameter of  $38 \pm 1$  mm for high level cistern and  $38 + 1$  mm for low level cistern. The steel flush pipe shall be not less than 1 mm thick whereas the lead flush pipe shall have a minimum thickness of 3.5 mm. For high density polyethylene pipes, the outside diameter of the pipes shall be 40 mm. For unplasticised PVC plumbing pipes the outside diameter of the pipe shall be 40 mm for high level cisterns, and 50 mm for low level cisterns. In the case of high level flushing cisterns, a pipe clip fitted with a rubber buffer shall be fixed to the flush pipe to prevent damage either to the pipe or to the seat when the seat is raised. No flush pipe is required for coupled cisterns.

Note: The minimum thickness specified is for normal conditions of service. Where highly corrosive atmospheres are expected, greater thicknesses are required to be provided as per nomenclature of the item.



### ***Flush Pipe Connection to Cistern***

The flush pipe shall be securely connected to cistern outlet and made airtight by means of a coupling nut. The nuts made of injection-molded HDPE/Polyacetal may be used only if the end pipe is also made of plastic. The nominal internal diameter of the cistern outlet shall be not less than 32 mm and 38 mm for high-level and low-level cisterns respectively.

The screw threads for connection to the flush pipe shall not be less than size 1½ of IS 2643 (Part 3). In the case of polyethylene and unplasticised PVC flush pipes, the upper end of the flush pipe shall be provided with suitable means of ensuring and maintaining a watertight and airtight joint to the flushing cistern. When ordered for use with a flush pipe, the outlet connection may be supplied with coupling nut made of copper based alloy or other non-corrodible material and a plain tail piece having a minimum length of 60 mm. The centre of the outlet hole shall be generally central to the length of the cistern. The length of the outlet shall be 37±2 mm in case of interchangeable siphon; however, where integral siphon is provided, the outlet length shall be 20±2 mm.

Note: The length of the cistern outlet shall be the dimension from the bottom surface of the cistern to the end of the outlet after the cistern with siphon/stand pipe has been duly fitted with all washers, lock-nuts, etc.

### ***Inlet and Overflow Holes***

The cistern shall be provided with inlet and overflow holes, situated one at each end, which shall be capable of accommodating overflow pipe of not less than 20 mm nominal bore and a 15 mm size float valve. The holes shall be cleanly moulded or drilled and the adjacent surfaces shall be smooth.

### ***Float Valve***

The float valve shall be 15 mm nominal size and shall conform to IS 1703 or IS 12234 or IS 13049.

### ***Operating Mechanism Lever***

The operating mechanism/lever shall not project beyond the side of the cistern for a distance greater than 350 mm measured from the centre of the cistern to the end of the lever arm. The lever arm shall be provided with a suitable hole near the end through which a split ring or S-hook can be inserted. A string (chain) shall be attached to the ring or hook. When S-hook is employed, it shall be effectively closed after assembly to prevent accidental disconnection.

In the case of low-level cisterns, where the mechanism is handle operated, the handle, whether situated on the front or at the end of the cistern, shall be within the projection limit. Particular attention shall be given to the case of operation of the handle.

### ***String (Chain)***

The string (chain) shall be of such strength as to sustain a dead load of 500 N without any apparent or permanent deformation.

The string (chain) shall terminate in a suitable handle or pull made of a moulding in any heat-resisting and non-absorbent plastic or any other equally suitable material. The finish shall be smooth and all burrs which are liable to cause injury to the hand when gripped shall be removed.

### ***Overflow Pipe***

The overflow pipe shall be of not less than 20 mm nominal bore and shall incorporate a non-corrodible mosquito-proof device secured in a manner which will permit it to be readily cleaned or renewed when necessary. No provision shall be made whereby the overflow from the cistern shall discharge directly into the water-closet or soil pipe without being detected.



The invert of the overflow pipe in the case of high-level and low level cisterns and the top edge of the overflow pipe in the case of coupled cistern shall be 19 mm (Min) above the working water level. In case of overflow due to any reason, water should drain out through the overflow pipe and not through the siphon pipe.

### ***Finish***

The surface of the cistern including cover shall be free from blisters and delamination, and reasonably free from flow lines, streaking or colour variations. The cistern and cover shall be opaque to light.

### ***Operational and Performance Requirements***

#### ***Flushing Arrangement***

The cistern under working conditions and with the float valve in closed position shall operate on a single operation of the operating mechanism/lever without calling for a sudden jerk in pulling. If a valve is used instead of siphon for flushing purposes, the valve shall be completely leak proof.

#### ***Working Water Level***

The working water-level shall be a minimum of 6.5 cm. below the effective top edge of the cistern and shall be legibly and permanently marked on the inside of the cistern. Effective top edge shall be taken on edge after top of the body without considering bead.

#### ***Freedom from Self Siphonage***

The siphonic system shall be capable of being rapidly brought into action when the water is at the working water level but shall not self siphon or leak into the flush pipe when the water is up to 1 cm above the invert of the overflow pipe.

#### ***Reduced Water Level***

The discharge shall operate satisfactorily when the cistern is filled to a level up to 1 cm. below the working water level.

#### ***Discharge Capacity***

When tested in accordance with IS 7231, cistern of 5 litres and 10 litres capacities, when required to give a full flush, shall respectively discharge 5 litres and 10 litres with variation of  $\pm 0.5$  litres. Dual-flush cistern of 10 litres capacity shall discharge alternatively a short flush of  $5 \pm 0.5$  litres. Dual flush cistern of 6/3 litres capacity shall discharge  $6 \pm 0.5$  litres and alternatively a half flush of  $3 \pm 0.5$  litres.

#### ***Discharge Rate***

When tested in accordance with IS 7231, the discharge rate shall be  $10 \pm 0.5$  litres within 6 seconds and  $5 \pm 0.5$  litres within 3 seconds for cistern of capacities 10 litres and 5 litres and  $6 \pm 0.5$  litres within 6 second and  $3 \pm 0.5$  litres within 3 second for cistern of 6/3 litres capacity respectively. The cistern shall be so designed that there is no appreciable variation in the force of the flush during the discharge of the required quantity of water. For coupled cisterns, this test shall not be applicable.

### ***Special Requirements***

#### ***Distortion Resistance Test***

The cisterns, complete with its fittings, shall be installed and filled with water to the marked water line and observed for any distortion. The cistern shall not budge more than 6 mm and the cover shall not be dislodged.

#### ***Dead Load Test***





When the flushing mechanism incorporates chain pull or hand operated lever, the cistern, complete with its fittings, when installed and filled with water to the marked water line and tested by the application of a dead load of 230 N applied 6 mm from the end of the operating lever arm for 30 seconds, shall not distort to such an extent that any part becomes detached. In the case of other operating mechanism, the dead load applied shall be a mass equivalent to the operating force required to overcome the normal hydrostatic head; Thirty seconds after the load is removed, the function and appearance of the cistern shall not be impaired.

#### **Front Thrust Test**

The front thrust test shall be applied only to cisterns intended for low level use. The cistern complete with its fittings, when installed and filled with water to the marked water line and tested by the method described in IS 7231, shall not distort to such an extent as to be inoperable or unsightly when the load is removed.

#### **Impact Test**

The cistern, complete with its fittings, when installed and filled as described in IS 7231 shall show no defect after one impact. Repeat the test but with the cistern empty. The cistern shall show no defect after the further impact.

### **17.1.2 Draining Board**

Draining board made of Glazed fireclay conforming to C.P.W.D. Specifications and as per directions of Engineer-in-Charge, shall be provided. The size of the board shall be as specified. The entire surface including bottom of the board shall be finished smooth.

### **17.1.3 Foot Rests (Fig. 17.4)**

Foot rests shall be of Vitreous China conforming to IS 2556 (Part- X). Foot rests which are rectangular shall meet the minimum requirements and dimensions shown in Fig. 4 and may be of different designs where so specified. Foot rests of different shapes and sizes shall also be allowed subject to approval of Engineer-in-Charge.

### **17.1.4 Glass Shelf/PVC Shelf**

Glass shelf shall consist of an assembly of glass shelf, with anodised aluminium angle frame to support the glass shelf. The shelf shall be of glass of best quality with edges rounded off and shall be free from flaws specks or bubbles. The size of the shelf shall be 60 x 12 cm unless otherwise specified and thickness not less than 5.5 mm. The shelf shall have C.P. brass brackets which shall be fixed with C.P. brass screws to rawl plugs firmly embedded in the walls.

PVC shelf as per manufacturer's specifications and size as specified shall be provided.

### **17.1.5 Mirror**

The mirror shall be of superior glass with edges rounded off or beveled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60 x 45 cm unless specified otherwise and its thickness shall not be less than 5.5 mm. It shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint. Where beveled edge mirrors of 5.5 mm thickness are not available, fancy looking mirrors with PVC beading/border or aluminium beading or stainless steel beading/border based on manufacture's specifications be provided nothing extra shall be paid on this account. Backing of mirrors shall be provided with environmentally friendly material other than asbestos cement sheet.

### **17.1.6 M.S. Stays and Clamps (Fig. 17.5)**

The clamps shall be made from 1.5 mm thick M.S. flat of 32 mm width, bent to the required shape and size to fit tightly on the socket, when tightened with nuts & bolts. It shall be formed of two semicircular





pieces with flanged ends on both sides with holes to fit in the screws, bolts and nuts 40 mm long. The stay shall be minimum one metre long of 10 mm dia M.S. bar. One end of the stay shall be bent for embedding in the wall in cement concrete block of size 20 x 10 x 10 cm in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The concrete shall be finished to match with the surrounding surface.

#### 17.1.7 Pillar Taps

Pillar taps shall be chromium plated brass and shall conform to IS 1795. The nominal sizes of the pillar tap shall be 15 mm or 20 mm as specified. The nominal size shall be designated by the nominal bore of the pipe outlet to which the tap is to be fitted. Finished weights of 15 mm and 20 mm pillar taps shall be as prescribed in Table 17.2.

**TABLE 17.2**

**Minimum Finished Weights of Pillar Taps**

Particulars	Weights in gms	
	15 mm size	20 mm size
Body	255	505
Washer plate loose valve	15	28
Back nut	40	50
Tap	650	1175

Casting shall be sound and free from laps, blow hole and pitting. External and internal surfaces shall be clean, smooth and free from sand and be neatly dressed. The body, bonnet and other parts shall be machined true so that when assembled, the parts shall be axial, parallel and cylindrical with surfaces smoothly finished.

The area of waterway through the body shall not be less than the area of the circle of diameter equal to the bore of the seating of the tap. The seating of pillar tap shall be integral with the body and edges rounded to avoid cutting of washer. Pillar taps shall be nickel chromium plated and thickness of coating shall not be less than service grade No. 2 of IS 4827 and plating shall be capable of taking high polish which shall not easily tarnish or scale.

Every pillar tap, complete with its component parts shall withstand an internally applied hydraulic pressure of 20 Kg/sq. cm maintained for a period of 2 minutes during which period it shall neither leak nor sweat.

#### 17.1.8 Sand Cast Iron or Centrifugally Cast (Spun) Iron Pipes and Fittings

Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 1729. Centrifugally cast (Spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories shall conform to IS 3989.

The fittings shall conform to the same I.S. specifications to which the pipe itself conforms in which they are connected.

The pipes shall have spigot and socket ends, with head on spigot end in case of sand cast iron pipes and without head on spigot end in case of cast iron (Spun) pipes. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and shall be free from cracks, taps, pinholes and other imperfections and shall be neatly dressed and carefully fettled. All pipes and fittings shall ring clearly when struck with a light hand hammer.

The ends of pipes and fittings shall be reasonably square to their axis. The sand cast iron pipes shall be 1.5/1.8/2.0 metre in length including socket ends, cast iron (Spun) pipes shall be 1.5/1.75/2.0/2.5/3.0 metre



in length excluding socket ends, unless shorter lengths are either specified or required at junctions etc. The pipe and fittings shall be supplied without ears, unless specified or directed otherwise.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fitting being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar or other suitable base. The coating material shall have good adherence and shall not scale off. In all instances where the coating material has tar or similar base it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree centigrade but not so brittle at a temperature of 0 degree centigrade as to chip off when scribed lightly with a pen knife.

The standard weights and thicknesses of pipes and their tolerances shall be as prescribed in Appendix A.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerance in weights & thicknesses shall be the same as for straight pipes.

The access door fittings shall be designed so as to avoid dead spaces in which filth may accumulate. Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be water tight.

#### **Sand Cast Iron Floor Trap or Nahani Trap**

Sand cast Iron Floor trap or Nahani trap shall be 'P' or 'S' type with minimum 50 mm seal. However, if the plumbing is in two pipe system and with a gully trap at the ground level the minimum water seal shall be 35 mm. The traps shall be of self cleansing design and shall have exit of same size as that of waste pipe. These shall conform to IS 1729.

#### **17.1.8A Hubless Centrifugally Cast (Spun) Iron Pipes and Fittings**

Hubless Centrifugally Cast (Spun) Iron Pipes and Fittings soil, waste and ventilating pipes, fittings and accessories shall conform to IS 15905.

The hubless centrifugally cast (spun) iron pipes shall have plain both ends (spigot type), without sockets. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and shall be free from cracks, taps, pinholes and other imperfections and shall be neatly dressed and carefully fettled. All pipes and fittings shall emit a clear ringing sound when struck with a light hand hammer. The ends of pipes and fittings shall be reasonably square to their axis. The hubless centrifugally cast iron pipes shall be 3.0 metre or more in length.

All pipes and fittings shall be coated internally and externally with the epoxy coating material at the factory, the fitting being preheated prior to total immersion in a bath containing a uniformly heated composition. The coating material shall have good adherence and shall not scale off. The tolerance in diameter of pipes shall be as prescribed in Table-17.2A below:

**Table-17.2A**

**External Diameters and Tolerances**

Sl. No.	Nominal size DN (in mm)	External Diameter DE (in mm)	Tolerance on External diameter DE (in mm)
(1)	(2)	(3)	(4)
1	50	58	+2



			-1
2	75	83	+2 -1
3	100	110	+2 -2
4	150	160	+2 -2
5	200	210	+2.5 -2.5

The thickness of fittings and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The nominal & minimum thicknesses of pipes & fittings shall be as per Table-2 below:

**Table-17.2A**

**Nominal & Minimum Thickness of Pipes & Fittings**

Sl. No.	Nominal size (DN)	Thickness 'e' mm			
		Pipe		Fittings	
		Nominal	Minimum	Nominal	Minimum
(1)	(2)	(3)	(4)	(5)	(6)
1	50	3.5	3.0	4.2	3.0
2	75	3.5	3.0	4.2	3.0
3	100	3.5	3.0	4.2	3.0
4	150	4.0	3.5	5.3	3.5
5	200	5.0	4.0	6.0	4.0

The access door fittings shall have no dead spaces in which filth may accumulate. Doors shall be provided with 3 mm rubber insertion packing and when closed and bolted, these shall be water tight.

**Joints:**

The pipes and fittings may assembled using various types of joints, The joints are intrinsic components of the drainage, whose characteristics and tolerances shall be specified in the manufactures catalogues. Taking into account the different applications of cast iron pipe work systems, various joint designs are permitted provided that they satisfy the requirement to this standard. The joints shall incorporate one or more EPDM rubber gasket(s) to ensure leak tightness and prevent direct contact between the ends of pipes, fittings and accessories. Materials for coupling of clamping components shall usually be made from:

- Ductile iron of grade 500/7 as per IS 1865, or
- Stainless steels in accordance with IS 1570 (Part 5) in order to ensure resistance to corrosion and a stabilization against the austenitic stainless steel with at least 17 percent chrome and 9 percent nickel of equivalent, or from material of comparable resistance.



- c) Ductile iron couplings of clamping components shall be coated internally and externally.
- d) All parts of the joints shall free from defects likely to compromise their suitability for use.

#### **17.1.9 Plastic Seat and Covers for Water Closet (Fig. 17.6)**

The seat and cover shall be of thermosetting or thermoplastic conforming to IS 2548 (Part-1) or of thermoplastic conforming to IS 2548 (Part-2) as specified. Unless otherwise specified these shall be of closed pattern.

**17.1.9.1** Thermosetting plastic used shall conform to grade 2 or 3 of IS 1300 when it is phenolic plastic or IS 3389 when of urea formaldehyde. Thermo plastic materials used may be of Polystyrene conforming to type 2 or 3 of IS 2267 or of polypropylene, Appendix A of IS 2548. In public buildings where rough and heavy use of seats and covers are common, plastic seats shall be moulded out of thermosetting materials, phenolic or urea formaldehyde only and the underside of the seat shall be flat with solid moulding.

**17.1.9.2** The hinging device shall be bronze or brass with nickel chromium plating confirming to IS 1068 and the seat shall have not less than three rubber or plastic buffers of size 25 mm x 40 mm x 10 mm for closed front seats and not less than four for open front seats, which shall be securely fixed to the underside of the seat unless otherwise specified. The cover shall be fitted with the same number of buffers as provided for the seat.

**17.1.9.3** Seats shall have a smooth finish and shall be non absorptive and free from cracks and crevices. They shall be capable of being easily cleaned and shall not be adversely affected by common solvents or household cleanser.

**17.1.9.4** *Strength:* The seats shall withstand without permanent distortion of the seat or hinge fittings or damage to any finish, a load of 1150 N for 30 minutes applied in the manner prescribed in IS 2548.

#### **17.1.10 Sinks (Fig. 17.7)**

**17.1.10.1** Laboratory sinks and Kitchen sinks shall be of white glazed fire clay confirming to IS 771 (Part-2) with up to date amendments. The kitchen sink shall be of one piece construction with or without rim but without overflow. Stainless steel kitchen sink shall be of sizes as specified and shall be conforming to IS 13983 (Fig. 17.7).

#### **17.1.11 Towel Rail**

The towel rail shall be of PTMT as specified and as per direction of Engineer-in-charge.

#### **17.1.12 Toilet Paper Holder**

The toilet paper holder shall be of CP brass or vitreous china as specified and of size and design as approved by the Engineer-in-Charge. It shall be fixed in position by means of C.P. brass screws and rawl plugs embedded in the wall.

#### **17.1.13 Urinals**

**17.1.13.1 Bowl Type Urinals (Fig. 17.9 & 17.10):** Urinal basins shall be of flat back or corner wall type lipped in front. These shall be of white vitreous china conforming to IS 2556-(Part 6). The urinals shall of one piece construction. Each urinal shall be provided with not less than two fixing holes of minimum dia 6.5 mm on each side. Each urinal shall have an integral flushing rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weep hole at the flushing inlet of the urinals. At the bottom of the urinal an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the outlet pipe. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front towards the outlet such that there is efficient draining.



**17.1.13.2 Half Stall Urinals (Fig. 17.11):** They shall be of white vitreous China conforming to IS 2556 (Part 6). They shall be of one piece construction with or without an integral flushing box rim and provided with slots or alternative fixing arrangement at the flat back end. They shall be provided with ridges where integral flushing rim is not provided in the sides of the interior of the bowl, to divert the water towards the front line of the urinal where integral flushing box rim is specified, water spreaders provided shall conform to IS 2556 Part-6 (Fig. 17.13). These shall be vitreous China of one piece construction with integral flush inlet. The tolerance of  $\pm 4$  per cent may be allowed on the dimensions specified.

**17.1.13.3 Urinal Partition Slabs:** Urinal Partition slabs shall be provided, as specified in the item of work.

**17.1.13.4 Squatting Plate Urinal (Fig. 17.12):** The plates shall be of white vitreous china conforming to IS 2556 (Part-1) and IS 2556 (Part-6) with internal flushing rim with front or side inlet. Squatting Plate shall be of one piece construction. Each urinal shall have integral longitudinal flushing pipe of suitable type which may be connected to flush pipe. These shall be 100 mm dia white glazed vitreous china channel with stop and outlet piece in front.

**17.1.14 Wash Basins (Fig. 17.14, 17.15, 17.16, 17.17 & 17.18)**

Wash basins shall be of white vitreous china conforming to IS 2556 (Part -I) and IS 2556 (Part-4). Wash basins either of flat back or angle back as specified shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each basin shall have a rim on all sides, except sides in contact with the walls and shall have a skirting at the back. Basins shall be provided with single or double tap holes as specified. The tap holes shall be 28 mm square or 30 mm round or 25 mm round for pop up hole. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or beveled internally with dia meter of 65 mm at top. Each basin shall be provided with a non-ferrous 32 mm waste fitting. Stud slots to receive the brackets on the underside of the wash basin shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses, which shall fully drain into the bowl. A slot type of overflow having an area of not less than 5 sq. cm, shall be provided and shall be so designed as to facilitate cleaning of the overflow.

Where oval shape or round shape wash basins are required to be fixed these shall be fixed preferably in RCC platform with local available stone topping either fully sunk in stone top or top flush with the stone topping as directed by Engineer-in-Charge.

The wash basins shall be one of the following patterns and sizes as specified (Fig. 17.14).

Flat back: 660 x 460 mm (Surgeon's Basin)

630 x 450 mm

550 x 400 mm

450 x 300 mm

Angle back: 600 x 480 mm

400 x 400 mm

White glazed pedestals for wash basins, where specified shall be provided. The quality of the glazing of the pedestal shall be exactly the same as that of the basin along with which it is to be installed. It shall be completely recessed at the back to accommodate supply and waste pipes and fittings. It shall be capable of supporting the basin rigidly and adequately and shall be so designed as to make the height from the floor to top of the rim of basin 75 to 80 cm as shown in Fig. 17.14, 17.15, 17.16, 17.17 & 17.18. All the waste fittings shall be brass chromium plated, or as specified.



#### 17.1.15 Waste Fittings for Wash Basins and Sinks (Fig. 17.8)

The waste fittings shall be of nickel chromium plated brass, with thickness of plating not less than service grade 2 of IS 4827 which is capable of receiving polish and will not easily scale off. The fitting shall conform in all respect to IS 2963 and shall be sound, free from laps, blow holes and fittings and other manufacturing defects. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and be truly machined so that the nut smoothly moves on the body.

Waste fitting for wash basins shall be of nominal size of 32 mm. Waste fittings for sinks shall be of nominal size 50 mm.

#### 17.1.16 Water Closet (Fig. 17.19, 17.20, 17.21, 17.22 & 17.23)

**17.1.15.1 Squatting Pans (Indian Type W.C.) (Fig. 17.19, 17.20 & 17.21):** Squatting pans shall be of white vitreous china conforming to IS 2556 Part-I for General Requirements and relevant IS codes for each pattern as described below:

Long pattern-conforming to IS 2556 (Part-3).

Orissa pattern-conforming to IS 2556 (Part-3).

Integrated type conforming to IS 2556 (Part-14). Preferably Orissa type pan should be used.

Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes, as shown in Fig. 17.19, 17.20 & 17.21. The flushing rim and inlet shall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer-in- Charge. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a (100 mm) S.C.I. trap 'P' or 'S' type with approximately 50 mm water seal and 50 mm dia vent horn, where required by the Engineer-in-Charge.

**17.1.15.2 Wash Down Type (European Type W.C.) (Fig. 17.22 & 17.23):** Water closets shall be of white vitreous china conforming to IS 2556 (Part-1) and 2556 (Part-2), as specified and shall be of "Washdown type". The closets shall be either of the two patterns (Pattern I & Pattern II) and sizes as shown in Fig. 17.22 & 17.23 as specified. The closets shall be of one piece construction. Each water closet shall have not less than two holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flushing pipe of dimensions as shown in table in Fig. 17.20 & 17.21 the flushing rim may be boxed or open type. In the case of box rims adequate number of holes, on each side together with a slot opposite the inlet shall be provided. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either 'S' or 'P' outlet with at least 50 mm water seal. For P trap, the slope of the outlet shall be 14 deg. below the horizontal. Where required the water closet shall have an antisiphonage 50 mm dia vent horn on the outlet side of the trap with dimension conforming to those given in Fig. 17.22 and on either right or left hand or centre as specified set at an angle of 45 deg. and invert of vent hole not below the central line of the outlet. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet, when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 15 litres of water between the normal water level and the highest possible water level of the water closet as installed.

### 17.2 GENERAL REQUIREMENTS FOR INSTALLATION OF W.C. PAN

**17.2.1** The work shall be carried out, complying in all respects with the requirements of relevant bye-laws of the local body in whose jurisdiction the work is situated.





- 17.2.2** Any damage caused to the building, or to electric, sanitary, water supply or other, installations etc. therein, either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the contractor. Nothing extra shall be paid for such restoration works except where otherwise specified.
- 17.2.3** For making good the damage to the under mentioned items of work, the specifications as given in the following paras shall apply, unless directed otherwise.
- a) *Masonry Work*: The masonry work shall be made good by using the same class of bricks, tiles or stones as was damaged during the execution of the work. The mortar used shall be cement mortar 1:5 (1 cement: 5 fine sand) or as directed by the Engineer-in-Charge.
  - b) *Plain Concrete Work*: Concrete work for sub-grade of the flooring, foundations and other plain concrete works shall be cement concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size). A coat of neat cement slurry shall be applied at the junction with old work, before laying fresh concrete.
  - c) *Cement Concrete Flooring and R.C.C. Work*: Cement concrete 1:2:4 (1 Cement : 2 Coarse sand : 4 graded stone aggregate 20 mm nominal size) shall be used after applying a coat of neat cement slurry at the junction with old work, and the surface finished to match with the surrounding surface.
  - d) *Plastering*: Cement plaster 1:4 (1 cement: 4 sand) shall be used. The sand shall be fine or coarse, as used in the original work. The surface shall be finished with two or more coats of white wash, colour wash, distemper or painting as required, but where the surface is not to be white washed, colour washed, distempered or painted, it shall be finished as required to match with the surrounding surface.
  - e) *Other Items*: Damage to any other item shall be made good as directed by the Engineer-in- Charge.
- Note: In all the above operations the damaged portion shall be cut in regular geometric shape and cleaned before making good the same.
- 17.2.4** All exposed G.I., C.I. or lead pipes and fittings shall be painted with approved quality of paint and shade as specified. The painting work shall conform to specification described under SH: Painting.
- 17.2.5** All sanitary and plumbing work shall be carried out through licensed plumbers.
- 17.2.6** On completion of the work the site shall be cleaned and all rubbish disposed off as directed by the Engineer-in-Charge.
- 17.2.7** Various sanitary fittings described under 17.1 including fixing shall be enumerated individually or in combination under relevant items of works as described below. When used in combination, specifications as described under relevant paras shall apply but nothing extra shall be paid for making connections required for successful functioning of the combination.

### **17.3 INSTALLATION OF DRAINING BOARD**

#### **17.3.1 Fixing**

One end of the board shall rest on sink and the other end shall be supported on C.I. bracket embedded in cement concrete (1:2:4) block 100 × 75 × 150 mm. The brackets used shall be of cantilever type or wall fixed type as for the sink.

#### **17.3.2 Painting**

The brackets shall be painted with two or more coats of approved paint.

#### **17.3.3 Measurements**

Draining board shall be measured in numbers.



#### 17.3.4 Rate

The rate shall include the cost of all materials and labour involved in all operations.

### 17.4 INSTALLATIONS OF FLUSHING CISTERN

#### 17.4.1 Fixing

*Low Level Cistern:* The cistern shall be fixed on C.I. cantilever brackets which shall be firmly embedded in the wall in cement concrete (1:2:4) block 100 x 75 x 150 mm. Connection between cistern and closet shall be made by means of 40 mm dia flush bend with rubber or G.I. inlet connection as specified.

*Automatic Cistern:* Clause 17.4.1.1 shall apply except that CP Brass stop cock shall be provided for cistern having a capacity of more than 5 liter. The main & distribution flush pipe shall be fixed to the wall by means of standard pattern holder bat clamp shown in Fig. 17.5.

#### 17.4.2 Painting

The brackets shall be painted, if specified, with two or more coats of paint of approved shade and quality.

#### 17.4.3 Measurements

Cistern, including all fittings, shall be measured in numbers.

#### 17.4.4 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

### 17.5 INSTALLATION OF MIRROR

#### 17.5.1 Fixing

The mirror shall be mounted on backing with environmentally friendly material other than asbestos cement sheet shall be fixed in position by means of 4 C.P. brass screws and C.P. brass washers, over rubber washers and wooden plugs firmly embedded in walls. C.P. brass clamps with C.P. brass screws may be an alternative method of fixing, where so directed. Unless specified otherwise the longer side shall be fixed horizontally.

#### 17.5.2 Measurements

Mirror shall be measured in numbers.

#### 17.5.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

### 17.6 FIXING AND JOINTING OF PIPES AND FITTINGS

The specifications described in sub-head 12.0 shall apply, as far as applicable, except that the joint shall be lead caulked. All soil pipes shall be carried up above the roof and shall have sand cast iron terminal guard.

#### 17.6.1 Height of Ventilating Pipes

The ventilating pipe or shaft shall be carried to a height of at least 60 cms above the outer covering of the roof of the building or in the case of a window in a gable wall or a dormer window it shall be carried up to the ridge of the roof or at least 2 metres above the top of the window. In the case of a flat roof to which access for use is provided it shall be carried up to a height of 2 metres above the roof and shall not terminate within 2 metres, measured vertically from the top of any window opening which may exist up to a horizontal distance of 3 meters from the vent pipe into such building and in no case shall be carried to a height less than 3 metres above plinth level. In case the adjoining building is taller, the ventilating pipe shall be carried higher than the roof of the adjoining building, wherever it is possible.





The pipes above the parapet shall be secured to the wall by means of M.S. stay and clamps as specified in 17.1.6.

The connections between the main pipe and branch pipes shall be made by using branches and bends with access doors for cleaning. The waste from lavatories, kitchen, basins, sinks, baths and other floor traps shall be separately connected to respective waste stack of upper floors. The waste stack of lavatories shall be connected directly to manhole while the waste stack of others shall separately discharge over gully trap. Where single stack system is provided, the connection shall be made direct to the manhole.

#### 17.6.2 Jointing

The interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of treated spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment.

The leading of pipes shall be made by means of ropes covered with clay or by using special leading rings. The lead shall be melted so as to be thoroughly fluid and each joint shall be filled in one pouring.

The following precautions shall be taken for melting lead:

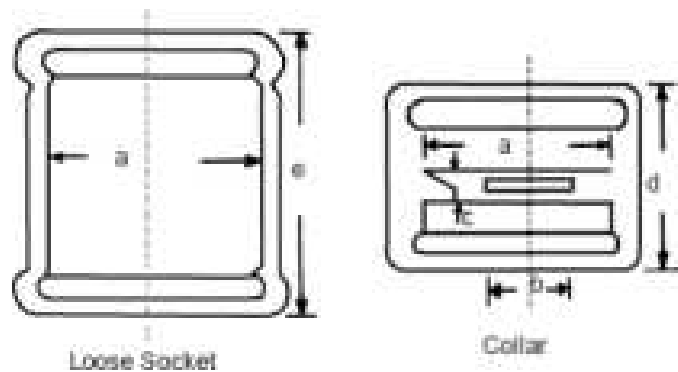
- a) The pot and the ladle in which lead shall be put shall be clean and dry.
- b) Sufficient quantity of lead shall be melted.
- c) Any scum or dross which may appear on the surface of the lead during melting shall be skimmed off.
- d) Lead shall not be overheated.

After the lead has been run into the joint the lead shall be thoroughly caulked. Caulking of joints shall be done after a convenient length of the pipes has been laid and leaded.

The leading ring shall first be removed and any lead outside the socket shall be removed with a flat chisel and then the joint caulked round three times with caulking tools of increasing thickness and hammer 2 to 3 kg. weight. The joints shall not be covered till the pipe line has been tested under pressure.

Use of collars for jointing is not permitted in any concealed or embedded location. However, in exposed locations where full length pipes cannot be fixed due to site constraints, collars (and not loose sockets) may be used subject to the following:

- a) No two consecutive joint shall be with the use of collars.
- b) The joint of collar with the cut/spigot end of the pipe shall be made on the ground in advance and tested against leakage before fixing.
- c) Cut/spigot end of the pipes shall be inserted in the collars up to the projection inside the collar and jointing shall be done as in the case of socket and spigot joint. The jointed pipe line shall be at required level/slope and alignment.



As marked in fig	Pipe dia (size in mm)			
	50	75	100	150
a	76	101	129	181
b	50	75	100	150
c	10	10	10	10
d	79	89	95	108
e	89	101	114	140

Note: The dimensions of loose sockets shall correspond to those of appropriate nominal size of pipe.

### 17.6.3 Testing

In order to ensure that adequate lead is poured properly into the joints and to control waste in use of lead, at the beginning of work three or four sample joints shall be made and the quantum of lead per joint approved by the Engineer-in-Charge. All sand cast iron/cast iron (Spun) pipes and fittings including joint shall be tested by smoke test to the satisfaction of the Engineer-in-Charge and left in working order after completion. The smoke test shall be carried out as under:

Smoke shall be pumped into the pipes at the lowest end from a smoke machine which consists of a bellow and burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell, if there is leak at any point of the drain.

### 17.6.4 Painting

All sand cast iron/cast iron (Spun) pipes and fittings shall be painted with shade to match the colour of the background as directed by the Engineer-in-Charge.

### 17.6.5 Measurements

**17.6.5.1** The pipes shall be measured net when fixed in position excluding all fittings along its length, correct to a cm.

**17.6.5.2** When collars are used for jointing SCI pipes these shall be measured as fittings and shall be paid for separately.

**17.6.5.3** No allowance shall be made for the portions of the pipe lengths entering the sockets of the adjacent pipes or fittings. The above shall apply to both cases i.e. whether the pipes are fixed on wall face or embedded in masonry.



**17.6.5.4** No deduction shall be made in the former case from the masonry measurement for the volume of concrete blocks embedded therein. Similarly no deduction shall be made for the volume occupied by the pipes from the masonry when the former are embedded in the later.

#### **17.6.6 Rates**

The rate shall include the cost of all labour and materials involved in all the operations described above, excluding fittings, lead caulk jointing, the supply and fixing M.S. holder bat clamps and M.S. stays and clamps, floor trap and painting, which shall be paid for separately.

### **17.7 INSTALLATION OF SEAT AND COVER TO WATER CLOSET**

#### **17.7.1 Fixing**

The seat shall be fixed to the pan by means of two corrosion resistant hinge bolts with a minimum length of shank of 65 mm and threaded to within 25 mm of the flange supplied by the manufacturer along with the seat. Each bolt shall be provided with two suitably shaped washers of rubber or other similar materials for adjusting the level of the seat while fixing it to the pans. In addition, one non-ferrous or stainless steel washer shall be provided with each bolt. The maximum external diameter of the washer fixed on the underside of the pan shall not be greater than 25 mm. Alternative hinging devices as supplied by the manufacturer of the seat can also be used for fixing with the approval of Engineer-in-Charge.

#### **17.7.2 Measurements**

Seat with cover shall be measured in numbers.

#### **17.7.3 Rate**

Rate shall include the cost of all the materials and labour involved in all the operations described above.

### **17.8 INSTALLATION OF SINK**

The installation shall consist of assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

#### **17.8.1 Fixing**

The sink shall be supported on C.I. cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 x 75 x 150 mm. Brackets shall be fixed in position before the dado work is done. The

C.P. brass or P.V.C. union shall be connected to 40 mm nominal bore G.I. or PVC waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap. C.P. brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

#### **17.8.2 Measurements**

The sinks shall be measured in numbers.

#### **17.8.3 Rate**

Rate shall include the cost of all materials and labour involved in all the operations described above but shall not include the cost of waste fitting and brackets which shall be paid for separately.

### **17.9 INSTALLATION OF URINAL LIPPED, HALF STALL (SINGLE OR RANGE) (FIG. 17.9 & 17.11)**

Urinal installation shall consist of a lipped urinal (Single or range), an automatic flushing cistern, G.I. flush and waste pipe. The capacity of flushing cistern and relevant size of flush pipe for urinals in a range shall be as prescribed in Table 17.3.

Waste pipe shall be of 32 mm nominal bore G.I. pipe and shall be paid separately.

#### **17.9.1 Fixing**



Urinals shall be fixed in position by using wooden plugs and screws. It shall be at a height of 65 cm from the standing level to the top of the lip of the urinal, unless otherwise directed by the Engineer-in-

Charge. The size of wooden plugs shall be 50 mm × 50 mm at base tapering to 38 mm × 38 mm at top and of length 5.0 cms. These shall be fixed in the wall in cement mortar 1:3 (1 cement: 3 fine sand). After the plug fixed in the wall, the mortar shall be cured till it is set.

**TABLE 17.3**

No. of Urinals	Capacity of Flushing Cistern	Size of Flush Pipe (Galvanised Iron)	
		Main	Distribution
One	5 Litres	15 mm	15 mm
Two	10 Litres	20 mm	15 mm
Three	10 Litres	25 mm	15 mm
Four	15 Litres	25 mm	15 mm

Each urinal shall be connected to 32 mm dia waste pipe which shall discharge into the channel or a floor trap. The connection between the urinal and flush or waste pipe shall be made by means of putty or white lead mixed with chopped hemp.

#### 17.9.2 Measurements

Urinals shall be measured in numbers.

#### 17.9.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

#### 17.10 INSTALLATION OF STALL URINAL (SINGLE OR RANGE)

**17.10.0** The installation shall consist of stall urinal (single or range), automatic flushing cistern, C.P. brass standard flush pipes, C.P. brass spreader and C.I. trap with tail piece and outlet grating of C.P. brass. Capacity of flushing cistern and relevant size of flush pipe, C.I. trap shall be as prescribed in Table 17.4.

**TABLE 17.4**

No. of Urinals in range	Capacity of Flushing cistern	Size of Flush Pipe (Chromium Plated)		Diameter of C.I. Traps
		Main	Distribution	
One	05 Litres	15 mm	15 mm	50 mm
Two	10 Liters	20 mm	15 mm	50 mm
Three	15 Litres	25 mm	15 mm	80 mm
Four	15 Litres	25 mm	15 mm	80 mm

#### 17.10.1 Fixing

The floor slab shall be suitably sunk to receive the stall urinal. Where the floor slab is not sunk, the stall urinal shall be provided over a platform. The lip of the stall urinal shall be flush with the finished floor level adjacent to it. The stall urinal shall be laid over a fine sand cushion of average 25 mm thickness. A space of not less than 3 mm shall be provided all -round, in front, sides and filled with water proofing plastic compound. Care shall be taken that after the sub-grade for the floor is cast, one week should lapse before urinals are installed. The trap and fittings shall be fixed as directed by the Engineer-in-Charge. Payment for the floor and its sub-grade shall be made separately.



### 17.10.2 Measurements

Stall urinals shall be measured in numbers.

### 17.10.3 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above.

## 17.11 INSTALLATION OF WASH BASIN (FIG. 17.14, 17.15, 17.16, 17.17 & 17.18)

The installation shall consist of an assembly of wash basin, pillar taps, C.I. brackets, C.P. brass or P.V.C. union, as specified. The wash basin shall be provided with one or two 15 mm C.P. brass pillar taps, as specified. The height of top of the rim of wash basin from the floor level shall be within 750 mm to 800 mm.

### 17.11.1 Fixing

The basin shall be supported on a pair of C.I. cantilever brackets conforming to IS 775 and be embedded in cement concrete (1:2:4) block 100 x 75 x 150 mm. Use of M.S. angle or Tee section as bracket is not permitted. Brackets shall be fixed in position before dado work is done. The brackets have been shown in Fig. 17.15. The wall plaster on the rear shall be cut to rest over the top edge of the basin so as not to leave any gap for water to seep through between wall plaster & skirting of basin. After fixing the basin, plaster shall be made good and surface finished matching with the existing one. S.C.I. floor traps conforming to IS 1729 having 50 mm water seal (minimum 35 mm in two pipe systems with gully trap) should be used. Waste pipes laid horizontally should have gradient not flatter than 1 in 50 and not steeper than 1 in 10.

The waste water from wash basin shall be discharged directly to vitreous semi-circular open drain, discharging to a floor trap and finally to the vertical stack (Fig.17.15) on upper floors and in case of ground floor, the waste water shall be discharged either directly to the gully trap or through the floor trap (Fig. 17.16). C.P. brass trap and union are not to be used in such situations.

If waste pipe is concealed or crosses the wall, waste water shall be discharged through non ferrous trap like PVC Engineering plastic or C.P. brass and union (Fig. 17.17) to vertical stack. The C.P. brass trap and union shall be paid for separately.

Where so specified a 20 mm G.I. puff pipe terminating with a perforated brass cap screwed on it on the outside of the wall or connected to the antisiphon stack shall be provided.

### 17.11.2 Measurements

Wash basins shall be measured in numbers.

### 17.11.3 Rate

The rate shall include the cost of all the materials and labour involved in all the operations described above.

## 17.12 INSTALLATION OF SQUATTING PAN

The installation shall consist of squatting pan, flushing cistern, flush pipe and a pair of foot rests.

### 17.12.1 Fixing

The pan shall be sunk into the floor and embedded in a cushion of average 15 cm thick cement concrete 1:5:10 (1 Cement : 5 fine sand : 10 graded brick ballast 40 mm nominal size). The concrete shall be left 115 mm below the top level of the pan so as to allow flooring and its bed concrete. The pan shall be provided with a 100 mm S.C.I., P or S type trap with an approximately 50 mm seal and 50 mm dia vent horn, where required by the Engineer-in-Charge. The joint between the pan and the trap shall be made leak proof with cement mortar 1:1 (1 cement : 1 fine sand).



### 17.12.2 Measurements

The squatting pans shall be measured in numbers.

### 17.12.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.  
Cost of concrete shall be paid separately.

## 17.13 INSTALLATION OF WATER CLOSET

Installation shall consist of water closet with seat and cover, flushing cistern and flush bend.

### 17.13.1 Fixing

The closet shall be fixed to the floor by means of 75 mm long 6.5 mm diameter counter-sunk bolts and nuts embedded in floor concrete.

### 17.13.2 Measurements

Water closets shall be measured in numbers.

### 17.13.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

## 17.14 INSTALLATION OF FOOT RESTS

**17.14.1** After laying the floor around squatting pan as specified a pair of foot rests shall be fixed in cement mortar 1 : 3 (1 cement : 3 coarse sand). The position of foot rests with respect to pan shall be as per Fig. 17.4.

### 17.14.2 Measurements

Pair of foot rests shall be measured in numbers.

### 17.14.3 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

## 17.15 INSTALLATION OF SQUATTING PLATE (SINGLE OR RANGE) (FIG. 17.12)

The installation shall consist of an assembly of squatting plates (single or range), vitreous China channel, automatic flushing cistern, flush pipe with fittings spreader and C.I. trap. The capacity of flushing cistern and relevant size of flush pipes shall be as specified in Table 17.5.

**TABLE 17.5**

No. of Squatting Plates in range	Capacity of Flushing Cistern	Size of Flush Pipe (Galvanised Iron)	
		Main	Distribution
One	5 liters	—	20 mm
Two	10 liters	25 mm	20 mm
Three	15 liters	32 mm	20 mm
Four	15 liters	32 mm	20 mm

### 17.15.1 Fixing

The floor slab shall be suitably sunk to receive the squatting plate. Where the floor slab is not sunk, the plates shall be provided over a platform. The top edge of the squatting plate shall be flush with the finished floor level adjacent to it. It shall be embedded on a layer of 25 mm thick cement mortar 1:8 (1 cement: 8



fine sand) laid over a bed of cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded brick aggregate 20 mm nominal size).

There shall be 100 mm dia, white glazed vitreous China channels with stop and outlet pieces suitably fixed in the floor in cement mortar 1:3 (1 cement :3 coarse sand) and joint finished with white cement. The squatting plate shall have 1200 high and half brick thick wall in front and on either side of the squatting plate. The brick work for the walls shall be paid separately. The exposed surface of walls shall be lined with white glazed tiles with proper corners and angles set in neat cement mortar, the face of the joints shall be gone over with whiting so as to match with the colour of the tiles. The tiles shall be 15 mm square. Space if any, left between the side walls and squatting plate shall be finished white to match the colour of the squatting plate. The trap and fittings shall be fixed as directed by the

Engineer-in-Charge. The vitreous China channel shall discharge into 65 mm diameter standard urinals, C.I. trap with vent arm having 65 mm C.P. brass outlet grating.

#### **17.15.2 Measurements**

Squatting plates shall be measured in numbers.

#### **17.15.3 Rate**

The rate shall include the cost of all the materials and labour involved in all the operations described above.

### **17.16 INSTALLATION OF TOWEL RAIL**

It shall be fixed in position by means of C.P. brass screws on wall surface by PVC dash fasteners, firmly embedded in wall.

#### **17.16.1 Measurements**

Towel rails shall be measured in numbers.

#### **17.16.2 Rate**

Rate shall include the cost of all the materials and labour involved in all the operations described above.

### **17.17 INSTALLATION OF SINK:**

Stainless steel A ISI 304 (18/8) kitchen sink. The installation shall consist of assembly of sink C.I. brackets, union and G.I. or P.V.C. waste pipe.

#### **17.17.1 Fixing**

The stainless steel sink shall be fixing as per IS:13983 and shall be supported on C.I. cantilever brackets, embedded in cement concrete (1:2:4) block of size 100 x 75 x 150 mm. Brackets shall be fixed in position before the dado work is done. The C.P. brass or P.V.C. union shall be connected to 40 mm nominal bore G.I. or PVC waste pipe which shall be suitably bent towards the wall and shall discharge into a floor trap. C.P. brass trap and union and waste shall be paid separately. The height of front edge of sink from the floor level shall be 80 cm.

#### **17.17.2 DIMENSIONS AND TOLERANCES**

##### **17.17.2.1 Thickness of Sheet/Strip**

**17.17.2.2** Nominal thickness of stainless steel sheet/ strip used in the construction of sink shall be not less than 1.00 mm before forming.

**17.17.2.3** Thickness at any point of sink, after forming, shall not be less than 0.75 mm.

##### **17.17.3 Depth of Bowls**



The depth of the sink bowl shall be 150 mm minimum, when measured from the top edge of the bowl to the base of the sink.

NOTE - Depth of smaller bowl shown in Fig. 17.7 A for Type E2 and E3 may be reduced up to 100 mm.

#### **17.17.4 Internal Dimensions of Bowls**

The minimum internal dimensions, when measured on the bowl centre lines across the top of the bowl, shall be 380 mm x 340 mm for rectangular bowls and 360 mm for round bowls.

NOTES I. There is no restriction on bowl shape provided the minimum dimensions given in this clause are complied with.

1. Internal width of smaller bowl shown in Fig. 17.7A for Type E2 and E3 may be reduced as per the manufacturers design.

#### **17.17.5 Bowl Locating Limits**

**17.17.5.1** The distance between the edge of the sink bowl and the end of the sink shall be 15 mm minimum for sit-on type sinks and 30 mm minimum for inset type sinks. Depth of the collar provided for inset sinks shall be  $10 \pm 2$  mm,

**17.17.5.2** For sinks designed for use with a 600 mm wide work top, the distance between the edge of the sink bowl and the front of the sink shall be 50 mm minimum and in the case of sinks designed for use with 500 mm wide worktop, the distance shall be 45 mm minimum.

**17.17.5.3** Both single and double bowl sink shall be set a minimum of 10 mm from gridline.

#### **17.17.6 Measurements**

The sinks shall be measured in numbers.

#### **17.17.7 Rate**

Rate shall include the cost of all materials and labour involved in all the operations described above but shall not include the cost of waste fitting and brackets which shall be paid for separately.

### **17.18 CUTTING CHASE IN MASONRY WALL**

**17.18.1** Cutting chasing in brick masonry wall shall be specified specification clause no. 18.22.

#### **17.18.2 Filling chases**

After sand cast iron/ centrifugally cast/spun iron pipe etc. are fixed in chases, the chases shall be filled with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 12.50 mm nominal size) or cement mortar 1:4 (1 cement: 4 coarse sand) as may be specified or otherwise directed by the Engineer-in-Charge and made flush with the masonry surface. The concrete surface shall be roughened with wire brushes to provide a key for plastering.

#### **17.18.3 Measurements**

Chases shall be measured in running meter correct to a cm.

#### **17.18.4 Rates**

The rate shall include the cost of labour the materials involved in all the operations described above excluding the cost of providing pipes etc. which shall be paid separately.

### **17.19 PAINTING SYNTHETIC ENAMEL PAINT ON SCI/CENTRIFUGALLY CAST (SPUN) IRON SOIL, WASTE AND VENT PIPES**





The primer and paint of approved brand and manufacturer shall be used as specified. Paint shall be synthetic enamel paint of any color such as chocolate, grey or buff etc.

#### **17.19.1 Painting new surface**

**17.19.1.1 Preparation of surface:** The surface of pipe and fittings shall be thoroughly cleaned. All unevenness shall be rubbed down and made them smooth with sand paper and dust shall be removed properly. After obtaining approval of Engineer-in-Charge, for SCI/CI pipe, the priming coat shall be applied before the pipe is fixed in position.

**17.19.1.2 Application:** The primer shall be applied with brushes properly on the pipe surface and spread even and smooth. The application of synthetic enamel paint over priming coat shall be carried out after drying of primer surfaces. Additional finishing coat shall be applied if found necessary, to ensure proper uniform surface. The two coats of synthetic enamel paint shall be applied. The second coat shall be applied when the previous coat has dried up.

**17.19.2 Measurement:** Measurement shall be taken over the finished line of pipe including specials and fittings such as socket, tee, bend, cowl, holder bat clamp etc. in running meter correct to a centimetre. Pipe of different diameter shall be measured and paid for separately.

**17.19.3 Rate:** The rate shall be inclusive of cost of all materials and labours involved in all the operations described above including painting all specials and fittings etc.

#### **17.20 REPAINTING SCI / CENTRIFUGALLY CAST (SPUN) IRON SOIL, WASTE AND VENT PIPE: DELETED**

#### **17.21 INSTALLATION OF WALL MOUNTING WATER CLOSET (WC)**

##### **17.21.1 Installation**

It shall consist of white vitreous china extended wall mounting WC of size 780x370x690 mm of approved shape, brand and manufacture with dual flush fitting of flushing capacity 3 Ltr / 6 Ltr (adjustable to 4 Ltr/8 Ltr) including seat cover and cistern fittings, nuts, bolts and gasket etc. complete in all respect as per direction of Engineer-in-Charge. Wall mounting water closet shall be of white vitreous China confirming to IS 2556 (Part 16) : 2002. For general requirement relating to terminology, materials, manufacture, glazing, defects, minimum thickness, tolerances, performance and methods of tests shall confirm to IS 2556 (Part 1). Wall mounted water closet shall be of one piece construction. Each wall mounted water closet shall be provided with fixing arrangement and shall have an integral flushing rim of suitable type. It shall have an inlet for connecting the flushing pipe of dimension confirming to IS 2556 and mentioned in Table No.2. The flushing rim may be box or open rim type or a combination of both. In case of box rim, adequate number of holes and slot be provided. The flushing rim and the inlet shall be of the self draining type and weep hole shall be provided at the flushing inlet of the wall mounted water closet. The WC shall be provided with not less than two fixing holes to enable the WC to be securely installed to the wall using metallic corrosion resistant bolts and nuts and an independent concealed support frame. The support frame (metal hanger or carrier), depending on the design shall be securely attached to the building structural members so that no strain is transmitted to WC connector or any part of the plumbing system. Each wall mounted water closet shall have an integral trap and P type outlet confirming to IS 2556 (Part 16): 2002 and mentioned in Fig. 25 & Fig. 26. Inside surface of water closet and trap shall be uniform and smooth in order to ensure an efficient flushing. The outlet if without serration, shall be glazed and if same is with serration, may not be glazed.

##### **17.21.2 Marking**

Each piece of wall mounted water closet shall be clearly and indelibly marked at a suitable place with the following:

- a) Name of trade mark of the manufacturer and



- b) Batch/lot numbers.

#### **17.21.3 BIS certification marking**

Wall mounted water closet shall be marked with the standard mark. The use of Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made .

#### **17.21.4 General requirement for installation of WC**

The specification described in 17.2 shall be hold good so far as it is applicable. All sanitary and plumbing work shall be carried out through licensed plumbers. On completion of the work the site shall be cleaned and all rubbish disposed off as directed by the Engineer-in-Charge.

#### **17.21.5 Measurement**

Wall mounted water closet shall be measured in numbers.

### **17.22 INSTALATION OF FLOOR MOUNTED SINGLE PIECE WATER CLOSET (WC)**

#### **17.22.1 Installation**

It shall consist of white vitreous China single piece, double traps syphonic water closet of approved shape, brand, size, pattern and manufacturer with integrated white vitreous china cistern of capacity 10 ltr. with dual flushing system, including all fitting and fixtures with seat cover, cistern fittings, nuts, bolts and gasket etc. including making connection with the existing P/S trap, complete in all respect as per direction of the Engineer-in-Charge.

The general requirement relating to terminology, materials, manufacture, glazing, defects, minimum thickness, tolerances, performance and methods of tests shall confirm to IS 2556 (Part-1). Single piece floor mounted WC generally smaller than a two piece floor mounted WC. The flushing tank is connected and sits lower on the bowl than on a two piece. Due to the smaller size, single piece WC are able to be installed in toilet/bathroom with less square footage.

#### **17.22.2 Fixing**

The water closet shall be fixed to the floor by means of 75mm long and 6.5mm dia counter sunk bolts and nuts embedded in the floor concrete.

##### **17.22.2.1 Marking**

Each piece of wall mounted water closet shall be cleary and indelibly marked at a suitable place with the following:

- (a) Name of trade mark of the manufacturer and
- (b) Batch/lot numbers.

#### **17.22.3 General requirement for installation of WC**

The specification described in 17.2 shall be hold good so far as they are applicable.

**17.22.3.1** All sanitary and plumbing work shall be carried out through licensed plumbers.

**17.22.3.2** On completion of the work the site shall be cleaned and all rubbish disposed off as directed by the Engineer-in-Charge.

#### **17.22.4 Measurement**

Single piece floor mounted water closet shall be measured in numbers.



## APPENDIX A

### STANDARD WEIGHTS AND THICKNESS OF C.I. PIPES (Clause 17.1.8)

#### For Sand Cast Iron Pipes IS 1729

Nominal dia of bore (mm)	Thickness (mm)	Overall weight of pipe		
		1.5 m long (Kg)	1.80 m long (Kg)	2.0 m long (Kg)
50	5.0	9.56	11.41	12.65
75	5.0	13.83	16.52	18.37
100	5.0	18.14	21.67	24.15
150	5.0	26.70	31.92	35.66

#### For Cast Iron (Spun Pipes IS 3989)

Nominal dia (mm)	Thickness (mm)	Overall Weight in Kg. for an effective length in metres of				
		3.000	2.500	2.000	1.800	1.500
50	3.5	13.40	11.3	9.2	8.4	7.1
75	3.5	20.0	16.8	13.8	12.5	10.6
100	4.0	30.0	25.5	21.0	18.8	16.0
150	5.0	56.0	47.0	38.5	34.9	29.5

#### Tolerances

- a. Tolerances on the external diameter of the barrel, the internal diameter of the socket and the depth of socket shall be as follows:

Dimensions (mm)	Nominal Diameter (mm)	Tolerance for lead joint (mm)	Tolerance for rubber joint (mm)
External diameter of barrel, DE	50, 75	±3.0	+3.0 -0
	100	±3.5	+3.5 -0
	150	±4.0	+4.0 -0
Internal diameter of socket, DI	All diameters	±3.0	+3.0 -0
Depth of socket, P	All diameters	±10.0	±10.0



The maximum and minimum jointing space resulting from these tolerances shall be such that the jointing of the pipes and fittings is not adversely affected. The tolerance on length of pipes shall be  $\pm 20$  mm.

b. The tolerances on dimensions of fittings shall be as given below:

Type of Casting	Dimension	Tolerance mm	
Bend pipes	a	+25	-10
	b	+20	-10
Branches with equal branch pipes	a	+25	-10
	b	+25	-10
Branches with unequal branch pipes	L	+30	-20
S. Shape casting	L	+50	-10
Taper collars	L	+25	-10
Other	L	+20	-10

**Note:**

1. Tolerance on wall-thickness shall be limited to  $-15$  per cent. No limits for plus tolerance is specified.
2. Tolerance for dimensions other than those specified above shall be as specified in IS 5519.
3. Tolerance on mass shall be limited to  $-10$  per cent. No limit for plus tolerance specified.

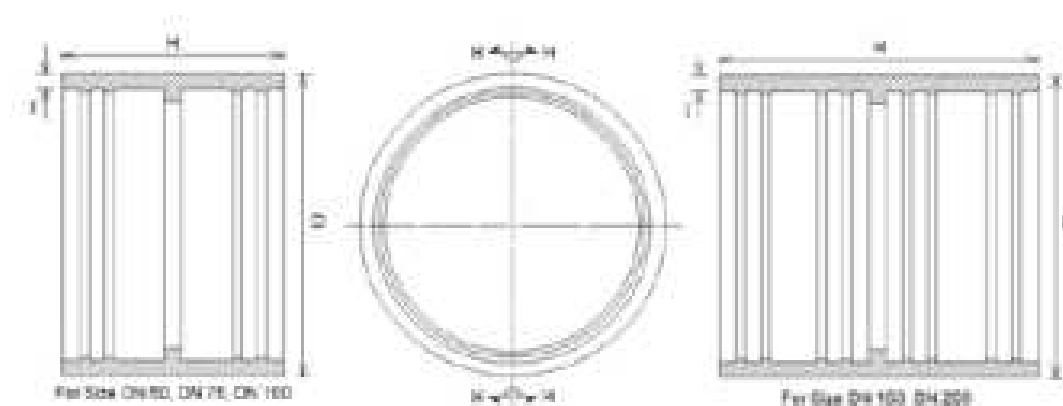
**DRAWING AND DIMENSIONS FOR STAINLESS STEEL SHIELDED COUPLING (Clause 17.1.8A)**

A1 - Profile of EPDM rubber gasket as given in Table-6.

A2 - Design of stainless steel shield and clamp as given in Table-7.

**Table- 6 EPDM Rubber Gasket**

**(Clause A-1)**



SI No.	DN mm	Outside Dia (D) Mm	Thickness (I) Mm	Height (H) mm
(1)	(2)	(3)	(4)	(5)
i)	50	59.8	2.4	54
ii)	75	84.8	2.4	54
iii)	100	111.0	2.5	54
iv)	150	162.0	3.0	76
v)	200	211.0	3.0	101

A-3.2 Firmly seat the pipe or fitting ends against the integrally moulded center stop inside the EPDM rubber gasket.

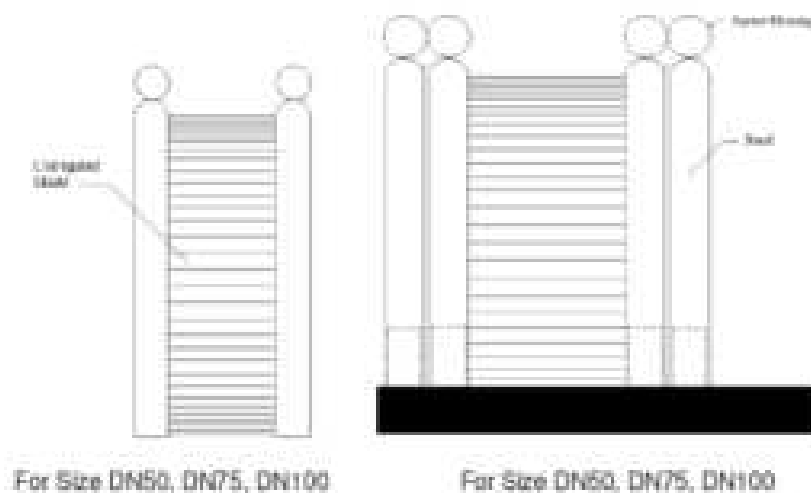
A-3.3 Slide the stainless steel shield and clamp assembly over the EPDM rubber gasket and tighten the bands. For larger diameter couplings which have four bands, the inner bands should be tightened first and then the outer bands.

A-3.4 In all the cases, when tightening bands they should be tightened alternately to insure that the coupling shield is drawn up uniformly.

NOTE — Other types of joints can also be used at the discretion of the customer. The details given in this Annex is for guidance only.

**Table-7 Stainless Steel Shield**

**(Clause A-2)**



Sl. No.	DN mm	Height (H) mm
(1)	(2)	(3)
i)	50	54
ii)	75	54
iii)	100	54
iv)	150	76
v)	200	101

## PIPE SYSTEMS AND PARTS

Sub Head : Sanitary Installations  
Clause : 17.1

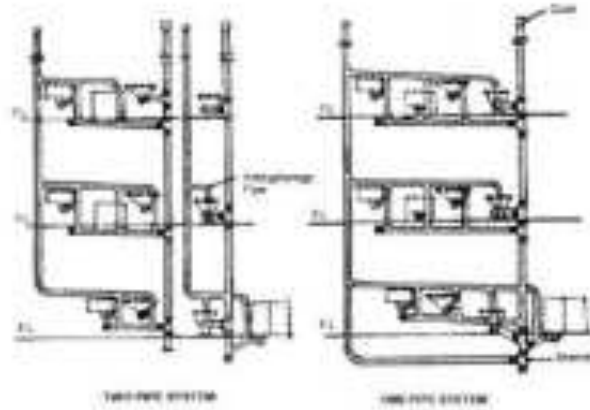


Figure 17.1 : Pipe System and Parts

Drawing Not to Scale  
All Dimensions are in mm

## PIPE SYSTEMS AND PARTS

Sub Head : Sanitary Installations  
Clause : 17.1

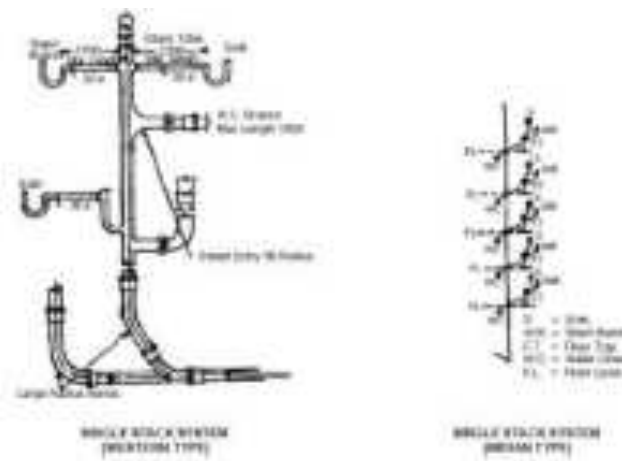


Figure 17.2 : Pipe System and Parts

Drawing Not to Scale  
All Dimensions are in mm

## M.S. STAYS AND CLAMP

Sub Head : Sanitary Installations  
Clause : 17.1.6

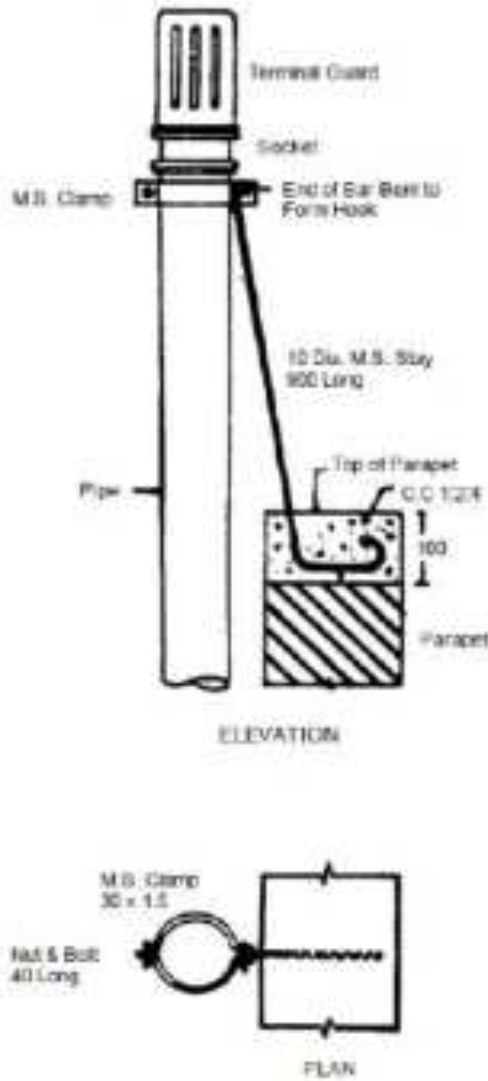


Figure 17.5 : M.S Stays and Clamp

Drawing Not to Scale  
All Dimensions are in mm



## PLASTIC SEAT AND COVER

Sub Head : Sanitary Installations  
Clause : 17.1.9

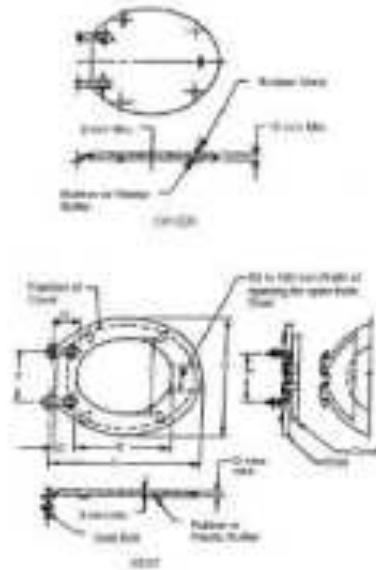


Figure 17.6 : Plastic Seat and Cover

Table 1 Dimensions of Seats and Covers

All dimensions are in mm

Sl.No	Description	Dimensions	
		Min	Max
(1)	(2)	(3)	(4)
(i)	Distance from centre line of hinge bolts to extreme edge of rim at front, A	445	475
(ii)	Length of opening at longest point, B	250	290
(iii)	Width of opening at widest point, C	215	240
(iv)	Overall width at widest point, D	380	-
(v)	Distance between inner and outer rims, E	55	-
(vi)	Centre-to-centre distance of seat bolt holes, F	145	175
(vii)	Distance from centre line of hinge bolts to inner rim of seat at the back, G	85	-
(viii)	Thickness of seat at thinnest point	3	-
(ix)	Thickness of cover at thinnest point	3	1
Note : Some hinging devices are made so as to provide adjustment in the longitudinal direction. This is not precluded by these figures.			

## KITCHEN & LABORATORY SINKS

Sub Head : Sanitary Installations

Clause : 17.1.10



Dimensions of Kitchen and Laboratory Sinks  
White Glazed Fire Clay  
All dimensions in millimeters

Pattern (1)	Size (2)	A (3)	B (4)	C (5)	D (6)
(a) Kitchen sinks (White glazed fire clay)	750 x 450 x 250	750	450	250	150
	600 x 450 x 250	600	450	250	150
	600 x 450 x 200	600	450	200	150
(b) Kitchen sink with drain board stainless steel	510x1040x250	510	1040	250	150
	510x1040x225	510	1040	225	150
	510x1040x200	510	1040	200	150
	510x1040x178	510	1040	178	150
(c) Kitchen sink without drain board stainless steel	610x510x200	610	510	200	150
	610x460x200	610	460	200	150
	470x420x178	470	420	178	150
(d) Laboratory sinks	600 x 400 x 200	600	450	200	90
	500 x 350 x 150	600	350	150	90
	450 x 300 x 150	450	300	150	90
	400 x 250 x 150	400	250	150	90

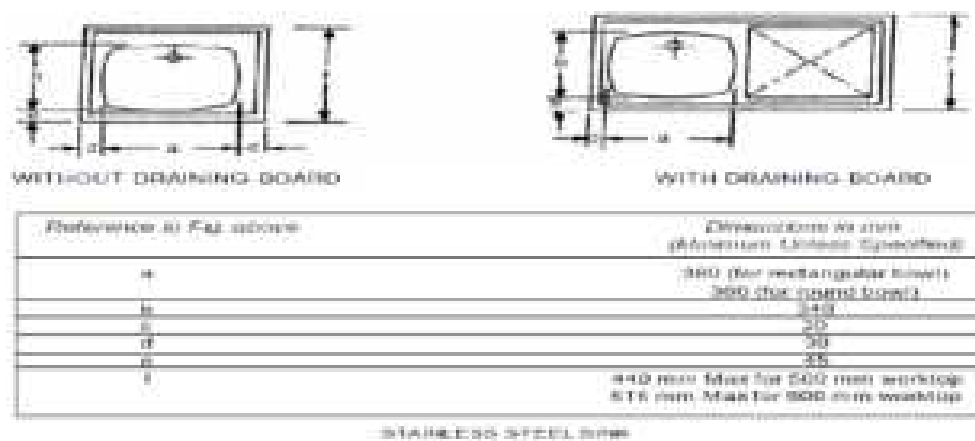


Figure 17.7 : Kitchen & Laboratory Sink

## WASTE FITTINGS FOR W.B. & SINKS

Sub Head : Sanitary Installations  
Clause : 17.1.15

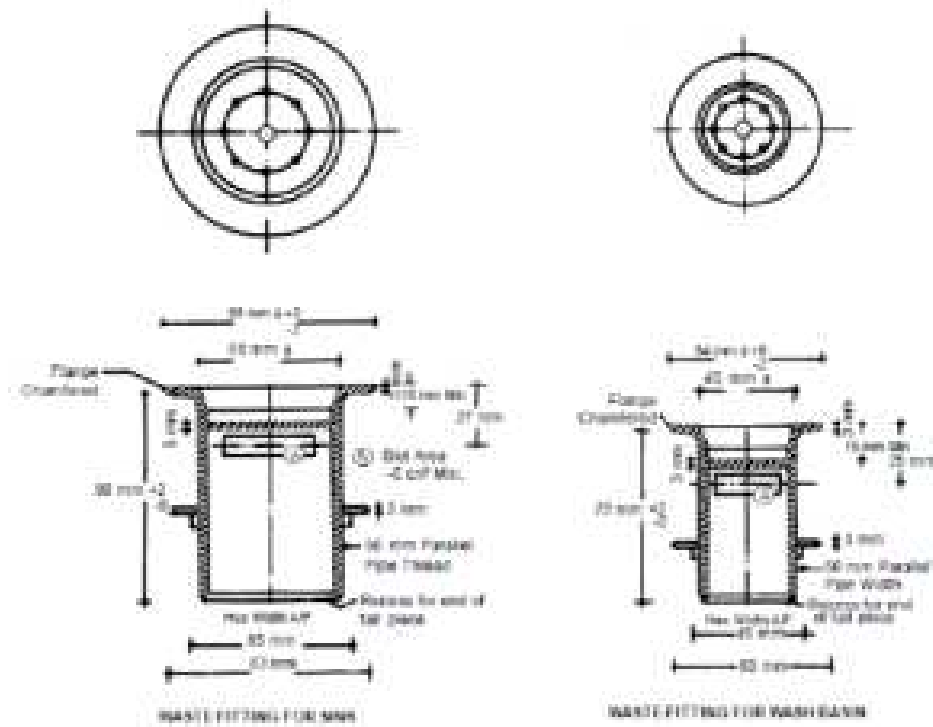


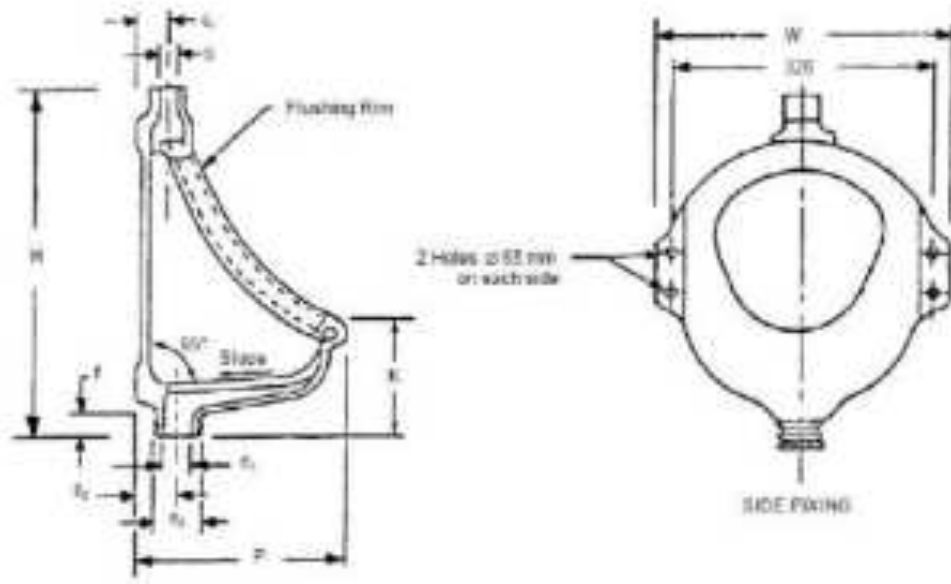
Figure 17.8 : Waste Fittings for W.B & Sinks

Drawing Not to Scale  
No. and Sizes of Holes Indicative

## URINAL BOWL TYPE

Sub Head : Sanitary Installations

Clause : 17.1.13



## BOWL PATTERN URINAL (FLAT BACK)

Figure 17.9 : Urinal Bowl Type

All dimensions in millimetres

**Note :** Where a closed channel with overflow is not provided a domed grating with perforating starting from the base and the crown of which shall be 25 mm, minimum above surface shall be provided which may be integral or otherwise.

## URINAL BOWL TYPE (Contd.)

Sub Head : Sanitary Installations  
Clause : 17.1.13

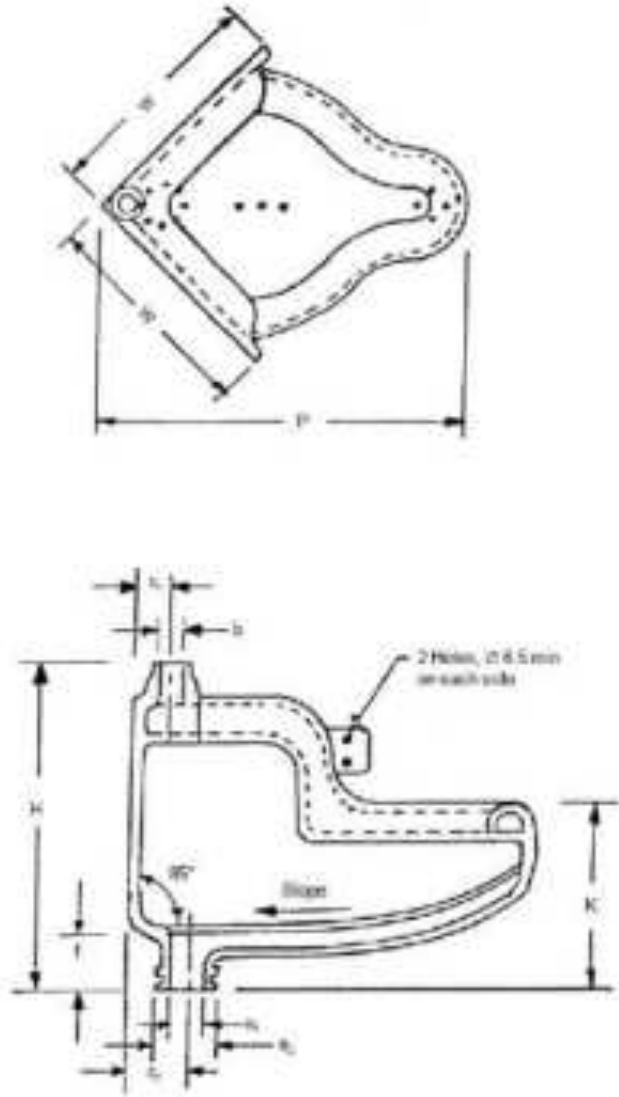


Figure 17.10 : Urinal Bowl Type (Corner Wall Type)

Note : Ovality of 5 percent is permissible on inlet and outlet diameters.  
All Dimensions in Millimetres

## URINAL – HALF STALL

Chapter : Sanitary Installations  
Clause : 17.1.13.2

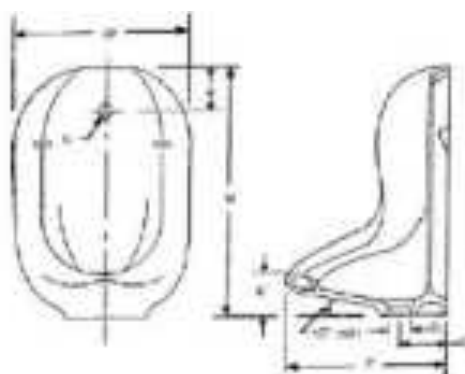


Figure 17.11 : Urinal Half-Stall

### BOWL TYPE FLAT BACK URINAL WITHOUT RIM FUNCTIONAL DIMENSIONS OF BOWL PATTERN URINALS All dimensions in millimetres

Sl. No.	Pattern	Dimension			
		Height	Projection	Width	Distance
		H	P	W	K, Min
1	Flat back with flushing rim				
	Size 1	440	265	355	140
	Size 2	440	265	315	140
2	Flat back without flushing rim				
	Size 1	410	265	305	100
	Size 2	590	375	390	100
3	Angle back with flushing rim	345	420	270	190
4	Angle back without flushing rim				
	Size 1	450	350	275	100
	Size 2	580	500	300	100

### CONNECTING DIMENSIONS OF BOWL PATTERN URINALS All dimensions in millimetres

Sl.No .		Pattern				Dimension in mm			
		a	B1)	c1	c2	d	e1	e2	f, Min
1	Flat back, with flushing rim	—	20 ± 3	40 ± 5	50 ± 5	—	35 ± 2	55	20
2	Flat back, without flushing rim	75 Max	20 ± 3	—	100 Min	65 ± 5	45 ± 2	60 Min	20



3	Angle back, with flushing rim	—	20 ± 3	35 ± 5	65 ± 5	—	35 ± 2	55	20
4	Angle back, without flushing rim	75 max	20 ± 3	—	150 (for size 1) 225 (for size 2)	65 ± 5	45 ± 2	60	20

#### Explanation for Legends Used

a = Dimension from top of bowl to centre of water supply hole or spreader

b = Diameter of water supply hole

c1= Distance from centre of water supply hole to back of bowl

c2= Distance from centre of waste outlet to back of bowl

d= Dimension of outlet of the waste flange

e1= Internal diameter of waste outlet

e2= Outside diameter of the outlet hole

f= Depth of waste outlet

*Note* : Distance between pairs of screw holes for flat back with flushing rim bowl urinal shall be 395 mm for top/bottom fixing arrangement and 320 mm for side fixing arrangement.

1. Ovality is permissible within the variation allowed for the dimensions
2. Ovality is permissible within  $\pm 2$  mm of the dimensions.



## URINAL SQUATTING PLATE

Chapter : Sanitary Installations

Clause : 17.1.13.4

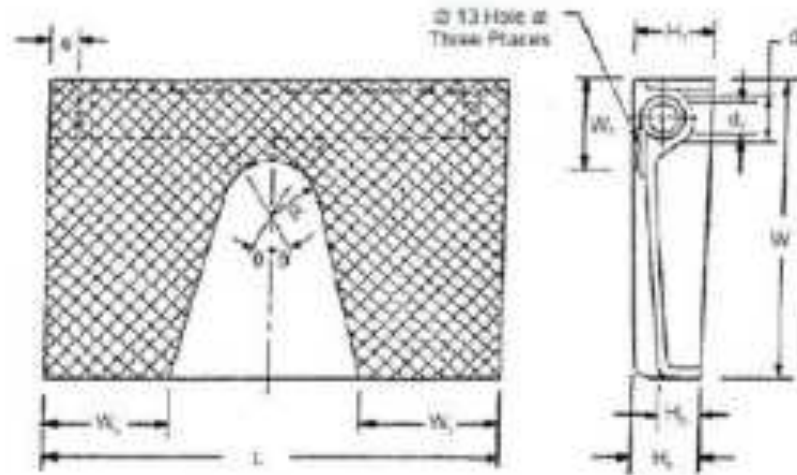


Figure 17.12 : Urinal Squatting Plate

### SQUATTING PLATE URINAL FUNCTIONAL DIMENSIONS OF SQUATTING PLATES (IN MM)

Sl. No.	Description	Ref. in Fig. above	Size 1	Size 2
1.	Size	—	450 x 350	600 x 350
2.	Length	L	450	600
3.	Minimum foot rest width	W1	125	165
4.	Width	W	350	350
5.	Height at back end	H1	100	100
6.	Height at front end	H2	85	85
7.	Minimum height at bowl draining surface	H3	50	50
8.	Width at flat top	W2	100	100
9.	Radius of curvature of the bowl	R	65	65
10.	Angle of direction of the two end spray hole with that of the central one	Ø	30°	30°

### CONNECTING DIMENSIONS OF SQUATTING PLATES, MM

Description	Ref. in Fig. above	Size 1/Size 2
Diameter of inlet hole	d1	40
Diameter of the inlet socket	d2	50
Depth of the inlet socket, Min	e	25
1) Ovality is permissible within the variation allowed for the dimensions.		

## SPREADER FOR URINAL

Sub Head : Sanitary Installations  
Clause : 17.1.13

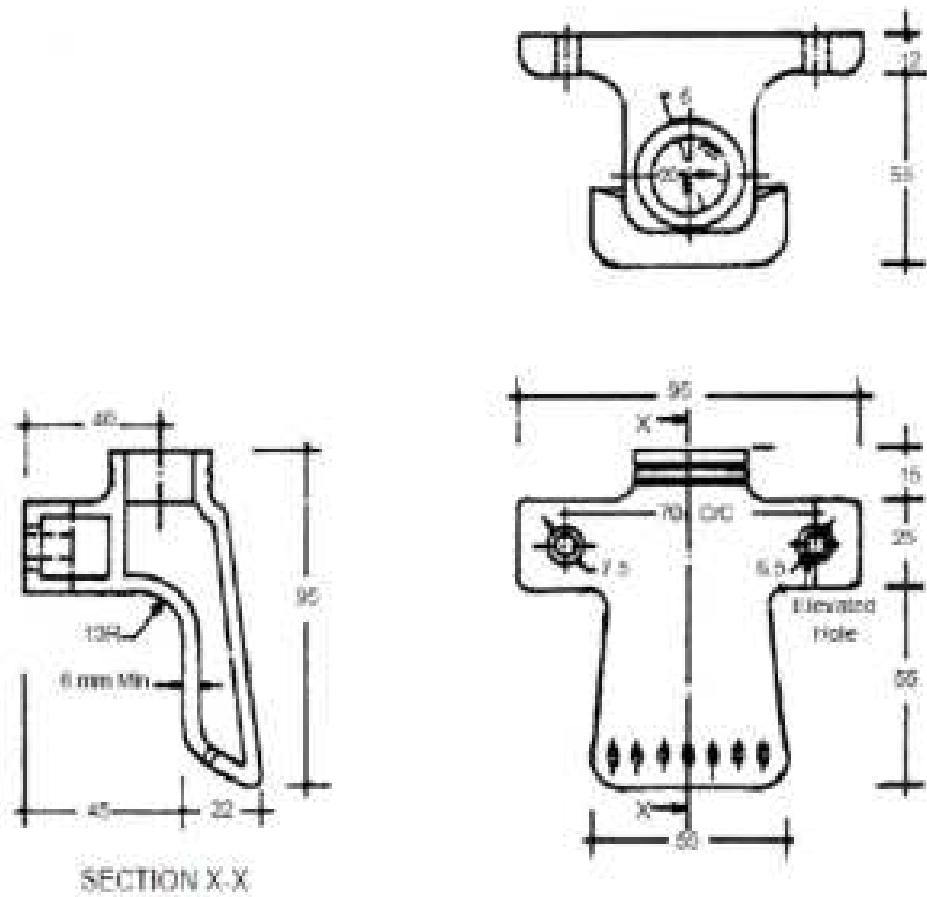


Figure 17.13 : Spreader for Urinal

Drawing Not to Scale  
All dimensions are in mm

## WASH BASINS

Sub Head : Sanitary Installations

Clause : 17.1.14

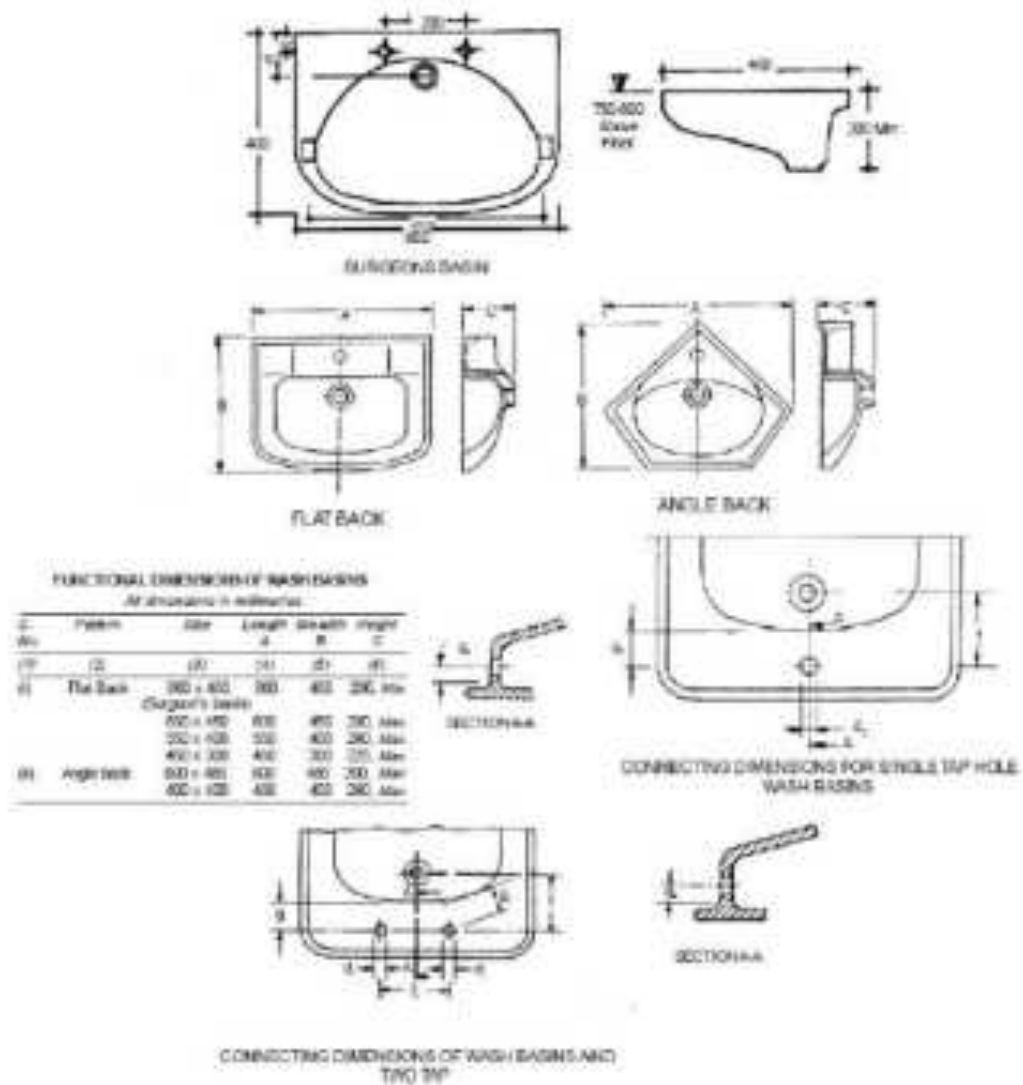


Figure 17.14 : Wash Basin

Drawing Not to Scale  
All dimensions are in mm





## TYPICAL VERTICAL SECTION OF WASH BASIN (WASTE PIPE CONCEALED FROM VIEW)

Sub Head : Sanitary Installations

Clause : 17.1.14

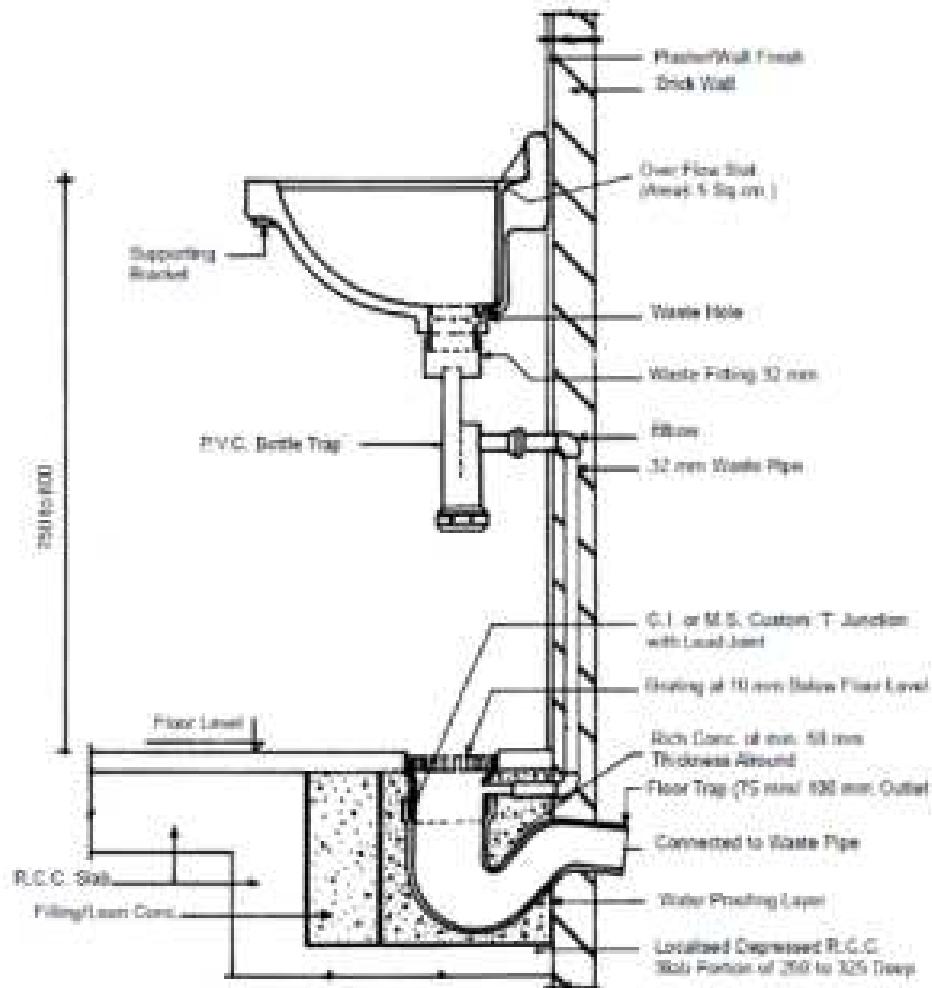


Figure 17.17 : Typical Vertical Section of Wash Basin (Waste Pipe Concealed from View)

Drawing Not to Scale  
All dimensions are in mm

## ANGLE BACK WASH BASIN (PATTERN-2)

Sub Head : Sanitary Installations

Clause : 17.1.14

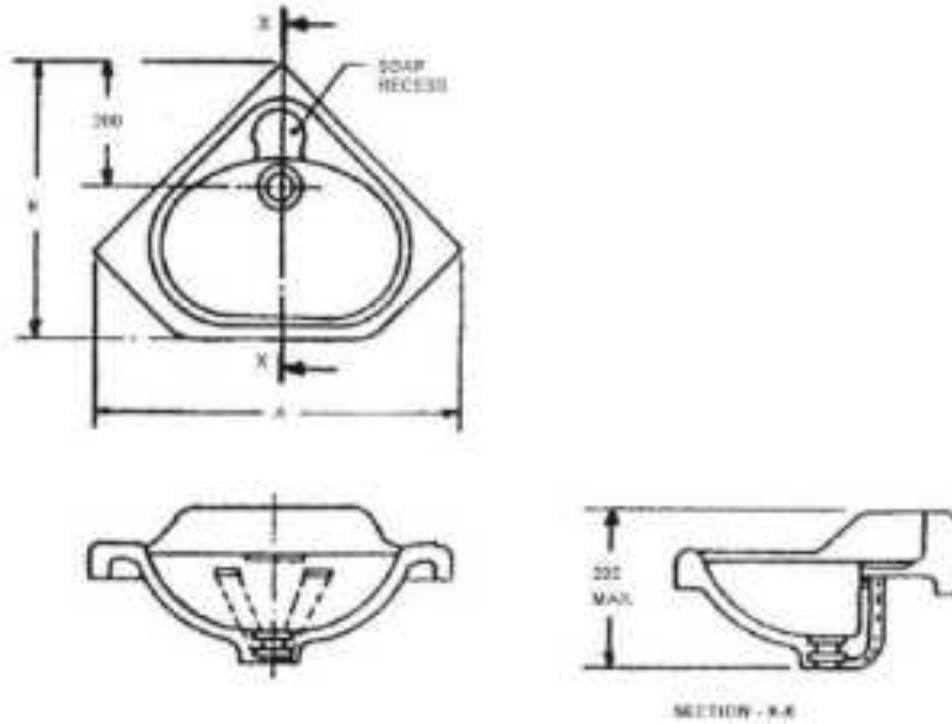


Figure 17.18 : Angle Back Wash Basin (Pattern-2)

### Notes :

1. Tap hole provisions are not shown. However provision shall be made for 1 or 2 Tap holes in any suitable position.
2. Stud provisions are not shown but suitable provision shall be made for fixing purposes.
3. Provision of soap recess need not be central in the case of single tap hole.
4. Drawing not to scale.
5. All dimensions are in mm.

## LONG PATTERN SQUATTING PAN, TYPE I

Sub Head : Sanitary Installations  
Clause : 17.1.16.1

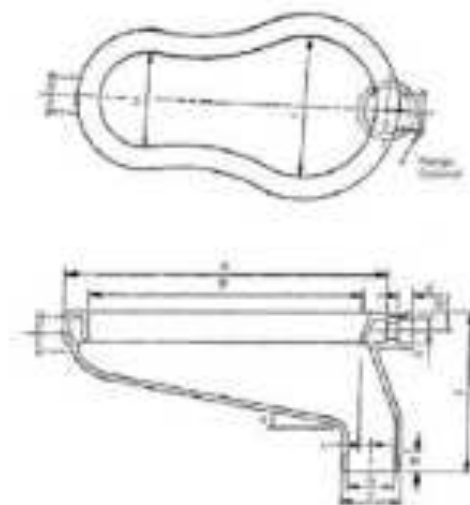


Figure 17.19 : Long Pattern Squatting Pan, Type I

Functional Dimensions of Long and Orissa Pattern  
All Dimensions in millimetres

Sl. No.	Description	Ref. in Fig. 19 and 20	Long Pattern of Size		Orissa Pattern of Size	
			360	600	360 x 440	600 x 450
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i) Length		A	580	850	580	850
(ii) Length of opening, Min.		B	480	500	470	500
(iii) Height		F	300 ± 10	320 ± 10	300 ± 10	320 ± 10
(iv) Width of opening, smallest		H	170 ± 10	170 ± 10	160 ± 10	160 ± 10
(v) Width of opening, wide end		I	260 ± 10	260 ± 10	210 ± 10	220 ± 10
(vi) Slope of bottom of Pan		e	15°	10°	15°	15°
(vii) Distance between the centre of corner to the inside face of flanging rim at the base, Min.		C	70	70	70	70
(viii) Width		W	—	—	440	450
(ix) Length of foot rest		P	—	—	310 ± 10	310 ± 10

Note : Tolerances which are not specified shall conform to Part I of IS-2058.



## ORISSA PATTERN SQUATTING PAN

Sub Head : Sanitary Installations  
Clause : 17.1.16.1

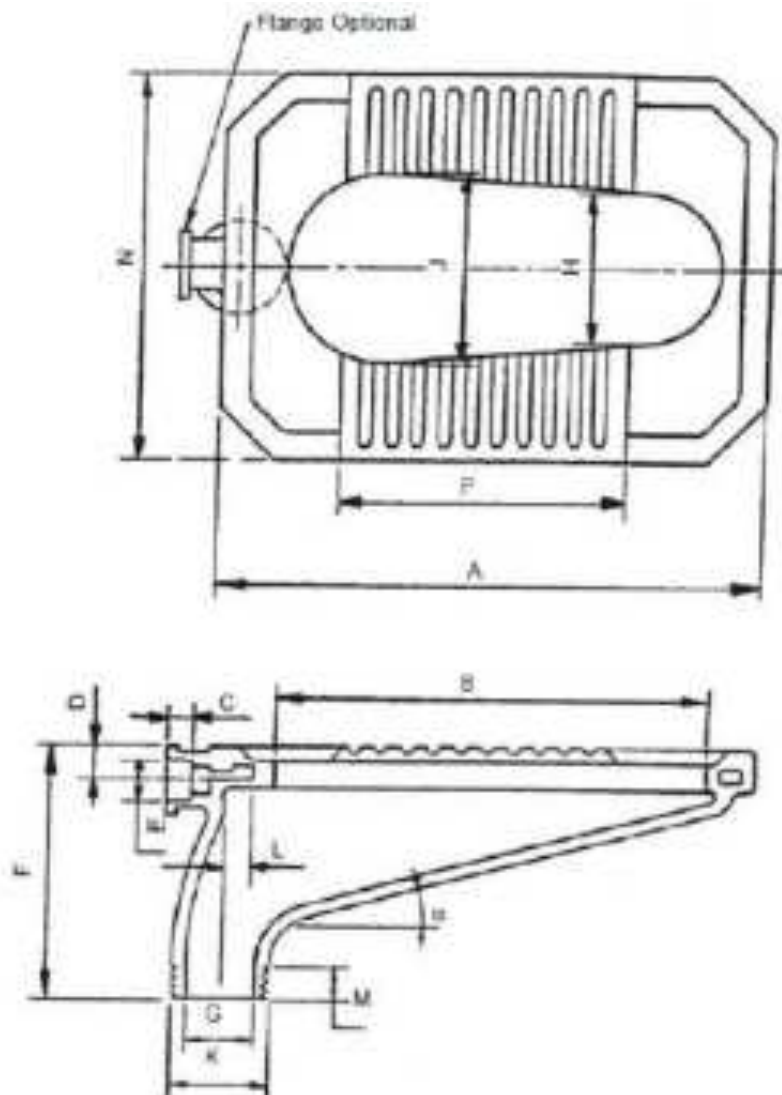


Figure 17.20 : Orissa Pattern Squatting Pan

Note : Footrest may be flushed or raised, clearance permissible between raised footrest and rim opening. All Dimensions in Millimetres.

## INTEGRATED SQUATTING PAN

Sub Head : Sanitary Installations  
Clause : 17.1.16.1

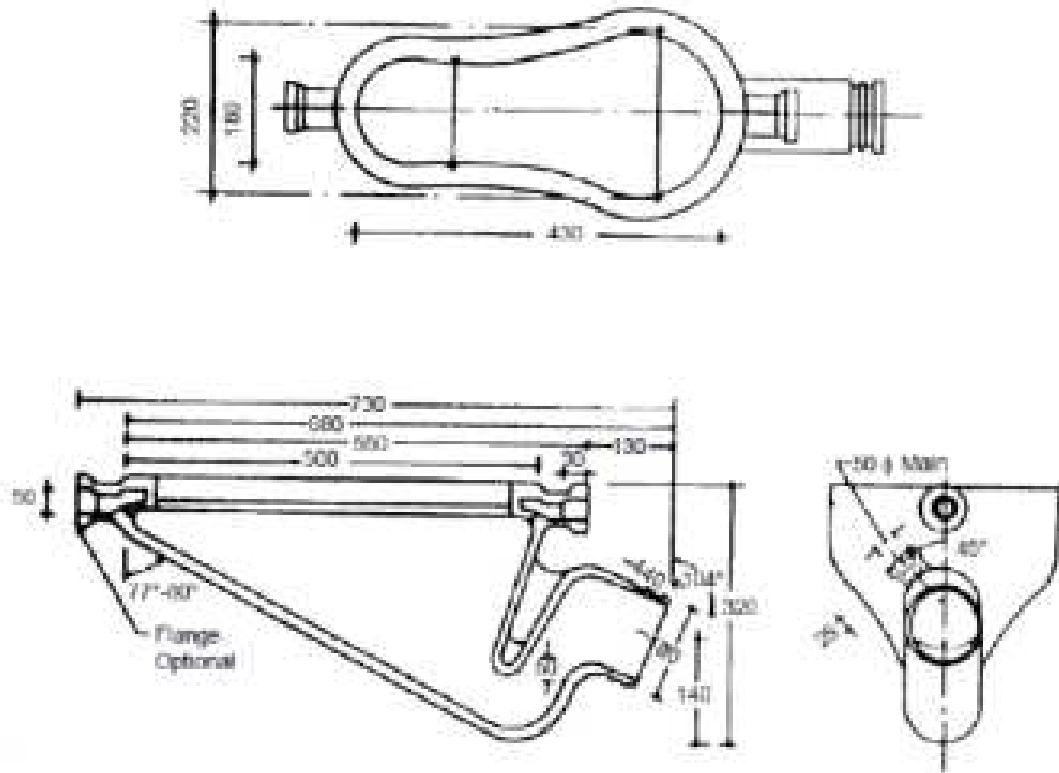


Figure 17.21 : Integrated Squatting Pan

## PATTERN 1 AND PATTERN 2 WATER CLOSETS

Sub Head : Sanitary Installations

Clause : 17.1.16.2

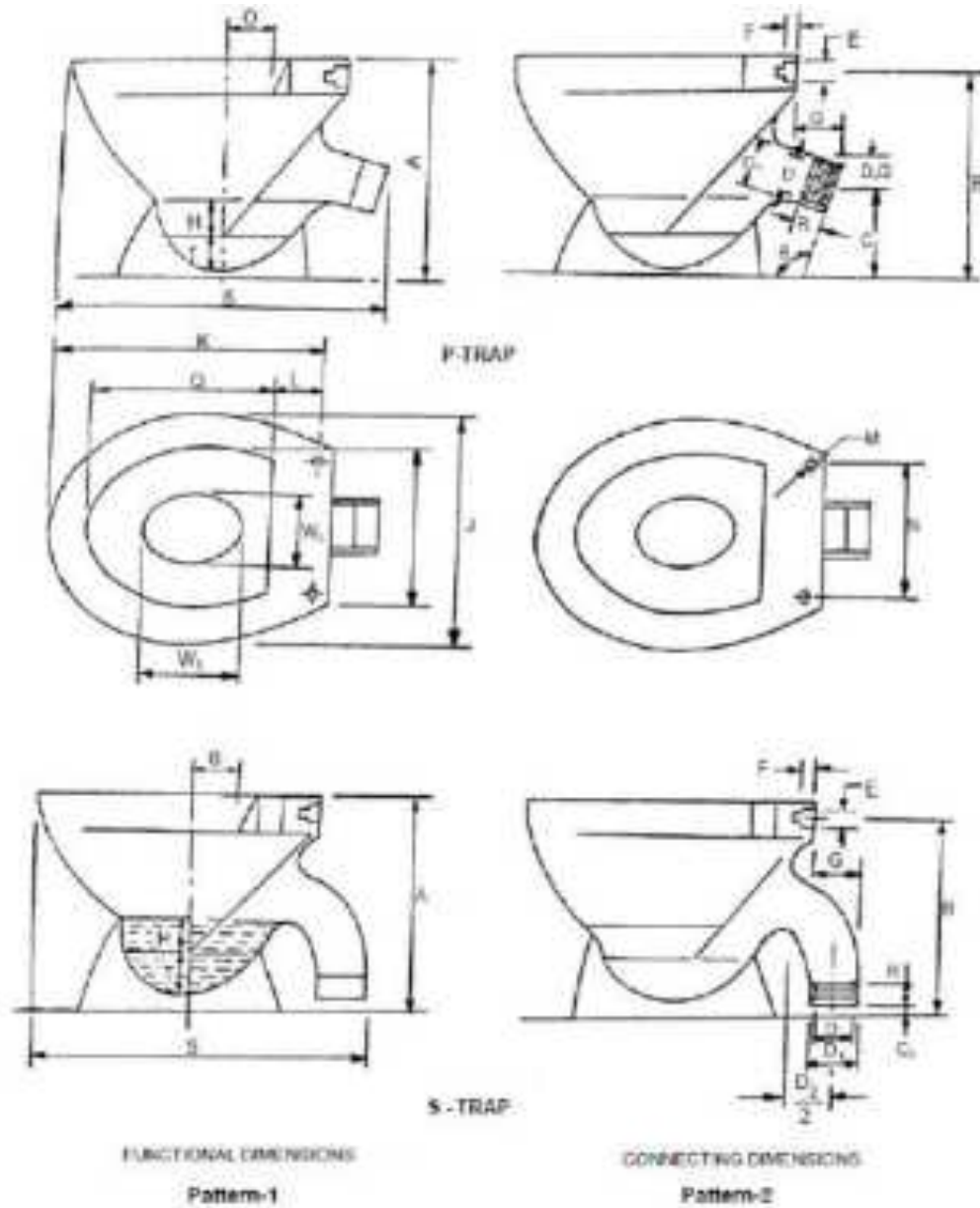


Figure 17.22 : Pattern 1 and Pattern 2 Water Closets

All dimensions in millimetres

## PATTERN 3 WATER CLOSET WITH HORIZONTAL P-TRAP

Sub Head : Sanitary Installations  
Clause : 17.1.16.2

### FUNCTIONAL DIMENSIONS All dimensions in millimetres

Sl.No.	Description	Ref. in Fig.	Pattern 1	Pattern 2	Pattern 3
(1)	(2)	(3)	(4)	(5)	(6)
(i)	Height	A	360 ± 10	380 ± 10	360 ± 10
(ii)	Depth of water seat, Min	H	50	50	50
(iii)	Width of water closet	J	360 ± 10	360 ± 10	360 ± 10
(iv)	Distance from centre of seat bolt hole to front of water closet	P	415 to 440	415 to 440	415 to 440
(v)	Distance from centre of seat bolt hole to inside face of flush rim at back, Min	L	60	60	60
(vi)	Distance between a vertical line from top of back panel to inside face of flush rim at back, Min	Q	70	70	70
(vii)	Width of opening, Min	P	240	240	240
(viii)	Length of opening, Min	Q	260	260	260
(ix)	Overall length	S	800-875	800-875	800 Min
(x)	Trap inlet depth, Min	T	70	70	70
(xi)	Water surface				
	Back to front	W <sub>1</sub>	150 Min	150 Min	150 Min
	Side to side	W <sub>2</sub>	110 Min	70 Min	110 Min

Note : (i) size of service vent in S-Trap, over all length should be taken as 3 + 70.

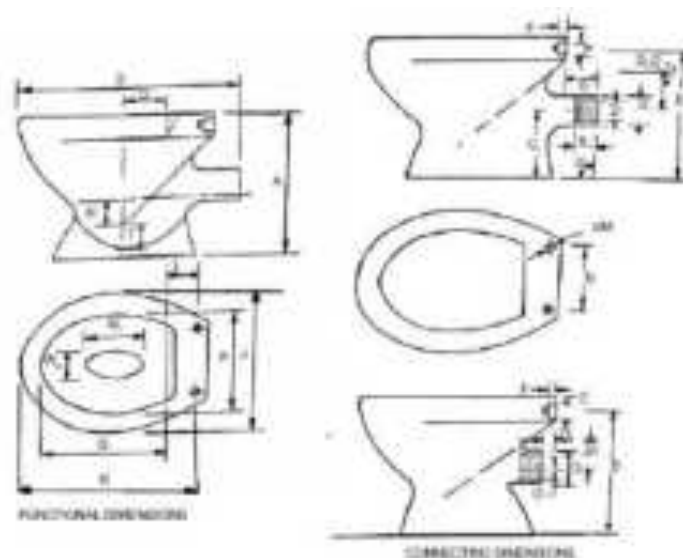


Figure 17.23 : Pattern 3 Water Closet with Horizontal P-Trap

All dimensions in millimetres

## TYPICAL COUPLING JOINT INSTALLATION

Sub Head : Sanitary Installations  
Clause : 17.1.8A

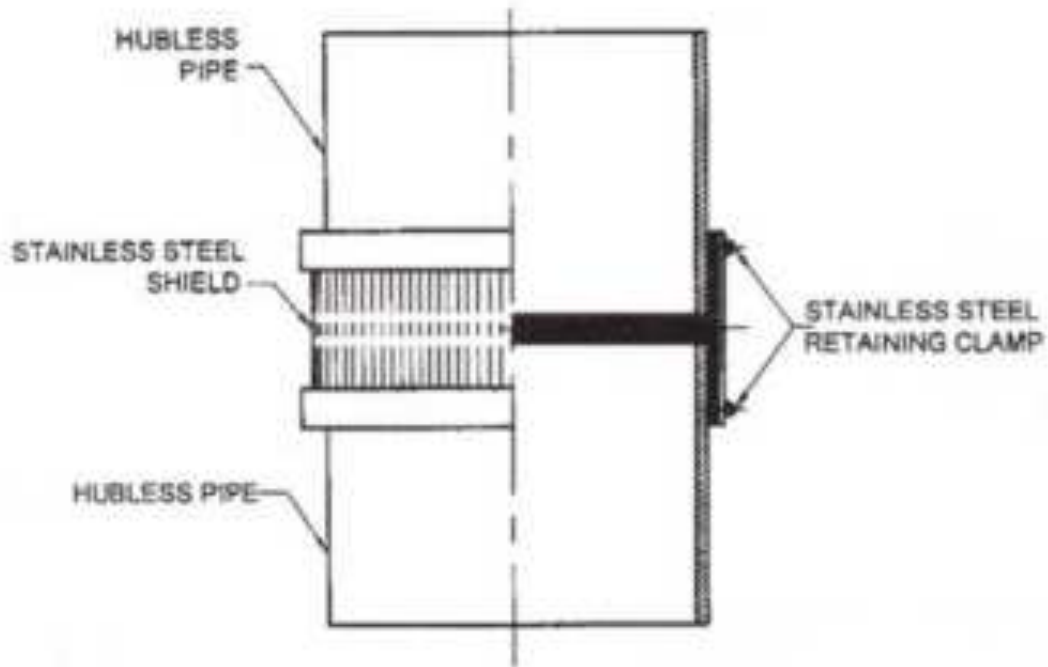


Figure 17.24 : Typical Coupling Joint Installation

# TYPICAL ILLUSTRATION OF WALL MOUNTED WATER CLOSET WITH CONCEALED OUTLET (PATTERN 1)

Sub Head : 17.0 Sanitary Installations  
Clause : 17.21.1

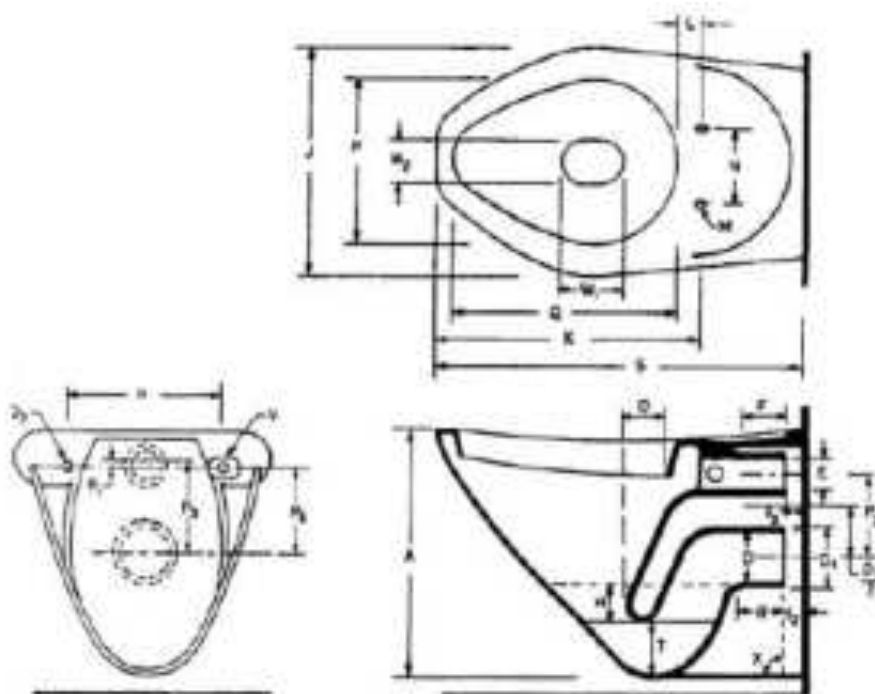


Figure 17.25 : Typical illustration of Wall Mounted Water Closet with Concealed Outlet (Pattern 1)

TABLE-2  
Connecting dimensions:

SL.No	Description	Reference to Fig 25 & Fig 26	Pattern t	Pattern 2
1	Internal Dia of Inlet	E	55+3 -1	55±3

**TYPICAL ILLUSTRATION OF WATER CLOSET WITH FIXING ARRANGEMENT ON TOP OF BRACKET  
(PATTERN 2)**

Sub Head : 17.0 Sanitary Installations  
Clause : 17.21.1

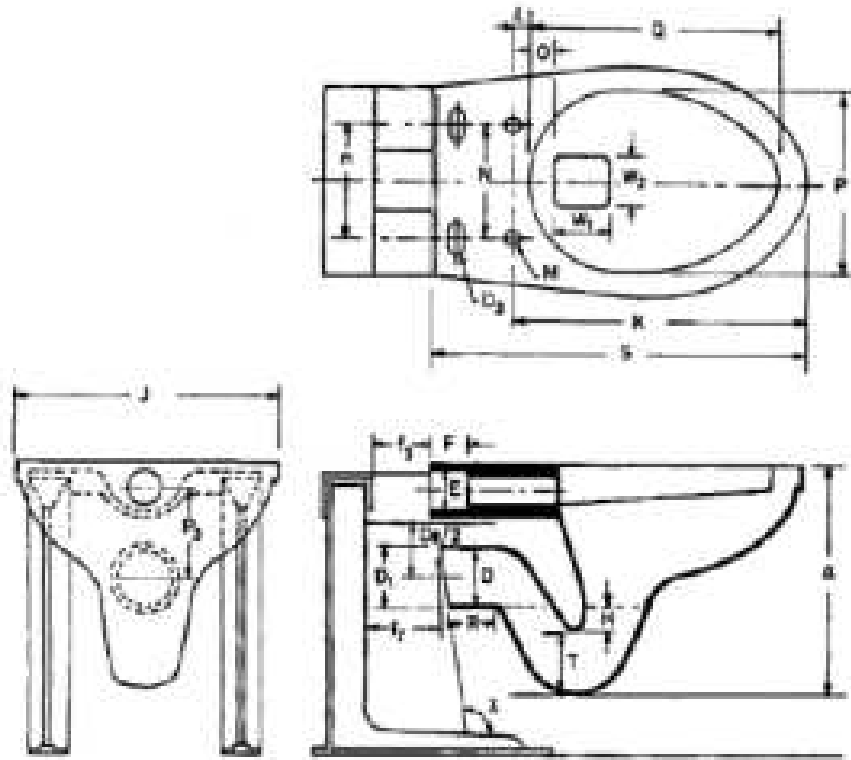


Figure 17.26 : Typical illustration of Water Closet with Fixing Arrangement on top of Bracket (Pattern 2)





## WATER SUPPLY



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## LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	IS No.	Subject
1	IS 554	Pipe threads where pressure tight joints are required on the threads- Dimensions, tolerances and designation.
2	IS 778	Specification for copper alloy gate, and check valves for water works purposes
3	IS 779	Water meters (domestic type) -Specification
4	IS 14846	Specification for sluice valves for water works purposes (50 to 1200 mm size)
5	IS 781	Specification for cast copper alloy screw down bib taps and stop valves for water services
6	IS 782	Specification for caulking lead
7	IS 909	Underground fire hydrant, sluice valve type-Specification
8	IS 1239 (Part 1)	Steel tubes tubular and other wrought steel fittings, Part 1- Steel tubes-Specification
9	IS 1239 (Part 2)	Specification for mild steel tubes tubular and other wrought steel fittings, Part 2- Mild street tubular and other wrought steel pipe fittings
10	IS 1536	Centrifugally cast (spun) iron pressure pipes for water gas and sewage-Specification
11	IS 1537	Specification for vertically cast iron pressure pipes for water, gas and sewage
12	IS 1538	Cast iron fittings for pressure pipes for water, gas and sewage - Specification
13	IS 1703	Water fittings - copper alloy float valves (horizontal plunger type)- Specification
14	IS 2692	Ferrules for water services- Specification
15	IS 3950	Specification for surface boxes for sluice valves
16	IS 4736	Specification for Hot-dip Zinc Coatings on mild steel tubes
17	IS 5312 (Part 1)	Swing type reflex (non return) valves for water works purposes. Part 1- Single door pattern
18	IS 5312 (Part 2)	Swing type reflex (non return) valves for water works purposes. Part 2- Multi door pattern
19	IS 5382	Rubber sealing rings for gas mains, water mains and sewers
20	IS 9762	Specification for polyethylene floats (spherical) for float valves
21	IS 9763	Plastic Bib taps and stop valves (rising spindle) for cold water services-Specifications
22	IS 15450	PE-AL-PE Pipes for hot and cold water supplies-Specifications
23	IS 15778	Chlorinated Polyvinyl Chloride (CPVC) pipes for potable hot and cold water distribution supplies-specifications.



Sl. No.	IS No.	Subject
24	IS 15801	Polypropylene- Random Copolymer Pipes for hot and cold water supplies- Specifications
25	IS 2685	Code for selection/Installation and Maintenance of Sluice Valve
26	IS 12701	Rotational Moulded Polyethylene Water Storage Tank



## 18 WATER SUPPLY

### 18.0 TERMINOLOGY

#### **Air Gap**

The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or fitting supplying water to a tank or other device and the flood level rim of the receptacle in a water supply system.

#### **Air Valve**

A valve that releases air from a pipe line automatically without loss of water, or introduces air into a pipe line automatically if the internal pressure becomes less than that of the atmosphere.

#### **Available Head**

The head of water available at the point of consideration due to main's pressure or overhead tank or any other source of pressure.

#### **Back Flow**

The flow of water into the distributing pipes of water system from any source or sources other than its intended source.

#### **Back Siphonage**

The flowing back of used, contaminated or polluted water from a plumbing fitting or vessel into a water supply system due to a lowering of pressure in such system.

#### **Ball Cock (Fig. 18.1)**

A faucet opened or closed by the fall or rise of a ball floating on the surface of water.

Branch (Fig. 18.2): (i) A special form of cast iron pipe used for making connections to water mains. The various types are called T, Y, T-Y, double Y, and V branches, according to their respective shapes.

(ii) Any part of a piping system other than a main.

#### **Capacity**

The storage capacity of storage or flushing cistern or a tank when filled up to the water line.

#### **Non Return Valve (Fig. 18.4)**

A device provided with a disc hinged on one edge so that it opens in the direction of normal flow and closes with reversal of flow.

#### **Collar**

A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment.

#### **Coupling**

A pipe fitting with inside threads only, used for connecting two pieces of pipe.

#### **Cross (Fig. 18.2)**

A pipe fitting used for connecting four pipes at right angles.

#### **Elbow (Fig. 18.2)**

A pipe fitting for providing a sharp change of direction in a pipe line.

**Ferrule (Fig. 18.2)**

A pipe fitting for connecting a service pipe to a water main.

**Fitting**

Anything fitted or fixed in connection with the supply, measurement, control, distribution, utilization or disposal of water.

**Fire Hydrant (Fig. 18.5)**

A device connected to a water main and provided with necessary valve and outlets, to which a fire hose may be attached for discharging water at a high rate for the purpose of extinguishing fires, washing down streets, or flushing out the water main.

**Flange (Fig. 18.2)**

A projecting flat rim on the end of a valve, pipe etc.

**Flanged Pipe (Fig. 18.2)**

A pipe provided with flanges so that the ends can be joined together by means of bolts.

**Float Valve**

A valve in which the closure to an opening such as a plug or gate is actuated by a float to control the flow into a tank.

**Sluice Valve (Gate Valve) (Fig. 18.4)**

A valve in which the flow of water is cut off by means of a circular disc., fitting against machine-smoothed faces, at right angles to the direction of flow. The disc is raised or lowered by means of a threaded stem connected to the handle of the valve; the opening in the valve is usually as large as the full bore of the pipe.

**Nipple (Fig. 18.2)**

A tubular pipe fitting usually threaded on both ends and less than 300 mm long used for connecting pipes or fittings.

**Offset**

A combination of elbows or bends which brings one section of the pipe out of line but into a line parallel with the other section in a piping system.

**Reflux Valve (Fig. 18.4)**

A non return valve used in a pipe line at a rising gradient to prevent water that is ascending the gradient from flowing back in the event of a burst lower down.

**Socket (Fig. 18.2)**

The female part of the spigot and socket joint.

**Spigot (Fig. 18.2)**

The male part of a spigot and socket joint.

**Stop Cock (Fig. 18.3)**

A control valve fixed at the end of a communication pipe which controls the supply from the water main.

**Storage Tank**



A tank or a cistern for storage of water which is connected to the water main by means of a supply pipe.

### **Service or Supply Pipe**

Pipe through which supply is drawn from water mains.

### **Union (Fig. 18.2)**

A pipe fitting used for joining the ends of two pipes neither of which can be turned.

### **Valve**

A device used for controlling the flow of water in a pipe line.

## **18.1 GENERAL REQUIREMENTS**

- 18.1.1** Any damage caused to the building, or to electric, sanitary water supply or other installations etc. therein either due to negligence on the part of the contractor, or due to actual requirements of the work, shall be made good and the building or the installations shall be restored to its original condition by the contractor. Nothing extra shall be paid for it, except where otherwise specified.
- 18.1.2** All water supply installation work shall be carried out through licensed plumbers.
- 18.1.3** It is most important to ensure that wholesome water supply provided for drinking and culinary purposes, is in no way liable to contamination from any less satisfactory water. There shall, therefore, be no cross connection whatsoever between a pipe or fitting for conveying or containing wholesome water and a pipe or fitting for conveying or containing impure water or water liable to contamination or of uncertain quality of water which has been used for any purpose. The provision of reflux or non-return valves or closed and sealed valves shall not be construed a permissible substitute for complete absence of cross-connection.
- 18.1.4** Where a supply of wholesome water is required as an alternative or standby to supply of less satisfactory water or is required to be mixed with the latter, it shall be delivered only into a cistern, and by a pipe or fitting discharging into the air gap at a height above the top edge of the cistern equal to twice its nominal bore, and in no case less than 15 cm.
- 18.1.5** No piping shall be laid or fixed so as to pass into, through or adjoining any sewer, scour outlet or drain or any manhole connected therewith nor through any ash pit or manure-pit or any material of such nature that can cause undue deterioration of the pipe.
- 18.1.6** Where the laying of any pipe through fouled soil or previous material is unavoidable, the piping shall be properly protected from contact with such soil or material by being carried through an exterior cast iron tube or by some other suitable means. Any piping or fitting laid or fixed which does not comply with the above requirements, shall be removed and re-laid in conformity with the above requirements.
- 18.1.7** The design of the pipe work shall be such that there is no possibility of backflow towards the source of supply from any cistern or appliance whether by siphonage or otherwise, and reflux or non- return valves shall not be relied upon to prevent such back flow.
- 18.1.8** All pipe work shall be so designed, laid or fixed, and maintained so that it remains completely watertight, thereby avoiding wastage of water, damage to property and the risk of contamination of the water conveyed.
- 18.1.9** In designing and planning the layout of the pipe work, due attention shall be given to the maximum rate of discharge, required economy in labour and materials, protection against damage and corrosion, protection from frost, if required, and to avoidance of airlocks, noise transmission and unsightly arrangement.
- 18.1.10** To reduce frictional losses, piping shall be as smooth as possible inside. Methods of jointing shall be such as to avoid internal roughness and projection at the joints, whether of the jointing materials or otherwise.





- 18.1.11** Change in diameter and in direction shall preferably be gradual rather than abrupt to avoid undue loss of head. No bend or curve in piping shall be made so as to materially reduce or alter the cross-section.
- 18.1.12** Underground piping shall be laid at such a depth that it is unlikely to be damaged by frost or traffic loads and vibrations. It shall not be laid in ground liable to subsidence, but where such ground cannot be avoided; special precautions shall be taken to avoid damage to the piping. Where piping has to be laid across recently disturbed ground, the ground shall be thoroughly consolidated so as to provide a continuous and even support.
- 18.1.13** Where the service pipe is of diameter less than 50 mm the stop valves shall be of the screw- down type and shall have loose washer plates to act as non-return valves. Other stop valves in the service line may be of the gate type.
- 18.1.14** In flats and tenements supplied by a common service pipe a stop valve shall be fixed to control the each branch separately. In large buildings a sufficient number of stop valves shall be fixed on branch pipes, and to control groups of ball valves and draw off taps, so as to minimize interruption of the supply during repairs, all such stop valves shall be fixed in accessible positions and properly protected from being tampered with, they may be of the gate type to minimize loss of head by friction.
- 18.1.15** Water for drinking or for culinary purposes as far as possible shall be on branch pipes connected directly to the service pipe.
- 18.1.16** Pumps shall not be allowed on the service pipe as they cause a drop of pressure on the suction side thereby affecting the supply to the adjoining properties. In cases where pumping is required, a properly protected storage tank of adequate capacity shall be provided to feed the pump.
- 18.1.17** Service pipes shall be so designed and constructed as to avoid air-locks, so that all piping and fittings above ground can be completely emptied of water to facilitate repairs. There shall be draining taps or draw-off taps (not underground) at the lowest points, from which the piping shall rise continuously to draw-off taps, ball valves, cisterns, or vents (where provided at the high points).
- 18.1.18** Service pipes shall be designed so as to reduce the production and transmission of noise as much as possible. Appliances which create noise shall be installed as far distant as possible from the living rooms of the house. High velocity of water in piping and fittings shall be avoided. Piping shall be confined, as far as possible, to rooms where appliances are fixed, it shall have easy bends, and where quietness is particularly desired, holder bats or clamps shall be insulated from the piping by suitable pads.
- 18.1.19** The rising pipe to the storage cistern, if any, or to any feed cistern shall be taken as directly as possible to the cistern and shall be fixed away from windows or ventilators.
- 18.1.20** All pipe work shall be planned so that the piping is accessible for inspection, replacement and repair. To avoid its being unsightly, it is usually possible to arrange it in or adjacent to cupboards, recesses, etc. provided there is sufficient space to work on the piping with the usual tools. Piping shall not be buried in walls or solid floors. Where unavoidable, piping may be buried for short distances provided that adequate protection is given against damage and that no joints are buried. If piping is laid in ducts or chases, these shall be roomy enough to facilitate repairs and shall be so constructed as to prevent the entry of vermin. To facilitate removal of pipe casing, floor boards covering piping shall be fixed with screws or bolts.
- 18.1.21** When it is necessary for a pipe to pass through a wall or floor, a sleeve shall be fixed therein for insertion of the pipe and to allow freedom for expansion, contraction and other movement. Piping laid in wood floors shall, where possible, be parallel with the joists.
- 18.1.22** Where storage tanks are provided to meet overall requirements of water connection of service pipe with any distributing pipe shall not be permitted except one direct connection for culinary or drinking requirements.



- 18.1.23** No service pipe shall be connected to any water closet or urinal. All such supplies shall be from flushing cisterns which shall have supply from storage tank.
- 18.1.24** No service or supply pipe shall be connected directly to any hot-water system or to any apparatus used for heating other than through a feed cistern thereof.

## 18.2 MATERIALS

- 18.2.0** The standard size of brass or gun metal fittings shall be designated by the nominal bore of the pipe outlet to which the fittings are attached. A sample of each kind of fittings shall be got approved from the Engineer-in-Charge and all supplies made according to the approved samples. All cast iron fittings shall be sound and free from laps, blow holes and pitting. Both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging, stopping or patching of the casting shall not be permissible. The bodies, bonnets, spindles and other parts shall be truly machined so that when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the water way of the fittings shall not be less than area of the nominal bore, chromium plating wherever specified shall be of 0.3 micron. The chromium shall never be deposited on brass unless a heavy coating of nickel is interposed. In the case of iron a thick coat of copper shall first be applied, then one of nickel and finally the chromium. In finish and appearance the plated articles when inspected shall be free from plating defects such as blisters, pits roughness and unplated areas and shall not be stained or discoloured. Before fitting is plated, the washer plate shall be removed from the fittings, the gland packing shall be protected from the plating solution.

### 18.2.1 Ball Valve (Brass)

The ball valve shall be of Brass or Gunmetal as specified conforming to IS 1703 (Fig. 18.1). The ball valve shall be of following two classes:

*High Pressure:* High pressure float valves are indicated by the abbreviation 'HP' and are designed for use on mains having pressure of 0.175 MPa or above.

*Low Pressure:* Low Pressure float valves are indicated by the abbreviation 'LP' and are designed for use on mains having a pressure up to. 0.175 MPa.

The ball valves shall be of following nominal sizes 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm. The nominal size shall correspond with the nominal bore of the inlet shanks. Polyethylene floats shall conform to IS 9762.

### 18.2.2 Bib Taps and Stop Valve

Brass (Fig. 18.3): A bib tap is a draw off tap with a horizontal inlet and free outlet and a stop valve is a valve with suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of screw down type and shall conform to IS 781. The closing device shall work by means of disc carrying a renewable non-metallic washer which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anti-clock wise direction.

The bib tap and stop valve shall be polished bright. The minimum finished weights of bib tap and stop valve shall be as specified in Table 18.1.

**TABLE 18.1**

**Minimum Finished Mass of Bib Taps and Stop Valves**

Size	Minimum Finished Mass
------	-----------------------



	Bib Taps	Internally Threaded	Externally Threaded	Mixed End
(1)	(2)	(3)	(4)	(5)
mm	kg	kg	kg	kg
8	0.250	0.220	0.250	0.235
10	0.300	0.300	0.350	0.325
15	0.400	0.330	0.400	0.365
20	0.750	0.675	0.750	0.710
25	1.250	1.180	1.300	1.250
32	--	1.680	1.800	1.750
40	--	2.090	2.250	2.170
50	--	3.700	3.850	3.750

In case these are required to be nickel plated, the plating shall be of the first quality with a good thick deposit of silvery whiteness capable of taking high polish which will not easily tarnish or scale.

### 18.2.3 Ferrules (Fig. 18.2)

The ferrules for connection with C.I. main shall generally conform to IS 2692. It shall be of non ferrous materials with a C.I. bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, if and when required.

### 18.2.4 Fire Hydrants (Fig. 18.5)

The hydrant shall conform to IS 909 and shall consist of the following components:

- Body
- Bonnet
- Spindle
- Gland
- Spindle Cap
- Spindle Nut
- Valve
- Screwed Outlet
- Outlet and Chain

The body, bonnet, gland, outlet cap and spindle cap and shall be of good quality cast iron grade FG 200 of IS 210. Outlet, seat for valve, valve, spindle nut, check nut shall be made of copper alloy as per IS 909.

### 18.2.5 Gate Valve - Gun Metal (Fig. 18.5)

These shall be of the gun metal fitted with wheel and shall be of gate valve type opening full way and of the size as specified. These shall generally conform to IS 778.

### 18.2.6 Pig Lead



Pig lead shall be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to IS 782 for caulking lead in all respects.

#### 18.2.7 Lead Wool

Lead wool shall conform to IS 782 in all respects. Lead wool shall consist of fine strands or plated ribbons of lead. The cross-section of the individual strands shall be flat. The dimensions in the sectional plane shall not be less than 0.13 mm and not more than 0.90 mm and the rope shall be supplied in minimum lengths of two metres and the maximum length in any one package shall be such that the package does not weigh more than 50 Kg.

#### 18.2.8 Non-Return Valve (Gun Metal) (Fig. 18.4)

A non- return valve permits water to flow in one direction only and is provided on the ascending part of the main to check return flow. The non-return valve shall be of Gun metal and shall be of horizontal or vertical flow type as specified. The valve shall be of quality approved by the Engineer-in-Charge and shall generally conform to IS 778.

#### 18.2.9 Pipes and Specials

Pipes and specials may be of any of the following types as specified:

- Cast iron centrifugally cast (spun) – IS 1536
- Galvanised steel – IS 1239 & IS 4736
- PE-AL-PE Pipes – IS 15450
- PP-R Pipes – IS 15801
- CPVC pipes – IS 15778

In choosing the material for piping and fittings, account shall be taken of the character of the water to be conveyed through it, the nature of the ground in which the pipes are to be laid and the relative economics.

#### 18.2.10 Pipes- Centrifugally Cast (Spun) Iron Pipes

**18.2.10.1** The spun iron pipes shall conform to IS 1536. The spun iron pipes shall be of cast iron cast centrifugally and vary in diameters from 80 mm to 750 mm. These shall be of class LA, class A and class B, as specified. Pipes shall be tested hydrostatically at the pressure specified in table 18.2 & Tolerances on specified dimensions shall be as prescribed in Appendix A.

**18.2.10.2 Specials:** The specials shall conform to IS 1538. The hydraulic test pressure of each class shall be as detailed in Table 18.4. Tolerances on specified dimensions shall be as prescribed in Appendix B of sub head- 18.

**TABLE 18.2**

<i>Hydrostatic Test pressure for centrifugally cast socket &amp; spigot pipes in MPa</i>		
<i>Hydrostatic Test pressure for works in MPa</i>		
<i>Class</i>	<i>Up to DN 600</i>	<i>DN 700 &amp; above</i>
<i>LA</i>	3.5	1.5
<i>A</i>	3.5	2.0
<i>B</i>	3.5	2.5

**TABLE 18.3**

<i>Hydrostatic Test pressure for centrifugally cast pipes with screwed on flanges in MPa</i>
--



Class	Up to DN 600	DN 700 & above
B	2.5	1.6

**TABLE 18.4**

Hydrostatic Test pressure for fittings in MPa (N/mm <sup>2</sup> )		
Nominal - Diameter	Fitting without branches or with branches not greater than half the principal diameter.	Fitting with Branches greater than half the Principal Diameter.
Up to and including 300 mm	2.5 (25)	2.5 (25)
Over 300 mm and up to and including 600 mm	2.0 (20)	2.0 (20)
Over 600 mm and up to and including 1500 mm	1.5 (15)	1.0 (10)

### 18.2.11 Pipes-Galvanised Iron

**18.2.11.1** The pipes (tubes) shall be manufactured through one of the following processes:

- Hot finished seamless (HFS)
- Cold finished seamless (CFS)
- Hot finished seamless (HFW)
- Electric resistance or high frequency induction weld (ERW or HFIW)

The pipe shall be conforming to the requirements of IS 1239 Part-I for medium grade. They shall be of the diameter (nominal bore) specified in the description of the item. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

**18.2.11.2** Galvanising shall conform to IS 4736: The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare patches, black spots, pimples, lumping runs, rust stains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

**18.2.11.3** The dimensions and weights of pipes and sockets and tolerances shall be as prescribed in Appendix C.

**18.2.11.4** All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS 554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

**18.2.11.5** All tubes shall withstand a test pressure of 50 Kg/sq.cm without showing defects of any kind.

**18.2.11.6** Fittings: The fittings shall be of mild steel tubular or wrought steel fittings conforming to IS 1239 (Part-2) or as specified. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended.

### 18.2.12 Shower Rose Brass

The shower rose shall be of chromium plated brass of specified diameter. It shall have uniform perforations. The inlet size shall be 15 mm or 20 mm as required.



### 18.2.13 Sluice Valves-Brass/Gun Metal (Fig. 18.4)

The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside non-raising screw type up to 300 mm size and raising or non-raising screw type above 300 mm with either double flange or double socket ends and cap or hand wheel. These shall in all respects comply with the Indian Standard Specification IS 14846. Class I sluice valves are used for maximum working pressure of 10 Kg/sq.cm (100 metre head) and class II sluice valve for 15 Kg/sq.cm (150 metre head).

The body, domes covers, wedge gate and stuffing box shall be of good quality cast iron, the spindle of bronze, and the nut and valve seats of leaded tin bronze. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe.

The valve shall be marked with an arrow to show the direction of turn for closing of the valve.

### 18.2.14 Surface Box (Fig. 18.6 & 18.7)

This shall be of cast iron, well made and free from casting and other defects. All sharp edges shall be removed and finished smooth. The shape and dimensions for surface boxes for stop cocks, sluice valves, fire hydrants, water meters etc. shall be as specified in Fig. 18.3 & 18.4.

The C.I. surface boxes shall be coated with a black bituminous composition except in case of fire hydrants where the cover of the surface box shall be painted with two coats of rust resisting bright luminous yellow paint for clear visibility during night.

### 18.2.15 Water Meter (Domestic Type) (Fig. 18.4)

**18.2.15.1** Water meters shall be selected according to flow to be measured and not necessarily to suit a certain size of main. The following points shall govern the selection of meters:

- a. The maximum flow shall not exceed the nominal capacity of the meter.
- b. The continuous flow shall be not greater than the continuous running capacity rating.
- c. The minimum flow to be measured shall be within minimum starting flows.

**18.2.15.2** Inferential water meter has the same accuracy as the semi -positive type at higher flows; it passes unfiltered water better than a semi-positive meter and is lower in cost.

**18.2.15.3** Special care is necessary in selecting the most suitable meter where large rates of flow may exist for short periods. The normal working flow shall be well within the continuous running capacity specified in IS 779, as high rates of flow over short period may cause excessive wear if the meter chosen is too small for the duty.

**18.2.15.4** Owing to the fine clearances in the working parts of meters, they are not suitable for measuring water containing sand or similar foreign matter, and in such cases a filter or dirt box of adequate effective area shall be fitted on the upstream side of the meter. See Fig. 18.4. It shall be noted that the normal strainer fitted inside a meter is not a filter and does not prevent the entry of small particles, such as sand.

**18.2.15.5** Water meters and their parts, especially parts coming in continuous contact with water shall be made of materials resistant to corrosion and shall be non -toxic and non-training. Use of dissimilar metals in contact under water shall be avoided as far as possible in order to minimise electrolytic corrosion.

**18.2.15.6** Body: The body of water meter shall be made either from Type A or Type B materials as specified below:

*Type A:* The body of water meters shall be made from bronze, brass or any other corrosion resistant material e.g. Grey iron castings, blackheart malleable iron, pearlitic graphite iron casting.

*Type B:* The body of the water meters shall be made from suitable plastics.



**Note:** Plastics shall have following qualities:

- a. It shall not affect the potability of water.
- b. Elongation, 15 per cent, Min. on a specimen of length 150 mm (for procedure of determination of elongation).
- c. Water absorption on immersion for 24 hours should not exceed 0.6 per cent by weight (for procedure of determination of water absorption).
- d. It shall be capable of withstanding temperature up to 55°C without undergoing deformation or softening and becoming unsatisfactorily in performance.

**18.2.15.7 Registration Box:** Registration box of water meters of Type A shall be made from bronze, brass, aluminium alloy or suitable plastics. Registration box of water meters of Type B shall be made from suitable plastics or aluminium alloys. The registration box of dry dial water meters shall be provided with one or two escape holes for minimising the accumulation of condensed water.

**18.2.15.8 Cap:** Cap of water meters of Type A shall be made from brass, bronze, aluminium alloy or suitable plastics. The cap of water meters of Type B shall be made of plastics or aluminium alloy. Where the cap and registration box are integral, the materials for cap may be the same as used for registration box. The cap shall be so designed and fixed to the registration box as to avoid entry of water and dirt. The transparent window which covers the dial shall be inserted from the inside into the cap. The protective lid shall be secured by a robust hinge or other suitable method of robust construction.

**18.2.15.9 Locking Arrangement:** Provision shall also be made to lock the lid. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be of a diameter not less than 4 mm.

**18.2.15.10 Wiper:** Where so required for dry-type water meters the transparent window covering the dial shall be provided with a wiper on the inner side for wiping off condensed water.

**18.2.15.11 Connecting Arrangements:** The meter casing shall be fitted in the pipe line by means of two conical or cylindrical nipples or tail pieces with connecting nuts which shall be provided with each meter. The nipples of water meters of Type A shall be made of the same materials as specified for body. Nipples of water meters of Type B shall be made of the same materials as specified for the body where they are integral with the body of the water meters; where they are separate, they shall be made of malleable iron, galvanized steel or suitable plastics. The nuts shall be of the same material as used for nipples. The internal diameter of the nipple where it connects the pipe line shall be equal to that corresponding to the nominal size of the meter. The threads on the connection shall conform to IS 779. The minimum length of the threads shall be as given in Table 18.5.

**18.2.15.12 Strainers:** Water meters shall be provided with strainers. Strainers shall be of a material which is not susceptible to electrolytic corrosion. They shall be of plastics or other corrosion-resistant materials for both Type A and Type B meters. They shall be rigid, easy to remove and clean, and shall be fitted on the inlet side of the water meter. It shall be possible to remove and clean the strainer in such a way as not to permit disturbing the registration box or tampering with it. The strainer shall have a total area of holes not less than twice the area of the nominal inlet bore of the pipe to which the meter is connected however, in the case of meters provided with internal strainer involving opening of the registration box for cleaning, an additional external strainer shall be fitted on the inlet side satisfying the above requirements.

Overall dimension of water meters shall be as specified in Table 18.6.

**TABLE 18.5**

**Minimum Length of Thread on Connections**





Nominal size of meter	Minimum length of thread
15	12
20	14
25	16
40	20
50	25

(All dimensions in millimeters)

Screws & studs shall be of brass or other corrosion resistant material.

**TABLE 18.6**

**Overall Dimensions of Water Meters**

Nominal size of Meter	Overall length including nipples	Overall width. (Max.)	Overall height (Max.)
1	2	3	4
15	250	100	180
20	290	130	240
25	380	170	260
40	430	210	300
50	470	270	300

All dimensions are in mm.

Tolerance on the overall length shall be  $\pm 5$  mm. for meter with nipples and +0, -2 mm for meters without nipples.

**18.2.15.13 Capacity on Short Period Rating or Nominal Capacity:** The nominal capacity of the water meters shall be as specified in Table 18.7. The meters shall be capable of giving minimum discharges as stated in the table without the head loss exceeding 10 m within the meters.

#### 18.2.16 Yarn (Spun)

Spun yarn shall be of clean hemp and of good quality. It shall be soaked in hot coal tar or bitumen and cooled before use.

### 18.3 LAYING AND JOINTING OF PIPES AND FITTINGS

#### 18.3.1 Unloading

**18.3.1.1** The pipes shall be unloaded where they are required.

**18.3.1.2 Unloading (except where mechanical handling facilities are available):** Pipes weighing up to 60 kg shall be handled by two persons by hand passing. Heavier pipes shall be unloaded from the lorry or wagon by holding them in loops, formed with ropes and sliding over planks set not steeper than 45 degree. The planks shall be sufficiently rigid and two ropes shall always be used to roll the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.

**TABLE 18.7**





### Nominal Capacity of Water Meters

Discharge per hour		
Nominal size of meter (mm)	Semi positive Type (liters)	Inferential Type (liters)
15	2000	2500
20	3400	3500
25	5500	5500
40	10000	16000
50	15000	23000

**18.3.1.3** Under no circumstances shall the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.

**18.3.1.4** The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded.

#### 18.3.2 Storing

**18.3.2.1** The pipes and specials shall be handled with sufficient care to avoid damage to them. These shall be lined up on one side of the alignment of the trench, socket facing upgrade when line runs uphill and upstream when line runs on level ground.

**18.3.2.2** Each stack shall contain pipes of same class and size, consignment or batch number and particulars of suppliers, wherever possible, shall be marked on the stack.

**18.3.2.3** Storage shall be done on firm, level and clean ground. Wedges shall be provided at the bottom layer to keep the stack stable.

#### 18.3.3 Cutting

**18.3.3.1** Cutting of pipes may be necessary when pipes are to be laid in lengths shorter than the lengths supplied, such as while replacing accessories like tees, bends, etc. at fixed position in the pipe lines.

**18.3.3.2** A line shall be marked around the pipe with a chalk piece at the point where it is to be cut. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe. The pipe shall be rigidly held on two parallel rafters nailed to cross beams, taking care that the portion to be cut does not overhang and the cut mark is between the two rafters. The pipe shall be neatly cut at the chalk mark with carpenter's saw or hacksaw having a long blade, by slowly rotating the pipe around its longitudinal axis so as to have the uncut portion on top for cutting. Cutting of the pipe at the overhang should, as far as possible, be avoided, as an overhanging and is liable to tear off due to its weight before the cutting is complete.

#### 18.3.4 Trenches

**18.3.4.1** The trenches shall be so dug that the pipes may be laid to the required alignment and at required depth.

**18.3.4.2** Cover shall be measured from top of pipe to the surface of the ground.

**18.3.4.3** The bed of the trench, if in soft or made up earth, shall be well watered and rammed before laying the pipes and the depressions, if any, shall be properly filled with earth and consolidated in 20 cm layers.



- 18.3.4.4** If the trench bottom is extremely hard or rocky or loose stony soil, the trench shall be excavated at least 150 mm below the trench grade. Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine moorum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe. Where excavation requires blasting operation, it shall be ensured that no pipes have been stacked in the vicinity and completed pipe line in the vicinity has already been covered before starting of blasting operations; this is necessary to prevent damage to the exposed pipes in the vicinity by falling stones as a result of blasting.
- 18.3.4.5** After the excavation of the trench is completed, hollows shall be cut at the required position to receive the socket of the pipes and these hollows shall be of sufficient depth to ensure that the barrels of the pipes shall rest throughout their entire length on the solid ground and that sufficient spaces left for jointing the underside of the pipe joint. These socket holes shall be refilled with sand after jointing the pipe.
- 18.3.4.6** Roots of trees within a distance of about 0.5 metre from the side of the pipe line shall be removed or killed.
- 18.3.4.7** The excavated materials shall not be placed within 1 metre or half of the depth of the trench, whichever is greater, from the edge of the trench. The materials excavated shall be separated and stacked so that in refilling they may be re-laid and compacted in the same order to the satisfaction of the Engineer-in-Charge.
- 18.3.4.8** The trench shall be kept free from water. Shoring and timbering shall be provided wherever required. Excavation below water table shall be done after dewatering the trenches.
- 18.3.4.9** Where the pipe line or drain crosses an existing road, the road crossing shall be excavated half at a time, the 2nd half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measures for traffic as directed shall be adopted. All types, water mains cables, etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable met with during course of excavation, removal of which, if necessary, shall be arranged by the Engineer-in-Charge.

### **18.3.5 Laying**

- 18.3.5.1** The pipes shall be lowered into the trench by means of suitable pulley blocks, sheer legs chains ropes etc. In no case the pipes shall be rolled and dropped into the trench. One end of each rope may be tied to a wooden or steel peg driven into the ground and the other end held by men which when slowly released will lower the pipe into the trench. After lowering, the pipes shall be arranged so that the spigot of one pipe is carefully centered into the socket of the next pipe and pushed to the full distance that it can go. The pipe line shall be laid to the levels required. Specials shall also be laid in their proper position as stated above.
- 18.3.5.2** Where so directed, the pipes and specials may be laid on masonry or concrete pillars. The pipe laid on the level ground, shall be laid with socket facing the direction of flow of water.
- 18.3.5.3** The pipes shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four metre long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to length of the collar plus 30mm on both sides shall be provided at the joint which shall be refilled from sides after the joint is made.
- 18.3.5.4** In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipe lines and if required suitable special foundation shall be provided.
- 18.3.5.5** Soe clayey soils (for example black cotton soil) are drastically affected by extremes of saturation and dryness. In changing from saturated to a dry condition, these soils are subjected to extraordinary shrinkage which is usually seen in the form of wide and deep cracks in the earth surface and may result in damages to under ground structures, including pipe materials. The clay forms a tight gripping bond



with the pipe, subjecting it to excessive stresses as the clay shrinks. It is recommended that in such cases an envelope of a minimum 100 mm of tamped sand shall be made around the pipe line to avoid any bonding.

- 18.3.5.6** In places where rock is encountered, cushion of fine earth or sand shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion. Where the gradient of the bed slopes is more than 30 degree it may be necessary to anchor a few pipes against sliding downwards (Fig. 18.8).

### **18.3.6 Thrust Blocks (Fig. 18.8)**

- 18.3.6.0** Thrust blocks are required to transfer the resulting hydraulic thrust from the fitting of pipe on to a larger load bearing soil section.
- 18.3.6.1** Thrust blocks shall be installed wherever there is a change in the direction/size of the pipe line or the pressure line diagram, or when the pipe line ends at a dead end. If necessary, thrust blocks may be constructed at valves also.
- 18.3.6.2** Thrust blocks shall be constructed taking into account the pipe size, water pressure, type of fitting, gravity component when laid on slopes and the type of soil. The location of thrust blocks for various types' fittings is given in Fig. 18.8.
- 18.3.6.3** When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust. Similarly at joints, deflected in vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.
- 18.3.6.4** When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement. However, if soft soil conditions are encountered, it may be necessary to provide side thrust blocks of other means of anchoring. In such cases only pipe on each side of the deflected coupling shall be anchored without restricting the coupling.
- 18.3.6.5** Pipes on slopes need be anchored only when there is a possibility of the back fill around the pipe sloping down the hill and carrying the pipe with it. Generally for slopes up to 30 degree good well drained soil carefully tamped in layers of 100 mm under and over the pipe, right up to the top of trench will not require anchoring.
- 18.3.6.6** For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

### **18.3.7 Back Filling and Tamping**

- 18.3.7.1** Back filling shall follow pipe installation as closely as possible to protect pipe from falling boulders, eliminating possibility of lifting of the pipe due to flooding of open trench and shifting pipe out of line by caved in soil.
- 18.3.7.2** The soil under the pipe and coupling shall be solidly tamped to provide firm and continuous support for the pipe line. Tamping shall be done either by tamping bars or by using water to consolidate the back fill materials.
- 18.3.7.3** The initial back fill material used shall be free of large stones and dry lumps. In stony areas the material for initial back fill can be shaved from the sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes. In such cases, gravel or crushed stone shall be hauled in.



- 18.3.7.4** The initial back fill shall be placed evenly in a layer of about 100 mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.
- 18.3.7.5** If it is desired to observe the joint or coupling during the testing of mains they shall be left exposed. Sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing.
- 18.3.7.6** Balance of the back fill need not be so carefully selected as the initial material. However, care shall be taken to avoid back filling with large stones which might damage the pipe when spaded into the trench.
- 18.3.7.7** Pipes in trenches on a slope shall have extra attention to make certain that the newly placed back fill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the back fill shall be tamped with extra care and the tamping continued in 100 mm layers right up to the ground level.

### **18.3.8 Hydrostatic Tests (Fig. 18.9)**

- 18.3.8.1** After a new pipe has been laid, jointed and back filled (or any valved section thereof), it shall be subjected to the following two tests:
- Pressure test at a pressure of at least double the maximum working pressure-pipe and joints shall be absolutely water tight under the test.
  - Leakage test (to be conducted after the satisfactory completion of the pressure test) at a pressure to be specified by the authority for duration of two hours.
- 18.3.8.2 *Hydrostatic Tests:*** The portions of the line shall be tested by subjecting to pressure test as the laying progresses before the entire line is completed. In this way any error of workmanship will be found immediately and can be corrected at a minimum cost. Usually the length of the section to be tested shall not exceed 500 m.
- 18.3.8.3** Where any section of a main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete is cast. If rapid hardening cement has been used in these blocks or anchorages, test shall not be made until at least two days have elapsed.
- 18.3.8.4** Prior to testing, enough back fill as described in 18.4.7 shall be placed over the pipe line to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.
- 18.3.8.5** The open end of the section shall be sealed temporarily with an end cap having an outlet which can serve as an air relief vent or for filling the line, as may be required. The blind face of the end cap shall be properly braced during testing by screw jacks and wooden planks or steel plate as shown in Fig. 18.6.
- 18.3.8.6** The section of the line to be tested shall be filled with water manually or by a low pressure pump. Air shall be vented from all high spots in the pipe line before making the pressure strength test because entrapped air gets compressed and causes difficulty in raising the required pressure for the pressure strength test.
- 18.3.8.7** The test pressure shall be gradually raised at the rate of approximately one Kg./sq. cm./min. The duration of the test period if not specified shall be sufficient to make a careful check on the pipe line section.

### **18.4 LAYING AND JOINTING OF CAST IRON PIPES AND FITTINGS (EXTERNAL WORK)**

Specifications described in 18.4 shall apply, as far as applicable.

**TABLE 18.8**

**Test Pressure for Pipes**

Class of pipe	Maximum field test pressure kgf./sq.cm
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5	3.75
10	7.50
15	11.25
20	15.00
25	18.75

#### 18.4.1 Trenches

**18.4.1.1** The gradient is to be set out by means of boning rods and the required depth to be excavated at any point of the trench shall be regarded as directed by the Engineer -in-Charge. The depth of the trench shall not be less than 1 metre measured from the top of the pipe to the surface of the ground under roads and not less than 0.75 metre elsewhere.

**18.4.1.2** The width of the trench shall be the nominal diameter of the pipe plus 40 cm but it shall not be less than 55 cm in case of all kinds of soils excluding rock and not less than 1 metre in case of rock.

#### 18.4.2 Laying

Any deviation either in plan or elevation less than 11.25 degrees shall be effected by laying the straight pipes around a flat curve of such radius that minimum thickness of lead at the face of the socket shall not be reduced below 6 mm or the opening between spigot and socket increased beyond 12 mm at any joint. A deviation of about 2.25 degree can be effected at each joint in this way. At the end of each day's work the last pipe laid shall have its open ends securely closed with a wooden plug to prevent entry of water, soil, rats and any other foreign matter into the pipe.

#### 18.4.3 Lead Caulked Joints with Pig Lead

**18.4.3.1** This type of lead caulking is generally done in providing joints in gas water and sewer lines wherever it is practicable to use cast lead caulking, but not in case of wet conditions.

**18.4.3.2** The approximate depth and weights of pig lead for various diameters of C.I. pipes and specials shall be as given in Table 18.9.

**TABLE 18.9**

**Lead for Different Sizes of Pipes**

Nominal size of pipe (mm)	Lead per joint (Kg)	Depth of lead joint (mm)
(1)	(2)	(3)
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50
250	6.1	50
300	7.2	55
350	8.4	55
400	9.5	55



450	14.0	55
500	15.0	60
600	19.0	60
700	22.0	60
750	25.0	60

**Note:**

1. The quantity of lead given in the table is on average basis and a variation of 10 per cent is permissible.
2. Before pipes are jointed on large scale, three or four sample joints shall be made and the average consumption of lead per joint shall be got approved by the Engineer-in-Charge.

Only required quantity of spun yarn shall be put so as to give the specified depth of lead in the joint.

#### 18.4.4 Lead Caulked Joint with Lead Wool Yarn

**18.4.4.1** This type of lead caulking is generally done when it is inconvenient or dangerous to use molten lead for joints, for example in cases such as inverted joints or in wet trenches or in exceptional cases. In such cases the joints shall be made with lead wool or yarn. Caulking with lead wool or yarn shall however be not carried out without the prior permission of Engineer-in-Charge.

**18.4.4.2** The approximate weights and depths of lead wool or lead yarn required for each joint of various dia. of C.I. pipes and specials shall be as given in Table 18.10. Just sufficient quantity of spun yarn shall be put so as to give specified depth of lead wool.

**18.4.4.3 Jointing:** The spun yarn shall first be inserted and caulked into the socket as described under jointing with pig lead. Lead wool or yarn shall then be introduced in the joint in strings not less than 6 mm thick and the caulking shall be repeated with each turn of lead wool or yarn. The whole of the lead wool or yarn shall be compressed into a dense mass. The joint shall then be finally finished flush with face of the socket.

#### 18.4.5 Flanged joints

**18.4.5.1** Cast iron pipes may be jointed by means of flanges cast on. The jointing material used between flanges of pipes shall be compressed fiber board or rubber of thickness between 1.5 mm to 3 mm. The fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per m<sup>2</sup> shall be not less than 112 gm/mm thickness.

**TABLE 18.10**

Diameter of pipe (mm)	Weight of lead wool or lead yarn (kg)	Depth of lead wool or lead yarn (mm)
80	0.80	19
100	0.90	19
125	1.25	20
150	1.60	23
200	2.05	23



250	2.95	25
300	3.50	25
350	4.65	29
400	5.70	31
450	6.70	32
500	8.30	33
600	10.00	35
700	11.80	36
750	13.60	38
800	15.40	40
900	16.80	40

**Note:** An allowance of five per cent variation in the specified weights and depths is permissible.

**18.4.5.2** Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another shall not be allowed.

**18.4.5.3** Several proprietary flexible joints are available for jointing cast iron pipes and these may be used with the specific approval of the authority, however, they shall be used strictly in accordance with the manufacturer's instructions.

**18.4.5.4** For joints in small diameter cast iron piping, copper-alloy screwed unions or ferrules shall be used, and for large dia. The joints shall be made by flanged connecting pieces.

#### **18.4.6 Hydrostatic**

The procedure for testing for leakage under pressure shall be as described in Appendix D of Chapter 18 which is to be read in addition to 18.4.8. The joints of pipes and specials have to be repaired till the leakage in the portion under test is within the specified limit indicated in Appendix-D.

#### **18.4.7 Measurements**

**18.4.7.1** The net length of pipes as laid or fixed, shall be measured in the running metres correct to a cm. specials shall be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

**18.4.7.2** Excavation, refilling, shoring and timbering in trenches masonry or concrete pillars and thrust blocks, wherever required, shall be measured and paid for separately, under relevant items of work.

**18.4.7.3** Lead caulked joints shall be measured and paid for separately.

#### **18.4.8 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above except for the items measured/enumerated separately under Para 18.4.7.1, 18.4.7.2, 18.4.7.3 which shall be paid for separately.

### **18.5 LAYING AND JOINTING OF G.I. PIPES (EXTERNAL WORK)**

**18.5.0** The specifications described in 18.4 shall apply, as far as applicable.





### 18.5.1 Trenches

The galvanised iron pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameters of the pipes shall be as in Table 18.11.

**TABLE 18.11**

Dia of pipe (mm)	Width of trench (cm)	Depth of trench (cm)
15 to 50	30	60
65 to 100	45	75

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

### 18.5.2 Cutting and Threading

Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered. The end of the pipes shall then be carefully threaded conforming to the requirements of IS 554 with pipe dies and tapes in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joint. The screw threads of pipes and fitting shall be protected from damage until they are fitted.

### 18.5.3 Jointing

The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over. Teflon Tape should be used on threads instead of 'Dhaaga/ Safeda'. The end shall then be screwed in the socket, Tee etc. with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

### 18.5.4 Thrust Blocks (Fig. 18.8)

In case of bigger diameter pipes where the pressure is very high, thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate of 20 mm nominal size) of adequate size and shape shall be provided on all bends to transmit the hydraulic thrust to the ground, spreading it over a sufficient areas, depending upon the type of soil met with.

### 18.5.5 Painting

The pipes shall be painted with two coats of anticorrosive bitumastic paint of approved quality.

### 18.5.6 Testing of Joints

The pipes and fittings after they are laid and jointed shall be tested to hydraulic pressure of 6 Kg/sq. cm (60 meter). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the





work of laying proceeds, having the joints exposed for inspection during the testing. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

#### 18.5.7 Trench Filling

The pipes shall be laid on a layer of 7.5 cm sand and filled up to 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth as described in 20.3.7. The surplus earth shall be disposed off as directed.

#### 18.5.8 Measurements

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees, elbows reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and wastage. In case of fittings of unequal bore the largest bore shall be measured.

**Note:** G.I. unions shall be paid for separately in external work as well as in internal work.

Digging and refilling of trenches shall either be measured separately as specified in the appropriate clauses of excavation and earth work or clubbed with main item.

#### 18.5.9 Rate

The rate shall include the cost of labour and materials involved in all the operations described above. The rate shall not include excavation in trenches, painting of pipes and sand filling all round the pipes, unless otherwise specified.

### 18.6 LAYING AND JOINTING G.I. PIPES (INTERNAL WORK)

**18.6.0** For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the Engineer-in- Charge, a M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paints of approved quality. The pipe shall not come in contact with lime mortar or lime concrete as the pipe is affected by time. Under the floors the pipes shall be laid in layer of sand filling as done under concrete floors.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts, these clamps shall be embedded in brick work in cement mortar 1:3 (1 cement: 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in Table 18.12.

The clamps shall be fixed at shorter lengths near the fittings as directed by the Engineer-in-Charge.

For G.I. pipes 15 mm diameter, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the Engineer-in-Charge. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) and properly finished to match the adjacent surface.

**Table 18.2**

Dia. of Pipe (mm)	Horizontal length (m)	Vertical length (m)
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3	3.5
65	3.5	5
80	3.5	5

Unions will be provided to facilitate connections additions and alterations as well as for maintenance and for change of pipes. The locations where unions are to be provided will be decided with prior written approval of the Engineer-in-Charge.

#### 18.6.1 Measurements

The lengths shall be measured in running metre correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, unions, lead connection pipes and shower rose. All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured. Pipes laid in trenches (or without supports) and pipes fixed to walls, ceilings, etc. with supports shall be measured separately.

#### 18.6.2 Rate

The rate shall include the cost of labour and material involved in all the operations described above. The rate shall include the cost of cutting holes in walls and floors and making good the same. This shall not however, include concealed pipe work in which case cutting of chase and making good shall be paid separately. It shall not include painting of pipes and providing sleeves, unless specified otherwise. It will also not include union which shall be paid for separately.

### 18.7 POLYPROPYLENE RANDOM CO-POLYMER (PP-R) PIPES

#### 18.7.1 The PP-R is a bonded, multilayer pipe consisting of different layers of the pipe: -

- The inner-most layer of the pipe to be Anti – bacterial to prevent bacteria growth inside pipe surface.
- The middle layer to be of plain PP-R which is neither in contact with Water and nor under direct effect of the atmospheric conditions.
- The outer-most layer to be of U.V. stabilized PP-R to prevent the pipe surface from sunlight under exposed atmospheric conditions. The pipes should in general be conforming to the requirements of IS 15801 except that specified with in nomenclature of the item. The pipes should have smooth inner surface with non-contracting diameters. The pipes shall be cleanly finished, free from cracks and other defects. The pipes shall be clean and well cut along ends after taking into consideration the desired length, using the pipe scissors. The Polypropylene used for manufacturing the pipe shall conform to the requirements of IS 10951 and IS



10910. The specified base density shall be between 900 kg/m<sup>3</sup> and 910 kg/m<sup>3</sup> when determined at 27°C. The resin should be mixed with sufficient quantity of colour master batches. The colour master batch should be uniform throughout the pipe surface. The standard dimension ratio (SDR) i.e., ratio of the nominal outer diameter of a pipe to its nominal wall thickness should be 7.4/11 as given in the item.

### 18.7.2 Fittings

Plain fittings, Chrome plated brass threaded fittings and Valves shall be as per nomenclature of item or as directed by engineer- in- charge.

- a. The plain fittings shall be Polypropylene Random Copolymer and comply with all the requirements of the pipes. The plain fittings shall comprise of Socket, Elbow, Tee, Cross, Reducer socket, Reduction Tee, End Cap, Crossover, Omega, Threaded Plug and wall clamps in available sizes.
- b. The Chrome Plated Brass threaded fittings shall be Chrome Plated Brass threaded piece molded inside Polypropylene random copolymer fitting. The material shall comply with all the requirements of the pipes. The Chrome plated Brass threaded fittings shall comprise of Socket, Elbow and Tee (Male & Female) in available sizes. These are the fittings for C.P. connections and for continuations from existing Galvanized Iron Pipes and fittings.
- c. The valves shall be Polypropylene Random Copolymer Valves. The valves comprise of Gate Valve, Ball Valve, Concealed stop valve and Chrome Coated Valve in available sizes.

The Valves sizes availability in Polypropylene Random Copolymer is as follows:

- |                            |   |
|----------------------------|---|
| (i) Gate Valve             | - 20 mm to 63 mm                            |
| (ii) Ball Valve            | - 20 mm, 25 mm, 32 mm, 40 mm, 50 mm & 63 mm |
| (iii) Concealed Stop valve | - 20 mm & 25 mm                             |
| (iv) Chrome Coated Valve   | - 20 mm & 25 mm                             |

However, the other Brass/Bronze Valves can be connected to Polypropylene Random pipes using C.P. Brass threaded fittings of desired sizes.

### 18.7.3 Laying and Jointing of Pipes and Fittings

The specifications described in 18.4 shall apply as far as possible. The pipes and fittings shall run in wall chase as specified. Pipes shall run only in vertical or horizontal alignment as far as possible. The installation of pipes is similar to that of the metal pipes with the only difference in the jointing procedure. The jointing of the PP-R pipes and fittings are done by fusion welding by means of a welding machine. The marking on pipe shall carry the following information:

- a. Manufacturer's name/ trade mark
- b. PPR pipe
- c. SDR
- d. Out side diameter and minimum wall thickness
- e. Lot No. / Batch No. containing date of manufacturing. And machine number.

### 18.7.4 The out side diameter of pipes, tolerance in the same and ovality of pipe shall be as given in Table 18.13 below.

**TABLE 18.13**

**Outside Diameter, Tolerance and Ovality of Pipes**



Sl. No.	Nominal Size DN	Outside Diameter (mm)	Tolerance (Only positive tolerance) (mm)	Ovality (mm)
(i)	16	16.0	0.3	1.2
(ii)	20	20.0	0.3	1.2
(iii)	25	25.0	0.3	1.2
(iv)	32	32.0	0.3	1.3
(v)	40	40.0	0.4	1.4
(vi)	50	50.0	0.5	1.4
(vii)	63	63.0	0.6	1.6
(viii)	75	75.0	0.7	1.6
(ix)	90	90.0	0.9	1.8
(x)	110	110.0	0.9	2.2
(xi)	160	160.0	1.5	3.2

- The values specified for tolerance on outside diameter have been calculated as  $0.009DN$ , rounded off to the next higher 0.1 mm subject to minimum of 0.3 mm. No negative tolerances are allowed.
- The basis for the values specified for ovality is:
  - For nominal outside diameters  $< 75$  mm, the tolerance equals  $(0.008 DN + 1.0)$  mm, rounded to the next higher 0.1 mm, with a minimum value of 1.2 mm.
  - For nominal outside diameters  $\geq 75$  mm and  $\leq 250$  mm, the tolerance equals  $0.20 DN$ , rounded to the next higher 0.1 mm.
  - For nominal outside diameter  $> 250$  mm, the tolerance equals  $0.35 DN$ , rounded to the next higher 0.1 mm.

### 18.7.5 Wall Thickness

The minimum and maximum wall thickness (mm) of pipes shall be as given in Table 18.14 below: -

**TABLE 18.14**

Sl No	Nominal Size DN	SDR 11		SDR 7.4	
		Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)
(i)	16	-	-	2.20	2.70
(ii)	20	1.90	2.30	2.80	3.30
(iii)	25	2.30	2.80	3.50	4.10
(iv)	32	2.90	3.40	4.40	5.10
(v)	40	3.70	4.30	5.50	6.30
(vi)	50	4.60	5.30	6.90	7.80



(vii)	63	5.80	6.60	8.60	9.70
(viii)	75	6.80	7.70	10.30	11.60
(ix)	90	8.20	9.30	12.30	13.80
(x)	110	10.00	11.20	15.10	16.90
(xi)	160	14.60	16.30	21.90	24.30

**Note:** The wall thickness tolerances have been calculated on the following basis:

- Limit deviation =  $0.1e + 0.2$  mm rounded up to the nearest 0.1 mm.
- A local increase in wall thickness of up to  $+0.2e$  is permissible for  $e$  up to 10 mm and up to  $0.15e$  for  $e$  greater than 10 mm. The mean of the measurement shall, however, still lie within the given limit deviations.

The quality of each installation system ultimately depends on the tightness, stability and lifetime of its connections. The pipe of the desired length is cut using the pipe scissors. The proper heating piece is taken and mounted on the welding machine. The welding device is switched on - Control lamp and switch lamp will lit. When ready, control lamp gets off, which means that welding temperature of 260 Degrees  $\pm 10$  Degrees Celsius has been reached. The pipe end and the fitting to be welded are heated on the welding machine. Before heating the fitting and the pipe, the dirty welding tools, pipe and fitting are cleaned with a cloth. When heated up (with heating time as per the Table shown below), the pipe and the fitting is removed from the welding machine and the two pieces connected together by applying a little pressure without twisting. The joint is allowed to cool down for a few seconds. The welding process is that safe because the properly heated part of Polypropylene create a homogeneous connection.

#### Guidelines for Welding PP-R Pipes and Fittings (DVS Guideline 2207, Part II)

Outer diameter of pipe (mm)	Heating Time (Seconds)	Cooling Period (Minutes)
16	5	2
20	5	2
25	7	2
32	8	4
40	12	4
50	18	4
63	24	6
75	30	8
90	30	8

The same procedure shall be adapted for exposed as well as concealed fittings. The Crossovers may be used wherever the overlapping of the PP-R pipes is required. The fixing shall be done by means of Wall Support Clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on the surface. Where it is specified to conceal the pipes, chasing may be adopted. For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. Pipe sleeves shall be fixed at a place



the pipe is passing, through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. Fixed supports prevent any movement of the pipe by fixing it at some points. Fittings are used in creating the fixed points. Fixed supports must not be installed at bending parts and the direction changes must be done in the pipe itself. In between the fixed supports some arrangements must be done to compensate any potential elongation or shrinkage in the pipe length. For exposed straight pipes having length more than 5 meters, to compensate the expansion an expansion piece must be used.

#### 18.7.6 Piping Installation Support

Piping shall be properly supported by means of wall support clamps as specified and as required, keeping in view the proper designing for expansion and contraction. Risers shall be supported at each floor with clamps. Due to high coefficient of thermal expansion the heat losses through the pipes is highly reduced. Therefore, for internal Bathroom hot geyser water distribution lines, the insulation is often not required.

#### 18.7.7 Installation of Water Meter and Valves

PP-R lines shall be cut to the required lengths at the position where the meter and Valves are required to be fixed. Suitable C.P. Brass threaded fittings shall be attached to the pipes. The meter and Valves shall be fixed in a position by means of connecting pipes, jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed. And the meter shall be installed exactly horizontally or vertically in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken to not to disturb the factory seal of the meter. Wherever the meter shall be fixed to a newly fitted pipeline, the pipeline shall have to be completely washed before fitting the meter.

#### 18.7.8 Testing

All water supply system shall be tested to Hydrostatic pressure test. Maximum operating pressure at varying degree of temperature is given in Table 18.15:

**TABLE 18.15**

Sl. No.	Temperature	SDR 11	SDR 7.4
		Pressure MPa	Pressure MPa
(i)	10	1.91	3.02
(ii)	20	1.63	2.58
(iii)	30	1.37	2.17
(iv)	40	1.15	1.84
(v)	50	0.98	1.55
(vi)	60	0.82	1.28
(vii)	70	0.62	0.98
(viii)	80	0.39	0.62
(ix)	95	0.27	0.4

The pressure test is performed in 3 steps being preliminary test, main test and final test. For the preliminary test a pressure which is 1.5 times higher than the possible working pressure is applied and this is repeated two times in 30 minutes with intervals of 10 minutes. After a test period of 30 minutes, the test pressure must not be dropped more than 0.6 bar and no leak must occur. Main test follows the preliminary test. Test time is two hours, in doing so the test pressure taken from the preliminary test must not have fallen



more than 0.2 bar. After completion of these tests, the final test comes which has to be done under a test pressure of 10 bars and 5 bar in the interval of 15 minutes. Between the respective test courses, pressure has to be removed.

All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely checked on completion of connection to the overhead tanks or pumping system or mains. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which are not working efficiently shall be replaced by new ones.

### 18.7.9 Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work, which shall include PP -R pipe and fittings including plain fittings and Chrome Plated Brass Threaded fittings. Deductions for the length of valves shall be made. The cost includes cutting chases in the masonry wall and making good the same, trenching, refilling and testing of joints. The cost of gate valves/ wheel valves/union shall be paid for separately.

## 18.8 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPES

**18.8.1** CPVC pipes & fittings used in hot & cold potable water distribution system shall conform to requirement of IS 15778. The material from which the pipe is produced shall consist of chlorinated polyvinyl chlorides. The polymer from which the pipe compounds are to be manufactured shall have chlorine content not less than 55% when tested in accordance with IS 15778.

The internal and external surfaces of the pipe shall be smooth, clean and free from grooving and other defects. The pipes shall not have any detrimental effect on the composition of the water flowing through it.

Diameter and wall thickness of CPVC pipes are as per given in Table 18.16 below.

**TABLE 18.16**

Sl.No	Nominal size	Nominal outer diameter	Mean Outside Diameter		Outer diameter at any point		Wall Thickness					
							Class 1, SDR 11			Class 3, SDR 17		
			Max	Min	Max	Min	Avg. Max	Min	Max	Avg. Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(i)	15	15.9	15.8	16.0	15.8	16.0	2.2	1.7	2.2	-	-	-
(ii)	20	22.2	22.1	22.3	22.0	22.4	2.5	2.0	2.5	-	-	-
(iii)	25	28.6	28.5	28.7	28.4	28.8	3.1	2.6	3.1	-	-	-
(iv)	32	34.9	34.8	35.0	34.7	35.1	3.7	3.2	3.7	-	-	-
(v)	40	41.3	41.2	41.4	41.1	41.5	4.3	3.8	4.3	-	-	-
(vi)	50	54.0	53.9	54.1	53.7	54.3	5.5	4.9	5.5	-	-	-



(vii)	65	73.0	72.8	73.2	72.2	73.8	-	-	-	4.8	4.3	4.8
(viii)	80	88.9	88.7	89.1	88.1	89.7	-	-	-	5.9	5.2	5.9
(ix)	100	114.3	114.1	114.5	113.5	115.1	-	-	-	7.5	6.7	7.5
(x)	150	168.3	168.0	168.6	166.5	170.1	-	-	-	11.1	9.9	11.1

### Notes

1. For CPVC pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm, it shall be increased to 1.52 mm. The SDR values shall be rounded to the nearest 0.5.

### 18.8.2 Dimensions of Pipes

The outside diameter, outside diameter at any point and wall thickness shall be as given in Table 18.16.

**18.8.2.1 Diameter:** The outside diameter and outside diameter at any point as given in Table 18.16 shall be measured according to the method given in IS 12235 (part 1).

**18.8.2.2 Diameter at any point:** The difference between the measured maximum outside diameter and measured minimum outside diameter in the same cross-section of pipe (also called tolerance on ovality) shall not exceed the greater of the following two values:

- 0.5 mm, and
- $0.012 d_n$  rounded off to the next higher 0.1 mm.

**18.8.2.3 Wall Thickness:** The wall thickness of the pipes shall be as given in Table 18.16. Wall thickness shall be measured by any of the three methods given in IS 12235 (part 1). To check the conformity of the wall thickness of the pipe throughout its entire length, it is necessary to measure the wall thickness of the pipe at any point along its length. This shall be done by cutting the pipe at any point along its length and measuring the wall thickness as above. Alternatively, to avoid destruction of the pipe, non destructive testing methods such as the use of ultrasonic wall thickness measurement gauges shall be used at any four points along the length of the pipe.

### Tolerance on Wall Thickness

- For pipes of minimum wall thickness 6 mm or less, the permissible variation between the minimum wall thickness ( $e_{Min}$ ) and the wall thickness at any point ( $e$ ), ( $e - e_{Min}$ ) shall be positive in the form of  $+y$ , where  $y = 0.1 e_{Min} + 0.2$  mm.
- For pipes of minimum wall thickness greater than 6mm, the permissible variation of wall thickness shall again be positive in the form of  $+y$ , where  $y$  would be applied in two parts.
- The average wall thickness shall be determined by taking at least six measurements of wall thickness round the pipe and including both the absolute minimum and absolute maximum measured values. The tolerance applied to this average wall thickness from these measurements shall be within the range  $0.1 e_{Min} + 0.2$  mm (see Table 18.16).
- The maximum wall thickness at any point shall be within the range  $0.15e_{Min}$  (see Table 18.16).
- The results of these calculations for checking tolerance shall be rounded off to the next higher 0.1 mm.





**18.8.2.4 Effective Length (Le):** If the length of a pipe is specified, the effective length shall not be less than that specified. The preferred effective length of pipes shall be 3, 5 or 6 m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and the purchaser.

### 18.8.3 Pipe Ends

The ends of the pipes meant for solvent cementing shall be cleanly cut and shall be reasonably square to the axis of the pipe or may be chamfered at the plain end.

### 18.8.4 Physical and Chemical Characteristics

**18.8.4.1 Visual Appearance:** The colour of the pipes shall be off-white. Slight variations in the appearance of the colour are permitted. The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects.

**18.8.4.2 Opacity:** The wall of the plain pipe shall not transmit more than 0.1 per cent of the visible light falling on it when tested in accordance with IS 12235 (Part 3).

**18.8.4.3 Effect on Water:** The pipes shall not have any determinate effect on the composition of the water flowing through them, when tested as per 10.3 of IS 4985.

**18.8.4.4 Reversion Test:** When tested by the method prescribed in IS 12235 (Part 5/ Sec 1 and Sec 2), a length of pipe 200 ±20 mm long shall not alter in length by more than 5 per cent.

**18.8.4.5 Vicat Softening Temperature:** When tested by the method prescribed in IS 12235 (part 2), the Vicat softening temperature of the specimen shall not be less than 110°C.

**18.8.4.6 Density:** When tested in accordance with IS 12235 (Part 14), the density of the pipes shall be between 1450kg/m<sup>3</sup> and 1650kg/m<sup>3</sup>.

### 18.8.5 Mechanical Properties

**18.8.5.1 Hydrostatic Characteristics:** When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (part 8/Sec 1), the pipe shall not fail during the prescribed test duration. The temperatures, duration and hydrostatic (hoop) stress for the test shall conform to the requirements given in Table 18.17. The test shall be carried out not earlier than 24 h after the pipes have been manufactured.

**TABLE 18.17**

#### Requirements of Pipes for Internal Hydrostatic Pressure Test

(Clause 18.9.5.1)

Sl. No.	Test	Test Temperature Min	Test Period	Hydrostatic (Hoop) Stress
		°C	h	MPa
(1)	(2)	(3)	(4)	(5)
(i)	Acceptance	20	1	43.0
(ii)	Type	95	165	5.6
(iii)	Type	95	1000	4.6
(iv)	Type	95	8760	3.6 (Test for thermal stability)

**18.8.5.2 Thermal Stability by Hydrostatic Pressure Testing:** When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (Part 8/Sec 1) and as per requirement given in Table 18.17, Sl. No. (iv), the pipe shall not burst or leak during the prescribed test duration.



**18.8.5.3 Resistance to External Blow at 0°C:** When tested by the method prescribed in IS 4985, with classified striker mass and drop height as given in Table 18.18, the pipe shall have a true impact rate of not more than 10 per cent.

**TABLE 18.18**

**Classified Striker Mass and Drop Height Conditions for the Falling Weight Impact Test**

**(Clause 18.9.5.3)**

Sl. No.	Nominal Pipe Size	Mass of Falling Weight	Falling Height
	mm	Kg	mm
(1)	(2)	(3)	(4)
(i)	15	0.5±0.5%	300±10
(ii)	20	0.5±0.5%	400±10
(iii)	25	0.5±0.5%	500±10
(iv)	32	0.5±0.5%	600±10
(v)	40	0.5±0.5%	800±10
(vi)	50	0.5±0.5%	1000± 10
(vii)	65	0.8±0.5%	1000±10
(viii)	80	0.8±0.5%	1200±10
(ix)	100	1.0±0.5%	1600±10
(x)	150	1.6±0.5%	2000±10

**18.8.5.4 Flattening Test:** When tested by the method prescribed in IS 12235 (part 19), pipe shall show no signs of cracking, splitting and breaking.

**18.8.5.5 Tensile Strength:** When tested by the method prescribed in IS 12235 (Part 13), the tensile strength at yield shall not be less than 50 MPa at 27 ± 2°C.

#### 18.8.6 Sampling and Criteria for Conformity

The sampling procedure and criteria for conformity shall be as given in Annexure F.

#### 18.8.7 Marking

Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at intervals of not more than 3 m. The marking shall show the following:

- Manufacturer's name or trade-mark
- Outside diameter,
- Class of pipe and pressure rating, and
- Batch or lot number

**18.8.7.1 BIS Certification Marking:** Each pipe may also be marked with the Standard Mark.

#### 18.8.8 Fittings

The fittings shall be as follows:

- Plain CPVC solvent cement fittings from size 15 mm to 160 mm.



- b. Brass threaded fittings.
- c. Valve from size 15 mm to 160 mm
- d. Brass Threaded Fittings: All types of one end brass threaded male/female adaptors in various fittings like coupler, socket, elbow, tee are available for transition to other plastic/metal piping and for fixing of CP fittings. Ball, Gate valves in CPVC are available in all dimensions. All fittings shall carry the following information:
  - 1. Manufacturer's name/trade mark.
  - 2. Size of fitting

### 18.8.9 Piping Installation Support and Spacing

**18.8.9.1 Concealed Piping:** Pipes can be concealed in chases. The pipes and fitting are to be pressure tested prior to concealing the chases. To maintain alignment of CP fittings while joining, all alignment of fittings and pipe shall be done correctly. DO NOT USE NAILS FOR HOLDING OF PIPES IN THE CHASES.

**18.8.9.2 External Installations:** For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes. Pipes sleeves shall be fixed at a place the pipe is passing through a wall or floor so as to allow freedom for expansion and contraction. Clamping of the pipe is done to support it while allowing the freedom for movement.

All pipes exposed to sunlight shall be painted with a water based acrylic paint emulsion to enhance UV protection. Pipes in trenching shall be laid in accordance to the Good Plumbing practices followed for Metal piping.

#### Recommended Support Spacing (Distance between Pipe Clamps Horizontal Support)

Pipe Size	Horizontal Support (In meters)			
	Temperature			
	23°C	38°C	60°C	82°C
16 mm (1/2")	1.22	1.22	1.07	0.92
20 mm (3/4")	1.53	1.37	1.22	0.92
25 mm (1/0")	1.68	1.3	1.37	0.92
32 mm (1 1/4")	1.83	1.68	1.53	1.22
40 mm (1 1/2")	1.98	1.83	1.68	1.22
50 mm (2")	2.29	2.14	1.98	1.22

**18.8.9.3 Expansion LOOP:** CPVC systems, like all piping materials, expand and contract with changes in temperatures. CPVC pipes shall expand 7.5 cm per 30 m length for a 40°C temperature change. Expansion does not vary with Pipe size. Thermal expansion can generally be accommodated at changes in direction. On a long straight run, an offset or loop based on the following chart is required.

Nominal Pipe Size	Length of Run (Meter), Loop length in cms.				
	6 metre	12 metre	18 metre	24 metre	30 metre
15 mm	43	56	69	79	86



20 mm	48	66	81	91	104
25 mm	53	74	91	104	117
32 mm	58	81	102	117	130
40 mm	63	89	109	127	142
50 mm	71	102	124	145	163

#### 18.8.10 Testing

All water supply systems shall be tested to hydrostatic pressure test. The pressure tests are similar to the test pressure used for other plastic/metal pipes. System may be tested in sections and such section shall be entirely checked on completion of connection to the overhead tank or pumping system or mains.

#### 18.8.11 Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work, which shall include CPVC pipe and fittings including plain and Brass threaded fittings and jointing solvent cement.

### 18.9 PE-AL-PE PIPES: DELETED

### 18.10 MAKING CONNECTION OF G.I. DISTRIBUTION BRANCH WITH G.I. MAIN

#### 18.10.1 Preliminary Work

A pit of suitable dimensions shall be dug at the point where the connection is to be made with the main and earth removed up to 15 cm below the main. The flow of water in the water main shall also be disconnected by closing the sluice or wheel valves on the mains.

#### 18.10.2 Making Connection

For cutting and jointing 18.6.2 and 18.6.3 shall apply. The G.I. main shall first be cut. Water if any collected in the pit shall be bailed out and, ends of the G.I. pipes threaded. The connection of distribution pipe shall then be made after fixing G.I. tee of the required size to the G.I. main and fittings such as Jam nut, G.I. socket connecting piece etc.

#### 18.10.3 Testing of Joints

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra payment.

The pipes & fittings after they are laid shall be tested to hydraulic pressure of 6 kg./sq.cm. (60 m). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock of water hammer. The draw of laps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

#### 18.10.4 Finishing

The portion of the pipe in the pit shall be painted with bitumastic paint and encased with sand 15 cm all-round. The pit shall be filled with earth in level with the original ground surface watered, rammed and the area dressed.

#### 18.10.5 Measurements



The work of making connections shall be enumerated.

#### **18.10.6 Rate**

The rate shall include the cost of labour and materials involved in all the operations described above.

### **18.11 FIXING BRASS AND GUN METAL WATER FITTINGS**

**18.11.0** The fitting shall be fully examined and cleared of all foreign matter before being fixed. The fitting shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be leak-proof when tested to a pressure of 17.5 kg/sq.cm. The defective fittings and joints shall be replaced or redone.

#### **18.11.1 Measurements**

Fittings shall be enumerated.

#### **18.11.2 Rate**

The rate shall include cost of all the material and labor involved in all the operation described above.

### **18.12 FIXING FERRULES**

**18.12.1** For fixing ferrule the empty main shall be drilled and tapped at 45 degree to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

#### **18.12.2 Measurements**

Ferrule shall be enumerated.

#### **18.12.3 Rate**

The rate shall include the cost of all materials and labour involved in fixing the ferrule.

### **18.13 INSTALLATION OF FIRE HYDRANT**

**18.13.1** The hydrant shall be fully examined and cleared of all foreign matter before being fixed. The fixing shall be done on the water main which shall be of minimum 80 mm dia. The flanged end of the hydrant shall be fixed to the flanged outlet of a tee in the water main by means of bolts, nuts and 3 mm rubber insertion or chemically treated compressed fiber board 1.5 mm minimum thickness and of weight not less than 0.183 gm. per sq.cm. This can also be fixed by means of flanged tail piece which may be connected to the water main by C.I. specials.

#### **18.13.2 Measurements**

Fire hydrant shall be enumerated.

#### **18.13.3 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above against relevant item of work.

### **18.14 INSTALLATION OF SLUICE VALVE**

**18.14.1** The valve shall be fully examined and cleared of all foreign matter before being fixed. The fixing of the valve shall be done by means of bolts, nuts and 3 mm rubber insertions or chemically treated compressed fiber board 1.5 mm minimum thickness and of weight not less than 0.183 gm./ sq.cm. with the flanges of spigot and the socketed tail pieces drilled to the same specification in case of S&S pipes and with flanges in case of flanged pipes. The tail pieces shall conform to IS 1938. These shall be jointed to the pipe line by means of lead caulked joints.

#### **18.14.2 Measurements**



Sluice valve shall be enumerated.

#### **18.14.3 Rate**

The rate shall include the cost of material and labour involved in all the operations described above.

### **18.15 INSTALLATION OF WATER METER AND STOP VALVE (FIG. 18.3 and 18.4)**

**18.15.0** The G.I. line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends at the pipe shall then be threaded. The meter and stop cock shall be fixed in position by means of connecting pipes, G.I. jam nut and socket etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the nipples of the meter shall be removed and the meter installed exactly horizontal or vertical in the flow line in the direction shown by the arrow cast on the body of the meter. Care shall be taken that the factory seal of the meter is not disturbed. Wherever the meter shall be fixed to a newly fitted pipe line, the pipe line shall have to be completely washed before fitting the meter. For this purpose a piece of pipe equal to the length of the meter shall be fitted in the proposed position of the meter in the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

#### **18.15.1 Testing of Joints**

Testing of joints shall be done as described in 18.6.6.

#### **18.15.2 Measurements**

The work of fixing meters and stop cocks shall be counted in numbers separately according to the diameters.

#### **18.15.3 Rate**

The rate shall include the cost of labour and materials involved in all the operations described above excluding the cost of stop cock and water meter.

### **18.16 FIXING SURFACE BOX (FIG. 18.6)**

**18.16.1** The C.I. surface box shall be fixed on the top of masonry chamber in plain or reinforced cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) as the case may be.

#### **18.16.2 Measurements**

Masonry chambers shall be enumerated under the relevant items.

#### **18.16.3 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above, except the excavation in saturated soil, soft or decomposed and hard rock if met with. The difference of cost, between ordinary soil and saturated soil or soft or decomposed or hard rock as the case may be, shall be paid for separately.

### **18.17 POLYETHYLENE WATER STORAGE TANKS**

#### **18.17.1 Material**

Polyethylene resin to be used for manufacture of water tanks shall confirm to IS 12701. The material of construction of tank, lid and fittings which come in contact with water shall be such that it does not impart any taste, colour or odour to water, nor have any toxic effect, and it shall not contaminate water thereby making it unpotable.

#### **18.17.2 Manufacture and Finish**



The tanks shall be manufactured by rotational moulding process. Each tank and the manhole lid shall be single piece having arrangement for fixing and locking the manhole lid with the tanks. Excess material at the mould parting line and near the top rim shall be neatly cut and finished. The internal and external surface of the tanks shall be smooth, clean and free from hidden internal defects like air bubbles, pit and metallic or other foreign material inclusion. Capacity of the tank, minimum weight of the empty tank (without manhole lid) and the manufacture brand name shall be embossed on the top surface of the tank near manhole.

#### 18.17.3 Shape, Size and Capacity

The tank shall be cylindrical vertical or rectangular with closed top having a manhole. Diameter and height of cylindrical vertical tank or length, width and height of rectangular tank of various capacities shall conform to IS 1270I. The net capacity shall be net volume of water contained between the lowest level of the inlet and lowest specified level. Extra capacity if any shall be ignored.

#### 18.17.4 Weight and Wall Thickness

Minimum weight of the empty tank (exclusive of manhole lid fittings) and the minimum wall thickness of top, bottom and sides shall be specified in Table 18.23 and 18.23 A.

#### 18.17.5 Installation and Fittings

The flat base of the tank shall be fully supported over its whole bottom area on a durable rigid flat and level platform sufficiently strong to stand without deflection the weight of the tank when fully filled with water. Depending upon the capacity and location tanks may be suitably anchored as per the directions of the Engineer-in-Charge. For inlet, outlet and other connections fully threaded GI, HDPE or PVC connections with hexagonal check nuts and washers on either side of the tank wall shall be provided. Holes for threaded connections shall be drilled and not punched. Pipes entering or leaving the tank shall be provided with unions and suitably supported on a firm base to avoid damage to the tank walls.

#### 18.17.6 Manhole Lid

The lid shall rest evenly and fit over the rim of the manhole so as to prevent the ingress of any foreign matter into the tank. The lid shall be provided with suitable arrangement for locking it with the tank.

18.17.7 The tank and its components shall conform to the local bye-laws for preventions of mosquito menace.

#### 18.17.8 Measurements

Dimensions shall be measured to the nearest mm. and weight of the empty tank shall be recorded to the nearest 100g. Net capacity of the tank as defined in 18.18.3 shall be calculated to the nearest litre for the purpose of payment.

**TABLE 18.23**

S.No	Capacity litres	Minimum Wall Thickness	Minimum Weight of Empty Tank
		mm	kg
(1)	(2)	(3)	(4)
1.	200	3.0	7.8
2.	300	3.0	9.0
3.	400	3.5	15.0
4.	500	4.0	18.0



5.	700	4.4	23.0
6.	1000	4.5	33.0
7.	1500	4.5	47.0
8.	1700	4.5	54.0
9.	2000	5.4	64.0
10.	2500	7.7	81.0
11.	3000	8.1	96.0
12.	4000	10.4	147.0
13.	5000	10.7	180.0
14.	6000	10.7	205.0
15.	7500	10.7	239.0
16.	10000	11.5	319.0
17.	15000	11.5	408.0
18.	20000	13.2	566.0

NOTE - The gross capacity of the tanks shall be at least 5 percent in excess of the minimum net capacity.

**TABLE 18.23 A**

**Dimensions of cylindrical Vertical tank**

S. No.	Minimum Net Capacity (Litres)	Minimum Wall Thickness (measured on) rectangular vertical port and bottom thickness mm	Minimum Weight of Empty Tank (Without Lid) kg
1.	150	2.75	6.6
2.	200	2.75	7.7
3.	300	2.75	11.0
4.	400	2.75	13.0
5.	500	2.75	17.5

NOTE - The gross capacity of the tanks shall be at least 5 percent in excess of the minimum net capacity.

**18.17.9 Rates**

The rate shall include the cost of the tank, manhole lid, carriage and delivery at the place specified. Hoisting, installation, fittings, platform and anchoring shall be payable separately.

**18.18 TUBE WELLS WITH HAND PUMPS**

**18.18.1 Casing Pipe**

The casing pipe shall be of M.S. or W.I. of 100 mm dia. and strong enough to stand hammering and vibrations to which it is subjects.





### **18.18.2 Filter and Brass Strainer**

The filter shall consist of a G.I. pipe of the required diameter with 15 mm diameter holes covered with brass strainer both inside and outside. It shall have a driving point riveted or welded to it.

### **18.18.3 Hand Pump**

This shall be of approved quality. It shall be complete with necessary bolt and nuts for joining to the masonry or concrete base.

## **18.19 CUTTING HOLES IN WALL UPTO 30 × 30 CM**

**18.19.0** Square holes of size as specified or as directed by the Engineer-in-Charge shall be cut in the masonry. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-in-Charge. All dismantled material shall be removed from the site.

### **18.19.1 Masonry Work**

Brick work etc. shall be made good by using the same class of brick, tile or stone masonry as was cut during the execution of work. The mortar to be used shall be cement mortar 1:4 (1 cement: 4 fine sand) or as directed by the Engineer-in-Charge.

### **18.19.2 Finishing**

Cement mortar in 1:4 mix (1 cement: 4 sand) shall be used for plastering or pointing, as may be required. Sand shall be fine or coarse, as used in the original work. The surface shall be finished with two or more coats of white wash, colour wash, distemper or painting as required but where the surface is not to be white washed, colour washed, distempered or painted; it shall be finished smooth with a floating coat of neat cement or as required to match with the surrounding surfaces.

### **18.19.3 Measurements**

The holes shall be enumerated.

### **18.19.4 Rate**

The rate shall include the cost of labour and materials required for all the operations described above.

## **18.20 CUTTING HOLES IN R.C.C. FLOORS (UPTO 15 × 15 CM)**

**18.20.0** Square holes of size as specified shall be cut in R.C.C. floor and roofs for passing drain pipe etc. Any damage to the adjoining portion or to any other item shall be made good as directed by the Engineer-in-Charge. All the dismantled material shall be removed from the site.

### **18.20.1 Cement Concrete**

After insertion of drain pipe etc. the hole shall be repaired with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and the surface finished to match with the existing surface. The top and bottom shall be finished properly to make the joint leak proof. The specifications for cement concrete work and finishing etc. shall be the same as detailed under relevant sub-heads.

### **18.20.2 Measurements**

Holes shall be enumerated.

### **18.20.3 Rate**

The rate shall include the cost of labour and material required for all the operations described above except the pipe which shall be paid for separately.

## **18.21 CUTTING CHASES IN MASONRY WALLS**



### 18.21.1 Making Chases

Chases are made in the walls for housing G.I. Pipes etc.

#### I. Cutting of chases in one brick thick and above load bearing walls:

1. As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.
2. The depths of vertical chases and horizontal chases shall not exceed one third and one sixth of the thickness of the masonry respectively.
3. When narrow stretches of masonry (or short lengths of walls) such as between doors and windows, cannot be avoided, they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration, such narrow lengths of walls shall be checked for stresses and high strength bricks mortar or concrete walls provided, if required.
4. Horizontal chases when unavoidable should be located in the upper or lower one third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.
5. Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.
6. Masonry directly above a recess, if under than 30 cm (Horizontal dimension) should be supported on lintel. Holes in masonry may be provided up to 30 cm width x 30 cm height without any lintel. In the case of circular holes in masonry, no lintel should be provided up to 40 cm in diameter.

#### II. Cutting of chases in half brick load bearing walls

No chase shall be permitted in a half brick load bearing wall and as such no recessed conduits and concealed pipes shall be provided in half brick thick load bearing walls.

#### III. Cutting of chases in half brick non-loading bearing walls

In case of non load bearing half brick walls services should be planned with the help of vertical chases. Horizontal chases should be provided only when unavoidable.

#### IV. Cutting of chases in stone masonry walls

The provision (i) to (vi) under Sl. No. I are equally applicable to stone masonry walls also.

Note:

1. No inclined chase shall be permitted in brick masonry or stone masonry walls. In case inclined chases are unavoidable these shall be cut with written approval of the Engineer-in-Charge, and shall be repaired properly to his satisfaction. However, in half brick masonry wall, no inclined chase will be permitted.
2. Chases shall be made by chiseling out the masonry to proper line & depth. Any damage to the adjoining portion or to any other item shall be made good, as decided by the Engineer-in-Charge, for which no extra payment shall be made. All dismantled material shall be removed from site.

### 18.21.2 Filling Chases

After G.I. Pipes etc. are fixed in chases, the chases shall be filled with cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded stone aggregate 20 mm nominal size) or cement mortar 1:4 (1 cement: 4 coarse sand) as may be specified or otherwise directed by the Engineer-in-Charge and made flush with the



masonry surface. The concrete surface shall be roughened with wire brushes to provide a key for plastering.

#### **18.21.3 Measurements**

Chases shall be measured in running meter correct to a cm.

#### **18.21.4 Rates**

The rate shall include the cost of labour the materials involved in all the operations described above excluding the cost of providing pipes etc. which shall be paid separately.

#### **18.22 CP BRASS BIBCOCK**

The CP brass bib cock shall be conforming to IS : 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the bib cocks are normally fitted.

The dimensions of body for Bib Cock shall be as per table given to IS : 8931. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

#### **18.23 CP BRASS LONG NOSE BIB COCK**

The CP brass long nose bib cock shall be conforming to IS standards. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the bib cocks are normally fitted.

The weight of long nose Bib Cock shall be less than 810 grams. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

#### **18.24 CP BRASS LONG BODY BIB COCK**

The CP brass long body bib cock shall be conforming to IS standards. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the long body bib cocks are normally fitted.

The weight of long body Bib Cock shall be less than 690 grams. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

#### **18.25 CP BRASS STOP COCK (CONCEALED)**

The CP brass stop cock shall be conforming to IS : 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the stop cocks are normally fitted.

The dimensions of body for stop Cock shall be as per table given to IS : 8931. Each stop cock shall be legibly marked with the Manufacture's name and trade mark.

#### **18.26 CP BRASS ANGLE VALVE**

A valve with the inlet and outlet at right angles to each other and is intended to facilitate servicing of water fittings or appliances.

The CP brass angle valve shall be conforming to IS: 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the angle valves are normally fitted.

The dimensions of body for angle valve shall be as per table given to IS: 8931. Each angle valve shall be legibly marked with the Manufacture's name and trade mark.



#### **18.27 CP BRASS EXTENSION NIPPLE**

The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The size of CP brass extension nipple shall be 15mm x 50mm.

#### **18.28 PTMT BIB COCK**

The PTMT (Poly-tetra Methylene Terephthalate) bib cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

#### **18.29 PTMT STOP COCK**

The PTMT (Poly-tetra Methylene Terephthalate) stop cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

#### **18.30 PTMT PILLAR COCK**

The PTMT (Poly-tetra Methylene Terephthalate) pillar cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

#### **18.31 PTMT PUSH COCK**

The PTMT (Poly-tetra Methylene Terephthalate) push cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

#### **18.32 PTMT GRATING**

The PTMT (Poly-tetra Methylene Terephthalate) grating shall be of appropriate size as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark.

#### **18.33 PTMT BALL COCK**

The PTMT (Poly-tetra Methylene Terephthalate) ball cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

#### **18.34 PTMT ANGLE STOP COCK**

The PTMT (Poly-tetra Methylene Terephthalate) angle stop cock shall be of appropriate size as specified and weight should not be less than as specified. External and internal surfaces shall be clean and smooth with good finish. Its colour shall be uniform. Each fitting shall be legibly marked with the manufacture's name and trade mark. Teflon tape shall be used on threads while fixing to make them leak proof.

#### **18.35 PVC CONNECTION PIPE**

The PVC connection pipe with PTMT nuts, collar and bush shall be conforming to IS: 1024. The standard size of PVC connection pipe shall be designated by the nominal bore with length. A sample of each kind of fitting shall be got approved from the Engineer-in-charge and supplies made according to the approved sample. PVC



connection pipe shall be enumerated and rate shall include the cost of material and labour involved in fixing the same.

#### **18.36 PTMT EXTENSION NIPPLE FOR WATER TANK PIPE**

The standard size of PTMT extension Nipple for water tank pipe, fitting shall be designated by the nominal bore weighing not less than prescribed in the item. A sample of each kind of fitting shall be got approved from the Engineer-in-charge and supplies made according to the approved sample. PTMT extension Nipple for water tank pipe shall be enumerated and rate shall include the cost of material and labour involved in fixing the same.

#### **18.37 DISINFECTING C.I WATER MAINS BY FLUSHING WITH WATER**

Disinfecting C.I water mains of different diameter pipe by flushing with water containing bleaching powder @0.5 gms per litre of water and cleaning the same with fresh water, operation to be repeated three times including getting the sample of water from the disinfected main and shall be tested in the municipal laboratory and final sample obtained shall confirm to the standards.

#### **18.38 CHROME PLATED BRASS BATTERY BASED INFRARED SENSOR OPERATED PILLAR COCK**

The chrome plated brass battery based infrared sensor operated pillar cock shall be of chromium plated copper alloy and external and internal surface shall be clean, smooth and free from sand. The 15 mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the chrome plated brass battery based infrared sensor operated pillar cock are normally fitted.

Each chrome plated brass battery based infrared sensor operated pillar cock shall be legibly marked with the manufacture's name and trade mark. Chrome plated brass battery based infrared sensor operated pillar cock shall be enumerated and rate shall include the cost of material and labour involved in fixing the same.



## APPENDIX A

### TOLERANCES FOR CAST IRON (CENTRIFUGALLY CAST) PIPES (Clause 18.3.10)

Dimensions	Nominal diameter (DN)	Tolerances in mm
(a) External diameter of barrel (DE)	All diameters.	$\pm 1/2f = \pm (4.5 + 0.0015 \text{ DN})$
(b) Internal diameter of socket (DI)	All diameters.	$\pm 1/3f = \pm (3 \pm 0.001 \text{ DN})$
(c) Depth of socket (P)	(1) Up to and including 600 mm	$\pm 5$
	(2) Over 600 mm and up to and including 1000 mm	$\pm 10$

Note:

1.  $f$  is the caulking space of the joint in millimeters and is equal to  $9 + 0.003 \text{ DN}$ .
2. The jointing tolerances applicable to rubber joints (mechanical or push in joints) shall be as specified by their manufacturer and shall be within the tolerances specified above.

#### Tolerance on Thickness

Dimensions	Tolerance in mm
(a) Wall thickness	$-(1 + 0.05 e)$
(b) Flange thickness	$\pm (2 + 0.05 b)$

Where  $e$  = is the thickness of the wall in millimeters and  $b$  = is the thickness of the flange in millimeters.

#### Tolerance on Length

Dimensions	Tolerance in mm
(a) Socket and spigot, and plain ended pipes	$\pm 25$
(b) Flanged pipes	$\pm 10$



## APPENDIX B

### TOLERANCES FOR SPECIALS OF CAST IRON PIPES (Clause 18.3.10.2)

#### Tolerances in Diameter

Dimension	Nature of joint	Nominal diameter (DN)	Tolerance in mm
External diameter of spigot (DE) f or $\pm (4.5 + 0.0015 \text{ DN})$	Lead joints	All diameters	$\pm 1/2$
Internal diameter of socket (DI) f or $\pm (3 + 0.001 \text{ DN})$	Lead joints	All diameters	$\pm 1/3$
Depth of socket (P)	Lead joints	Up to and including 600 mm	$\pm 5$
		Over 600 mm up to and including 1000 mm.	$\pm 10$
		Over 1000 mm up to and including 1500 mm.	$\pm 15$

#### Tolerances on Thickness

Dimension	Tolerance in mm
Wall thickness	$-(2 + 0.05 e)$
Flange thickness	$\pm (3 + 0.05 b)$

Where  $e$  = the standard thickness of the wall in millimeters, and  $b$  = the standard thickness of the flange in millimeters.

#### Tolerance on Lengths

Type of fitting	Nominal diameter	Tolerance in mm
Socket fittings and flange spigot pieces	Up to and including 450 mm	$\pm 20$
	Over 450 mm	$\pm 20 - 30$
Flanged fittings	All diameters	$\pm 10$



## APPENDIX C

### PARTICULARS OF MEDIUM GRADE G.I. PIPES (Clause 18.3.11.3)

Nominal bore	Dimension of pipes			Weight of pipe	
	Outer diameter		Thickness	Plain end	Screwed end socket
	Max	Min			
(mm)	(mm)	(mm)	(mm)	(kg/m)	(kg/m)
6	10.6	9.8	2.0	0.404	0.407
8	14.0	13.2	2.3	0.641	0.645
10	17.5	16.7	2.3	0.839	0.845
15	21.8	21.0	2.6	1.21	1.22
20	27.3	26.5	2.6	1.56	1.57
25	34.2	33.3	3.2	2.41	2.43
32	42.9	42.0	3.2	3.10	3.13
40	48.8	47.9	3.2	3.56	3.60
50	60.8	59.7	3.6	5.03	5.10
65	76.6	75.3	3.6	6.42	6.54
80	89.5	88.0	4.0	8.36	8.53
100	115.0	113.1	4.5	12.2	12.50
125	140.8	138.5	4.8	15.90	16.40
150	166.5	163.9	4.8	18.90	19.50

#### Tolerance in Thickness and Weight

##### A - Thickness

Butt welded medium tubes	+ not limited
	– 10 per cent
Seamless tubes	+ not limited
	– 12.5 per cent

##### B - Weight

Single tube (light series)	+ 10 percent
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	- 8 per cent
Single tube (medium and heavy series)	$\pm 10$ per cent
For quantities per load of 10 tonnes, min (light series)	$\pm 5$ per cent
	- 8 per cent
For quantities per load of 10 tonnes, min (medium and heavy series)	$\pm 7.5$ per cent



**PROCEDURE FOR PRESSURE TEST**  
(Clause 18.5.6)

1. Each valved section of the pipe shall be slowly filled with water and all air shall be expelled from the pipe through hydrants and blow-offs. If these are not available at high places, necessary tapping may be made at points of highest elevation before the test is made and plugs inserted after the tests have been completed.
2. If the trench has been partially back-filled the specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer-in-Charge. The duration of the test shall not be less than 5 minutes.
3. Examination **under Pressure**: All exposed pipes, fittings, valves, hydrants and joints should be carefully examined during the open-trench test. When the joints are made with lead, all such joints showing visible leaks shall be recaulked until tight. When the joints are made with cement and show seepage or slight leakage, such joints shall be cut out and replaced as directed by the authority. Any cracked or defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by sound material and the test shall be repeated until satisfactory to the Engineer-in-Charge.
4. If the trench has been back-filled to the top, the section shall be first subjected to water pressure normal to the area and the exposed parts shall be carefully examined. If any defects are found, they shall be repaired and the pressure test repeated until no defects are found. The duration of the final pressure tests shall be at least one hour.

**Procedure for Leakage Test**

5. Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

No pipe installation shall be accepted until the leakage is less than the number of cm<sup>3</sup>/h determined by the formula:

$$ql = \frac{ND\sqrt{P}}{3.3}$$

Where ql = the allowable leakage in cm<sup>3</sup>/h.

N = number of joints in the length of the pipe line.

D = diameter in mm.

P = the average test pressure during the leakage testing kg/cm<sup>2</sup>.

6. **Variation from Permissible Leakage**: Should any test of pipe laid in position discloses leakage greater than that specified in Para 5 the defective joints shall be repaired until the leakage is within the specified allowance.

**GUIDELINES FOR STORAGE AND INSTALLATION OF CPVC PIPES****E1 - STORAGE**

CPVC pipes of all sizes are packed in polyethylene packing rolls and both the ends of the packed roll are sealed with air bubble film cap in order to provide protection during handling and transportation. After packing, the whole bunch of pipes is tightened with polypropylene/ HDPE strapping. Each roll is then marked with size/type of the pipe, lot number and quantity. The packed pipe rolls are stored in their respective racks in properly covered storage area. Apart from providing protection during handling and transportation, the packing rolls also protect the pipe from ultra violet rays.

**E2 - INSTALLATION GUIDELINES**

**E-2.1** Visually inspect pipe ends before making the joint. Use of a chamfering tool will help identify and crakes, as it will catch on to any crack.

**E-2.2** Pipe may be cut quickly and efficiently by several methods. Wheel type plastic tubing cutters are preferred. Ratchet type cutter or fine tooth saw are another options. However, when using the ratchet cutter be certain to score the exterior wall by rotating the cutter blade in circular motion around the pipe. Do this before applying significant downward pressure to finalize the cut. This step leads to a square cut. In addition, make sure ratchet cutter blades are sharp. Cutting tubing as squarely as possible provides optimal bonding area within a joint.

**E-2.3** Burrs and filings can prevent proper contact between the tube and fittings during the assembly, and should be removed from the outside and inside of the tube. A chamfering tool is preferred, but a pocket knife or file is also suitable for this purpose.

**E-2.4** Use only CPVC cement jointing. Use CPVC cement, which is fully recommended by the manufacturer.

**E-2.5** When using adhesive solution/solvent cement be certain of proper ventilation.

**E-2.6** When making a join, apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged waterways. Do not allow excess cement to puddle in the fitting and pipe assembly. This could result in a weakening of the pipe wall and possible pipe failure when the system is pressurized.

**E-2.7** Rotate pipe one-quarter to one-half turn while inserting it into the fitting socket and remove the excess adhesive solution/solvent cement from the joint with clean rag.

**E-2.8** When making a transition connection to metal threads, use a special transition fitting or CPVC male threaded adapter whenever possible. Do not over-torque plastic threaded connections. Hand tight plus one-half turn should be adequate.

**E-2.9** Hang or strap CPVC systems loosely to allow for thermal expansion. Do not use metal straps with sharp edges that might damage the tubing.

**E- 2.10** CPVC stub outs for lavatories, closets and sinks are appropriate. However, on areas where there is a likelihood that movement or impact abuse will occur, metal pipe nipples may be amore appropriate stub-out material. Showerheads, tub spouts and outside still cocks are examples.

**E-2.11** When connected to a gas water heater, CPVC tubing should not be located within 50 cm of the flue. For water heaters lacking reliable temperature control, this distance may be increased up to 1 m a metal nipple or flexible appliance connector should be utilized. This measure eliminates the potential for damage to plastic piping that might result from excessive radiant heat from the flue.

**APPENDIX F****SAMPLING AND CRITERIA FOR CONFORMITY OF CPVC PIPES**  
(Clause 18.9.6)**F1 - ACCEPTANCE TESTS**

**F-1.1** Acceptance test are carried out on samples selected from a lot for the purpose of acceptance of the lot.

**F-1.2 Lot**

All CPVC pipes in a single consignment of the same class, same size and manufactured under essentially similar conditions shall constitute a lot.

**F-1.3** For ascertaining conformity of the lot to the requirements of the specification, samples shall be tested from each lot separately.

**F-1.4 Visual and Dimensional Requirements**

**F-1.4.1** The number of test samples to be taken from a lot shall depend on the size of the lot and the outside diameter of the pipe, and shall be in accordance with Table F-1.

**TABLE F-1****Scale of Sampling of Visual Appearance and Dimensional Requirements**

(Clause F-1.4.1 and F-1.4.3)

Sl. No.	Number of pipes in the lot	Sample number	Sample size	Cumulative sample size	Acceptance number	Rejection number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Up to 1000	First	13	13	0	2
		Second	13	26	1	2
(ii)	1001 to 3000	First	20	20	0	2
		Second	20	40	1	2
(iii)	3001 to 10000	First	32	32	0	3
		Second	32	64	3	4
(iv)	10001 & above	First	50	50	1	4
		Second	50	100	4	5

**F-1.4.2** These pipes shall be selected at random from the lot and in order to ensure the randomness of selection, a random number table shall be used. For guidance and use of random number tables, IS-4905 may be referred to. In the absence of a random number table, the following procedure may be adopted:



Starting from any pipe in the lot, count them as 1, 2, 3, etc, up to  $r$  and so on, where  $r$  is the integral part of  $N/n$ ,  $N$  being the number of pipes in the lot, and  $n$  the number of pipes in the sample. Every  $r$ th pipe so counted shall be withdrawn so as to constitute the required sample size.

**F-1.4.3** The number of pipes given for the first sample in col. 4 of Table F-1, shall be taken from the lot and examined for visual and dimensional requirements given in Table 18.16 and 18.9.4.1. A pipe failing to satisfy any of these requirements shall be considered as defective. The lot shall be deemed to have satisfied these requirements, if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col. 6 of Table F-1. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col. 7 of Table F-1. If, however, the number of defectives found in the first sample lies between the corresponding acceptance and rejection numbers given in cols. 6 and 7, a second sample of the size given in col. 4 shall be taken and examined for the requirements. The lot shall be considered to have satisfied these requirements. The lot shall be considered to have satisfied these requirements if the cumulative sample is less than or equal to the corresponding acceptance number given in col. 6, otherwise not.

#### F-1.5 Reversion Test

**F-1.5.1** The lot, having satisfied visual and dimensional requirements, shall be tested for reversion as given in 18.9.4.4.

**F-1.5.2** For this purpose, the number of pipes given for the first sample in col. 4 of Table F-2 shall be taken from the lot. The sample pipe failing the reversion test shall be considered as defective. The lot shall be deemed to have met the requirements given in this specification for the reversion test, if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col. 6. This lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col. 7 if, however, the number of defectives in the first sample lies between the corresponding acceptance and rejection numbers given in col. 6 and col. 7, a second sample of size given in col. 4 shall be taken and examined for the requirements. The lot shall be considered to have satisfied the requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col. 6, otherwise not.

**TABLE F-2**

**Scale of Sampling for Reversion, Vicat Softening Temperature and Density Test**  
(Clause F-1.5.2, F-1.6.2 and F-1.7.2)

Sl. No.	Number of pipes in the lot	Sample number	Sample size	Cumulative sample size	Acceptance number	Rejection number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Up to 1000	First	5	5	0	2
		Second	5	10	1	2
(ii)	1001 to 3000	First	8	8	0	2
		Second	8	16	1	2
(iii)	3001 to 10000	First	13	13	0	2



		Second	13	26	1	2
(iv)	10001 & above	First	20	20	0	3
		Second	20	40	3	4

### F-1.6 Vicat Softening Test

**F-1.6.1** The lot, having satisfied visual and dimensional requirements shall be tested for Vicat softening temperature as given in 18.9.4.5.

**F-1.6.2** For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as that for reversion under F-1.5.2 using Table F-2.

### F-1.7 Density

**F-1.7.1** The lot, having satisfied the visual and dimensional requirements, shall be tested for density as given in 18.9.4.6.

**F-1.7.2** For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as that for reversion under F-1.5.2 using Table F-2.

### F-1.8 Resistance to External Blow at 0°C

**F-1.8.1** The lot, having been found satisfactory according to F-1.4, F-1.5, F-1.6 and F-1.7 shall be tested for resistance to external blow at 0°C as given in 18.9.5.3.

**F-1.8.2** For this purpose, the procedure adopted for sampling and criteria for conformity shall be as specified in Table 18.18 and Table F-3.

**TABLE F-3**

**Scale of Sampling for Resistance to External Blow at 0°C**

Sl. No.	Number of pipes in the lot	Sample number	Sample size	Cumulative sample size	Acceptance number	Rejection number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
(i)	Up to 3000	First	3	3	0	2
		Second	3	6	1	2
(ii)	3001 to 10000	First	3	5	0	2
		Second	5	10	1	2
(iii)	10000 & above	First	8	8	0	2
		Second	8	10	1	2

**F-1.9 Internal Hydrostatic Pressure Test (Acceptance Test)** **F-1.9.1** The lot having been found satisfactory according to F-1.4, F-1.5, F-1.6, F-1.7 and F-1.8 shall be subjected to the requirements of the acceptance test for internal hydrostatic pressure as given in 18.9.5.1 and Table 18.17 Sl.No. (i). The number of pipes to be taken from the lot shall depend on the size of the lot and shall be according to Table F-4.

**TABLE F-4**



**Scale of Sampling for Internal Hydrostatic Test**  
**(Clause F-1.9.1 and F-1.9.3)**

Sl. No.	Number of pipes in the lot	Sample size	Acceptance number
(1)	(2)	(3)	(4)
(i)	Up to 3000	2	0
(ii)	3001 to 10000	3	0
(iii)	10000 & above	5	0

**F-1.9.2** The pipes shall be taken at random from the lot. In order to ensure the randomness of selection, procedures given in IS 4905 may be followed.

**F-1.9.3 Number of Tests and Criteria for Conformity**

The number of test samples shall be as given in Table F-4. The lot shall be considered to have satisfied the requirements for this test, if the number of test samples failing in this requirement is equal to the corresponding acceptance number given in column 4 of Table F-4.

**TYPE TESTS**

**F-2.1** Type tests are intended to prove the suitability and performance of a new composition or a new size of pipe. Such tests, therefore, need to be applied only when a change is made in polymer composition or when a new size of pipe is to be introduced. Type test for compliance with 18.9.4.2, 18.9.4.3, 18.9.5.1 (Type test only) and 18.9.5.4 shall be carried out.

**F-2.1.1 Verification of Malfunction Temperature  $T_{mal}$**

For this test, the manufacturer to the testing authority one assembly, selected preferably from a regular production lot.

**F-2.1.2 Opacity**

For this test, the manufacturer or the supplier shall furnish to the testing authority one sample of the pipe of the thinnest wall section, selected preferably from a regular production lot.

**F-2.1.2.1** The sample so selected shall be tested for compliance with requirements for opacity as given in 18.9.4.2.

**F-2.1.2.2** If the sample passes the requirements of the opacity test, the type of the pipe under consideration shall be considered to be eligible for approval, which shall be valid for a period of one year.

**F-2.1.2.3** In case the sample fails in the test, the testing authority, at its discretion, may call for a fresh sample and subject the same to the opacity test. If the sample passes the repeat test, the type of pipe under consideration shall be considered eligible for approval. If the sample fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and re-submit the product for type approval.

**F-2.1.2.4** At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for a fresh sample for opacity test for the purpose of type approval.

**F-2.1.3 Test for Effect on Water**



For this type test, the manufacturer or the supplier shall furnish to the testing authority three samples of the smallest size of pipe taken from each machine (selected preferably from a regular production lot).

**F-2.1.3.1** Three samples so selected shall be tested for compliance with the requirements for effect on water as given in 18.9.4.3.

**F-2.1.3.2** If all three samples pass the requirements for effect on water, the type test of the pipe under consideration shall be considered to be eligible for approval, which shall be normally valid for a period of one year.

**F-2.1.3.3** In case any of the samples fails in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number, and subject them to the test for effect on water. If, in the repeat test, no single failure occurs, the type of pipe under consideration shall be considered eligible for type approval. If any of the samples fails in the repeat test, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

**F-2.1.3.4** At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for effect on water test for the purpose of type approval.

#### **F-2.1.4 Internal Hydrostatic Pressure Test (Type Test) and thermal Stability**

For this type test, the manufacturer or the supplier shall furnish to the testing authority, three samples of pipes of different diameters and different classes (selected preferably from a regular production lot).

**F-2.1.4.1** Three samples so selected shall be tested for compliance with the requirements of type test given in Table 18.9.4.3.

**F-2.1.4.2** If all the three samples pass the requirements of the quality test, the type of pipe under consideration shall be considered to be eligible for type approval which shall be normally valid for a period of one year.

**F-2.1.4.3** In case any of the samples fail in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test. If, in the repeat test, no single failure occurs, the type of pipe shall be considered for type approval. If any of the samples fails in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

**F-2.1.4.4** At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

#### **F-2.1.5 Tensile Strength Test (Type Test)**

For this type test, the manufacturer or the supplier shall furnish to the testing authority, five samples of pipe of different diameters and different class (selected preferably from a regular production lot).

**F-2.1.5.1** Five samples so selected shall be tested for compliance with the requirements of type test given in 18.9.5.4.

**F-2.1.5.2** If all the five samples pass the requirement of the quality test, the type test of pipe under consideration shall be considered to be eligible for type approval which shall be normally valid for a period of one year.

**F-2.1.5.3** In case any of the samples fails in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original numbers and subject them to the type test. If, in the repeat test no single failure occurs, the type of pipe shall be considered for type approval. If any of the samples fail in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.





**F-2.1.5.4** At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

## BALL VALVE (ASSEMBLY)

Sub Head : Water Supply  
Clause : 18.3.1

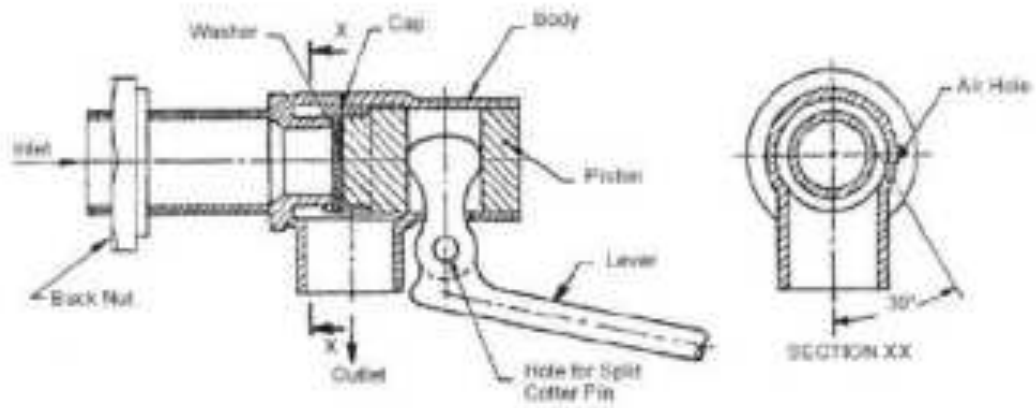


Figure 18.1 : Ball Valve (Assembly)

Note : The shapes of the component parts are only illustrative but the dimensions and minimum requirements, where specified, are binding.

## FITTINGS & SPECIALS

Sub Head : Water Supply  
Clause : 18.3.9

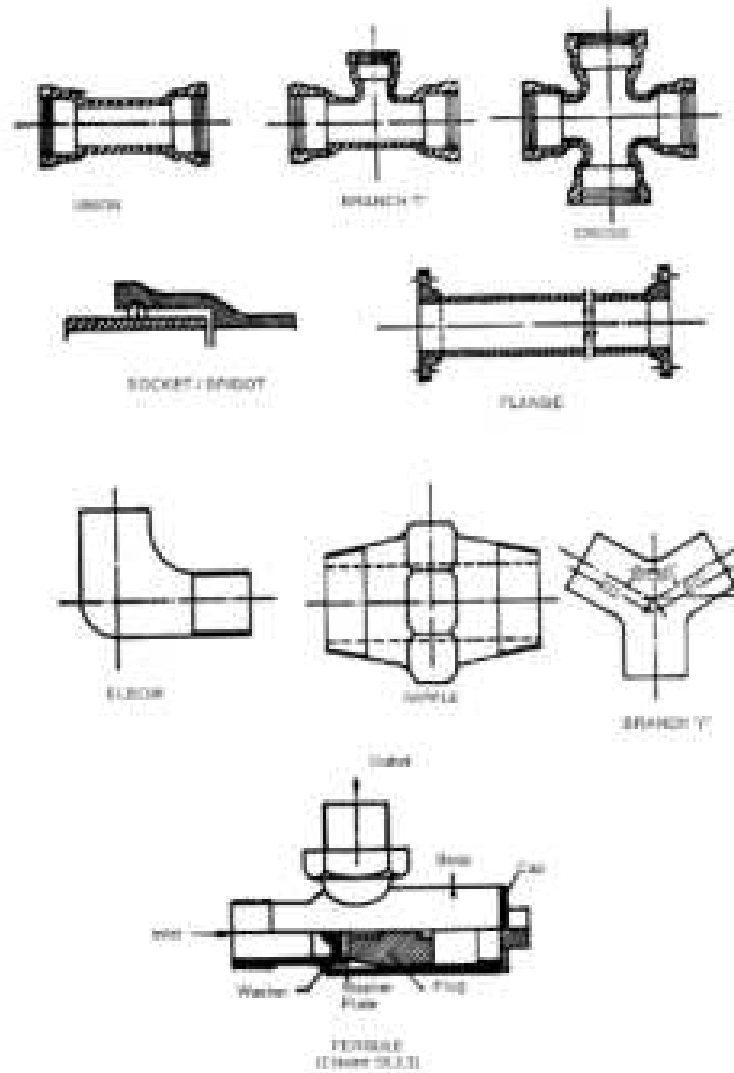


Figure 18.2 : Fittings & Specials

Drawing not to Scale  
Fig. 18.2 : Fittings & Specials

## BIB TAP & STOP VALVE

Sub Head : Water Supply  
Clause : 18.3.2

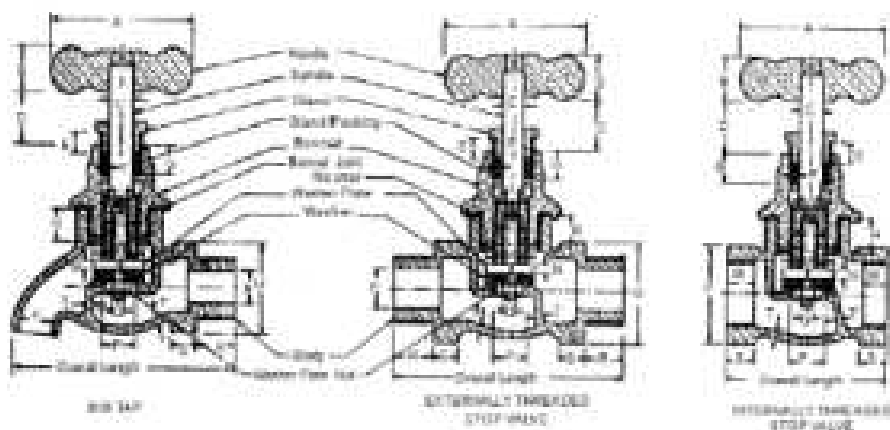


Figure 18.3 : Bib Tap & Stop Valve

Dimensions	A	B	C	D	E	F	G	H	J	K	L	M	N	P +0.0 -0.5	Q	R	S	T	U	V	W	Lift of washer plate (with washer in position)
Nominal sizes	M in	M in	M in	M in	M in	M in	M in	M in	M in	M in	Min.	M in	M in	Min.	M in	M in	M in	M in	M in	M in	M in	Min.
8	4 7.8	1 3.3	7.8	1 6.5	6.3	2.0	7.9	7.0	3.8	1.0	M20x1.5	1 4.3	2.8	6.5	2.4	1.0	4.7	1.6	1.5	1.2	7.9	3.5
10	5 4.0	1 4.0	9.4	1 8.7	7.5	2.0	9.5	9.5	4.7	1.5	M20x1.5	1 5.9	3.2	9.0	3.2	1.4	7.9	2.0	2.8	2.3	7.3	4
15	5 4.0	1 4.0	9.4	1 9.0	7.5	2.0	9.5	1.0	5.6	1.5	M24 1.5	1 9.0	3.2	13.0	4.1	1.5	9.5	2.0	2.6	2.8	9.3	4.5
20	6 0.4	1 5.7	1.0	2 0.1	8.9	2.1	1.1	1.2	6.4	1.3	M30x1.5	2 5.4	4.0	18.0	4.9	1.6	1.0	2.0	3.5	3.0	1.0	6
25	6 6.8	1 8.0	1.2	2 3.0	1.0	2.1	1.2	1.3	7.1	1.7	M39x1.5	3 3.3	4.0	23.0	4.9	1.9	1.0	2.8	3.6	4.4	1.5	7
32	7 4.6	2 0.5	1.3	3 0.9	1.1	2.1	1.3	1.4	7.8	1.9	M48x1.5	4 0.1	4.3	30	5.9	2.4	1.7	3.2	4.2	5.1	1.5	9.5
40	8 2.5	2 2.0	1.5	3 3.3	1.2	2.1	1.4	1.5	8.6	2.0	M56x1.5	4 7.7	5.5	36	6.6	2.4	1.3	3.2	5.4	5.8	1.5	11
50	9 5.0	2 5.3	1.7	3 5.9	1.4	2.1	1.5	1.6	1.2	2.6	M72x1.5	6 3.5	6.3	46	8.3	2.5	1.9	4.0	7.0	7.1	1.5	14.5



**Note 1 :** Length of thread R includes cut back under hexagon, if any.

**Note 2 :** The values of K are for core diameter.

**Note 3 :** The diameter of U and V are for face to face.

**Note 4 :** The dimension F is packing space.

## COCKS VALVES & METER

Sub Head : Water Supply

Clause : 18.3.15

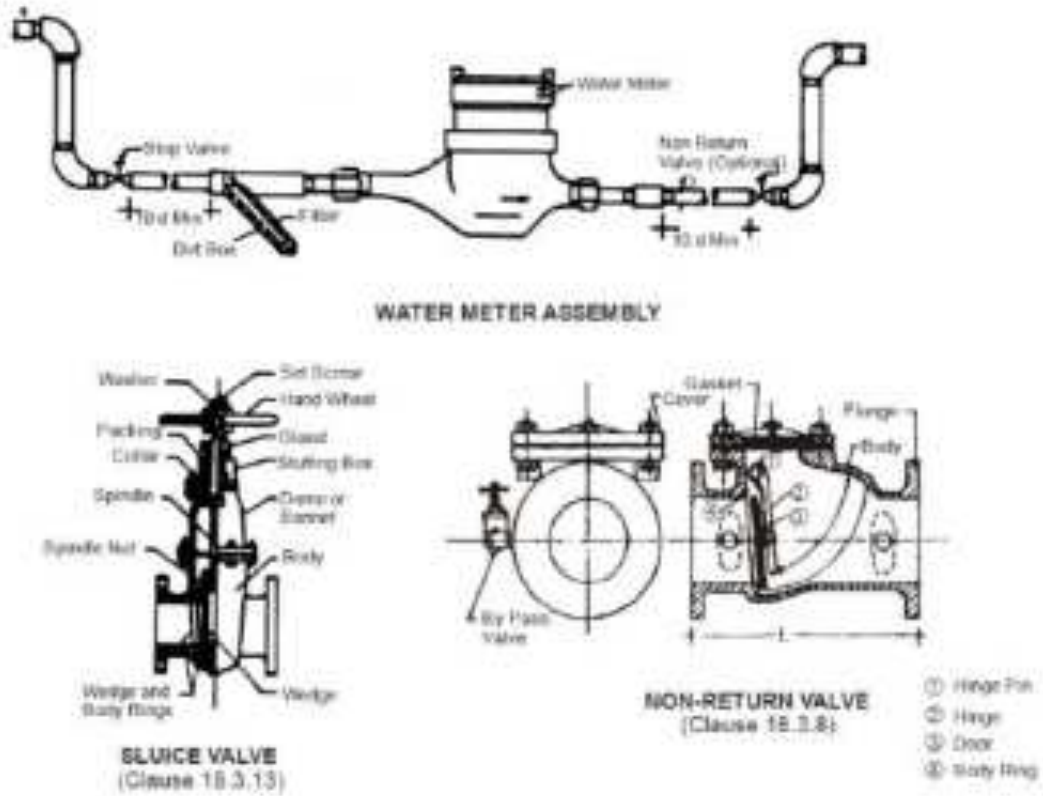


Figure 18.4 : Cocks Valves & Meter

Drawing not to Scale  
All Dimensions are in MM

## MASONRY CHAMBERS & SURFACE BOXES

Sub Head : Water Supply

Clause : 18.3.14

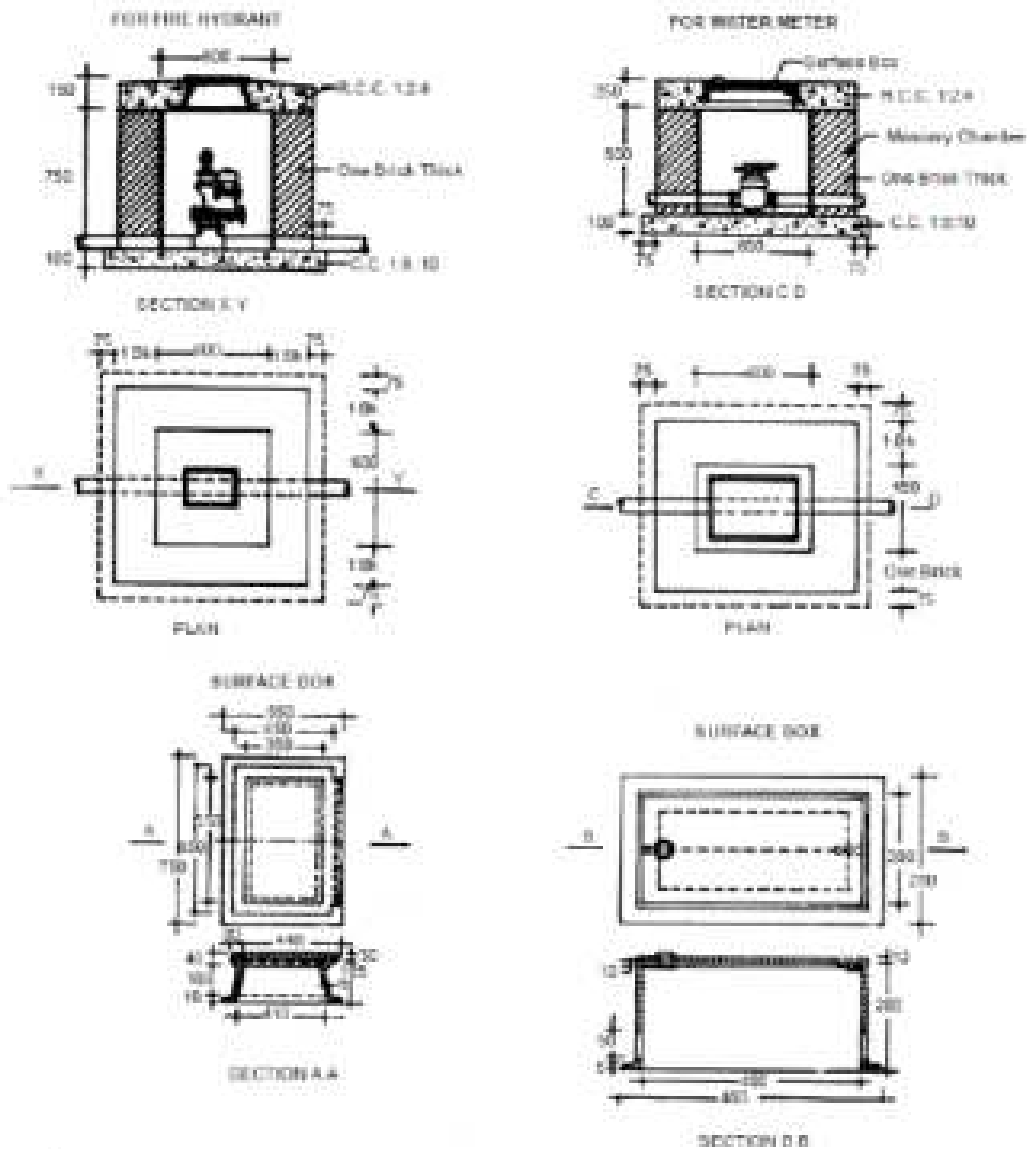


Figure 18.6 : Masonry Chambers & Surface Boxes

Drawing not to Scale  
All Dimensions are in MM

## MASONRY CHAMBERS & SURFACE BOXES (Contd.)

Sub Head : Water Supply

Clause : 18.3.14

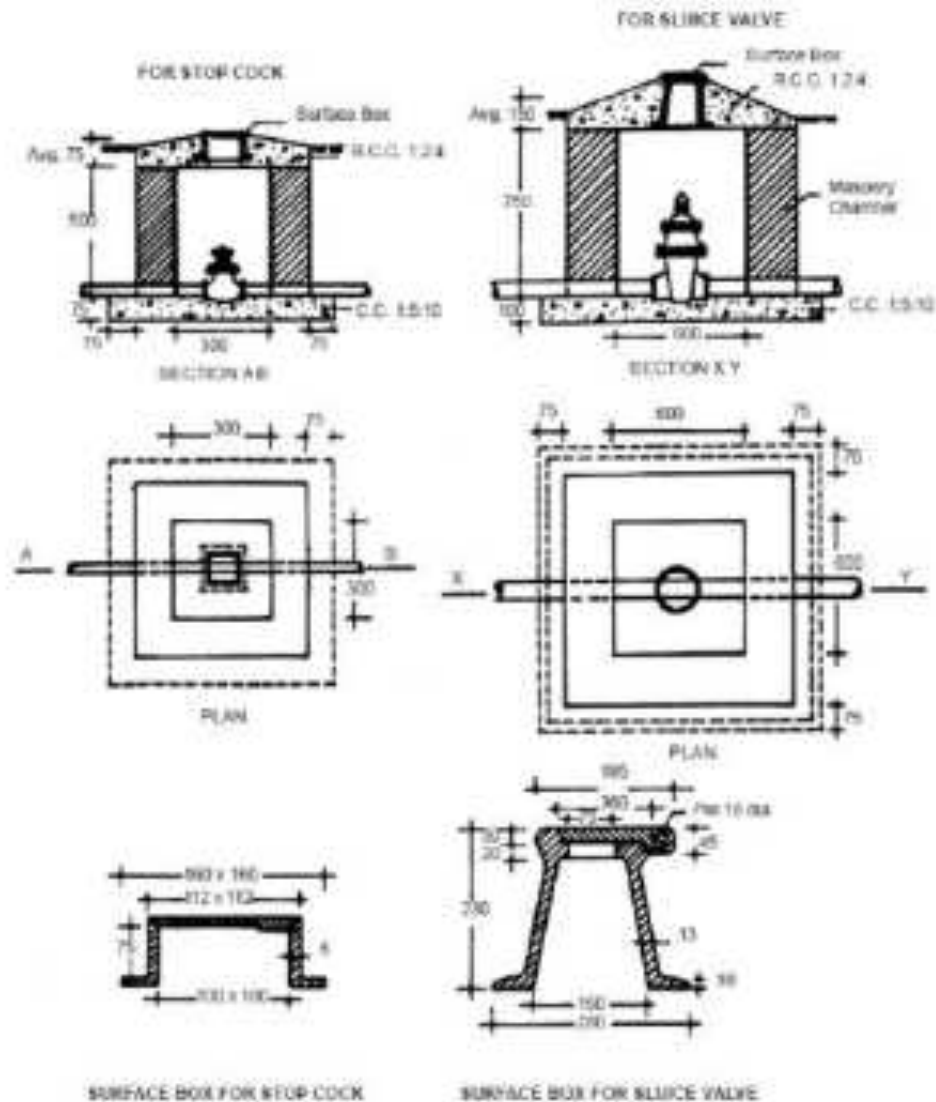


Figure 18.7 : Masonry Chambers & Surface Boxes (Contd.)

Drawing not to Scale  
All Dimensions are in MM



## THRUST BLOCKS

Sub Head : Water Supply  
Clause : 18.4.6

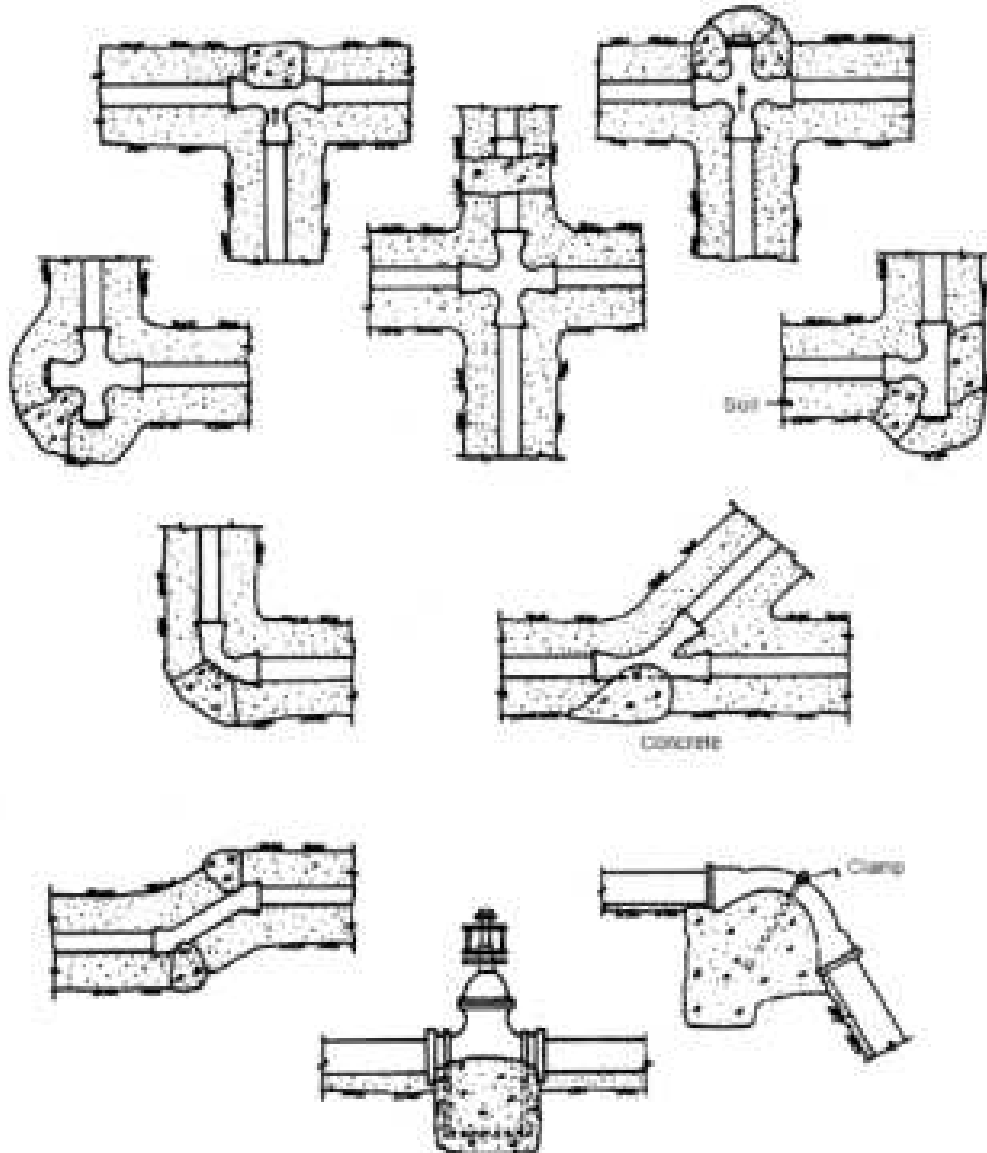


Figure 18.8 : Thrust Blocks

Drawing Not to Scale

## HYDROSTATIC TESTS (END CLOSURE FOR PIPES)

Sub Head : Water Supply  
Clause : 18.4.8

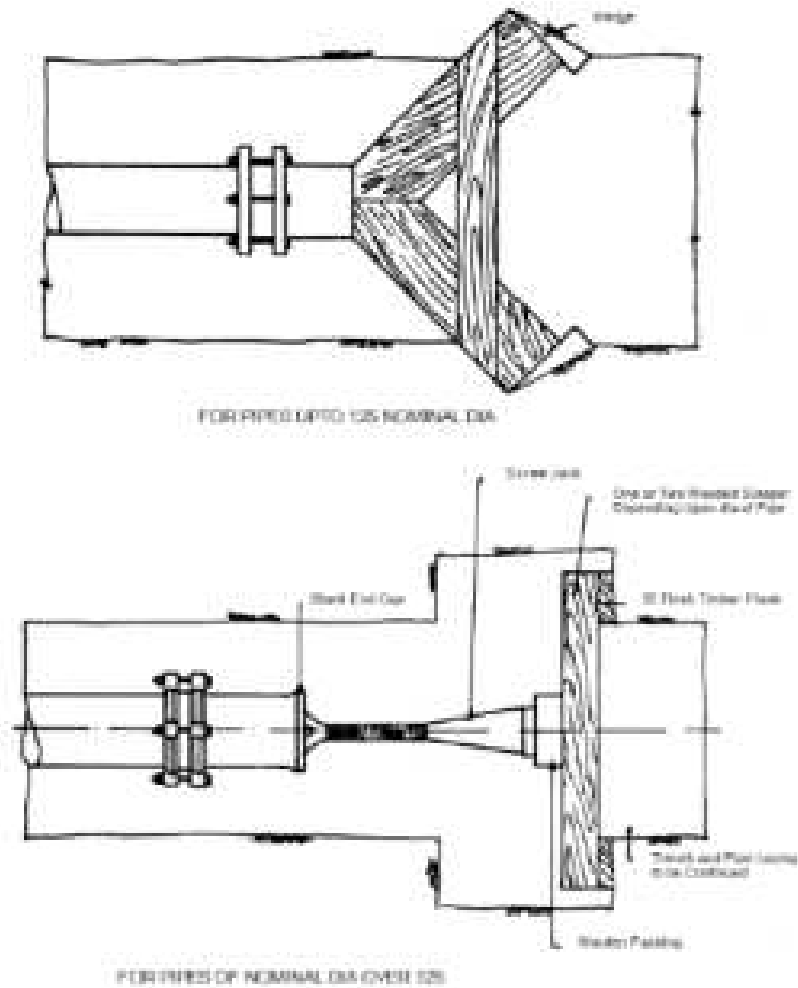


Figure 18.9 : Hydrostatic Test (End Closure for Pipes)

Drawing Not to Scale  
All Dimensions are in mm



## DRAINAGE



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### LIST OF BUREAU OF INDIAN STANDARDS CODES

S. No.	IS No.	Subject
1.	IS 458	Pre-cast Concrete Pipes (with and without reinforcement).
2.	IS 651	Specification for Salt Glazed Stoneware Pipes and Fittings.
3.	IS 783	Code of Practice for Laying Concrete Pipes
4.	IS 1726	Specification for Cast Iron Manhole Covers and Frames
5.	IS 1729	Cast Iron /Ductile Iron Drainage Pipes and Pipe Fittings Socket and Spigot Series for Over-ground Non-pressure Pipe Line.
6.	IS 4127	Code of Practice for Laying of Glazed Stone Ware Pipes
7.	IS 4885	Specifications for Sewer Bricks
8.	IS 12592	Pre-cast Concrete Manhole Covers and Frames – Specifications
9.	IS 3114	Code or Practice for laying of Cast iron pipes.
10.	IS 5961	Specification for cast iron grating for drainage purpose.
11.	IS 2470 (Part -1)	Code of practice for Installation of septic tank : Part 1 Design criteria and construction



## 19 DRAINAGE

### 19.0 TERMINOLOGY

#### **Benching (Fig. 19.8)**

The sloped floor of a manhole or an inspection chamber on both sides and above the top of the channel.

#### **Channel**

The open waterway through which sewage, storm water or other liquid waste flow at the invert of a manhole or an inspection chamber.

#### **Cleaning Eye (Fig. 19.8)**

An access opening having a removable cover to enable obstructions to be cleared by means of a drain rod.

#### **Connections**

The junction of a foul water drain, surface water drains with public sewer, cesspool soak-way or other water courses.

#### **Flushing Tank (Fig. 19.1)**

Tank used to flush the sewer lime/manholes.

#### **Curb, Kerb**

The stone margin of a side walk.

#### **Dispersion Trench**

A trench in which open jointed pipes surrounded by coarse aggregate media and overlaid by fine aggregate, are laid. The effluent from septic tank gets dispersed through the open joints and is absorbed in the surrounding soil.

#### **Depth of Manhole**

The vertical distance from the top of the manhole to the outgoing invert of the main drain channel.

#### **Drain**

A line of pipes including all fittings and equipment, such as manholes traps, gullies and floor traps used for the drainage of a building, or a number of buildings or yards appurtenant to the buildings, within the same cartilage. Drain shall also include open channels used for conveying surface water.

#### **Drainage**

The removal of any liquid by a system constructed for the purpose.

#### **Drop Connection (Fig. 19.8)**

A branch drain of which the last length of piping of the incoming drain, before connection to the sewer, is vertical.

#### **Drop Manhole (Fig. 19.8)**

A manhole incorporating a vertical drop for the purpose of connecting a sewer or drain at high level to one at lower level.

#### **Effluents**





**Tank Effluent:** The supernatant liquid discharge from a septic tank.

**Filter Effluent:** The liquid discharged from a biological filter.

**Gully Chamber (Fig. 19.2)**

The chamber built of masonry around a gully trap, for housing the same.

**Gully Trap (Fig. 19.2)**

A trap water seal provided in a drainage system in a suitable position to collect waste water from the scullery, kitchen sink, wash basins, baths and rain water pipes.

**Haunching (Fig. 19.11)**

Concrete bedding with additional concrete at the sides of the pipe.

**Junction Pipe**

A pipe incorporating one or more branches.

**Invert**

The lowest point of the interior of a sewer or drain at any cross action.

**Inspection Chamber**

A water tight chamber constructed in any house drainage system which takes wastes from gully traps and disposes off to manhole with access for inspection and maintenance.

**Interceptor Manhole (Interceptor Chamber)**

A manhole incorporating an intercepting trap, and providing means of access thereto and equipped with a fresh air inlet on the upstream side of the trap.

**Manhole (Manhole Chamber)**

Any chamber constructed on a drain or sewer so as to provide access thereto for inspection testing or the clearance of obstruction.

**Rest Bend (Duck Foot Bend)**

A bend supported in a vertical position by a foot formed at its base.

**Saddle**

A purpose made fitting, so shaped as to fit over a hole cut in a sewer or drain, and used to form connections.

**Soffit**

The highest portion of the interior of a sewer or drain at any cross-section.

**Soil Waste**

The discharge from water closets, urinals, slope sinks, stable or cowshed gullies and similar appliances.

**Soil Pipe**

Which receives the discharges from soil fitments, such as water closets urinals, and slope sinks.

**Sullage Waste Water**

Spent water from baths, wash basins kitchen sinks, and similar appliances which does not contain human or animal excreta.

**Sewer**

A closed drain carrying night soil and other water borne waste.

**Surface Water Drain**

A drain conveying surface water including storm water.

**Surface Water**

The run off from precipitation, other water that flows over surface of the ground.

**Sub Soil Water**

Water occurring naturally below the surface of the ground.

**Sludge**

The settled solid matter in semi solid condition.

**Soak Pit (Seepage Pit Soak Way) (Fig. 19.17)**

A pit through which effluent is allowed to seep or leach into the surrounding soil.

**Septic Tank (Fig. 19.15 & 19.16)**

A water tight single storied tank in which sewage is retained sufficiently long to permit sedimentation of suspended solids and partial digestion of settled sludge by anaerobic bacteria.

**Scum**

The greasy and other substances floating on the surface of sewage.

**Vent Pipe**

A pipe line installed to provide flow of air to or from a drainage system or to provide circulation of air within such system to protect trap seals from siphonage and back flow.

**Waste Water**

The discharge from wash basins, sinks and similar appliance, which does not contain human excreta.

**19.1 GENERAL REQUIREMENTS**

- 19.1.1** In designing a drainage system for building(s), the aim shall be to provide a self cleansing conduit for the conveyance of soil, waste, surface or sub-surface waters and for the removal of such wastes speedily and efficiently to a sewer or other outlet, without risk of nuisance and hazard to health.
- 19.1.2** The discharge of water through a domestic drain is intermittent and limited in quantity and therefore, small accumulations of solid matter are liable to form in the drains between the building and the public sewer. There is usually a gradual shifting of these deposits as discharges take place. Gradients shall be sufficient to prevent these temporary accumulations building up and blocking the drains.
- 19.1.3** Normally, the sewer shall be designed for discharging three times the dry weather flow flowing half-full with a minimum self cleansing velocity of 0.75 metre per second. The approximate gradients which give this velocity for the sizes of pipes likely to be used in building drainage and the corresponding discharges when flowing half-full are given in Table 19.1. The sizes and slopes shall conform to Local Municipal Bye-laws.
- 19.1.4** In cases, where it is practically not possible to conform to the minimum gradients, a flatter gradient may be used but the minimum velocity in such cases shall on no account be less than 0.61 metres per second.
- 19.1.5** On the other hand, it is undesirable to employ gradients giving velocity of flow greater than 2.4 metres per second. Where it is unavoidable, cast iron pipes shall be used. The approximate gradients which give a



velocity of 2.4 metres per second for the various sizes of pipes and the corresponding discharge when flowing half-full are given in Table 19.1.

**TABLE 19.1**  
**Gradients for Sewers**

Diameter mm	Minimum Gradient		Maximum Gradient	
	Gradients	Discharge cum/Min.	Gradients	Discharge cum/Min.
100	1 in 57	0.18	1 in 5.6	0.59
150	1 in 100	0.42	1 in 9.7	1.32
200	1 in 145	0.73	1 in 14	2.4
230	1 in 175	0.93	1 in 17	2.98
250	1 in 195	1.10	1 in 19	3.60
300	1 in 250	1.70	1 in 24.5	5.30

## 19.2 PIPES AND SPECIALS

### 19.2.1 Glazed Stone Ware Pipes and Fittings

All pipes with spigot and socket end and fittings shall conform to class SP1 of IS 651. These shall be sound, free from visible defects such as fire cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear tone when struck with a light hammer. There shall be no broken blisters. The thickness of pipes shall be as given in the Table 19.2.

**TABLE 19.2**  
**Stoneware Pipes**

Internal Diameter (mm)	Mean Thickness of the Barrel and Socket (mm)
100	12
150	15
200	16
230	19
250	20
300	25
350	30
400	35
450	37

The length of pipes shall be 60, 75, 90 cm exclusive of the internal depth of the socket. The pipes shall be handled with sufficient care to avoid damage to them.

**19.2.1.1 S.W. Gully Trap (Fig. 19.2):** Gully traps shall conform to IS 651. These shall be sound, free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear tone when struck with light hammer. There shall be no broken blisters. Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also



have a water tight C.I. cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.50 Kg and the frame not less than 2.70 Kg. The grating, cover and frame shall be of sound and good casting and shall have truly square machined seating faces.

**19.2.1.2 Laying and Jointing Stone Ware Pipes:** For all sewers and drains, glazed stoneware pipes shall be used as far as possible in preference to other types of pipes. These are suitable, particularly where acid effluents or acid sub-soil conditions are likely to be encountered.

(i) Trenches: Specifications described in 19.2.2.1 shall apply, as far as possible.

The trench shall be so dug that the pipe can be laid to the required alignment and at the required depth. When the pipe line is under a roadway, a minimum cover of 90 cm is recommended for adoption, but it may be modified to suit local conditions. The trench shall be excavated only so far in advance of pipe laying as specified by the Engineer-in-Charge. The trench shall be so shored and drained that the workmen may work therein safely and efficiently. The discharge of the trench dewatering pumps shall be conveyed either to drainage channels or to natural drains.

The excavation shall be carried out with manual labour or with suitable mechanical equipment as approved by the Engineer-in-Charge.

Unless otherwise specified by the Engineer-in-Charge, the width at bottom of trenches for different diameters of pipes laid at different depths shall be as given below:

For all diameters, up to an average depth of 120 cm, width of trench in cm = diameter of pipe + 30 cm.

For all diameters for depths above 120 cm, width of trench in cm = diameter of pipe + 40 cm.

Notwithstanding (a) and (b) the total width of trench shall not be less than 75 cm for depths exceeding 90 cm.

The width of trench in the upper reaches shall be increased as described in sub-head 'Earthwork'.

(ii) Laying (*Fig. 19.11*): Where the pipes are laid on soft soil with maximum water table lying at invert level of the pipe, the pipes shall be bedded in cement concrete with thickness and mix as specified, projecting on each side of the pipe to the specified width of the trench (*Fig. 19.11(i)*). The pipes with their crown level at 1.20 m depth and less from ground shall be covered with 15 cm thick. Concrete above the crown of the pipe and sloped off to meet the outer edges of the concrete, to give a minimum thickness of 15 cm all-around the pipe (*Fig. 19.11 (iii)*). Pipes laid at a depth greater than 1.20 m at crown and maximum water table level rising above the invert level of pipe, shall be concreted at the sides up to the level of the centre of the pipe and sloped off from the edges to meet the pipe tangentially (*Fig. 19.11(ii)*).

The pipe shall be carefully laid to the alignments, levels and gradients shown on the plans and sectins. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in a straight line without vertical or horizontal undulation. The pipes shall be laid with socket ends facing upstream. The body of the pipe shall for its entire length rest on an even bed of concrete and places shall be excavated in the concrete to receive the socket of the pipe.

Where pipes are not bedded on concrete, the trench floor shall be left slightly high and carefully bottomed up as pipe laying proceeds, so that the pipe barrels rest on firm and undisturbed ground. If the excavation has been carried too low, the desired levels shall be made up with concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) for which no extra payment shall be made.

If the floor of the trench consists of rock or very hard ground that cannot easily be excavated to smooth surface the pipe shall be laid on a levelling course of concrete as desired.



When S.W. pipes are used for storm water drainage, no concreting will normally be necessary. The cement mortar for jointing will be 1:3 (1 cement: 3 fine sand). Testing of joints will also not be done.

- (iii) Jointing: Tarred gasket or hemp yarn soaked in thick cement slurry shall first be placed round the spigot of each pipe and the spigot shall then be slipped home well into the socket of the pipe previously laid. The pipe shall then be adjusted and fixed in the correct position and the gasket caulked tightly home so as to fill not more than 1/4th of the total depth of the socket.

The remainder of the socket shall be filled with stiff mixture of cement mortar in the proportion of 1:1 (1 cement: 1 fine sand). When the socket is filled, a fillet shall be formed round the joint with a trowel forming an angle of 45 degree with the barrel of the pipe.

After a day's work any extraneous material shall be removed from the inside of the pipe. The newly made joints shall be cured for at least seven days.

- (iv) *Testing of Joints*: Stoneware pipes used for sewers shall be subjected to a test pressure of 2.5 m head of water at the highest point of the section under test. Before commencing test, the pipeline shall be filled with water and maintained full for 24 hours under head of 0.6 m of water. The test shall be carried out by suitably plugging the lower end of the drain and the ends of the connection if any and filling the system with water. A knuckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head, or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitable for observation. The tolerance of two liters per centimeter of diameter per kilometer may be allowed during a period of 10 minutes.

If any leakage is visible, the defective part of the work shall be cut out and made good. A slight amount of sweating which is uniform may be overlooked, but excessive sweating from a particular pipe or joint shall be watched for and taken as indicating a defect to be made good.

Any joint found leaking or sweating, shall be rectified or embedded into 15 cm layer of cement concrete (1:2:4) 30 cm in length and the section retested.

- (v) Refilling: In cases where pipes are not bedded on concrete special care shall be taken in refilling trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe and rammed with a shovel and light tamper. This method of filling will be continued up to the top of pipe. The refilling shall rise evenly on both sides of the pipe continued up to 60 cm above the top of pipe so as not to disturb the pipe. No tamping should be done within 15 cm of the top of pipe.
- (vi) Measurements: The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

- (vii) *Rate*: The rate shall include the cost of materials and labour involved in all the operations described above excluding the cost of concrete which shall be paid for separately.

#### 19.2.1.3 Fixing S.W. Gully Trap (Fig. 19.2)

- (i) Excavation: The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-Charge.



- (ii) Fixing: The gully traps shall be fixed on cement concrete foundation 65 cm square and not less than 10 cm thick. The mix for the concrete will be 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes described above.
- (iii) *Brick Masonry Chamber*: After fixing and testing gully and branch drain, a brick masonry chamber 300 x 300 mm (inside) in brick work of specified class in cement mortar 1:4 (1 cement: 4 fine sand) shall be built with a half brick thick brick work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber walls and the trap shall be filled in with cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement: 3 coarse sand), finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

C.I. cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth. The finished top of cover shall be left about 4 cm above the adjoining ground level so as to exclude the surface water from entering the gully trap.

- (iv) Measurements: The work shall be enumerated. Excavation shall be measured separately under relevant item of earth work.
- (v) Rate: The rate shall include the cost of materials and labour involved in all the operations described above, except earth work which shall be paid for separately.

#### 19.2.2 Cement Concrete Pipes (with and without Reinforcement) (Light Duty, Non-Pressure)

The pipes shall be with or without reinforcement as required and shall be of class not lesser than NP2. These shall conform to IS 458 and shall be capable of withstanding a test pressure of 0.07 MPa (7 m head). The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process while un-reinforced cement concrete pipes by spun or pressure process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Concrete used for the manufacture of un-reinforced and reinforced concrete pipes and collars shall not be leaner than 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm internal diameter. But for pipes of internal diameter 80 to 250 mm, the maximum size of aggregate should be 10mm. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

The dimensional requirements of concrete pipes are given in Appendix I.

The minimum clear cover for reinforcement in pipes and collars shall be as given in Table 19.3.

**TABLE 19.3**

Sl. No.	Precast concrete pipe/collar	Minimum clear cover, mm
(i)	Barrel wall thickness	
(a)	Upto and including 75 mm	8
(b)	Over 75 mm	15



(ii)	At spigot steps	5
(iii)	At end of longitudinal	5

Note: An effective means shall be provided for maintaining the reinforcement in position and for ensuring correct cover during manufacture of the unit. Spacers for this purpose shall be of rust proof material or of steel protected against corrosion.

#### 19.2.2.1 Laying and Jointing Cement Concrete Pipes and Specials

- i. **Trenches:** Trenches shall be as described in 18.4.4. Where the pipes are to be bedded directly on soil, the bed shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe itself.
- ii. **Loading,** transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.
- iii. If *the* pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.
- iv. In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipe shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.
- v. In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on *proper* foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal dia of the pipe subject to the min. of 10 cm and a maximum of 30 cm. The concrete shall extend up the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and over in dia. The pipe shall be laid in this concrete bedding before the concrete has set. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.
- vi. When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalising bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.
- vii. The method of *bedding* and laying the pipes under different conditions are illustrated in Fig. 19.9.
- viii. When the *pipes* are laid completely above the ground the foundations shall be made even and sufficiently compacted to support the pipe line without any material settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipe line in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joints come in the centre of the span. Care shall be taken to see that super imposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted.





Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

- ix. *Jointing*: Joints are generally of rigid type. Where specified flexible type joints may also be provided.

*Rigid Spigot and Socket Joint (Fig. 19.10)*: The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine sand) which shall be rammed with caulking tool. After a day's work any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.

- a) *Rigid Collar Joint (Fig. 19.10)*: The two adjoining pipes shall be butted against each other and adjusted in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The annular space shall be filled with stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) which shall be rammed with caulking tool. After a day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.
  - b) *Semi Flexible Spigot and Socket Joint (Fig. 19.10)*: The joint is composed of specially shaped spigot and socket ends on the concrete pipes. A rubber ring shall be placed on the spigot which shall be forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and the socket, stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.
  - c) *Semi Flexible Collar Joint*: This is made up of a loose collar which covers two specially shaped pipe ends as shown in the Fig. 19.10. Each end shall be fitted with a rubber ring which when compressed between the spigot and the collar, seal the joint. Stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand), shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.
  - d) *Internal Flush Joint (Fig. 19.10)*: This joint is generally used for culvert pipe of 60 cm dia and over. The ends of the pipe are specially shaped to form a self centering joint with an internal jointing space 1.3 cm wide the finished joint is flush with both inside and outside with the pipe wall as shown in Fig. 19.10. The jointing space is filled with cement mortar 1:2 (1 cement: 2 fine sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. After day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.
  - e) *External Flush Joint* : This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends as shown in Fig. 19.10. Each end shall be butted against each other and adjusted in correct position. The jointing space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) sufficiently dry and finished off flush. Great care shall be taken to ensure that the projecting ends are not damaged as no repairs can be readily affected from inside the pipe.
- x. In *all* pressure pipe lines the recess at the end of the pipe line shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

The number of pipes that shall be jacked together at a time shall depend on the diameter of the pipes and the bearing capacity of the soil, for small pipes up to 25 cm diameter, six pipes can be jacked together at a time.





The quantity of jute and bitumen in the ring shall be just sufficient to fill the recess in the pipe when pressed hard by jacking or by any other suitable method. Before and during jacking care shall be taken to see that there is no offset at the joint.

- xi. **Testing:** For pressure pipes, the completed pipeline shall be tested for pressure (Known as site test pressure) which shall not be less than the maximum pipeline operating pressure plus the calculated surge pressure, but in no case shall it exceed the hydrostatic test pressure. For non- pressure pipes the joints shall be tested as per procedure laid down under Para 19.2.1.2 (iv).
- xii. **Refilling of Trenches:** The specification described in 19.2.1.2 (v) shall apply. In case where pipes are not bedded on concrete special care shall be taken in refilling, trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe and rammed with a shovel and light tamper. This method of filling will be continued up to the top of pipe. The refilling shall rise evenly on both sides of the pipe and continued up to 60 cm above the top of pipe so as not to disturb the pipe. No tamping shall be done within 15 cm of the top of pipe. The tamping shall become progressively heavier as the depth of the backfill increases.
- xiii. **Measurements :** The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, collars, junctions, etc. which shall not be measured separately.  
  
Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.
- xiv. **Rate:** The rate shall include the cost of materials and labour involved in all the operations described above.

### 19.2.3 Cast Iron (Centrifugally Cast) Pipes and Specials

Cast iron (centrifugally cast) pipes and specials shall conform to the specifications described in 18.3.10.

### 19.2.4 Road Gully Grating (Fig. 19.13)

**19.2.4.1 Horizontal Gully Grating:** The casting of the grating and frames shall be the same as that of manhole covers described in 19.2.2.1. The gully grating cover shall be hinged to the frame to facilitate its opening for cleaning and repairs. A typical grating is shown in Fig. 19.13 & 19.14. The weight of grating shown in Figure shall be minimum 75 Kg. In case of R.C.C. horizontal gully grating it shall be in cement concrete 1:1:2 (1 cement: 1 coarse sand: 2 graded stone aggregate 20 mm nominal size) as shown in Fig. 19.13.

**19.2.4.2 Vertical Gully Grating:** The chamber shall be of brick masonry, 12 mm dia, round bar shall be fixed in cement concrete block at the bottom. The bars at the top shall be welded or riveted to

M.S. flat 40×6 mm as shown in Fig. 19.14.

**19.2.4.3 Horizontal and Vertical Gully Grating:** The details of typical road gully chamber of brick masonry with horizontal and vertical grating shall be as given in Fig. 19.14.

## 19.3 MANHOLE COVERS & FRAMES

### 19.3.1 Manhole Covers

The covers and frames shall conform to IS 1726 for cast Iron and IS 12592 for pre-cast concrete covers and shall be of the following grades and types.

Grades	Grade Designation	Type/shape of cover
Light Duty	LD - 2.5	Rectangular, Square, Circular



<i>Medium Duty</i>	<i>MD - 10</i>	<i>Rectangular, Circular and Square (for pre-cast concrete manhole covers)</i>
<i>Heavy Duty</i>	<i>HD - 20</i>	<i>Circular-Square, Rectangular, (Scraper Manhole)</i>
<i>Extra Heavy Duty</i>	<i>EHD - 35</i>	<i>Circular, Square, Rectangular, (Scraper Manhole)</i>

#### 19.3.1.1 Cast Iron Manhole Covers and Frames

- i. Manhole covers and frame shall be manufactured from appropriate grade of grey cast iron not inferior than FG150 grade of IS 210.
- ii. They shall be cleanly cast and shall be free from air and sand holes, cold shuts and warping.
- iii. Covers shall have on its operative top a raised chequered design to provide for an adequate no-slip grip. The rise of chequers shall be not less than 4mm.
- iv. Key holes, keys and lifting devices shall be provided in the manhole covered to facilitate their placement in the frames and their operative maintenance.
- v. Manhole covers and frames shall be coated with materials having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63°C and shall not be so brittle as to chip off at temperature of 0°C.
- vi. Size and shape and performance requirement of manhole covers and frames shall conform to IS 1726.
- vii. Each manhole covers and frame shall have cast on them the following information:
  - a) Manufacturer's name or trade-mark
  - b) Grade designation
  - c) Date of manufacturer
  - d) The words SWD or 'Sewer' to denote 'storm water drain' or 'sewer' respectively
  - e) Identification marks as required by Engineer-in-Charge.
- viii. The cover shall be gas tight and water tight.
- ix. The sizes of covers specified shall be taken as the clear internal dimensions of the frame.
- x. The approximate weight of the various type of manhole covers and frames shall be as per IS 1726.
- xi. The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

#### 19.3.2 Pre-Cast Concrete Manhole Covers & Frames

Pre-cast reinforced cement concrete manhole covers intended for use in sewerage and water works shall generally conform to IS 12592.

##### 19.3.2.1 Materials

**Cement:** Cement used for the manufacture of pre-cast concrete manhole covers shall be 43 grade Portland cement conforming to IS-8112.

**Aggregates:** The aggregates used shall be clean and free from deleterious matter and shall conform to the requirements of IS -383. The aggregates shall be well graded and the nominal maximum size of coarse aggregate shall not exceed 20 mm.



**Concrete:** The mix proportions of concrete shall be determined by the manufacturer and shall be such as will produce a dense concrete without voids, honey combing etc. The minimum cement content in the concrete shall be 410 kg/m<sup>3</sup> with a maximum water cement ratio of 0.45. Concrete weaker than grade M-30 (design mix) shall not be used. Compaction of concrete shall be done by machine vibration.

#### Reinforcement

- a) The reinforcement steel shall conform to IS 1786. Reinforcement shall be clean and free from loose mill scale, loose rust, and mud, oil, grease or any other coating which may reduce or destroy the bond between the concrete and steel. A light film of rust may not be regarded as harmful but steel shall not be visibly pitted by rust.
- b) *Fibers Steel:* The diameter/equivalent diameter of steel fibers where used, shall not be greater than 0.75 mm. The aspect ratio shall be in the range of 50 to 80. The minimum volume of fibers shall be 0.5 percent of the volume of concrete.

The reinforced concrete manhole cover and frame shall be designed in accordance with the provisions of IS 456. Clear cover to reinforcement shall not be less than 15 mm.

**19.3.2.2 Shapes and Dimensions:** Shape, dimensions and tolerance of pre-cast concrete manhole covers and frames shall conform to IS 12592. Outside dimension of cover at top shall match with corresponding frame so that the maximum clearance at top between the frame and the cover all round the periphery is not more than 5 mm and the top surface of the frame and covers, is in level within a tolerance of  $\pm 5$  mm.

For facility of removing the cover from the frame, suitable taper matching with taper given for the frame shall be provided to the periphery of the cover.

**19.3.2.3 Lifting Device:** The minimum diameter of mild steel rod used as lifting device shall be 12 mm for light and medium duty covers and 16 mm for heavy and extra heavy duty covers. The lifting device shall be protected from corrosion by hot galvanising or epoxy coating or any other suitable treatment.

**19.3.2.4 Finishing & Coating:** To prevent any possible damage from corrosion of steel the underside of the covers shall be treated with anticorrosive paint. The top surface of the covers shall be given a chequered finish.

In order to protect the edges of the covers from possible damage at the time of lifting and handling it is necessary that the manhole covers shall be cast with a protective mild steel sheet of minimum 2.5 mm thickness around the periphery of the covers. Exposed surface of mild steel sheet shall be given suitable treatment with anticorrosive paint or coating. To prevent the top outer edge of

frame from possible damages, it shall be protected by 25 mm X 3 mm mild steel flat as part of the frame.

#### 19.3.2.5 Physical Requirements

**General:** All units shall be sound and free from cracks and other defects which interface with the proper placing of the unit or impair the strength or performance of the units. Minor chipping at the edge/surface resulting from the customary methods of handling during delivery shall not be deemed for rejecting.

**Load Test:** The breaking load of individual units when tested in accordance with the method described in IS 12592 shall be not less than the values specified in Table 19.4.

**TABLE 19.4**

Grade of Cover	Type	Load in Tonnes	Diameter of Blocks in mm
EHD - 35	Circular, Square or Rectangular	35	300
HD - 20	Circular, Square or Rectangular	20	300



MD - 10	Circular or Rectangular	10	300
LD - 2.5	Rectangular, Square or Circular	2.5	300

**19.3.2.6 Fixing:** The frames of manhole shall be firmly embedded to correct alignment and level in RCC slab or plain concrete as the case may be on the top of masonry which shall be paid as extra unless specified otherwise.

**19.3.2.7 Measurements:** The manhole covers shall be enumerated under relevant items.

**19.3.2.8 Rates:** The rate shall include the cost of materials and labour involved in all the operation described above except fixing of frames and covers which shall be paid as extra unless specified otherwise in the item.

**19.3.2.9 Footrests:** Foot rests shall be of 20 mm M.S. square or round bars as specified.

#### 19.4 MANHOLES (FIG. 19.3 to 19.8)

At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 30 m.

Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer -in- Charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.

Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

Sewers of unequal sectional area shall not be jointed at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3 the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

No drain from house fittings, e.g. gully trap or soil pipe, etc. to manhole shall normally exceed a length of 6 m unless it is unavoidable.

Manholes 90 × 80 cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes 1.2 m × 90 cm are generally constructed for main drainage work for depths less than 1.5 m.

Manhole 1.4 m × 90 cm is of the arched type and is generally constructed for main drainage works where depth is 1.50 m or more. The width of manholes shall be increased more than 90 cm on bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side of the channel is minimum 20 cm.

Manholes 1.4 m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450 mm in the same manner as in the case of rectangular manholes.

Before deciding size of manholes, Local Municipal Bye Laws shall be consulted. As a general guide some typical type designs of manholes followed in Delhi have been shown in Fig. 19.4 to 19.7. When manholes are constructed on foot path, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

##### 19.4.1 Excavation



The excavation for manhole shall be true to dimensions and levels shown on the plans or as directed by the Engineer-in-Charge.

#### 19.4.2 Bed Concrete

The manhole shall be built on a bed of cement concrete 1:4:8 (1 cement: 4 coarse sand: 8 graded stone aggregate 40 mm nominal size) unless required by local authorities. The thickness of the bed concrete shall be 20 cm for manholes up to 4.25 m depth and 30 cm for depths beyond 4.25 m unless otherwise specified or directed by the Engineer-in-Charge. In bad ground, special foundations as suitable shall be provided.

#### 19.4.3 Brick Work

The brick work shall be with class 75 bricks in cement mortar 1:4 (1 cement: 4 coarse sand). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof. For arched type and circular manholes, brick masonry in arches and arching over the pipes shall be in cement mortar 1:3 (1 cement: 3 fine sand). In the case of manholes of circular type the excess shaft shall be corbelled inwardly on three sides at the top to reduce its size to the cover frame to be fitted.

The walls shall be built of one brick thickness for depths up to 4.25 m. Below a depth of 4.25 m in ordinary subsoil the wall thickness shall be increased to one and half brick and at 9.75 m below ground two brick thick walls shall be built.

#### 19.4.4 Plaster and Pointing

The walls of the manholes shall be plastered inside with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth. In the case of arched type manhole the walls of the manhole shall be plastered inside all-around only up to the crown level, and flush pointed for the shaft with cement mortar 1:2 (1 cement: 2 fine sand). Where the saturated soil is met with, also the external surface of the walls of the manhole shall be plastered with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth up to 30 cm above the highest sub-soil water level with the approval of the Engineer-in-Charge. The plaster shall further be water proofed with addition of approved water proofing compound in a quantity as per manufacturer's specifications. In case Local Authorities/Bye Laws specify richer specifications, the same shall be adopted.

For earth work excavation, bed concrete brick work, plaster and pointing, R.C.C. work and refilling of earth, respective specifications shall be followed.

#### 19.4.5 Benching

The channels and benching shall be done in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth with neat cement. The depth of channels and benching shall be as given in Table 19.5.

#### 19.4.6 Foot Rests (Fig. 19.8)

All manholes deeper than 0.8 m shall be provided with M.S. foot rests. These shall be embedded 20 cm deep in 20 x 20 x 10 cm blocks of cement concrete 1:3:6 (1 cement: 3 coarse sand 6 graded stone aggregate 20 mm nominal size). The concrete block with M.S. foot rest placed in its centre shall be cast in situ along with the masonry and surface finished with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth.

TABLE 19.5

Sizes of drain (mm)	Top of channel at the centre above bed concrete (cm)	Depth of benching at side walls above bed concrete (cm)
------------------------	---	--



100	15	20
150	20	30
200	25	35
250	30	40
300	35	45
350	40	50
400	45	55
450	50	60

Foot rests which shall be of 20 × 20 Sq. M.S. bars as shown in Fig. 19.8 shall be fixed 40 cm apart vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top foot rest shall be 45 cm below the manhole cover.

Foot rests shall be painted with coal tar, the portion embedded in the cement concrete block being painted with thick cement slurry before fixing.

#### 19.4.7 Manhole Covers and Frames

The frame of manhole shall be firmly embedded to correct alignment and levels in R.C.C. slab or plain concrete as the case may be on the top of the masonry. After completion of the work, manhole covers shall be sealed by means of thick grease.

#### 19.4.8 Measurements

Manholes shall be enumerated under relevant items. The depth of the manhole shall be reckoned from the top level of C.I. cover to the invert level of channel. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

#### 19.4.9 Rate

The rate shall include the cost of materials and labour involved in all the operations described above but excludes the cost of (i) excavation, (ii) M.S. foot rests and (iii) 12 mm thick cement plaster with water proofing material applied at the external surface of the manhole if required. These items shall be paid for separately under relevant items of work.

Payment for extra depths of manholes shall be made separately under relevant items of work.

### 19.5 DROP CONNECTION (FIG. 19.8)

**19.5.0** In cases where branch pipe sewer enters the manhole of main pipe sewer at a higher level than the main sewer, a drop connection shall be provided. The work shall be carried out as per Fig. 19.8.

S.C.I. pipes and special conforming to IS 1729 shall be of the same size as that of the branch pipe sewer.

For 150 and 250 mm main line, if the difference in level between the water line (peak flow level) and the invert level of the branch line is less than 60 cm, a drop connection may be provided with in the manhole by giving suitable ramp. If the difference in level is more than 60 cm, the drop shall be provided externally.

The main lines up to 350 mm dia, are designed for half depth of flow, from 350 mm to 900 mm for 2/3 depth of flow and beyond 900 mm for 3/4 depth of flow.

#### 19.5.1 Excavation



The excavation shall be done for the drop connection at the place where the branch line meets the manhole. The excavation shall be carried up to the bed concrete of the manhole and to the full width of the branch line.

### 19.5.2 Laying

At the end of branch sewer line S.C.I. cross shall be fixed to the line which shall be extended through the wall of the manhole by a horizontal piece of S.C.I. pipe to form an inspection or cleaning eye. The open end shall be provided with chain and lid. The S.C.I. drop pipe shall be connected to the cross at the top and to the S.C.I. bend at the bottom. The bend shall be extended through the wall of the manhole by a piece of C.I. pipe which shall discharge into the channel. Necessary channel shall be made with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and finished smooth to connect the main channel. The joint between S.C.I. pipe and fittings shall be lead caulked as described in 18.5.3. The joint between S.C.I. cross and S.W. branch line shall be made with cement mortar 1:1 (1 cement: 1 fine sand). The exposed portion of the drop connection shall be encased all-around with minimum 15 cm thick concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) and cured. For encasing the concrete around the drop connection, the necessary centering and shuttering shall be provided. The holes made in the walls of the manhole shall be made good with brick work in cement mortar 1:4 (1 cement: 4 coarse sand) and plastered with cement mortar 1:3 (1 cement: 3 coarse sand) on the inside of the manhole wall. The excavated earth shall be back filled in the trench in level with the original ground level.

### 19.5.3 Measurements

Drop connection shall be enumerated. The depths beyond 60 cm shall be measured in running metres correct to a cm under relevant items.

### 19.5.4 Rate

The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of excavations and refilling.

## 19.6 OPEN SURFACE DRAIN (FIG. 19.12)

The open drains shall be of the size, as specified in the item and laid to such gradients and in such locations as may be shown in the relevant drawing or as directed by the Engineer-in-Charge.

The size of the drain as specified shall be the width of the drain at the top, measured between the masonry walls. The drain shall be given, as far as possible, uniform slope from the starting point to the discharge point.

The average depths of the various sizes of drains shall be as follows:

<i>Drain size</i>	<i>Depth</i>
10 cm	20 cm
15 cm	20 cm
25 cm	30 cm

### 19.6.1 Measurements

The drains shall be measured in running metres, correct to a cm.

### 19.6.2 Rate

The rate shall include the cost of labour and materials required for all the operations described above, suitable deduction or extra payment, per cm basis shall be made in case there is a variation in average depths from those stated above.





## **19.7 ROAD GULLY CHAMBER WITH GRATING**

### **19.7.1 Road Gully Chamber with Horizontal Grating (Fig. 19.14)**

The chamber shall be of brick masonry of specified class and shall have a C.I. grating with frame fixed in 15 cm thick cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) at the top. The size of the chamber shall be taken as the clear internal dimensions of the C.I. frame. The chamber shall have a connection pipe, the length of which in metre between the road gully chamber and the manhole of the drain shall not be less than one by forty (1/40) times the nominal diameter of pipe in mm (i.e. for 150 mm connection pipe, length shall not be less than 3.7 m and for 250 mm connection pipe length shall not be less than 6.25 m). The chamber shall be built at the location fixed by the Engineer-in-Charge. Generally the spacing of the chambers shall be 18 to 36 m depending upon the grading of the road channel and the area of the drainage. R.C.C. gully grating shall be fixed in cement mortar 1:2 (1 cement: 2 coarse sand) as shown in Fig. 19.13.

### **19.7.2 Road Gully Chamber with Vertical Grating (Fig. 19.14)**

The chamber shall be of brick masonry 12 mm dia round bar shall be fixed in cement concrete block at the bottom. The bars at the top shall be welded or riveted to M.S. flat 40 × 6 mm as shown in Fig. 19.14. The specifications shall be same as described in 19.7.1.

### **19.7.3 Road Gully Chamber with Horizontal and Vertical Grating**

The details of typical road gully chamber of brick masonry shall be same as shown in Fig. 19.14.

### **19.7.4 Measurements**

Road gully chambers shall be enumerated.

### **19.7.5 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above except the cost of excavation and connection pipes.

## **19.8 BRICK MASONRY GULLY TRAP (FIG. 19.2)**

The internal size of the trap shall be 80 × 40 × 46 cm. The height shall be measured from the top of the floor to the top of the cover. 40 mm thick stone baffles shall be fixed 50 mm deep in masonry with cement mortar 1:4 (1 cement: 4 fine sand), as shown in the Fig. 19.2. The connection of open surface, drain with a soak pit shall be invariably through a grease trap.

### **19.8.1 Measurements**

Grease traps shall be enumerated.

### **19.8.2 Rate**

The rate shall include the cost of labour and materials required for all the operations described above.

## **19.9 SEPTIC TANK (FIG. 19.15 & 19.16)**

In unsewered area, every house shall have arrangements for its sewage being treated in septic tank, effluent from which should be given secondary treatment either in a biological filter or on the land, or in a sub-surface disposal system.

Surface and sub-soil water should be excluded from finding way into the septic tank. Waste water may be passed into the septic tank provided the tank and the means for effluent disposal are designed to cope up with this extra liquid. Depending on the location of the water table and the nature of the strata, the type of disposal for the effluent from the septic tank shall be decided.

### **19.9.1 Dimensions**





Septic tanks shall have minimum width of 75 cm, minimum depth of one metre below water level and a minimum liquid capacity of the one cubic metre. Length of tanks shall be 2 to 4 times the width. Suitable sizes of septic tanks for use of 5, 10, 15, 20 and 50 persons based on certain assumptions are given in Appendix II.

#### **19.9.2 Cover and Frame**

Every septic tank shall be provided with C.I. cover of adequate strength. The cover and frames shall be 500 mm dia. (M.D.) minimum or 610 mm × 455 mm (LD). The specification for frames and cover given in 19.3.1 shall apply.

#### **19.9.3 Ventilating Pipe**

Every septic tank shall be provided with C.I. ventilating pipe of at least 50 mm diameter. The top of the pipe shall be provided with a suitable cage of mosquito proof wire mesh.

The ventilating pipe shall extend to a height which would cause no smell nuisance to any building in the area. Generally the ventilating pipe may extend to a height of about 2 m, when the septic tank is at least 15 m away from the nearest building and to a height of 2 m. above the top of the building when it is located closer than 15 metres. The ventilating pipe may also be connected to the normal soil ventilating system of the building where so desired.

#### **19.9.4 Disposal of Sludge**

The sludge from septic tanks may be delivered into covered pit or into a suitable vehicle for removal from the site. Spreading of sludge on the ground in the vicinity shall not be allowed.

#### **19.9.5 Testing**

Before the tank is commissioned for use, it shall be tested for water-tightness by filling it with water and allowing it to stand for 24 hours. It shall then be topped up, if necessary, and allowed to stand for a further period of 24 hours during which time the fall in the level of the water shall not be more than 1.5 cm.

#### **19.9.6 Commissioning of Septic Tank**

The tank shall be filled with water to its outlet level before the sewage is let into the tank. It shall, preferably, be seeded with small quantities of well digested sludge obtained from septic tanks or sludge digestion tanks. In the absence of digested sludge a small quantity of decaying organic matter, such as digested cow-dung, may be introduced.

#### **19.9.7 Sub-Surface Absorption System**

The effluent from septic tank shall be disposed of by soak pit or dispersion trench depending on the position of the sub-soil water level, soil and sub-soil conditions and the size of the installation.

#### **19.9.8 Measurements**

Septic tank shall be enumerated.

#### **19.9.9 Rate**

The rate shall include the cost of materials and labour involved in all the operation, except Sub- Surface absorption system which shall be paid for separately.

### **19.10 SOAK PITS 2.5 M DIA × 3 M DEEP (FIG. 19.17)**

#### **19.10.1 Construction**

The earth excavation shall be carried out to the exact dimensions as shown in the figure. In the soak pit shall be constructed a honey-comb dry brick shaft 45 x 45 cm and 292.5 cm high. Round the shaft and within the radius of 60 cm shall be placed well burnt brick bats. Brick ballast of size from 50 to 80 mm



nominal size shall be packed round the brick bats up to the radius of 90 cm. The remaining portion shall be filled with brick ballast of 40 mm nominal size. The construction of shaft and filling of the bats and the ballast shall progress simultaneously.

#### **19.10.2 Cover and Drain**

Over the filling shall be placed single matting which shall be covered with minimum layer of 7.5 cm earth. The shaft shall be covered with 7.5 cm thick stone or R.C.C. slab 10 cm wide and 10 cm deep brick edging with bricks of class designation 75 shall be provided round the pit. The connection of the open surface drain to the soak pit shall be made by means of 100 mm diameter S.W. pipe with open joints.

#### **19.10.3 Measurements**

Soak pit shall be enumerated.

#### **19.10.4 Rate**

Rate shall include the cost of labour and material involved in all the operations described above.

### **19.11 SOAK PIT 1.2 × 1.2 × 1.2 M**

#### **19.11.1 Construction**

The earth excavation shall conform to the general specifications for earth work. After the excavation is complete the soak pit shall be filled with brick bats. The brick bats shall be from properly burnt bricks. 10 cm wide and 10 cm deep brick edging with bricks of class designation 75 shall be provided round the soak pit.

#### **19.11.2 Measurements**

Soak pits shall be enumerated.

#### **19.11.3 Rate**

Rate shall include the cost of labour and materials involved in all the operations.

### **19.12 DISPERSION TRENCH (FIG. 19.18)**

It shall be provided when the sub-soil water level is within 180 cm from the ground level. Dispersion trenches are not recommended in areas where fibrous roots of trees or vegetation are likely to penetrate the system and cause blockages.

#### **19.12.1 Construction**

Dispersion trenches shall be 50 to 100 cm deep and 30 to 100 cm wide, excavated to a slight gradient and shall be provided with 15 to 25 cm of washed gravel or crushed stones. Open jointed pipes placed inside the trench shall be made of unglazed earthenware clay or concrete and shall have minimum internal diameter of 75 to 100 mm. Each dispersion trench should not be longer than 30 m and trenches should not be placed closer than 1.8 m.

The covering for the pipes on the top shall be with coarse aggregate of uniform size to a depth of approximately 15 cm. The aggregate above this level may be graded with aggregate 12 to 15 mm to prevent ingress of top soil while the free flow of water is no way retarded. The trench may be covered with about 30 cm of ordinary soil to form a mound and turned over. The finished top surface may be kept at least 15 cm above ground level to prevent direct flooding of the trench during rains.

#### **19.12.2 Measurements**

The length of dispersion trench shall be measured in running metres nearest to a cm.

#### **19.12.3 Rate**



The rate shall include the cost of materials and labour involved in all the operations described above.

### **19.13 DESLUDGING OF SEPTIC TANKS**

Septic tanks shall be desludged periodically, the intervals of desludging, depending upon the design of the septic tanks and the capacity in relation to its users. Desludging may be done when the sludge level reaches a predetermined level. A portion of the sludge may be left in the tank to seed the fresh deposits.

Desludging shall preferably be carried out by hydrostatic head or by using a portable pump. Manual handling of sludge shall be discouraged.

### **19.14 DISMANTLING OF OLD S.W. PIPES**

The specification specified in clause 15.3.16 shall be applicable.

### **19.15 6 MM THICK PLASTIC ENCAPSULATED M.S. FOOT REST: DELETED**

### **19.16 REPLACEMENT OF M.S. FOOT RESTS IN MANHOLES: DELETED**

### **19.17 RAISING OF MANHOLE COVER AND FRAME SLAB**

#### **19.17.1 General**

##### **Removal of RCC Cover and frame**

Shall be removed carefully and stacked properly as per direction of Engineer-in-charge.

##### **Dismantling of RCC Slab**

Dismantling of RCC slab shall conform to the specifications described in para 15.3.11.

##### **Brick Works**

Brick work shall conform to the specifications described in para 19.4.3

##### **Plaster and pointing**

Plaster and pointing shall conform to the specifications described in para 19.4.4.

##### **Frame Work (centering & shuttering)**

Frame Work (centering & shuttering) shall conform to the specifications described in para 5.2

##### **RCC Work**

RCC Work shall conform to the specifications described in para 5.4

##### **Placing of Covers and Frames**

Placing of Covers and Frames shall conform to the specifications described in para 19.4.7.

#### **19.17.2 Measurements**

Raising of Manhole shall be enumerated under relevant items.

#### **19.17.3 Rate**

The rate shall include the cost of materials and labour involved in all the operations described above but excludes the cost of (i) Reinforcement and (ii) The raising depth of the manhole to be paid separately.

### **19.18 INSPECTION CHAMBER (FIG.19.20 to 19.22)**

**19.18.1** At every change of alignment, gradient or diameter of drain, there shall be an inspection chamber. Bends and junctions in the drain shall be grouped together in inspection chamber as far as possible. The maximum distance between chambers shall be 30m.



Inspection chambers of different types and sizes as specified shall be constructed in the drainage line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer-in Charge. The size specified shall indicate the inside dimensions between brick faces of the inspection chamber.

Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the inspection chamber. In exceptional cases and where unavoidable, the crown of the branch drainage may be fixed at lower level but in such cases the peak flow level of the two drainage shall be kept the same.

Drainage of unequal sectional area shall not be jointed at the same invert in a inspection chamber. The invert of the smaller drainage at its junction with main shall be at least  $\frac{2}{3}$  the diameter of the main above the invert of the main. The branch drainage shall deliver drainage in the inspection chamber in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

Inspection chamber of 455 × 610 mm and 45 cm deep for single pipe line, 500 × 700 mm and 45 cm deep for one or two inlets and 600 × 850 mm and 45 cm deep for three or more inlets are generally constructed for drainage line.

#### **19.18.2 Excavation**

The excavation for inspection chamber shall be true to dimensions and levels shown on the plans or as directed by the Engineer-in-Charge.

#### **19.18.3 Bed Concrete**

The inspection chambers shall be built on a bed of cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate 40 mm nominal size) unless required by local authorities. The thickness of the bed concrete shall be 15 cm unless otherwise specified or directed by the Engineer-in-Charge and 40 mm thick cement concrete 1:2:4 (1 cement: 4 coarse sand: 4 grade stone aggregate 40 mm nominal size).

#### **19.18.4 Brick Work**

The brick work shall be with class 75 bricks in one brick thickness in cement mortar 1:4 (1 cement: 4 coarse sand). The external joints of the brick masonry shall be finished smooth, and the joints of the pipes with the masonry shall be made perfectly leak proof.

#### **19.18.5 Plaster and Pointing**

The walls of the inspection chambers shall be plastered inside including bed with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth.

For earth work excavation, bed concrete, brick work, plaster and pointing, R.C.C. work and refilling of earth, respective specifications shall be followed.

#### **19.18.6 Inspection Chamber Covers and Frames**

The frame of inspection chambers shall be firmly embedded to correct alignment and levels in

R.C.C. slab or plain concrete as the case may be on the top of the masonry. After completion of the work, inspection chambers covers shall be sealed by means of thick grease.

#### **19.18.7 Measurements**

Inspection chambers shall be enumerated under relevant items. The depth of the inspection chambers shall be reckoned from the top level of C.I. cover to the invert level. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

#### **19.18.8 Rate**



The rate shall include the cost of materials and labour involved in all the operations described above but excludes the cost of (i) excavation, (ii) 12 mm thick cement plaster with water proofing material applied at the external surface of the inspection chambers if required (iii) 40 mm thick cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 grade stone aggregate 40 mm nominal size). These items shall be paid for separately under relevant items of work. Payment for extra depths of inspection chambers shall be made separately under relevant items of work.

### 19.19 NON PRESSURE NP-3 CLASS (MEDIUM DUTY)/ NP-4 CLASS (HEAVY DUTY) R.C.C. PIPES

**19.19.1** The pipes shall be with reinforcement as required and shall be of class not lesser than NP2. These shall conform to IS 458 and shall be capable of withstanding a test pressure of 0.07 MPa (7 m head). The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process or vibrated casting process. All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or moulding.

Concrete used for the manufacture of reinforced concrete pipes and collars shall be as per design mix. The concrete quality (concrete mix, maximum water-cement ratio, minimum cement content. etc) shall be as per IS 456 for at least very severe environment exposure condition with minimum cement content 260 kg/m<sup>3</sup>. The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm internal diameter. But for pipes of internal diameter 80 to 250 mm, the maximum size of aggregate should be 10mm. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

The Design/ dimensional requirements of concrete pipes are given in Appendix I A (collar for NP2 pipe) and I B (for NP-2 pipe), Appendix I C (Collar for NP-3 & NP-4 pipe), Appendix I D and 1 E (for NP-3 pipe), Appendix I F and I G (for NP-4 pipe).

The minimum clear cover for reinforcement in pipes and collars shall be as given in Table 19.6.

**TABLE 19.6**

Sl. No.	Precast concrete pipe/collar	Minimum clear cover, mm
(i)	Barrel wall thickness	
	(a) Upto and including 75 mm	8
	(b) Over 75 mm	15
(ii)	At spigot steps	5
(iii)	At end of longitudinal	5

Note: An effective means shall be provided for maintaining the reinforcement in position and for ensuring correct cover during manufacture of the unit. Spacers for this purpose shall be of rust proof material or of steel protected against corrosion.

### 19.19.2 Laying and Jointing Cement Concrete Pipes and Specials

#### 19.19.2.1 Trenches:

- Trenches shall be as described in 18.4.4. Where the pipes are to be bedded directly on soil, the bed shall be suitably rounded to fit the lower part of the pipe, the cost for this operation being included in the rate for laying the pipe itself.



- ii. Loading, transporting and unloading of concrete pipes shall be done with care. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain pulley block is recommended. All pipe sections and connections shall be inspected carefully before being laid. Broken or defective pipes or connections shall not be used. Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used. Pipes shall be laid true to line and grade as specified. Laying of pipes shall proceed upgrade of a slope.
- iii. If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes with joints to be made with loose collars, the collars shall be slipped on before the next pipe is laid. Adequate and proper expansion joints shall be provided where directed.
- iv. In case where foundation conditions are unusual such as in the proximity of trees or holes, under existing or proposed tracks manholes etc. the pipe shall be encased all-around in 15 cm thick cement concrete 1:5:10 (1 cement : 5 fine sand : 10 graded stone aggregate 40 mm nominal size) or compacted sand or gravel.
- v. In cases where the natural foundation is inadequate the pipes shall be laid either in concrete cradle supported on proper foundations or on any other suitably designed structure. If a concrete cradle bedding is used the depth of concrete below the bottom of the pipe shall be at least 1/4th of the internal dia of the pipe subject to the min. of 10 cm and a maximum of 30 cm. The concrete shall extend up the sides of the pipe at least to a distance of 1/4th of the outside diameter of pipes 300 mm and over in dia. The pipe shall be laid in this concrete bedding before the concrete has set. Pipes laid in trenches in earth shall be bedded evenly and firmly and as far up the haunches of the pipe as to safely transmit the load expected from the backfill through the pipe to the bed. This shall be done either by excavating the bottom of the trench to fit the curve of the pipe or by compacting the earth under around the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.
- vi. When the pipe is laid in a trench in rock hard clay, shale or other hard material the space below the pipe shall be excavated and replaced with an equalising bed of concrete, sand or compacted earth. In no place shall pipe be laid directly on such hard material.
- vii. The method of bedding and laying the pipes under different conditions are illustrated in Fig. 19.9.
- viii. When the pipes are laid completely above the ground the foundations shall be made even and sufficiently compacted to support the pipe line without any material settlement. Alternatively the pipe line shall be supported on rigid foundations at intervals. Suitable arrangements shall be made to retain the pipe line in the proper alignment, such as by shaping the top of the supports to fit the lower part of the pipe. The distance between the supports shall in no case exceed the length of the pipe. The pipe shall be supported as far as possible close to the joints. In no case shall the joints come in the centre of the span. Care shall be taken to see that super imposed loads greater than the total load equivalent to the weight of the pipe when running full shall not be permitted. Suitably designed anchor blocks at change of direction and grades for pressure lines shall be provided where required.

#### 19.19.2.2 Jointing:

- i. Joints are generally of rigid type. Where specified flexible type joints may also be provided.
- ii. Rigid Spigot and Socket Joint (Fig. 19.10): The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar in the proportion of 1:2 (1 cement: 2 fine sand) which shall be rammed with caulking tool. After a day's work any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.
- iii. Rigid Collar Joint (Fig. 19.10): The two adjoining pipes shall be butted against each other and adjusted in correct position. The collar shall then be slipped over the joint, covering equally both the pipes. The annular



space shall be filled with stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) which shall be rammed with caulking fool. After a day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.

- iv. Semi Flexible Spigot and Socket Joint (Fig. 19.10): The joint is composed of specially shaped spigot and socket ends on the concrete pipes. A rubber ring shall be placed on the spigot which shall be forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and the socket, stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work any extraneous materials shall be removed from the inside of the pipe and the newly made joint shall be cured.
- v. Semi Flexible Collar Joint: This is made up of a loose collar which covers two specially shaped pipe ends as shown in the Fig. 19.10. Each end shall be fitted with a rubber ring which when compressed between the spigot and the collar, seal the joint. Stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand), shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.
- vi. Internal Flush Joint (Fig. 19.10): This joint is generally used for culvert pipe of 60 cm dia and over. The ends of the pipe are specially shaped to form a self centering joint with an internal jointing space 1.3 cm wide the finished joint is flush with both inside and outside with the pipe wall as shown in Fig. 19.10. The jointing space is filled with cement mortar 1:2 (1 cement: 2 fine sand) mixed sufficiently dry to remain in position when forced with a trowel or rammer. After day's work, any extraneous material shall be removed from the inside of the pipe and the newly made joint shall be cured.
- vii. External Flush Joint: This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends as shown in Fig. 19.10. Each end shall be butted against each other and adjusted in correct position. The jointing space shall then be filled with cement mortar 1:2 (1 cement: 2 fine sand) sufficiently dry and finished off flush. Great care shall be taken to ensure that the projecting ends are not damaged as no repairs can be readily affected from inside the pipe.

**19.19.2.3** In all pressure pipe lines the recess at the end of the pipe line shall be filled with jute braiding dipped in hot bitumen or other suitable approved compound. Pipes shall be so jointed that the bitumen ring of one pipe shall set into the recess of the next pipe. The ring shall be thoroughly compressed by jacking or by any other suitable method.

The number of pipes that shall be jacked together at a time shall depend on the diameter of the pipes and the bearing capacity of the soil, for small pipes up to 25 cm diameter, six pipes can be jacked together at a time.

The quantity of jute and bitumen in the ring shall be just sufficient to fill the recess in the pipe when pressed hard by jacking or by any other suitable method. Before and during jacking care shall be taken to see that there is no offset at the joint.

**19.19.2.4 Testing:** For pressure pipes, the completed pipeline shall be tested for pressure (Known as site test pressure) which shall not be less than the maximum pipeline operating pressure plus the calculated surge pressure, but in no case shall it exceed the hydrostatic test pressure. For non pressure pipes the joints shall be tested as per procedure laid down under Para

**19.19.2.5 Refilling of Trenches:**

The specification described in 19.2.1.2 (v) shall apply. In case where pipes are not bedded on concrete special care shall be taken in refilling, trenches to prevent the displacement and subsequent settlement at the surface resulting in uneven street surfaces and dangers to foundations etc. The backfilling materials shall be packed by hand under and around the pipe and rammed with a shovel and light tamper. This





method of filling will be continued up to the top of pipe. The refilling shall rise evenly on both sides of the pipe and continued up to 60 cm above the top of pipe so as not to disturb the pipe. No tamping shall be done within 15 cm of the top of pipe. The tamping shall become progressively heavier as the depth of the backfill increases.

#### **19.19.2.6 Measurements**

The lengths of pipes shall be measured in running metres nearest to a cm as laid or fixed, from inside of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes over all fittings such as bends, collars, junctions, etc. which shall not be measured separately.

Excavation, refilling, shoring and timbering in trenches, and cement concreting wherever required shall be measured separately under relevant items of work.

#### **19.19.2.7 Rate:**

The rate shall include the cost of materials and labour involved in all the operations described above.





## APPENDIX I

### A. DIMENSIONAL REQUIREMENT OF CLASS NP2-REINFORCED CONCRETE LIGHT DUTY, NON PRESSURE PIPES & COLLAR (Clause 19.2.2)

Nominal Internal Diameter of Pipe	Barrel Wall Thickness of pipe	Collar Dimensions			Reinforcements in Collar		
		Minimum Caulking Space	Minimum Thickness	Minimum Length	Longitudinal, Mild steel or Hard Drawn Steel	Spiral Hard Drawn Steel	
mm	mm	mm	mm	mm	Minimum Number	Weight Kg/Collar	Kg/Collar
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
80	25	13	25	150	6	0.08	0.07
100	25	13	25	150	6	0.08	0.08
150	25	13	25	150	6	0.08	0.10
200	25	13	25	150	6	0.08	0.12
225	25	13	25	150	6	0.08	0.14
250	25	13	25	150	6	0.08	0.16
300	30	16	30	150	8	0.11	0.22
350	32	16	32	150	8	0.11	0.25
400	32	16	32	150	8	0.11	0.27
450	35	19	35	200	8	0.15	0.40
500	35	19	35	200	8	0.15	0.60
600	45	19	40	200	8	0.15	0.70
700	50	19	40	200	8	0.23	1.05
800	50	19	45	200	8	0.23	1.85
900	55	19	50	200	8	0.23	2.05
1000	60	19	55	200	8	0.33	2.25
1100	65	19	60	200	8	0.33	3.09
1200	70	19	65	200	8	0.33	4.11
1400	75	19	75	200	12	0.50	5.08
1600	80	19	80	200	12 or 8+8	0.67	6.55
1800	90	19	90	200	12 or 8+8	0.67	9.00
2000	100	19	100	200	12+12	1.00	12.15



2200	110	19	110	200	12+12	1.00	13.30
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**Note:**

1. If the mild steel is used for spiral reinforcement, the weight specified under col. 7 shall be increased by a factor 140/25.
2. Soft grade mild steel wire may be used as reinforcement for collars of pipes of nominal internal diameter up to 250 mm only, by increasing the weight by a factor 140/84. Where only soft grade mild steel wire is used for making collar cages, the weight of reinforcement shall be total weight of col. 6 and 7 multiplied by 140/84. This is allowed as a process requirement.
3. Internal diameter of collar to suit the actual diameter of pipes with minimum caulking space as given in col. 2



**B. REINFORCED CONCRETE PRESSURE PIPES CLASS P1 TESTED TO 20 m HEAD, CLASS P2 TESTED TO 40 m HEAD AND CLASS P3 TESTED TO 60 m HEAD**

Internal diameter of pipes	Barrel dimension		
	Class P1	Class P2	Class P3
(mm)	(mm)	(mm)	(mm)
80	25	25	25
100	25	25	25
150	25	25	25
200	25	30	35
225	25	30	35
250	25	30	35
300	30	40	45
350	32	45	55
400	32	50	60
450	35	50	70
500	35	55	75
600	40	65	90
700	40	70	105
800	45	80	120
900	50	90	-
1000	55	100	-
1100	60	-	-
1200	65	-	-

**Notes:**

1. The effective length of barrel shall be 2 m up to 250 mm nominal diameter pipes and 2.5, 3.0, 3.5 or 4.0 m for pipes above 250 mm.
2. Collar dimensions will be same as specified for class NP2 pipes.



## APPENDIX - I A

**C. Table 21 DESIGN REQUIREMENT OF REINFORCED CONCRETE COLLAR FOR PIPE OF CLASS NP-2 (Clause 19.19) (Clause 6.3 and 8.1 of IS 458:2003)**

Nomin al Intern al Diamet er of Pipe	Collar Dimensions			Reinforcements in Collar		
	Minimum Caulking Space	Minimu m Thickne ss	Mini m um Leng th	Longitudinal, Mild steel or Hard Drawn Steel		Spiral Hard Drawn Steel
mm	mm	mm	mm	Minimum Number	Weight Kg/Collar	Kg/Collar
(1)	(3)	(4)	(5)	(6)	(7)	(8)
80	13	25	150	6	0.08	0.07
100	13	25	150	6	0.08	0.08
150	13	25	150	6	0.08	0.10
200	13	25	150	6	0.08	0.12
225	13	25	150	6	0.08	0.14
250	13	25	150	6	0.08	0.16
300	16	30	150	8	0.11	0.22
350	16	32	150	8	0.11	0.25
400	16	32	150	8	0.11	0.27
450	19	35	200	8	0.15	0.40
500	19	35	200	8	0.15	0.60
600	19	40	200	8	0.15	0.70
700	19	40	200	8	0.23	1.05
800	19	45	200	8	0.23	1.85
900	19	50	200	8	0.23	2.05
1000	19	55	200	8	0.33	2.25
1100	19	60	200	8	0.33	3.09
1200	19	65	200	8	0.33	4.11
1400	19	75	200	12	0.50	5.08
1600	19	80	200	12 or 8+8	0.67	6.55
1800	19	90	200	12 or 8+8	0.67	9.00
2000	19	100	200	12+12	1.00	12.15
2200	19	110	200	12+12	1.00	13.30



**Note:**

1. If the mild steel is used for spiral reinforcement, the weight specified under col. 7 shall be increased by a factor 140/125.
2. Soft grade mild steel wire may be used as reinforcement for collars of pipes of nominal internal diameter up to 250 mm only, by increasing the weight by a factor 140/84. Where only soft grade mild steel wire is used for making collar cages, the weight of reinforcement shall be total weight of col. 6 and 7 multiplied by 140/84. This is allowed as a process requirement.
3. Internal diameter of collar to suit the actual diameter of pipes with minimum caulking space as given in col. 2.



## APPENDIX-I B

**D. Table 2 Design and Strength Test Requirements of Concrete Pipes of Class NP2- Reinforced Concrete, Light Duty, Non-pressure Pipes (Clause 19.19) (Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20 of IS 458:2003)**

Internal Diameter of Pipes	Barred wall Thickness	Reinforcements			Strength Test requirements for Three Edge Bearing Test.	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spiral Hard Drawn Steel	Load to Produce 0.25 mm Crack	Ultimate Load
mm	mm	Minimum Number	Kg/linear metre	kg/linear metre	kN/linear metre	kN/linear metre
(1)	(2)	(3)	(4)	(5)	(6)	(7)
80	25	6	0.59	0.16	10.05	15.08
100	25	6	0.59	0.18	10.05	15.08
150	25	6	0.59	0.24	10.79	16.19
200	25	6	0.59	0.38	11.77	17.66
225	25	6	0.59	0.46	12.26	18.39
250	25	6	0.59	0.58	12.55	18.83
300	30	8	0.78	0.79	13.48	20.22
350	32	8	0.78	1.13	14.46	21.69
400	32	8	0.78	1.49	15.45	23.18
450	35	8	0.78	1.97	16.18	24.27
500	35	8	0.78	2.46	17.16	25.74
600	45	8	0.78	3.47	18.88	28.32
700	50	8	1.22	4.60	20.35	30.53
800	50	8	1.22	6.71	21.57	32.36
900	55	8	1.22	9.25	22.80	34.20
1000	60	8	1.76	10.69	24.27	36.41
1100	65	8	1.76	12.74	25.50	38.25
1200	70	8	1.76	15.47	26.97	40.46
1400	75	12	2.64	20.57	29.42	44.13
1600	80	12 or 8+8	3.52	25.40	32.12	48.18
1800	90	12 or 8+8	3.52	32.74	35.06	52.59



2000	100	12+12	5.28	45.14	37.76	56.64
2200	110	12+12	5.28	56.37	40.21	60.32

#### NOTES

1. If mild steel is used for spiral reinforcement, the weight specified under col. 5 shall be increased to 140/125.
2. Soft grade mild steel wire for spirals may be used for pipes of internal diameters 80 mm, 100 mm and 150 mm only by increasing weight to 140/84.
3. The longitudinal reinforcement given in this table is valid for pipes up to 25m effective length for internal diameter of pipe up to 250mm up to 3m effective length for higher diameter pipe.
4. Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col. 4 by the length of the pipe and then deducting for the cover length provided at the two ends.



## APPENDIX-I C

**E. Table 22 Design Requirements of Reinforced Concrete Collars for Pipes of Class NP3 and NP4  
(Clauses 6.3 and 8.1 of IS 458:2003)**

Nominal Internal Diameter of pipe	Collar Dimensions			Reinforcements		
	Minimum caulking Space	Minimum Thickness	Minimum Length	Longitudinal, Mild Steel or Hard Drawn Steel		Spiral Hard Drawn Steel
mm (1)	mm (2)	mm (3)	mm (4)	Nos (5)	Kg/collar (6)	Kg/collar (7)
90	13	25	150	6	0.08	0.07
100	13	25	150	6	0.08	0.08
150	13	25	150	6	0.08	0.10
200	13	25	150	6	0.08	0.12
225	13	25	150	6	0.08	0.14
250	13	25	150	6	0.08	0.16
300	16	30	150	8	0.11	0.22
350	19	35	200	8	0.15	0.40
400	19	35	200	8	0.15	0.50
450	19	35	200	8	0.15	0.60
500	19	40	200	8	0.15	0.70
600	19	40	200	8	0.23	1.05
700	19	45	200	8	0.23	1.85
800	19	50	200	8	0.23	2.05
900	19	55	200	8	0.33	2.25
1000	19	60	200	8	0.33	3.09
1100	19	65	200	8	0.33	4.11
1200	19	75	200	12	0.50	5.08
1400	19	80	200	12 or 8+8	0.67	6.55
1600	19	90	200	12 or 8+8	0.67	9.00
1800	19	100	200	12 +12	1.00	12.15
2000	19	110	200	12 +12	1.00	13.30





# APPENDIX-I D

**F. Table 3 Design and Strength Test Requirements of Concrete Pipes of Class NP3-Reinforced Concrete, Medium Duty, Non-pressure Pipes (Clauses 6.1.1, 6.1.2, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20 of IS 458:2003)**

Internal Diameter of Pipes	Barred wall Thickness	Reinforcements			Strength Test requirements for Three Edge Bearing Test.	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spiral Hard Drawn Steel	Load to Produce 0.25 mm Crack	Ultimate Load
mm	mm	Minimum Number	kg/linear metre	kg/linear metre	kN/linear metre	kN/linear metre
(1)	(2)	(3)	(4)	(5)	(6)	(7)
80	25	6	0.59	0.16	13.00	19.50
100	25	6	0.59	0.22	13.00	19.50
150	25	6	0.59	0.46	13.70	20.55
200	30	6	0.59	0.81	14.50	21.75
225	30	6	0.59	1.03	14.80	22.20
250	30	6	0.59	1.24	15.00	22.50
300	40	8	0.78	1.80	15.50	23.25
350	75	8	0.78	2.95	16.77	25.16
400	75	8	0.78	3.30	19.16	28.74
450	75	8	0.78	3.79	21.56	32.34
500	75	8	0.78	4.82	23.95	35.93
600	85	8 or 6+6	1.18	7.01	28.74	43.11
700	85	8 or 6+6	1.18	10.27	33.53	50.30
800	95	8 or 6+6	2.66	13.04	38.32	57.48
900	100	6+6	2.66	18.30	43.11	64.67
1000	115	6+6	2.66	21.52	47.90	71.85
1100	115	6+6	2.66	27.99	52.69	79.00
1200	120	8+8	3.55	33.57	57.48	86.22
1400	135	8+8	3.55	46.21	67.06	100.60
1600	140	8+8	3.55	65.40	76.64	114.96
1800	150	12+12	9.36	87.10	86.22	129.33
2000	170	12+12	9.36	97.90	95.80	143.70



2200	185	12+12	9.36	133.30	105.38	158.07
2400	200	12+12	14.88	146.61	114.96	172.44
2600	215	12+12	14.88	175.76	124.54	186.81

#### NOTES

1. If mild steel is used for spiral reinforcement, the weight specified under col 5 shall be increased to 140/125.
2. The longitudinal reinforcement given in this table is valid for pipes up to 25m effective length for internal diameter of pipe up to 250 mm and up to 3m effective length for higher diameter pipes.
3. Total mass of longitudinal reinforcement Shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.
4. Concrete for pipes shall have a minimum compressive strength of 35 N/mm<sup>2</sup> at 28 days.



## APPENDIX-I E

**G. Table 5 Design and Strength Test Requirements of Concrete Pipes of Class NP3-Reinforced Concrete, Medium Duty, Non-pressure Pipes made by Vibrated Casting Process (Clauses 5.5.1, 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20 of IS 458:2003)**

Internal Diameter of Pipes	Minimum Barred Thickness	Reinforcements			Strength Test requirements for Three Edge Bearing Test.	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spiral Hard Drawn Steel	Load to Produce 0.25 mm Crack	Ultimate Load
mm	mm	Minimum Number	Kg/linear metre	kg/linear metre	kN/linear metre	kN/linear metre
(1)	(2)	(3)	(4)	(5)	(6)	(7)
300	50	8	0.78	1.53	15.50	23.25
350	55	8	0.78	1.58	16.77	25.16
400	60	8	0.78	1.60	19.16	28.74
450	65	8	0.78	1.90	21.56	32.34
500	70	8	0.78	2.00	23.95	35.93
600	75	8 or 6+6	1.18	2.20	28.74	43.11
700	85	8 or 6+6	1.18	4.87	33.53	50.30
800	95	8 or 6+6	2.66	6.87	38.32	57.48
900	100	6+6	2.66	11.55	43.11	64.67
1000	115	6+6	2.66	15.70	47.90	71.85
1100	120	6+6	2.66	19.61	52.69	79.00
1200	125	8+8	3.55	21.25	57.48	86.22
1400	140	8+8	3.55	30.00	67.06	100.60
1600	165	8+8	3.55	50.63	76.64	114.96
1800	180	12+12	9.36	64.19	86.22	129.33
2000	190	12+12	9.36	83.12	95.80	143.70
2200	210	12+12	9.36	105.53	105.40	158.07
2400	225	12+12	14.88	133.30	115.00	172.44

NOTE -- Concrete for pipes shall have a minimum compressive strength or 35 N/mm<sup>2</sup> at 28 days



## APPENDIX-I F

**H. Table 6 Design and Strength Test Requirements of Concrete Pipes of Class NP4-Reinforced Concrete, Medium Duty, Non-pressure Pipes (Clauses 6.1.1, 6.1.2, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20 of IS 458:2003)**

Internal Diameter of Pipes	Barred wall Thickness	Reinforcements			Strength Test requirements for Three Edge Bearing Test.	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spiral Hard Drawn Steel	Load to Produce 0.25 mm Crack	Ultimate Load
mm	mm	Minimum Number	kg/linear metre	kg/linear metre	kN/linear metre	kN/linear metre
(1)	(2)	(3)	(4)	(5)	(6)	(7)
80	25	6	0.59	0.24	22.10	33.15
100	25	6	0.59	0.36	22.10	33.15
150	25	6	0.59	0.74	22.30	34.95
200	30	6	0.59	1.30	24.60	36.90
225	30	6	0.59	1.64	25.20	37.80
250	30	6	0.59	1.98	25.50	38.25
300	40	8	0.78	2.71	26.40	39.60
350	75	8	0.78	3.14	29.80	44.70
400	75	8	0.78	3.52	33.90	50.90
450	75	8	0.78	3.88	36.90	55.30
500	75	8	0.78	5.96	40.00	61.20
600	85	8 or 6+6	2.34	9.63	46.30	69.40
700	85	8 or 6+6	3.44	14.33	52.20	78.30
800	95	8 or 6+6	3.44	21.20	59.30	79.10
900	100	6+6	3.34	27.13	66.30	99.40
1000	115	8+8	6.04	35.48	72.60	108.90
1100	115	8+8	6.04	43.76	80.40	120.60
1200	120	8+8	6.04	53.07	88.30	132.40
1400	135	8+8	9.36	77.62	104.20	156.40
1600	140	12+12	9.36	108.97	119.60	179.50
1800	150	12+12	14.88	150.22	135.30	203.00
2000	170	12+12	14.88	151.79	135.30	203.00



2200	185	12+12	14.88	160.90	142.20	213.30
2400	200	12+12	14.88	216.96	155.00	232.50
2600	215	12+12	14.88	258.93	166.70	250.00

#### NOTES

1. If mild Steel is used for spiral reinforcement, the weight specified under col 5 shall be increased to 140/125.
2. The longitudinal reinforcement given in this table is valid for pipes up to 25m effective length for internal diameter of pipe up to 250 mm and 3 m effective length for higher diameter pipes.
3. The total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and then deducting for the cover length provided at the two ends.
4. Concrete for pipes shall have a minimum compressive strength of 35 N/mm<sup>2</sup> at 28 days.



## APPENDIX-I G

### I. Table 8 Design and Strength Test Requirements of Concrete Pipes of Class NP4-Reinforced Concrete, Heavy Duty, Non-pressure Pipes made by Vibrated Casting Process (Clauses 5.5.1, 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 7.3.2, 8.1 and Table 20 of IS 458:2003)

Internal Diameter of Pipes	Barred wall Thickness	Reinforcements			Strength Test requirements for Three Edge Bearing Test.	
		Longitudinal, Mild Steel or Hard Drawn Steel		Spiral Hard Drawn Steel	Load to Produce 0.25 mm Crack	Ultimate Load
mm	mm	Minimum Number	Kg/linear metre	kg/linear metre	kN/linear metre	kN/linear metre
(1)	(2)	(3)	(4)	(5)	(6)	(7)
300	50	8	0.78	1.53	26.40	38.60
350	55	8	0.78	1.61	29.80	44.70
400	60	8	0.78	1.97	33.90	50.90
450	65	8	0.78	3.36	36.90	55.30
500	70	8	0.78	5.56	40.00	61.20
600	75	8 or 6+6	2.34	8.50	46.30	69.40
700	85	8 or 6+6	3.44	12.78	52.20	78.30
800	95	8 or 6+6	3.44	16.72	59.30	89.10
900	100	6+6	3.44	20.92	66.30	99.40
1000	115	8+8	6.04	26.70	72.60	108.90
1100	120	8+8	6.04	35.60	80.40	120.60
1200	125	8+8	6.04	42.42	88.30	132.40
1400	140	8+8	9.36	53.39	104.20	156.40
1600	165	12+12	9.36	79.92	119.60	179.50
1800	180	12+12	14.88	85.75	135.30	203.00
2000	190	12+12	14.88	108.00	135.30	203.00

NOTES: - Concrete for pipe shall have a minimum compressive strength of 35 N/mm<sup>2</sup> at 28 days

#### Marking

The following information shall be clearly marked on each pipe/collar:

1. Indication of the source of manufacture.
2. Class and Size of pipe/collar.



3. The words 'SPUN PIPE' or 'VIBRATED CAST PIPE (UNREINFORCED)' or 'VIBRATED CAST PIPE (REINFORCED)' as may be applicable, for pipes; and
4. Date of manufacture

The above information shall be clearly marked on outside only for pipes up to and including 350 mm internal diameter, and both outside and inside for pipes above 350 mm internal diameter. The information shall be clearly marked only on the outside for collars.

'Each pipe/collar may also be marked with the Standard Mark'

The Number of tests and criteria for conformity shall be as given in table 22 of IS 458:2003 Table 22 Scale of Sampling and Permissible number of Defectives. (Clauses 11.1.3, 11.2.1.1 and 11.2.2 of IS 458:2003).

No. of Pipes in the Lot	For Requirement Under Clauses 8 and 9 of IS 458:2003		Sample Size for Test Under clause 10.2 of IS 458:2003 (Excluding Ultimate Load Test)
	Sample Size	Permissible Number or Defectives	
(1)	(2)	(3)	(4)
Up to 50	8	0	2
51 to 100	13	1	3
101 to 300	20	2	5
301 to 500	32	3	7
501 and above	50	5	10

The Lot shall be declared as conforming to these requirements if the number of defectives found in the sample does not exceed the number of defectives given in col. 3 of Table 22.

#### **Tolerances: (As per IS 458:2003 Para 8.2)**

The following tolerances shall be permitted:

Sl. No.	Dimensions	Tolerances
i)	Overall length	$\pm 1$ percent of standard length
ii)	Internal diameter of pipes:	
	a) Up to and including 300	$\pm 3$ mm
	b) Over 300 mm and up to and including 600 mm	$\pm 5$ mm
	c) Over 600 mm	$\pm 10$ mm
iii)	Barrel wall thickness:	
	a) Up to and including 30 mm	+2 mm -1 mm



	b) Over 30 mm up to and including 50 mm	+3 mm -1.5 mm
	c) Over 50 mm up to and including 65 mm	+4 mm -2 mm
	d) Over 65 mm up to and including 80 mm	+5 mm -2.5 mm
	e) Over 80 mm up to and including 95 mm	+6 mm -3 mm
	f) Over 95 mm	+7 mm -3.5 mm

**Note-** In case of pipes with flexible rubber ring joints, the tolerance on thickness near the ends will have to be reduced. Near the rubber ring joints, the tolerance on thickness shall be as given in tables 13 to 19 of IS 458:2003 in case of pipes manufactured by spinning process and as given in table 15 and table 16 of IS 458:2003 in case of pipes manufactured by vibrated casting process.



**APPENDIX - II****RECOMMENDED SIZES OF SEPTIC TANKS (Clause 19.9)****RECOMMENDED SIZES OF SEPTIC TANKS FOR 5-20 USERS**

No of users	Length	Breath	Liquid depth (cleaning interval of)	
			1 year	2 year
	(m)	(m)	(m)	(m)
05	1.5	0.75	1.0	1.05
10	2.0	0.90	1.0	1.40
15	2.0	0.90	1.3	2.00
20	2.3	1.10	1.3	1.80

Notes:

1. The capacities are recommended on the assumption that discharges from only WC will be treated in the septic tank.
2. A provision of 300 mm should be made for free board.
3. The sizes of septic tanks are based on certain assumptions, while choosing the size of septic tank exact calculation shall be made.

**RECOMMENDED SIZES OF SEPTIC TANKS FOR RESIDENTIAL COLONIES**

No of users	Length	Breath	Liquid depth (cleaning interval of)	
			1 year	2 year
	(m)	(m)	(m)	(m)
050	5.0	2.0	1.0	1.24
100	7.5	2.65	1.0	1.24
150	10.0	3.0	1.0	1.24
200	12.0	3.3	1.0	1.24
300	15.0	4.0	1.0	1.24

Notes:

4. A provision of 300 mm should be made for free board.
5. The sizes of the septic tank are based on certain assumptions while choosing the size of septic tank, exact calculation shall be made.
6. For population over 100, the tank may be divided into independent parallel chambers for ease of maintenance and cleaning.

**RECOMMENDED SIZES OF SEPTIC TANKS FOR HOSTEL AND BOARDING SCHOOLS**



No of users	Length	Breath	Liquid depth (D) for stated intervals of sludge withdrawal	
			Once in a year	Once in 2 year
	(m)	(m)	(m)	(m)
50	5.0	1.6	1.3	1.4
100	5.7	2.1	1.4	1.7
150	7.7	2.4	1.4	1.7
200	8.9	2.7	1.4	1.7
300	10.7	3.3	1.4	1.7

Notes:

1. A provision of 300 mm should be made for free board.
2. The sizes of the septic tank are based on certain assumptions while choosing the size of septic tank exact calculation shall be made.
3. For population over 100, the tank may be divided into independent parallel chambers for ease of maintenance and cleaning.



## GULLY TRAP

Sub Head : Drainage

Clause : 19.8

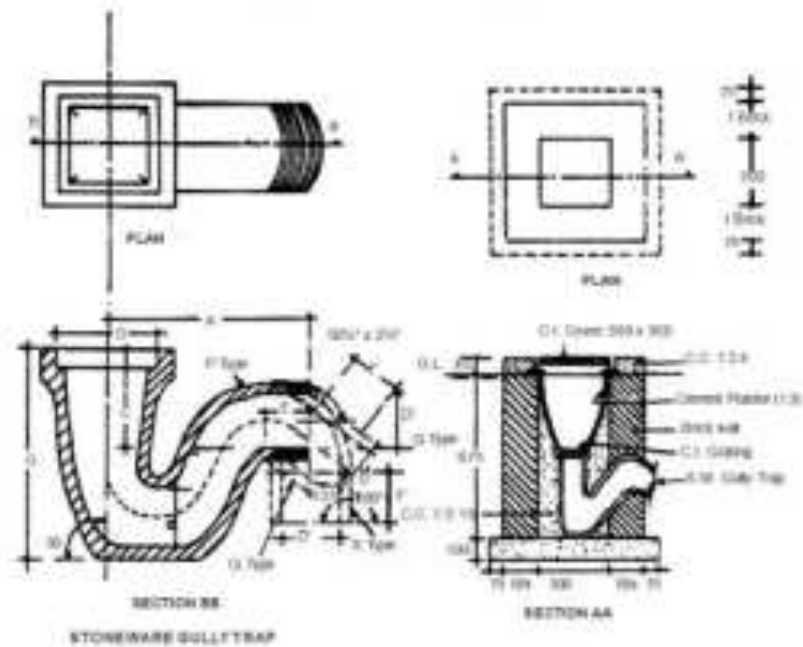


Figure 19.2 : Gully Trap

Type	Size	A	C	d	D	D	E	F	F	G
P	100 x 100	305	175	100	100	100	65	—	—	330
	125 x 100	265	165	100	125	100	60	—	—	345
	150 x 100	330	165	100	150	100	75	—	—	346
	180 x 100	320	200	100	180	100	65	—	—	380
	180 x 150	405	270	150	180	150	75	—	—	520
Q	125 x 100	330	165	100	125	100	—	80	—	345
S	125 x 100	290	165	100	125	100	—	—	100	345
	150 x 100	330	165	100	150	100	—	—	115	346
	180 x 150	445	275	150	180	150	—	—	125	520

Drawing Not to Scale  
All Dimensions are in mm

## MANHOLE

Sub Head : Drainage  
Clause : 19.4

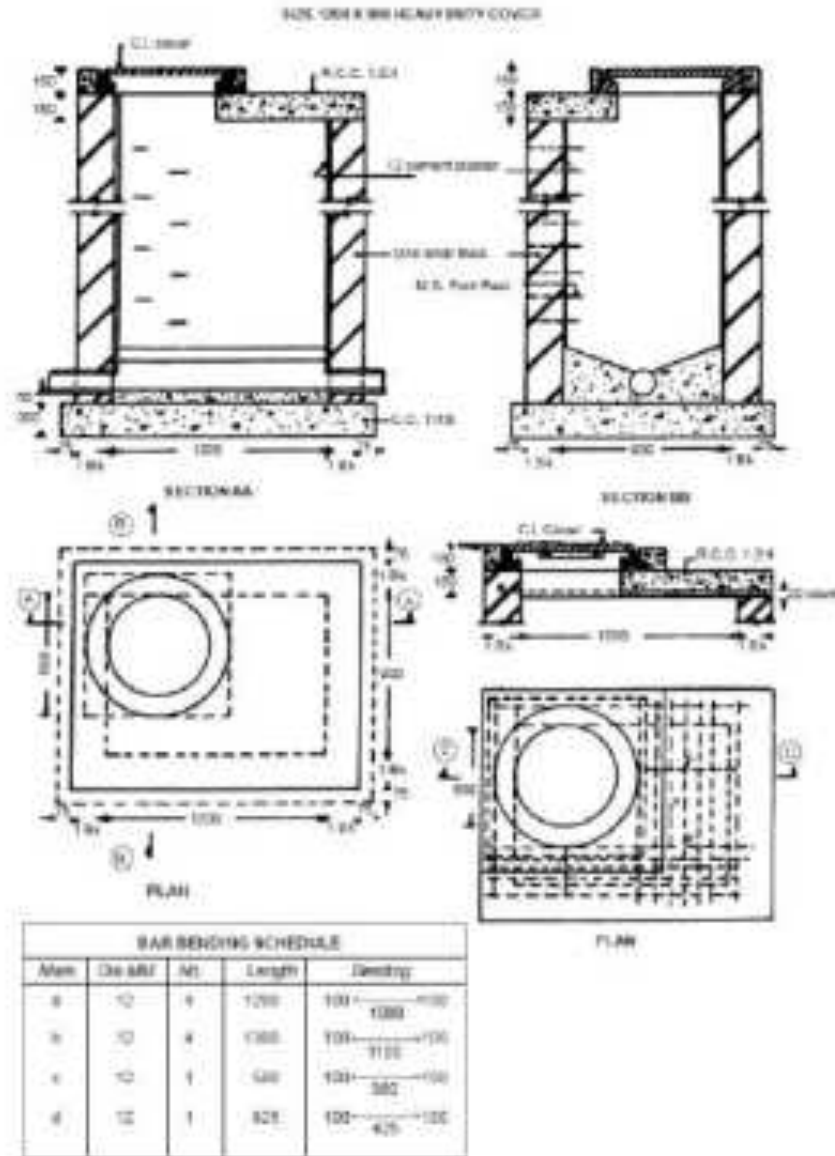


Figure 19.3 : Manhole

Drawing Not to Scale  
All Dimensions are in mm

## MANHOLE (Contd.)

Sub Head : Drainage  
Clause : 19.4

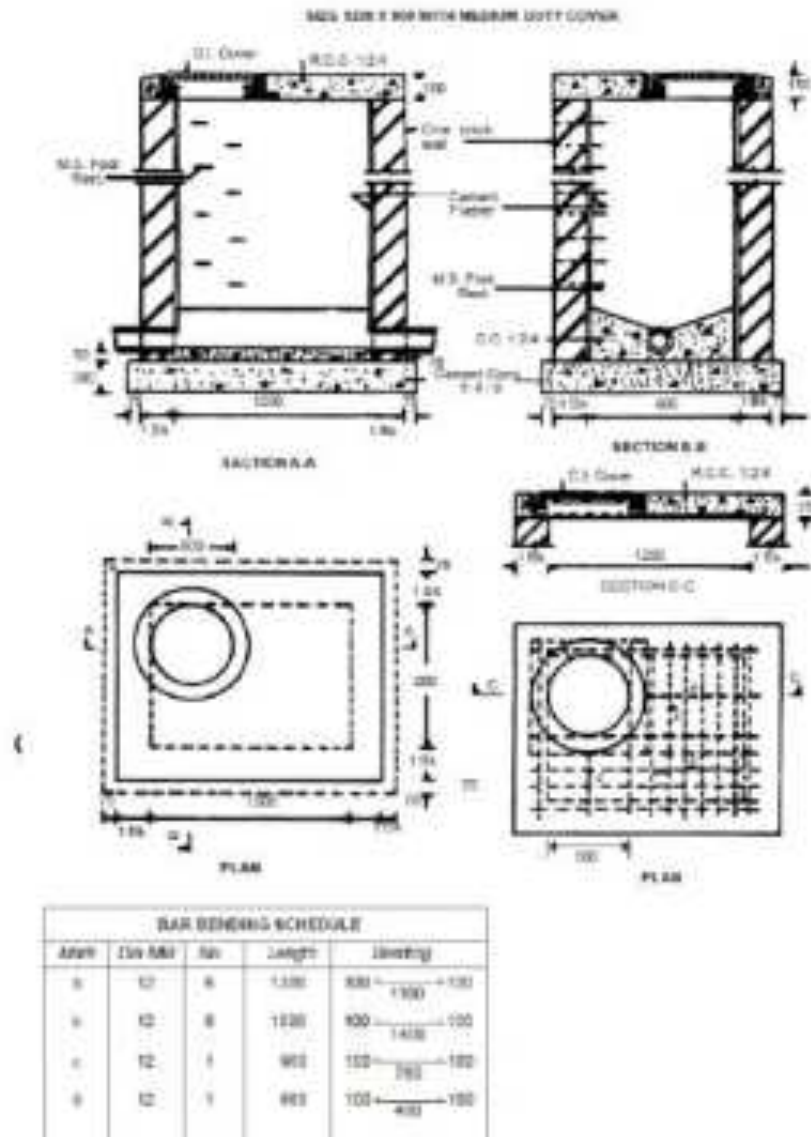


Figure 19.4 : Manhole(Contd)

Drawing Not to Scale  
All Dimensions are in mm

## MANHOLE (Contd.)

Sub Head : Drainage  
Clause : 19.4

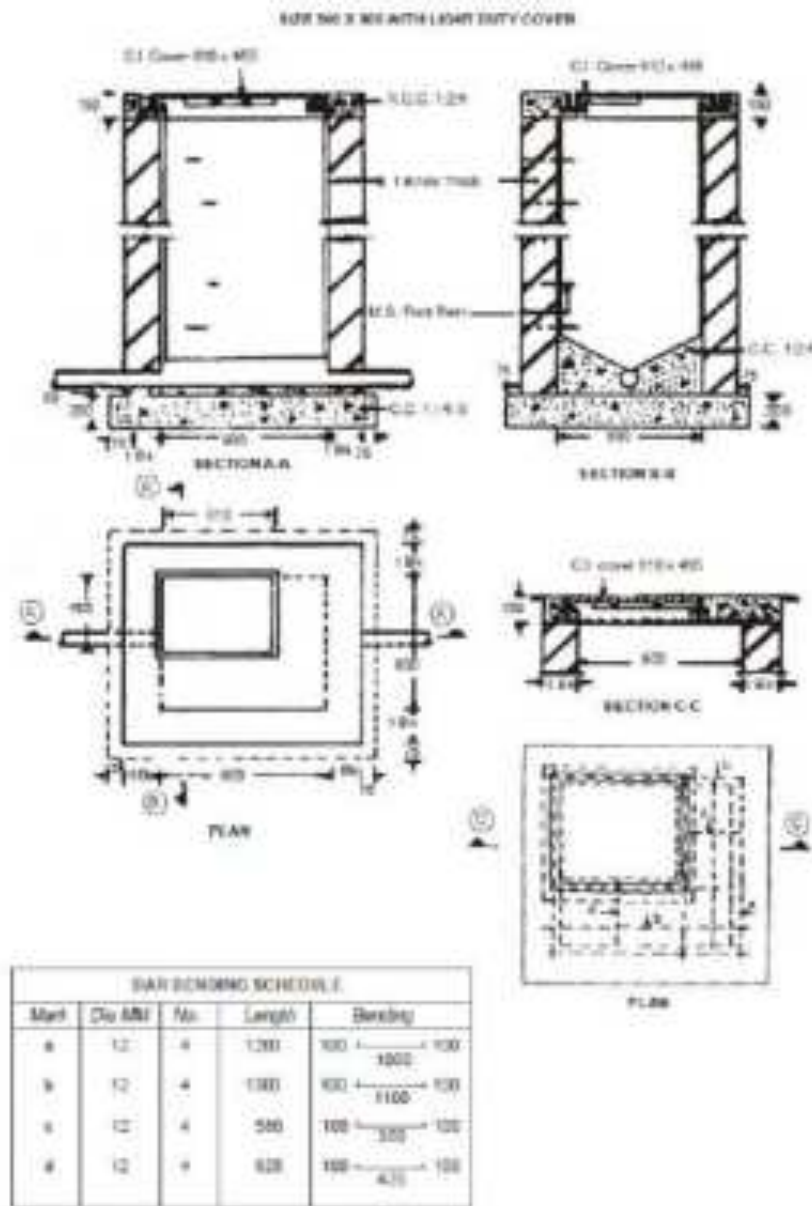


Figure 19.5 : Manhole(Contd)

Drawing Not to Scale  
All Dimensions are in mm

## MANHOLE (Contd.)

Sub Head : Drainage  
Clause : 19.4

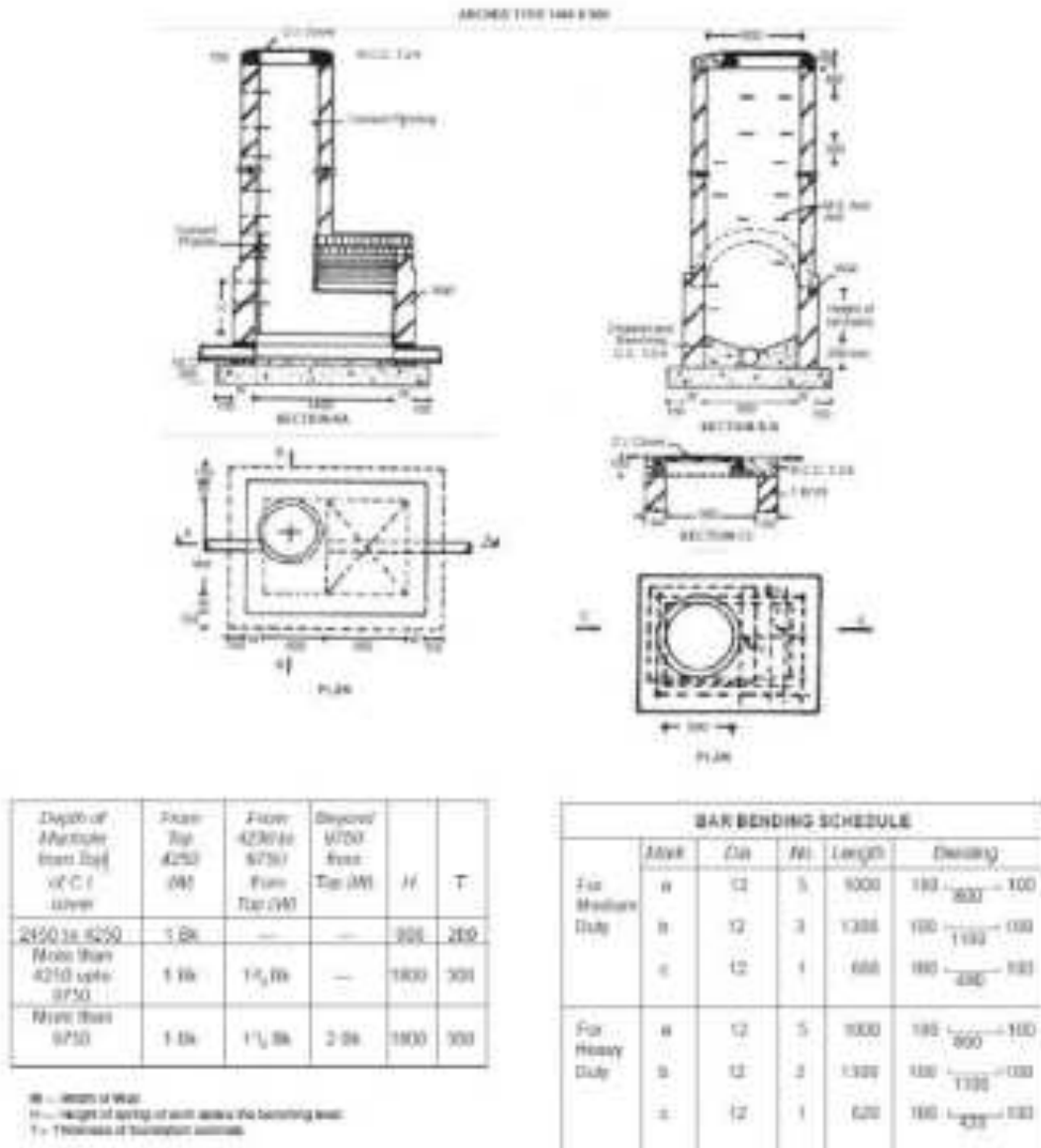


Figure 19.6 : Manhole(Contd)

Drawing Not to Scale  
All Dimensions are in mm





## MANHOLE (With Drop Connections)

Sub Head : Drainage  
Clause : 19.4 & 19.5

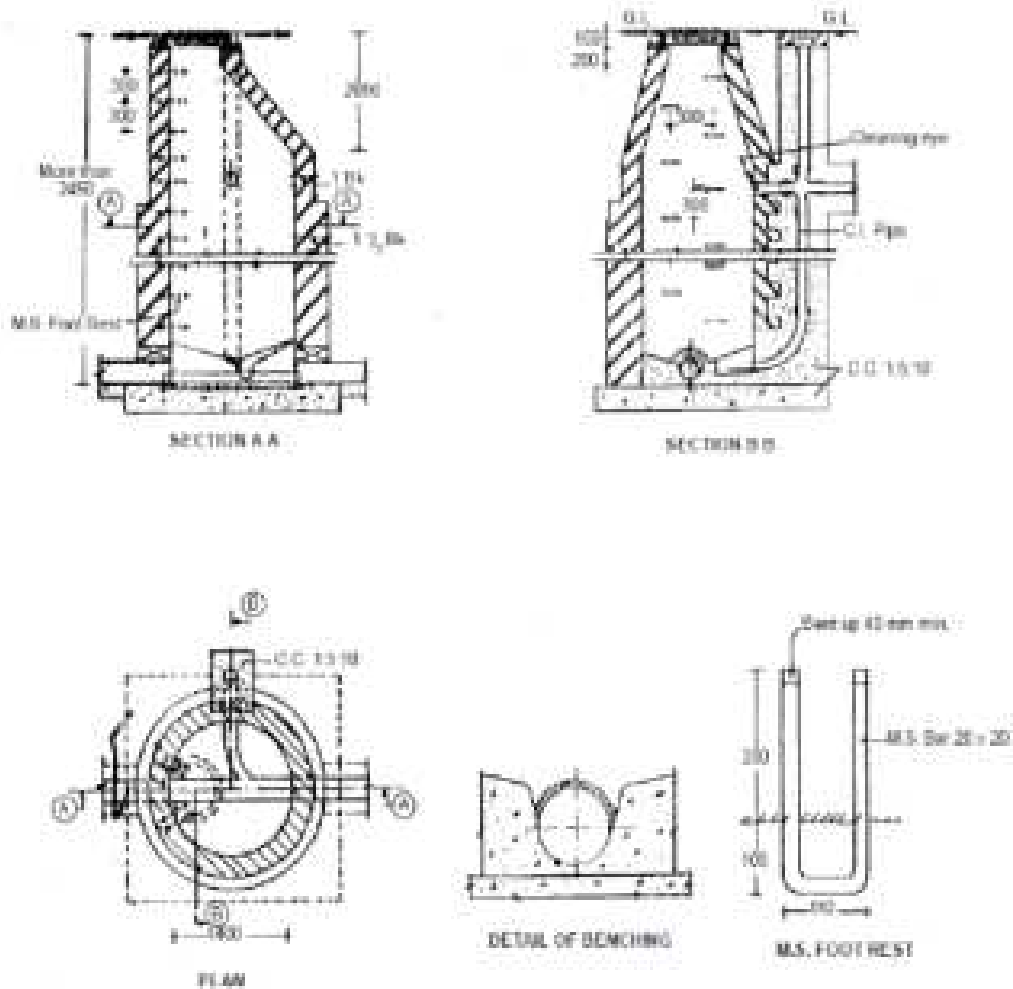


Figure 19.8 : Manhole(With Drop Connections)

Drawing Not to Scale  
All Dimensions are in mm

## BEDDING OF PIPES

Sub Head : Drainage  
Clause : 19.2.2.1

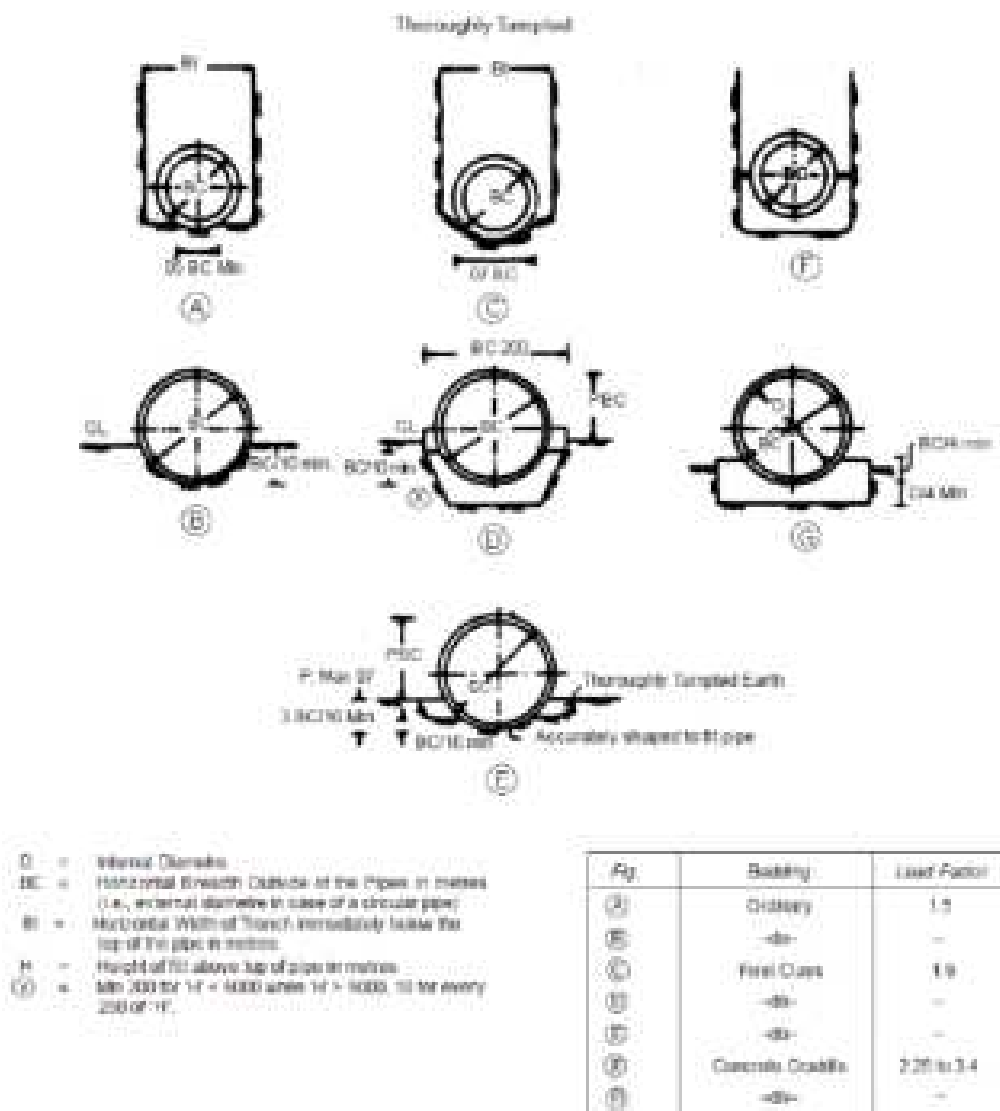


Figure 19.9 : Bedding of Pipes

Drawing Not to Scale  
All Dimensions are in mm

## JOINTS OF CONCRETE PIPES

Sub Head : Drainage  
Clause : 19.2.2.1

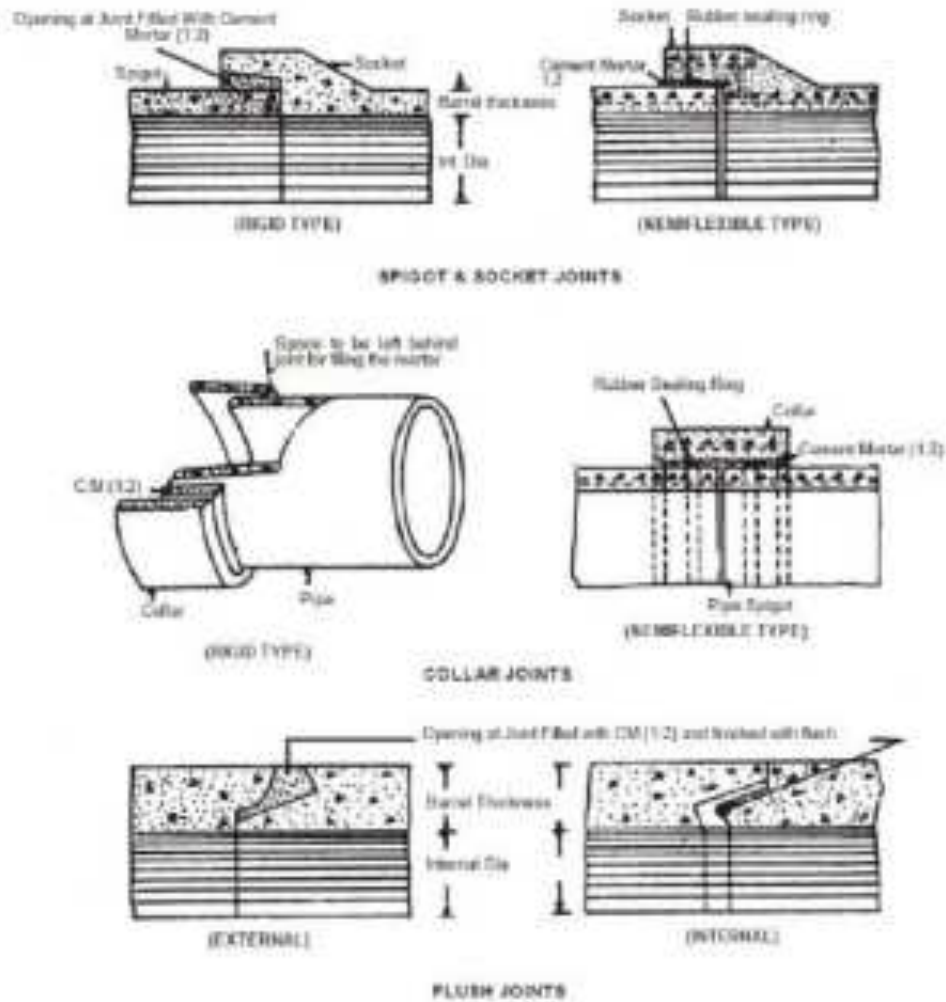


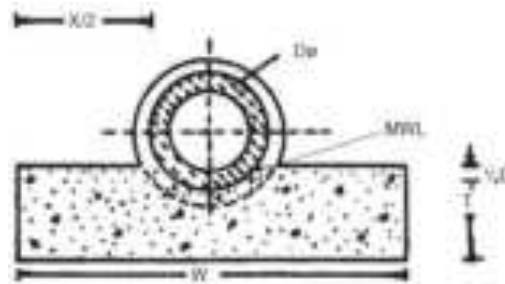
Figure 19.10 : Joints of Concrete Pipes

Drawing Not to Scale

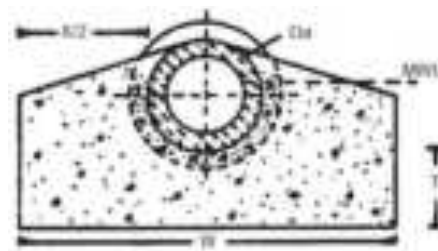
## BEDDING/ENCASING STONEWARE PIPES

Sub Head : Drainage  
Clause : 19.2.1

(i) CONCRETE BEDDING



(ii) CONCRETE UPTO HAUNCHES



(iii) CONCRETE ALLROUND

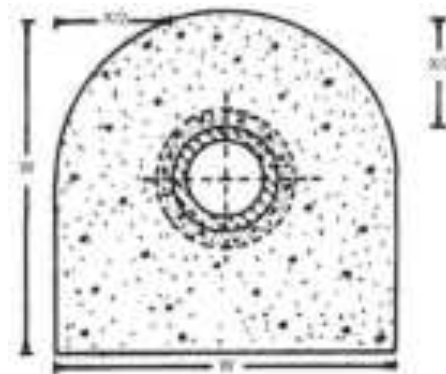


Figure 19.11 : Bedding/ Encasing Stoneware Pipes

$W = D + X$ , Where D is the External Diameter of the pipe

X = 300 up to Trench Depth of 1200

= 400 Trench Depth more than 1200

T = 100 for pipes under 150, 1/4th Internal dia subjected to a min. of 150mm and max. 300 mm for pipes more than 150 Dia

MWL = Maximum water level

Drawing Not to Scale

All Dimensions are in mm

## BRICK MASONRY OPEN SURFACE DRAINS

Sub Head : Drainage

Clause : 19.6

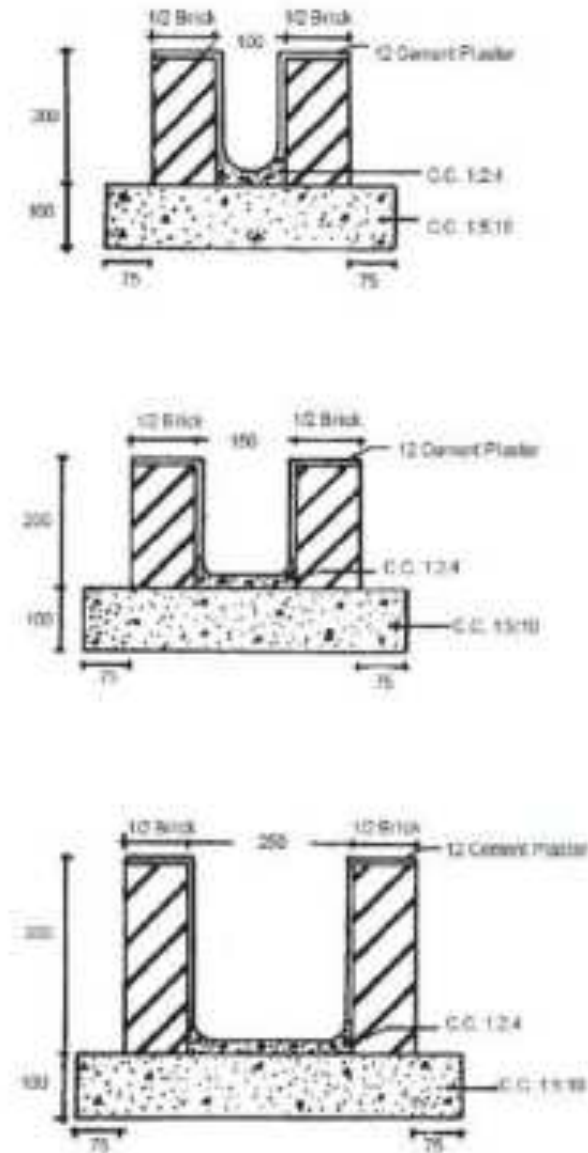


Figure 19.12 : Brick Masonry Open Surface Drains

Drawing Not to Scale  
All Dimensions are in mm

## R.C.C. ROAD GULLY GRATING

Sub Head : Drainage  
Clause : 19.2.4 & 19.7.1

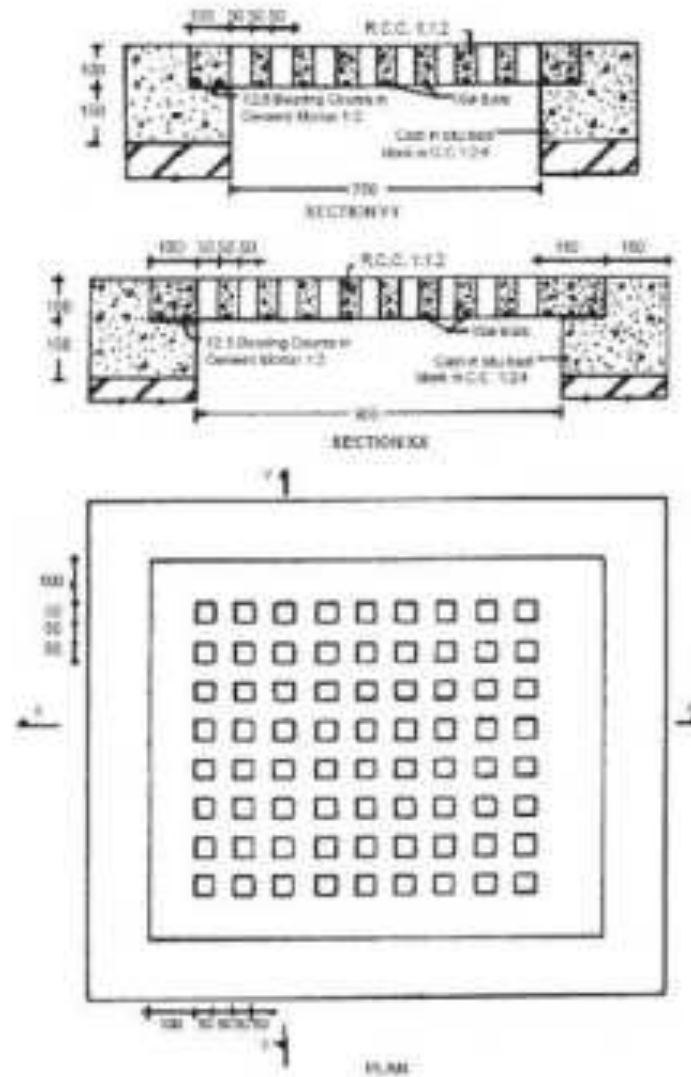


Figure 19.13 : R.C.C. Road Gully Grating

1. Drg not to scale
2. All dimensions are in mm
3. Clear cover over reinforcement shall be min 20 mm
4. The slab cover shall cast R.C.C. 1:1:2
5. The R.C.C. cover shall be properly cured

Drawing Not to Scale  
All Dimensions are in mm





## SEPTIC TANK

Sub Head : Drainage  
Clause : 19.9

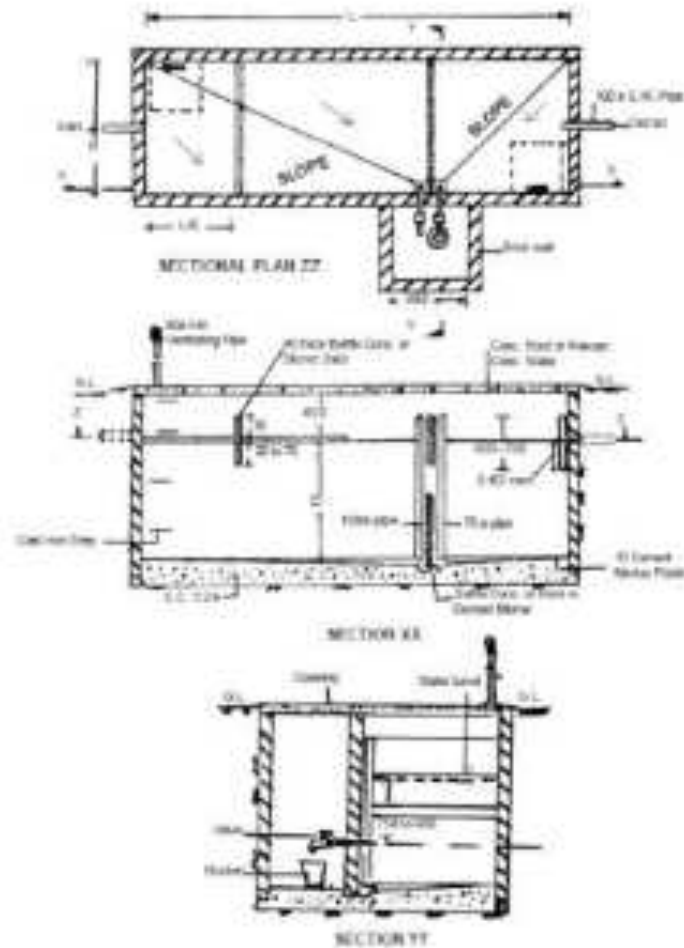


Figure 19.15 : Septic Tank

Drawing Not to Scale  
All Dimensions are in mm

## SEPTIC TANK (Contd.)

Sub Head : Drainage  
Clause : 19.9

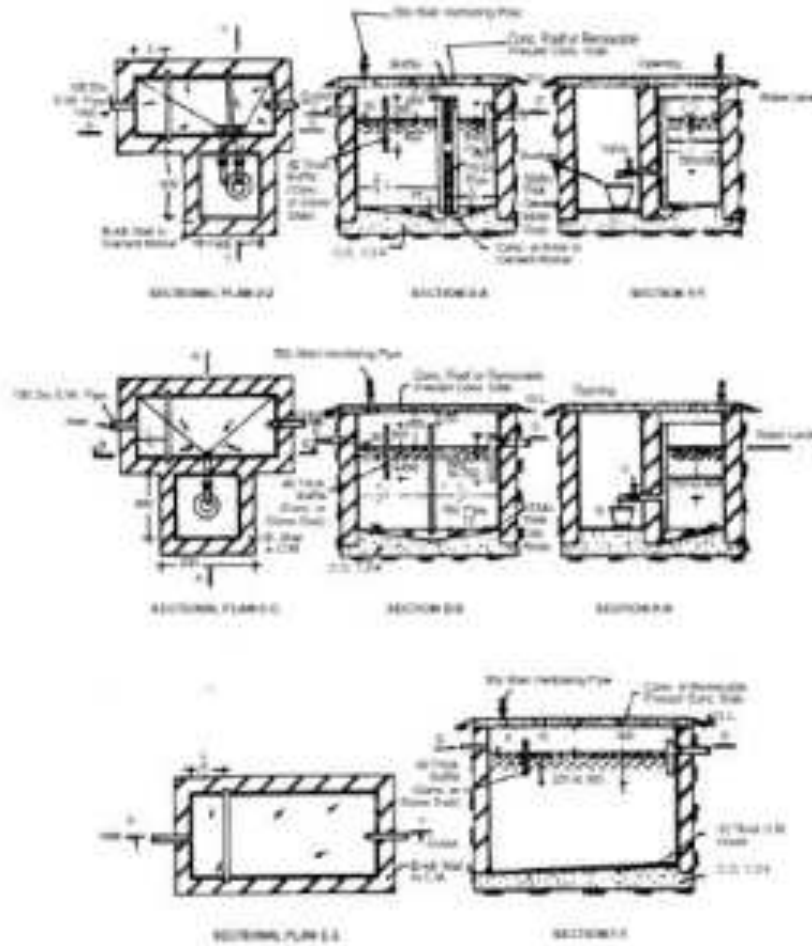


Figure 19.16 : Septic Tank (Contd.)

Drawing Not to Scale  
All Dimensions are in mm

## SOAK PIT

Sub Head : Drainage  
Clause : 19.10

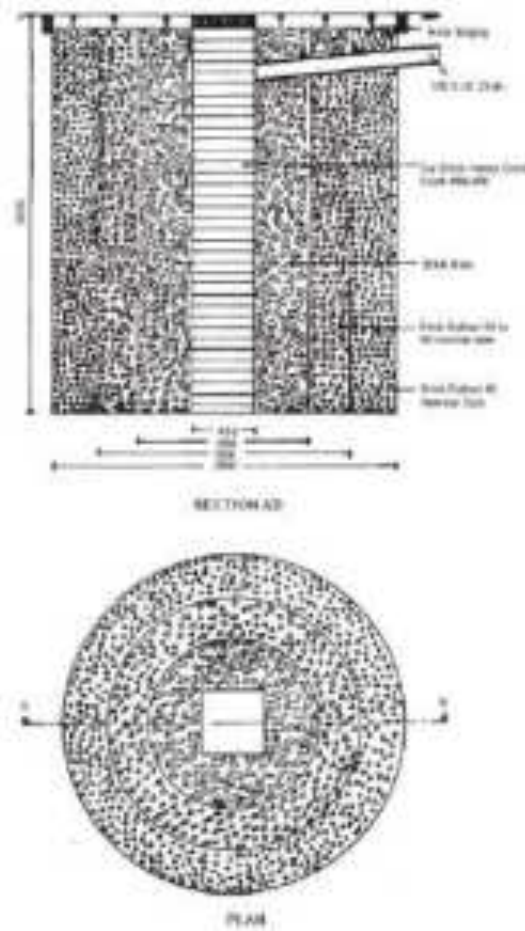


Figure 19.17 : Soak Pit

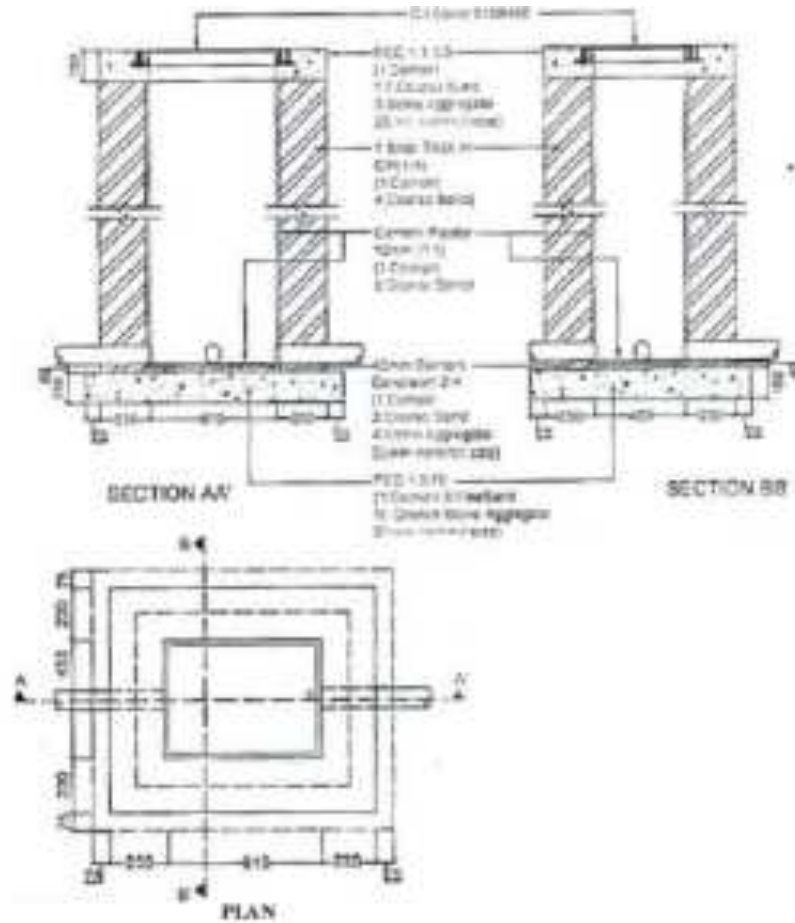
Drawing Not to Scale  
All Dimensions are in mm



## CHAMBER DETAILS

### 610X455 with Light Duty Cover

**Sub Head: Drainage**  
**Clause:19.18**



**Figure 19.20 : 610X455 with Light Duty Cover**

Note: All dimensions are in mm  
Drawing not to scale

## CHAMBER DETAILS 700X500 with Medium Duty Cover

Sub Head: Drainage  
Clause:19.18

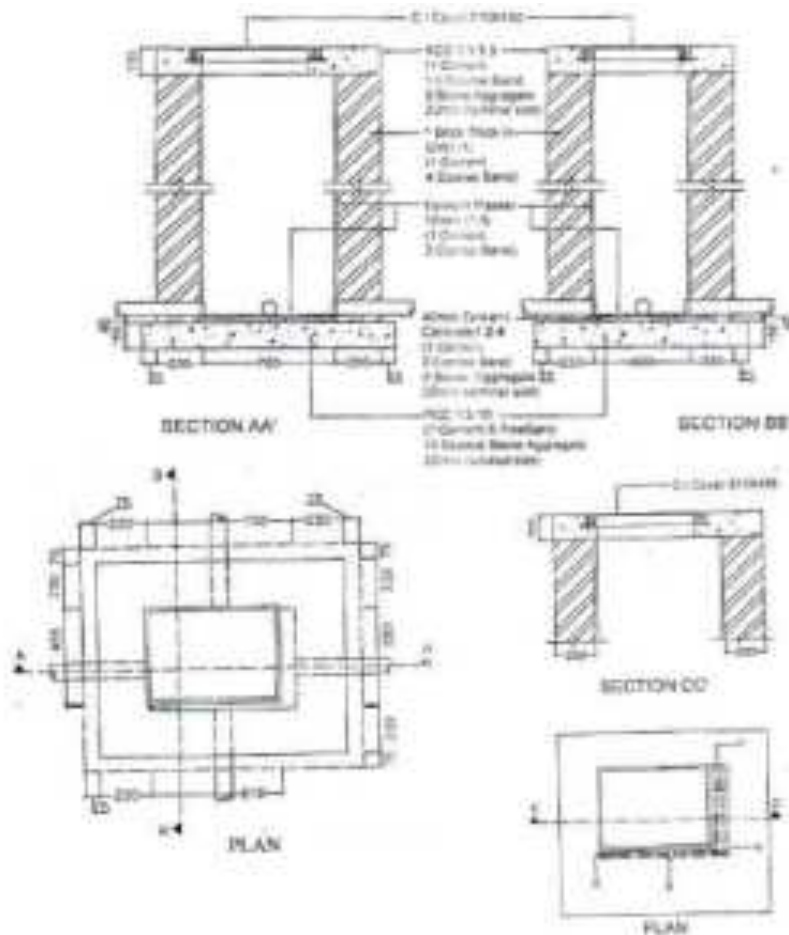


Figure 19.21 : 700X500 with Medium Duty Cover

BAR BENDING SCHEDULE			
MARK	DIA (mm)	Numbers	Length
a	10	4	920
b	10	3	1020
c	10	6	280
d	10	8	230

Note: All dimensions are in mm  
Drawing not to scale

## CHAMBER DETAILS 850X600 with Medium Duty Cover

Sub Head: Drainage  
Clause:19.18

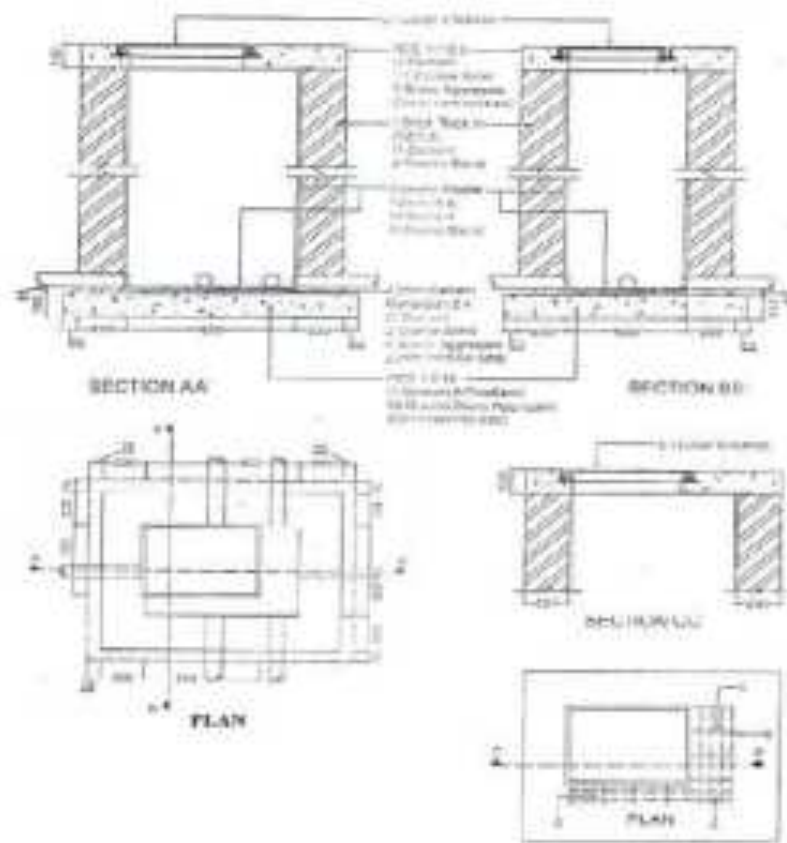


Figure 19.22 : 850X600 with Medium Duty Cover

BAR BENDING SCHEDULE			
MARK	DIA (mm)	Numbers	Length
a	10	5	1020
b	10	4	1270
c	10	6	430
d	10	7	330

Note: All dimensions are in mm  
Drawing not to scale





## PILE WORK



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### LIST OF BUREAU OF INDIAN STANDARD CODES

Sl. No.	IS No.	Subject
1.	IS-1200 (Part 23)	Method of measurement of building and Civil Engineering Works – Piling.
2.	IS-2911 (Part 1/Sec. 1)	Code of practice for Design and Construction of pile foundation. Driven cast-in-situ piles.
3.	IS-2911 (Part 1/Sec. 2)	Code of practice of Design and Construction of pile foundation. Bored Cast-in-situ piles.
4.	IS-2911 (Part 1/Sec. 3)	Code of practice for Design and Construction of pile foundation. Driven pre-cast concrete piles.
5.	IS-2911 (Part 1/Sec. 4)	Code of practice for Design and Construction of pile foundation. Bored pre-cast concrete piles.
6.	IS-2911 (Part 3)	Code of practice for Design and Construction of pile foundation. Under reamed piles.
7.	IS-2911 (Part 4)	Code of practice for design and Construction of pile foundation. Load test on piles.
8.	IS-5112	Safety Code for piling and other deep foundations.
9.	IS-6426	Specification for pile driving hammer.
10.	IS-6427	Glossary of terms relating to pile driving.
11.	IS-6428	Specification for pile frame.
12.	IS-9716	Guide for lateral dynamic load test on piles.
13.	IS-14362	Pile boring equipments. General requirements.



## 20 PILE WORK

### 20.0 TERMINOLOGY

**Allowable Load:**

It is load which is applied to a pile after taking into account its ultimate load capacity, pile spacing, Overall bearing capacity of the ground, the allowable settlement, negative skin friction including reversal of loads.

**Bearing Pile:**

A pile formed in the ground for transmitting load of a structure to the soil by the resistance developed at its tips and or along its surface. It is either vertical or batter pile. It may be 'End bearing pile' or friction pile if it supports the load primarily along the surface.

**Board Compaction Pile:**

It is bored cast- in-situ with or without bulb. In this compaction of surrounding ground and freshly filled concrete in pile, bore is simultaneously achieved by suitable method. A pile with a bulb is called a "under-reamed bored compaction pile". Under-reamed pile with more than one bulb is called Multi-under-reamed pile.

**Constant Rate of Penetration (CRP) Test:**

The ultimate bearing capacity of preliminary piles and piles which are not used as working piles.

**Constant Rate of Uplift (CRU) Test:**

The ultimate capacity in tension of preliminary piles and piles which are not used as working piles.

**Cut of Level:**

It is the level where the installed pile is cut off to support the pile caps or beams.

**Datum Bar:**

A rigid bar placed on immovable supports.

**Draft Bolt:**

A metal rod driven into hole bored in timber, the hole being smaller in diameter than the rod.

**Drop of Stroke:**

The distance through which the driving weight is allowed to fall for driving the piles.

**Factor of Safety:**

It is the ratio of the ultimate load capacity of a pile to the safe load of a pile.

**Follower Tube:**

A tube which is used following the main casing tube and it requires to be extended further. The inner diameter of the follower tube should be the same as the inner diameter of casing. The follower tube shall preferably be an outside guide and should be water tight when driven in water- bearing strata or soft clays.

**Initial Test:**

This test is carried out with a view to determine ultimate load capacity and safe load capacity.



**Raker or Batter Pile:** The pile which is installed at an angle to the vertical. Raker piles are normally provided where vertical piles cannot resist the required applied horizontal forces. The maximum rake to be permitted in piles shall not exceed –

1 in 8 for cast-in-situ piles of large diameter viz. 750 mm diameter. and above. 1 in 5 for smaller dia. cast-on-situ piles.

1 in 4 pre-cast piles.

**Routine Test:**

It is carried out with a view to check whether pile is capable of taking the working load assigned to it.

**Safe Load:**

It is the load arrived at by applying a factor of safety to the ultimate load capacity of the pile.

**Set:**

The net distance by which the pile penetrates in the ground due to stated number of blows of the hammer.

**Spliced Pile:**

A pile composed of two or more lengths secured together, end to end to form one pile.

**Test Pile:**

A pile which is selected for load testing and which is subsequently loaded for that purpose. This pile may form working pile itself if subjected to a routine load test with up to one and half time the safe load.

**Total displacement (Gross):**

The total movement of the pile under a given load.

**Total Elastic Displacement:**

This is the magnitude of the displacement of the pile due to rebound caused at the top after removal of given test load. This comprises two components as follows:

Elastic displacement of the soil participating in load transfer; and

Elastic displacement of the pile shaft.

**Trial Piles:**

These are installed initially to assess the load carrying capacity, it is either tested to ultimate bearing capacity or twice the estimated safe load.

**Ultimate Load Capacity:**

The maximum load which a pile can carry before failure of ground (when the soil fails by shear) or failure of pile materials.

**Working Load:**

It is a load assigned to a pile as per design.

**Working Pile:**

It is a pile forming part of foundation of a structural system.

## **20.1 DRIVEN CAST-IN-SITU REINFORCED CEMENT CONCRETE PILES**

### **20.1.1 General**



Cast -in-situ piles shall be installed by driving a metal casing with a shoe at the tip and displacing the material laterally. Driven cast-in -situ pile is formed by driving a casing, permanent or temporary and subsequently filling the hole with plain or reinforced concrete.

### 20.1.2 Equipment

The equipment and accessories used for driven cast-in-situ piles shall depend on type of sub-soil strata, ground water conditions, type of founding material and penetration etc.

Commonly used plants are as per Appendix 'F' and few more are given below:

**Dolly:** A cushion of hardwood or some suitable material placed on the top of the casing to receive the blows of the hammer

**Kentledge:** Dead weight used for applying a test load to a pile.

**Shoe:** Pile Shoe should be of material as specified in the item. The pile shoes may be either cast iron or mild steel. Cast iron pile shoes shall be made from chill hardened iron as used for making grey iron casting conforming to IS 210. The chilled iron point shall be free from blow holes and other surface defects. Cast steel piles shoe shall be of steel conforming to IS 2644. Straps or other fastenings to cast pile shoes shall be of steel conforming to IS 1079 and shall be cast into the point to form an integral part of shoe. Different types of pile shoes are shown in Fig. 20.1

**Drop Hammer (or Monkey):** Hammer, ram or monkey raised by a winch and allowed to fall under gravity.

**Single or Double Acting Hammer:** A hammer operated by steam compressed air or internal combustion, the energy of its blows being derived mainly from source of motive power and not from gravity along.

**Pile Frame (or Pile Rig):** A movable steel structure for driving piles in the correct position and alignment by means of a hammer operating in the guides or (leaders) of the frame.

### 20.1.3 Pile Driving

**20.1.3.1 Installation of Piles:** Installation of piles shall be as accurate as possible and as per design and drawings. The verticality or the required batter should be correctly maintained. Particular care shall be taken in respect of installing either single pile or piles in two pile groups.

#### 20.1.3.2 Deviation /Tolerance

- i. The deviation/tolerance should be as per IS 2911 (Part 1/Sec.1). The piles should not deviate more than 75 mm or  $D/6$  whichever is less (75 mm or  $D/10$  whichever is more in case of piles having diameter more than 600 mm) from their designed position at the working level.
- ii. In case of a single pile under a column, the positional deviation should not be more than 50 mm or  $D/4$  whichever is less (100 mm in case of piles having diameter more than 600 mm). Greater tolerance may be prescribed for piles driven over water and for raking piles.

**20.1.3.3 Sequence of Installation:** Normal sequence of installation of pile group is from the centre to the periphery of the group or from one side to the other. Particular care shall be taken to avoid damaging the already cast pile while driving a fresh tube nearby before the concrete has sufficiently set. The possibility of the pile getting damaged is more in compact soils than in loose soils.

#### 20.1.3.4 Driving a Group of Friction Piles

- i. The skin friction increases considerably when the pile bore is driven in the loose sand as the pile tends to compact the sand. Therefore in such cases the order of installation shall be altered so that a compact block is not created where driving further pile bore will not be possible. Similar precaution will have to be taken where stiff clay or compact sand layers will have to be penetrated.



- ii. However driving the pile bore from centre outwards or commencing at a particular selected edge or even working across the group the problem pointed out in Para (I) above can be avoided.
- iii. In case of very soft soil it is advisable to start driving the bore hole from outside to inside so that the soil gets restrained from flowing out during operation.

#### **20.1.3.5 Procedure of Pile Driving**

Driven cast-in-situ concrete piles are installed by driving a metal casing with a shoe at the tip/toe and displacing the material laterally.

These piles may be cast in metal shells which may remain permanently in place or the casing may be withdrawn which may be termed as uncased driven cast-in-situ cement concrete piles.

The metal casing shall be of sufficient thickness and strength to hold in original form and show no harmful distortion when the adjacent casing is driven and the driving core if any is withdrawn.

Driven cast-in-situ concrete piles shall be installed using a properly designed detachable shoe at the bottom of the casing.

Any liner or bore hole which is temporarily located and shows partial collapse that would affect the load carrying capacity of the pile, shall be rejected or repaired as directed by the Engineer- in-Charge.

- 20.1.3.6** A proper record of pile driving and other details such as depth driven, sequence of installation in a group, cut off level/working level shall be mentioned in sequence of occurrence worksheet for the inspection of Engineer-in-charge.

#### **20.1.4 Jetting**

- i. Driving of pile may be assisted by preboring holes or by the use of jets or both subject to the approval of the Engineer-in-charge. These may be used essentially to achieve the minimum penetration shown on the drawings where such penetration is not reached under normal conditions of driving. The diameter of the hole shall; not be greater than the diagonal dimension of the pile less 100 mm.
- ii. The maximum depth of the preboring shall be such that the specified set (or less) is obtained when the toe of the pile is at founding level. Preboring shall be as approved by the Engineer-in- charge and shall not extend beyond one metre above the founding level and the pile shall be driven to at least one metre below the prebored hole. To ensure that the pile is properly supported laterally in the hole, any space remaining around the pile at the ground level after driving is finished shall be backfilled with approved granular material.
- iii. When the water jetting is used at least two jets shall be attached to the pile symmetrically. The volume and pressure of water at the outlet nozzles shall be sufficient to freely erode material adjacent to the toe of the pile. The maximum depth of jetting shall be such that the specified set is obtained when the toe of the pile is at founding level. Jetting shall cease as directed by the Engineer-in-Charge and shall not proceed beyond one metre above the founding level and the pile shall be driven at least one metre below the prebored hole.
- iv. To avoid very hard driving and vibration in materials such as sand, jetting of piles by means of water may be carried out in such a manner as not to impair the bearing capacity of piles already in place, the stability of the soil or the safety of any adjoining buildings. Details of arrangement for jetting shall be got approved from the Engineer-in-Charge in advance.
- v. If large quantities of water are used for jetting it may be necessary to make provision for collection of water when it comes to the ground surface so that the stability of the piling plant is not endangered by the softening of the ground. Jetting shall be stopped before completing the driving which shall always be



finished by ordinary methods. Jetting shall be stopped if there is any tendency for the pile tips to be drawn towards the pile already driven owing to the disturbance to the ground.

### 20.1.5 Reinforcement

- i. The design of reinforcing cage varies depending upon the driving and installation conditions, the nature of the sub-soil and the nature of load to be transmitted by the shaft, axial or otherwise. The minimum area of longitudinal reinforcement of any type or grade within the pile shaft shall be 0.4 per cent of the cross-sectional area of the pile shaft. The minimum reinforcement shall be provided throughout the length of the shaft.
- ii. The curtailment of reinforcement along the depth of the pile, in general, depends on the type of loading and sub-soil strata. In case of piles subjected to compressive load only, the designed quantity of reinforcement may be curtailed at appropriate level according to design requirements. For piles subjected to uplift load, lateral load & moments, separately or with compressive loads, it may be necessary to provide reinforcement to the full depth of the pile. In soft clays or loose sands, or where there is likelihood of danger to green concrete due to driving of adjacent piles, the reinforcement should be provided up to full pile depth, regardless of whether or not it is required from uplift & lateral load considerations. However, in all cases, the minimum reinforcement specified in Para (i) above should be provided in full length of the pile.
- iii. Piles shall always be reinforced with a minimum amount of reinforcement as dowels keeping the minimum bond length into the pile shaft below its cut-off level, and with adequate projection into the pile cap, irrespective of design requirements.

Note: In some cases the cage may lift at bottom or at the laps during withdrawal of casing. This can be minimized by making the reinforcement “U” shaped at the bottom and up to well secured joints. Also the lifting 5 percent of the length should be considered not to affect the quality of pile.

- iv. Clear cover to all main reinforcement in pile shaft shall be not less than 50 mm and shall be maintained by suitable spacers. The laterals of reinforcing cage may be in the form of links or spirals. The diameter and spacing of the same is chosen to impart adequate rigidity of the reinforcing cage during the handling and installation. The minimum diameter of links or spirals shall be 8mm and the spacing of the links or spirals shall be not less than 150 mm. Stiffener rings preferably of 16 mm diameter at every 1.5 m centre-to-centre should be provided along the length of the cage for providing rigidity to reinforcement cage. Minimum 6 numbers of vertical bars shall be used for a circular pile and minimum diameter of the vertical bar shall be 12mm. the clear horizontal spacing b/w the adjacent vertical bars shall be four times the maximum aggregate size in concrete. If required, the bar can be bundled to maintain such spacing.
- v. The reinforcing cage should be left with adequate protruding length above the cut off level for proper embedment in the pile cap. Prior to the lowering of reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials.
- vi. Reinforcement in the form of cage shall be assembled with additional support, such as spreader forks and lacings; necessary to form a rigid cage hoops, links, or helical reinforcement has to fit closely around the main longitudinal bars and shall be tied by binding wire of approved quality. The ends of the binding wire shall be turned into the interior of the pile. Reinforcement shall be placed and maintained in correct position. The reinforcements shall be joined wherever necessary by welding and the procedure of welding be followed as described in IS 2751.

### 20.1.6 Concrete

- 20.1.6.1 Cement:** Cement shall be as specified in agreement item or as specified under sub-head 3.0 of IOCL Civil Specifications 2023. However, high alumina cement shall not be used.





**20.1.6.2 Water:** Water to be used for concreting shall be as specified under sub-head 3.0 of IOCL Civil Specifications 2023

**20.1.6.3 Fine Aggregate:** Fine aggregate to be used for concreting shall be as specified under sub-head 3.0 of IOCL Specifications.

**20.1.6.4 Coarse Aggregate:** For tremie concreting, coarse aggregate having nominal size more than 20 mm should not be used. Natural rounded shingle of appropriate size may also be used as coarse aggregate. It helps to give high slump with less water cement ratio.

**20.1.6.5 Chemical Admixtures:** Admixtures to be used in the concrete shall be as per IS 9103.

**20.1.6.6 Concrete Grades to be adopted**

- i. Concreting of piles shall be done only with design mix of appropriate grade with weigh batching of constituents. The grade of concrete to be kept as per nomenclature of the item.
- ii. Only concrete Grade M-25 and/or higher grades shall be used for concreting the piles. The exact grade of concrete to be used shall mainly depend upon the nature of work and the general design consideration. However, Concrete Grade M-15 and Grade M-20 shall not be used for concreting piles under any circumstances, even with weigh batching. The minimum cement content shall be  $400 \text{ kg/m}^3$  in all conditions. Even though cement content can be reduced by use of properly designed mixes or admixtures, but the cement content should not be less than  $350 \text{ kg/cum}$ .
- iii. When concreting under water or drilling mud 10 per cent additional cement over the minimum cement content for the particular grade shall be used.

**20.1.6.7 Workability of Concrete:** The minimum slump shall be 100 mm when the concrete for the piles is being vibrated and when the concrete is not vibrated the maximum permitted slump should be 150mm to 180mm at the time of pouring. The degree of workability in both the cases is considered as very high.

**20.1.6.8 Placing of Concrete**

- i. Before commencement of pouring of concrete, it shall be ensured that there is no ingress of water in the casing tubes from bottom. Further, adequate control during withdrawal of the casing tube is essential so as to maintain sufficient head of concrete inside the casing tube at all stages of withdrawal.
- ii. Wherever practicable concrete should be placed in a clean dry hole where concrete is placed in dry hole and when casing is present, the top 3 m pile shall be compacted using internal vibrators. The concrete should invariably be poured through a tremie, with a funnel so that the flow is directed and concrete can be deposited in the hole without segregation. Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting and also while extracting the tube shall be avoided.
- iii. Where the casing is withdrawn from cohesive soils for the formation of cast-in-situ pile, the concreting should be done with necessary precautions to minimize the softening of the soil by excess water. Where mud flow conditions exist, the casing of cast-in-situ piles shall not be allowed to be withdrawn.
- iv. The concrete shall be self compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silt clays and other soils with tendency to squeeze into newly deposited concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or water into concrete. The placing of concrete shall be continuous process from the toe level to the top of pile to prevent segregation, a tube of tremie pipe as appropriate shall be used to place concrete in all piles. To ensure

compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.



- v. The diameter of the finished pile shall not be less than specified and a continuous record shall be kept by the Engineer as to the volume of concrete placed in relation to the length of pile cast. After each pile has been cast and any empty pile hole remaining shall be protected and back filled as soon as possible with approved material.
- vi. The minimum embedment of cast-in-situ concrete piles into pile cap shall be 150 mm. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete. The clear cover between the bottom reinforcement in pile cap from top of pile shall not be less than 30 mm. The reinforcement in the pile shall be exposed for full anchorage length to permit it to be adequately bonded into the pile cap. Exposing such length shall be done carefully to avoid damaging the rest of the pile. In cases where the pile cap is to be laid on ground a leveling course with cement concrete of Grade M-15 and of 100 mm thickness shall be provided.
- vii. Normally concreting of piles should be uninterrupted. In exceptional case of interruption of concreting, but which can be resumed within 1 or 2 hours, the tremie shall not be taken out of the concrete. Instead it shall be raised and lowered slowly from time to time to prevent the concrete around the pipe from setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 200 mm for each displacement of the partly set concrete. If the concreting cannot be resumed before final set of concrete already laid, the pile so cast may be rejected.
- viii. In case of withdrawal of tremie out of concrete, either accidentally or to removed a choke in the tremie, the tremie may be re-introduced to prevent impregnation of laitance scum lying on the top of the concrete already deposited in the bore. The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug should be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm should be filled in the tremie which will push the plug forward and swirl emerges out of the tremie displacing the laitance/scum. The tremie will be pushed further in steps masking fresh concrete sweep away laitance scum in its way. When the tremie is buried by about 60 to 100 cms, concreting may be resumed.
- ix. The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.
- x. Where cut-off level is less than 1.5 metres below the working level concrete shall be cast to a minimum of 300 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile. When concrete is placed by tremie method concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut off level. In the circumstances where cut-off level is below ground water level the need to maintain pressure on the unset concrete equal to or greater than water pressure should be observed and accordingly length of extra concrete above cut-off level shall be determined.

#### **20.1.6.9 Placing Concrete under Water**

- i. Before concreting under water, the bottom of the hole shall be cleared of drilling mud and all soft loose materials very carefully. In case a hole is bored with use of drilling mud, concreting should not be taken up when the specific gravity of bottom slurry is more than 1.2. The drilling mud should be maintained at 1.5 m above the ground water level. Concreting under water for cast-in-situ concrete piles may be done either with the use of tremie method or by the use of approved method specialty designed to permit under water placement of concrete. General requirements and precautions for concreting under water are as follows:



- a. The concreting of pile must be completed in one continuous operation. Also for bored holes, the finishing of the bore, cleaning of the bore, lowering of reinforcement cage and concreting of pile for full length must be accomplished in one continuous operation without any stoppage.
- b. The concrete should be coherent, rich in cement with high slump & restricted water cement ratio.
- c. The tremie pipe will have to be large enough with due regard to the size of the aggregate. For 30 mm aggregate the tremie pipe should be of diameter not less than 150 mm and for larger aggregate, larger diameter of tremie pipe may be necessary.
- d. The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of water and concrete.
- e. The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.
- f. The pile should be concentrated wholly by tremie and the method of deposition should not be changed part way up the pile to prevent the laitance from being entrapped within the pile.
- g. All tremie tubes should be scrupulously cleaned after use.
- h. When concreting is carried out under water a temporary casing should be installed to the full depth of the bore hole or 2 m into non collapsible stratum, so that fragments of ground cannot drop from the sides of the hole into the concrete as it is placed. The temporary casing may not be required except near the top when concreting under drilling mud.

#### 20.1.7 Testing of Concrete

**20.1.7.1** The concrete for the piles shall be sampled in accordance with the norms specified in IS 456. The frequency of sampling is given in Table 20.1.

**TABLE 20.1**

Quantity of Concrete in the Work m <sup>3</sup>	Number of Samples
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50m <sup>3</sup> or part thereof.

Notes: (i) At least one sample shall be taken from each shift.

Where concrete is produced as continuous production unit, such as ready mix concrete plant. The frequency of sampling may be agreed upon mutually by suppliers and purchasers.

**20.1.7.2 Test Specimen:** Three test specimens shall be made for each sample for testing at 28 days. Additional samples may be required for various purposes such as to determine the strength of concrete at 7 days or to determine the duration of curing, or check the testing error, additional sample may also be required for testing samples cured by accelerated methods as described in IS 9103. The specimen shall be tested as described in IS 516.



**20.1.7.3 Test Results of Samples:** The test results of the samples shall be the average of the strength of three specimens. The individual variation should not be more than  $\pm 15\%$  percent of the average strength. If the variation is more, the test result of the sample is invalid.

#### **20.1.8 Curing**

As per IS 456 – 2000, exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, Hessian or similar materials and kept constantly wet for at least 10 days from the date of placing concrete. The period of curing shall not be less than 14 days for concrete exposed to dry and hot weather conditions.

#### **20.1.9 Defective Pile**

- i. In case defective piles are formed they shall be removed or left in place whichever is convenient without affecting performance of the adjacent piles or cap as a whole. Additional piles shall be provided to replace them as directed.
- ii. Any deviation from the designed location alignment or load capacity of any pile shall be noted and adequate measures taken well before concreting of the pile cap and plinth beam, if the deviations are beyond permissible limit.
- iii. During chipping of the pile, top manual chipping may be permitted after three days of pile casting pneumatic tools for chipping shall not be used before seven days after pile casting.
- iv. After concreting the actual quantity of concrete shall be compared with average obtained from observations actually made in the case of a few piles initially cast. If the actual quantity is found to be considerably less, special investigations shall be conducted and appropriate measures taken.

#### **20.1.10 Ready Mix Concrete (RMC)**

Alternatively, the contractor can be allowed to use Ready Mix Concrete (RMC) with the permission of Engineer-in- Charge, provided that the manufacturer assures that for RMC supplied for the particular work contains the minimum cement content and it is in conformity of approved design mix. The manufacturer of RMC has also to agree to the sampling and testing procedure as specified under clause 20.1.7 or alternatively he can propose his own sampling and testing procedure which should in turn be approved by the Engineer-in -Charge. Normally, RMC supplied to site are mixed with certain admixtures which enables the concrete to be used within 3 hours of supply at site. In case RMC supplied is not consumed within 3 hours of supply the quantity of RMC remaining unused beyond 3 hours shall be rejected and removed from site.

#### **20.1.11 Measurement**

Dimension shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured from top of shoe to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools and equipment for excavating driving etc.

#### **20.1.12 Rate**

The rate includes the cost of materials and labour involved in all the operations described above including pile embedded in pile cap, except soil investigation, reinforcement, pile cap and grade beam.

### **20.2 BORED CAST-IN-SITU REINFORCED CONCRETE PILES**

#### **20.2.1 General**



The piles are formed within the ground by excavating or boring a pile within it with or without the use of temporary casing and subsequently filling it with plain or reinforced concrete. When the casing is left permanently it is termed as cased pile and when the casing is taken out it is termed as uncased pile.

## **20.2.2 Equipment**

The equipment and accessories used for bored cast-in-situ piles shall depend on subsoil strata, ground water conditions, type of founding material and penetration etc.

General requirements of boring equipment are as per Appendix 'D'. The equipment is applicable for bored piles without the use of bentonite.

**20.2.2.1** Boring operation shall be done by rotary percussion type drilling rigs using direct mud circulation or reverse mud circulation methods to bail out the cuttings or as specified. In soft clays and loose sand, bailer and chisel method should be used with caution to avoid the effect of suction. Rope operated grabbing tool Kelly mounted hydraulically operated grab are also used. This method of advancing the hole avoids suction. The size of cutting tool shall be as per [IS 2911 (Part I Section 2)] and not less than the diameter of pile by more than 75 mm.

**20.2.2.2** Use of drilling mud is stabilizing sides of bore hole where specified shall have properties as defined in Appendix A.

Permanent casing where specified shall be used to avoid aggressive action of water.

## **20.2.3 Boring for installing Pile**

**20.2.3.1 Installation of Piles:** As described under clause 20.1.3.1

**20.2.3.2 Deviation and Tolerance:** As described under clause 20.1.3.2.

### **20.2.3.3 Procedure of Driving Pile Bore**

- i. Bored cast-in-situ concrete piles are installed by making a bore into the ground and removing out the material.
- ii. The ground shall be roughly leveled and position of pile marked. The boring shall be done with or without the use of temporary casing. The sides of bore hole; shall be stabilized with the aid of temporary casing or with the aid of drilling mud of suitable consistency.
- iii. The equipment and accessories shall depend upon the type of bored pile chosen for the job, consideration of sub-soil strata, ground water condition, type of founding material. Boring operation normally are done by rotary or percussion type drilling rigs using direct mud circulation on reverse mud tool shall be as detailed in IS 2911 (Part 1/Sec.2).
- iv. In case permanent/temporary casing is not used then bored pile is stabilised with drilling fluid. Bentonite supplied to site shall conform to IS 2720 (Part V). A certificate shall be obtained by the contractor from the manufacturer showing properties of each consignment and should be submitted to the Engineer-in-charge. Bentonite shall be mixed thoroughly with fresh clean water to make a suspension which will maintain the stability of the pile excavation for the period necessary to place concrete and complete construction. The temperature of the water used in mixing the bentonite suspension and when supplied to bore hole shall not be lower than 5°C. Consistency of the drilling fluid suspension and when controlled throughout the boring as well as in concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with thick suspension of mud.

Frequency and methods of testing drilling fluid shall be as specified and the test results shall be as specified in IS 2720 (Part V).



- v. Bored cast-in-situ piles in soils which are stable may often be installed with a small casing length at the top. A minimum of 2.0 m length of top of bore shall; invariably be provided with casing to ensure against loose soil falling in to drilling mud, or a suitable steel casing. The casing may be left in place permanently especially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of piles could be exposed due to scour.
- vi. For bored cast-in-situ piles, casing/liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length shown on the drawing or as directed by the Engineer-in-charge. Materials inside the casing shall be removed progressively by air lift, grap or percussion equipment or other approved means.
- vii. Where bored cast-in-situ piles are used in soils liable to inflow, the bottom of the casing shall be kept low enough in advance of the boring tool; to prevent the entry of soil into the casing, thus presenting the formation of settlements in the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joints of the casing shall be made as tight as possible to minimize inflow of water or leakage of slurry during concreting.
- viii. Boring shall be carried out using rotary or percussion type equipment. Unless otherwise directed by the Engineer-in-charge the diameter of the bore holes shall be not more than the inside diameter of the liner.
- ix. After the boring has reached the required depth, the steel reinforcement shall be lowered in position maintaining the specified size of cover on all sides. The bore shall then be flushed with bentonite slurry and concreting shall be taken up exactly as described under clause 20.1.6.8.

**20.2.3.4** A proper record of pile driving and other details such as sequence of installation of piles, dimension of piles, depth bored, time taken for concreting etc. shall be maintained in sequence of occurrence at site as per clause 20.1.3.6.

While drilling mud is used, the specific gravity of fresh supply and contaminated mud in the hole before concreting is taken up shall be recorded for first ten piles and subsequently at interval of 10 piles or as specified.

#### **20.2.4 Reinforcement**

As specified under clause 20.1.5.

#### **20.2.5 Concrete**

As specified under clause 20.1.6.

#### **20.2.6 Ready Mix Concrete**

As specified under clause 20.1.10.

#### **20.2.7 Measurement**

Dimensions shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured up to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools, equipment for excavating, driving etc.

#### **20.2.8 Rate**

The rate includes the cost of material and labour involved in all the operations described above including pile embedded in pile cap except reinforcement, pile cap and grade beam.

### **20.3 UNDER-READED R.C.C. PILES**

#### **20.3.1 General**





- i. Under-reamed piles are bored cast-in-situ and bored compaction concrete types having one or more bulbs formed by suitably enlarging the bore hole for the pile stem. With the provision of bulb(s) substantial bearing or anchorage is available.
- ii. These piles find application in widely varying situations in different types of soils where foundation are required to be taken down to a certain depth in view of considerations like the following requirements :
  - a) To avoid the undesirable effect of seasonal moisture changes as in expansive soils.
  - b) To reach firm strata.
  - c) To obtain adequate capacity for downward, upward and lateral loads and moments
  - d) To take foundations below scour level.
- iii. When the ground consists of expansive soil e.g. black cotton soil, the bulb of the under ream pile provides anchorage against uplift due to swelling pressure apart from the increased bearing capacity.
- iv. In case of filled up or otherwise weak strata overlying the firm strata, enlarged base in the form of under-reamed bulb in firm strata provides larger bearing area and piles of greater bearing capacity can be made.
- v. In loose to medium pervious sandy silty strata, bored compaction piles can be used as the process of compaction increases the loads bearing capacity of the piles.
- vi. Under- reamed piles may also be used under situations where the vibration and noise caused during construction of piles are to be avoided. The provision of bulb(s) is of special advantage in under reamed piles to resist uplift and they can be used as anchors.

#### 20.3.2 Pile Grouping

- i. For bored cast in situ under-reamed piles at usual spacing of 2 Du (DU is bulb diameter), the group capacity will be equal to the safe load of individual pile multiplied by the number of piles in the group. For piles at spacing of 1.5 Du the safe load assigned per pile in a group should be reduced by 10 per cent.
- ii. In under-reamed compaction piles, at the usual spacing of 1.5 Du, the group capacity will be equal to the safe load on individual pile multiplied by the number of piles in the group.

Note: In order-reamed compaction piles, the capacity of the group may be more than given in Para (i) above on account of compaction effect.
- iii. In non-expansive soils, when the cap of the pile group is cast directly on a reasonably firm stratum it may additionally contribute towards the bearing capacity of the group.
- iv. In load bearing walls piles should generally be provided under all wall junctions to avoid point loads on beams. Position of intermediate piles is then decided by keeping door openings fall in between two piles as far as possible.

#### 20.3.3 Equipment and Other Accessories

- i. The selection of equipment and accessories will depend upon the type of under-reamed piles, site conditions and nature of strata. Also it will depend on economic considerations and availability of manually or power operated equipment.
- ii. A typical list of equipment for manual construction is given in Appendix B.
- iii. Bore holes may be made by earth augers. In case of manual boring, an auger boring guide shall be used to keep bores vertical or to desired inclination and in position. After the bore is made to the required depth, enlarging of the base shall be carried out by means of an under-reaming tool.
- iv. In ground with higher water table having unstable pile bores, boring and under-reaming may be carried out using suitable drilling mud. General guidelines for bentonite drilling mud are given in Appendix 'A'. In



normally met soil strata, drilling mud can be poured from top while boring and under-reaming can be done by normal spiral earth auger and under-reamer.

- v. The level of drilling mud should always be about one meter above water table or the level at which caving-in occurs. In case of very unstable strata with excessive caving-in continuous circulation of drilling mud using suitable pumping equipment and tripod, etc along with modified auger and under-reamer may be used.
- vi. Some times permeable strata overlying a rim clayey stratum may be cased and normal boring and under-reaming operation may be carried out in clayey stratum.
- vii. To avoid irregular shape and widening of bore hole in very loose strata at top a casing pipe of suitable length may be used temporarily during boring and concreting.
- viii. For improved control over the inclination of batter/raker piles a tripod hoist with fixed pulley should be used for lowering in of under-reaming tools.
- ix. For placing concrete in bore holes full of drilling mud or sub-soil water tremie pipe of not less than 150 mm diameter with flap valve at the bottom should be used.
- x. For batter/raked under-reamed piles the reinforcement cage should be placed guiding it by a chute or any other suitable method. If concreting is not done by tremie, it should be done by chute.
- xi. In under-reamed compaction piles, suitable device should be used for guiding the movement of drop weight and specified core assembly for its vertical driving for operating the drop weight and specified core assembly for its vertical driving for operating the drop weights of adequate capacity, suitable winch with hoisting attachment should be used.

#### 20.3.4 Pile Boring

- i. Under-reamed piles may be constructed by selecting suitable installation techniques at given site depending on sub-soil strata conditions and type of under-reamed piles and number of bulbs.
- ii. In construction with equipment suggested under Appendix 'B' initially boring guide is fixed with its lower frame leveled for making desired angular adjustment for piles at batter/rake. Boring is done up to required depth and under-reaming is completed.
- iii. In order to achieve proper under-reamed bulb, the depth of bore hole should be checked before starting under reaming. It should also be checked during under-reaming and any extra soil at the bottom of bore hole; removed by auger before reinserting the under-reaming tool.
- iv. The completion of desired under-reamed bulb is ascertained by
  - a) The vertical movement of the handle and
  - b) When no further soil is cut.
- v. In double or multi under-reamed piles, boring is first completed to the depth to the first (top) under-ream only and after completing the under-reaming boring is extended further for the second under-ream and the process is repeated.

##### 20.3.4.1 Control of Alignment

- i. The piles shall be installed as correctly as possible at the correct location and truly vertical (or at the specified batter/inclination). Great care shall be exercised in respect of single pile or piles in two pile groups under a column.
- ii. As a guide for vertical piles a deviation of 1.5 per cent and for raker piles a deviation of four percent shall not normally be exceeded. In special cases, a closer tolerance may be necessary.





- iii. Piles shall not deviate more than 75 mm or one sixth the stem diameter, whichever is less (75 mm or  $D/10$  whichever is more in case of piles having diameter more than 600 mm) from the designed position at the working level.
- iv. In case of single pile under a column the positional deviation should not be more than 50 mm or one sixth of the stem diameter whichever is less (100 mm in case of piles having diameter more than 600 mm).
- v. For piles where cut-off is at substantial depths, the design should provide for worst combination of the above tolerances in position and inclination.
- vi. In case of piles deviating beyond these limits corrective measures where necessary may be taken in the form of increasing pile size, provision of extras reinforcement in the pile, redesign of pile cap and pile ties. If the resulting eccentricity cannot be taken care of by the above measures, the piles should be replaced or supplemented by; one more additional piles.

### 20.3.5 Reinforcement in Piles

- i. The provision of reinforcement will depend on nature and magnitude of loads, nature of strata and method of installation. It should be adequate for vertical loads, lateral load and moments acting individually or in combination. It may be curtailed at appropriate depths only under the advice of the structural engineer. However, provision of reinforcement shall be as specified in drawing.
- ii. The minimum area of longitudinal reinforcement (any type or grade) within the pile shaft should be 0.4 per cent of the sectional area calculated on the basis of outside area of shaft or casing if used.
- iii. Reinforcement is to be provided in the full length irrespective of any other considerations and is further subject to condition that a minimum number of three 10 mm dia mild steel or three 8 mm dia high strength steel bars shall be provided. The transverse reinforcement as circular stirrups shall not be less than 6 mm dia. Mild steel bars at a spacing of not more than the stem diameter or 30 cm, whichever is less.
- iv. For under reamed compaction piles, a minimum number of four 12 mm diameter mild steel or four 10 mm diameter high strength steel bars shall be provided.
- v. For piles of lengths exceeding 5 m and or 37.5 cm diameter, a minimum number of six 12 mm diameter HSD bars shall be provided.
- vi. For piles exceeding 40 cm diameter a minimum number of six 12 mm diameter high strength steel bars shall be provided.
- vii. The circular stirrups for piles of length exceeding 5 m and diameter exceeding 37.5 cm shall be bars of 8 mm diameter.
- viii. For piles subject to uplift loads, adequate reinforcement shall be provided to take full up lift which shall not be curtailed at any stage.
- ix. For piles up to 30 cm diameter, if concreting is done by tremie, equivalent amount of steel placed centrally, may be provided at sides.
- x. The minimum clear cover over longitudinal reinforcement shall be 50 mm. In aggressive environment of sulphates etc. it may be increased to 75 mm.

### 20.3.6 Concrete

**20.3.6.1 Materials:** Cement, water, fine aggregate, coarse aggregate and chemical admixtures etc. as described under clause 20.1.6.

**20.3.6.2 Concrete grades to be adopted:** Same as described under clause 20.1.6.6.

**20.3.6.3 Workability of Concrete:** Same as described under clause 20.1.6.7.



#### 20.3.6.4 Placing of Concrete

- i. Same as Para (i) to (x) under clause 20.1.6.8.
- ii. Concreting shall be done as soon as possible after completing the pile bore. The bore hole full of drilling mud should not be left un-concreted for more than 12 to 24 hours depending upon the stability of the bore hole.
- iii. For placing concrete in pile bores, a funnel should be used and method of concreting should be such the entire volume of the pile before is filled up without formation of voids and/or mixing of soil and drilling fluid in concrete.
- iv. In empty bore holes for under-reamed piles a small quantity of concrete is poured to give about 100 mm layer of concrete at bottom. Reinforcement is lowered next and positioned correctly. Then concrete is poured to fill the bore hole. Care should be taken that soil is not scrapped from side if rodding is done for compaction. Vibrators shall not be used.
- v. If water is confined up to the bucket length portion at the toe & seepage is low, the water should be bailed out and concreting should be done as prescribed in Para (iv) above.
- vi. In case the pile bore is stabilized with drilling mud or by maintaining water head within the bore hole, the bottom of bore hole shall be carefully cleaned by flushing it with fresh drilling mud and pile bore will be checked for its depth immediately before concreting.
- vii. Concreting shall be done by tremie method. The tremie should have a valve at bottom and lowered with valve closed at the start and filled up with concrete. The valve is then opened so permit the flow of concrete which permits upward displacement of drilling mud.
- viii. The pouring should be continuous and tremie is gradually lifted up such that the tremie pipe opening remains always in the concrete. At the final stage the quantity of concrete in tremie should be enough so that on final withdrawal some concrete spills over the ground.

**Note:** (1) The concrete should be coherent, rich in cement (not less than  $350 \text{ kg/m}^3$ ) and slump not less than 150 mm.

(2) The **tremie** pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.

- ix. In inclined piles, concreting should be done through a chute or by tremie method.
- x. For under-**reamed** bored compaction piles, the pile bore is first filled up without placing any reinforcement. Concreting is done as prescribed in paras (iv) depending upon the situation. Soon after the specified core assembly shall be driven and extra concrete shall be poured in simultaneously to keep the concrete up to ground level. If hollow driving pipe is used in core assembly the pipe shall be withdrawn after filling it with fresh concrete which will be left behind.

#### 20.3.6.5 Estimation of Concrete Quantity

- i. The extra quantity required for each bored cast-in-situ under-reamed bulb of 2.5 times the stem diameter may be taken equal to a stem length of 4 to 4.5 times its diameter, depending upon the nature of strata and other site conditions. The volume of concrete actually placed shall be observed in the case of quantities of the concrete and cement for the subsequent piles.
- ii. For under-reamed compaction piles the amount of concrete used is about 1.2 times of the under-reamed cast-in-situ piles.

**Note:** If the estimates of concrete consumption are on the volume of the bore holes and not on the basis of concrete quantity actually consumed, the concrete used may be found lesser than estimated and



cement consumption may work out to be less. **Placing Concrete under Water** : As described under clause 20.1.6.9.

**20.3.6.6 Testing Works Concrete:** As described under clause 20.1.7.

**20.3.6.7 Curing:** As described under clause 20.1.8.

**20.3.6.8 Ready Mix Concrete (RMC):** As described under clause 20.1.10.

### **20.3.7 Pile Cap (Fig. 20.2 and 20.3)**

Pile cap are generally designed considering pile reaction as either concentrated loads or distributed loads. The depth of pile cap should be adequate for the shear, diagonal tension and it should also provide the necessary anchorage of reinforcement both for the column and the pile.

The pile caps may be designed by assuming that the load from column or pedestal is dispersed at 45° from the top of the cap up to the mid depth of the pile cap from the based of the column or pedestal. The reaction from piles may also to be taken to be distributed at 45° from the edge of the pile, up to the mid depth of the pile cap on this basis, the maximum bending moment and shear forces should be worked out at critical sections.

Full dimension of the cap shall be taken as width to analyse the section for bending and shear in respective direction. Method of analysis and allowable stresses may be according to IS 456.

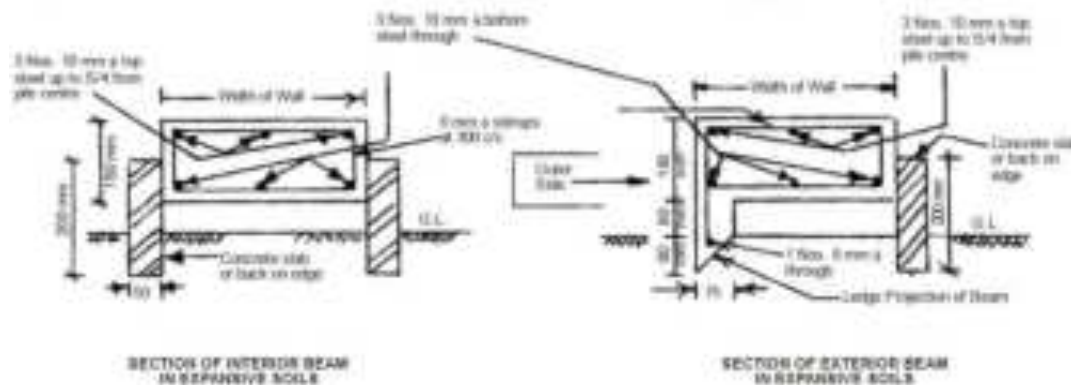
The clear overhang of the pile cap beyond the outermost pile in the group shall normally be 100 to 150 mm depending upon the size of the pile.

The cap is generally cast over a 75 mm thick leveling course of concrete. The clear cover for the main reinforcement of cap slab shall be not less than 75 mm.

The pile should project 50 mm into the cap concrete. The design of grade beams if used shall be as given in IS 2911 (Part III).

### **20.3.8 Grade Beams**

- i. The grade beams supporting the walls; shall be designed taking due account of arching effect due masonry above beam. The beam with masonry due to composite action behaves as a deep beam.
- ii. The minimum overall depth of grade beams shall be 150 mm. The reinforcement at bottom should be kept continuous in all the beams and an equal amount may be provided at top to a distance of quart span both ways from the pile centre.
- iii. The longitudinal reinforcement both at bottom and top should not be less than three bars of 10 m diameter mild steel (or equivalent deformed steel).
- iv. Stirrups of 6 mm diameter bars should be at 300 mm spacing which should be reduced to 100 m at the door openings near the wall edge to a distance of three times he depth of beam. No shear connectors are necessary in wall.
- v. In expansive soil the grade beam shall be kept a minimum of 80 mm clear off the ground. In other soils, the beams may rest on ground over a leveling concrete course of about 80 mm as shown. In this case part load may be considered to be borne by ground and it may be accounted for; in the design of piles. However, the beams should be designed as usual.
- vi. In case of exterior beams over piles in expansive soils a ledge projection of 75 mm thickness an extending 80 mm into ground as shown shall be provided on outer side beam. Typical sections of internal and external beams are shown below.



## 20.4 DRIVEN PRECAST R.C.C. PILES

### 20.4.1 General

Driven Precast Concrete Pile is a pile constructed in a casting yard and subsequently driven in the ground with or without jetting, or other technique like preboring (depending on the conditions of soil) when the pile has attained sufficient strength. By driving, the subsoil is displaced and remain in direct contact with the pile. These piles find wide application particularly for structures such as wharves, etc. to act as a free standing pile above the soil/water level or where conditions are unfavorable for use of cast-in-situ piles.

### 20.4.2 Reinforcement

- The longitudinal reinforcement of specified grade and size shall be provided in the pre-cast concrete piles, for the entire length. All the longitudinal bars shall be of same length and should fit tightly in the pile shoe if the same is provided.
- Extra bars for supporting the longitudinal steel shall be provided, to resist the local bending moments but the same should be detailed in the drawings prominently so that the sudden discontinuity can be avoided. The non provision of the extra bars may lead to cracks in the pile during heavy driving.
- As per IS 2911 (Part1/Sec.3) the area of main longitudinal reinforcement shall not be less than the percentages of cross sectional area of the piles as detailed below:
  - For piles with a length less than 30 times the least width: 1.25 per cent
  - For piles with a length **30** to 40 times the least width: 1.5 per cent
  - For piles with a length more than 40 times the least width: 1.5 per cent
- The laterals of a reinforcing cage may be in the form of links or spirals. The diameter and spacing of the same is chosen to impart adequate rigidity of the reinforcing cage during its handling and installations. The minimum diameter of the links or spirals shall be 8 mm and the spacing of the links or spirals shall be not less than 150 mm. Stiffner rings preferably of 16 mm diameter at every 1.5 m centre-to-centre to be provided along the length of the cage for providing rigidity to reinforcement cage.
- Minimum 6 numbers of vertical bars shall be used for a circular pile and minimum diameter of vertical bar shall 12 mm. The clear horizontal spacing between the adjacent vertical bars shall be four times the maximum aggregate size in concrete. If required, the bars can be bundled to maintain such spacing.
- The cover to reinforcement should be provided to longitudinal bars. In normal conditions the cover thickness to be provided is 50 mm and in case the piles are exposed to sea water or water having other corrosive contents the minimum thickness of cover shall be 75 mm.



Note: Where the concrete of pile is liable to attack of sulphates, chlorides present in ground water a minimum cover thickness of 75 mm shall be provided. In addition, the piles may be coated with some suitable material.

- vii. Each longitudinal bar shall be in one length as far as possible, also preferably the full length bar shall be used. However, in unavoidable cases if the bars are to be joined, they shall be done by butt welding duly staggering the joints.
- viii. The hoops or links that are to be tied to longitudinal reinforcement shall be tied with the specified type of binding wire and the free ends of the wire shall be turned into the interior of the pile.
- ix. Preferably the hoop or link reinforcement shall be welded to the longitudinal bars so as to achieve a tight fitting.
- x. Temporary or permanent spreader forks spaced at 1.5 m shall be used to keep the longitudinal bar in proper position and spacing.
- xi. Before concreting, the reinforcements shall be checked by Engineer-in-charge who shall ensure that the reinforcements are tied as per approved design and drawing and shall ascertain that the tying is perfect.

#### **20.4.3 Equipment and Ancillaries**

- i. The selection of equipment mostly depends upon the hardness of the strata. For deriving the size and weight of the pile to be handled, the most important point is the location of work.
- ii. Generally, the following equipments are necessary for the installation of piles:
  - a) Movable steel or timber structure duly designed to handle the pitching and driving the piles to the correct position and alignment.
  - b) Tackles to handle piles from casting/stacking yard.
  - c) To prevent the head of the pile from being damaged during drilling operation and to distribute the blow over the cross section of the head of the pile. A temporary steel driving cap, normally termed as 'Drive cap' is placed on the top of the pile.
  - d) A pad, block or packing of hard wood or some suitable resilient material normally termed as "Dolly" is fixed to the upper portion of the cap (helmet) for preventing the shock from hammer on the head of the pile.
  - e) A single acting" or "double acting" hammer is used depending on whether the hammer is allowed to fall under gravity along or is operated with the source of motive power to derive the energy.
  - f) Sometimes it so happens that the piles are to be driven below the pile frame leaders, with the result the hammer may not be in a position to reach the pile. Under such circumstances a removable extension piece known as "follower" or "long dolly" is used to transmit the hammer blows over the pile head.
  - g) When a particular type of soil strata is met with, the driving conditions may require equipments for jetting/pre-boring for installation of piles.
  - h) When the piles are to be driven in rock, coarse gravel, clay with cobbles, or other soils, which may damage the tip of the pile, flat or coaxial shoes made out of steel or cast iron shall be provided at the tip of the pile.
  - i) While driving a pile in a uniform clayey soil or sandy soil no advantage can be derived by tapering the tip of the pile hence no shoe need be provided for the tip of the pile while driving piles in such soils.



- j) When jetting is to be undertaken a jet tube may be cast into the pile by connecting the same to the pile shoe which is normally provided with jet holes. It is not advisable to provide a central which is likely to be choked.
- k) The best results can be achieved by providing four holes in four directions. However, providing two holes in opposite direction may also serve the purpose.
- l) Alternatively, two or more jet pies may be attached to the sides of the pile. The pile may get off loaded if proper balanced arrangement of jet is not made.

#### 20.4.4 Concrete

**20.4.4.1 Materials:** Cement, water, fine and coarse aggregate, chemical admixtures etc. As described under clauses 20.1.6.

**20.4.4.2 Concrete Grades to be Adopted:** Same as described under clause 20.1.6.6

**20.4.4.3 Workability of Concrete:** The degree of workability in this case is “low” as the concrete is placed where the section is not heavily reinforced, also the concrete in the pile is vibrated with both internal as well as external vibrators, and therefore minimum slump should be 25 mm to 50 mm.

#### 20.4.4.4 Formwork/Mould

- i. Only steel moulds manufactured out of sturdy steel sections and sheets to cast the required size of the pile are to be used. Timber moulds shall not be permitted, under any circumstances.
- ii. The mould shall sustain the stresses generated due to the use of immersion/plate vibrators and some time even form vibrator, depending upon the size and strength of the pile to be cast.
- iii. (ii) The manufacturing of the mould shall be so simple that the sides could be opened within 16 to 24 hours of casting by simply loosening the bolts without damaging the edges of the pile.
- iv. Fixing supports for the sides of the mould shall be done from outside and no use of through bolts through the concrete shall be permitted to support the opposite sides of the mould.
- v. Proper mechanism shall be introduced to fix the sides to the top of the casting platform so that the plate from vibrators can be operated without disturbing the mould.
- vi. In case of square piles provision for forming champhers of the pile for the corners shall be made in the mould itself.
- vii. The mould should be such that when the pile is demoulded all the surfaces of the pile except the side from which the concrete is laid should get form finish. No rendering or finishing shall be permitted on any surface of the concrete after demoulding.
- viii. Piles whose surfaces are plastered or rendered, edges repaired etc. shall be rejected and removed from site.
- ix. After every casting, when the sides of the mould are opened the same shall be cleaned nicely and form oil manufactured by reputed company shall be applied over the surface before the mould is adjusted for filling the concrete, for next pile. The normal practice of applying grease mixed with diesel or waste oil instead of the form-oil shall not be permitted.

#### 20.4.5 Casting Concrete Piles (Pre-casting)

- i. The casting yard shall be so constructed that the piles that are cast can be lifted directly from their beds and transported to the storing yard with minimum handling and avoiding any damage to the pile.
- ii. The casting yard shall have well drained surface so that the water used for curing the already cast piles do not accumulate on the yard inconveniencing the working on subsequent piles.



- iii. The size of the casting platform shall be large enough to accommodate the minimum number of piles to be cast for full 11 days depending upon the proposed progress of work per day, as a pile once cast cannot be lifted from the casting bed till the expiry of ten days, therefore no piles can be cast on these spaces till the piles more than 10 days old are shifted.
- iv. The casting yard shall be well covered not only from top but also from sides to avoid the direct sun-rays falling on the piles that are under set. The pile should also be protected from rain and wind.
- v. Before taking up actual concreting, the moulds to be concreted for full days work shall be fixed in position and preferably moulds for concreting on the subsequent day shall also be kept ready in advance.
- vi. If the contractor is permitted to start concrete with lesser number of moulds than that can be cast within a day, the action will prompt the contractor to open the sides of moulds already cast prematurely to continue concreting for the full day, which is not desirable as the quality of the concrete will be hampered.
- vii. The inner faces of the mould shall be cleaned; form-oil of approved brand and manufacture shall be applied.
- viii. The reinforcements shall be lowered carefully in the mould and fixed in position with proper cover blocks and spacers on all surfaces.
- ix. On getting formal approval of the Engineer-in-charge for the fixing of form-work in position and on getting the pre-measurements of the reinforcements recorded, concreting with specified grade shall be taken up. The slump should be checked frequently and constant w/c ratio shall be maintained.
- x. The piles should be cast from end to end, using immersion, form vibrators, avoiding over vibration. Proper care should be taken to see that the concrete is packed in the mould and consolidated. When the mould is full the top surface of concrete shall be neatly toweled and finished smooth.
- xi. Proper precaution shall be taken to ensure that the vibration from the adjoining work does not affect the previously placed concrete for piles during setting period.
- xii. On completing the concreting for a particular pile the following information shall be engraved (not painted) on each pile.
  - a) Date of casting.
  - b) Grade of concrete used.
  - c) No. of lot.

The lot No. will help to locate the exact position where the particular pile has to be used.

#### **20.4.6 Testing Works Complete**

As prescribed under clause 20.1.7.

#### **20.4.7 Ready Mix Concrete**

As prescribed under clause 20.1.10.

#### **20.4.8 Curing**

- i. Provision for curing as given under clause 20.1.8 shall be followed in addition.
- ii. The piles shall not be lifted from the casting bed for a minimum period of 10 days from the date of casting.
- iii. When the piles are shifted to stacking yard after the expiry of ten days, where the piles will have to be kept for a period of 28 days from the date of casting, the piles in stacks shall be covered with sacks so that the piles do not come in contact with sun rays till they attain full strength.





- iv. Lastly, the most important factors affecting the time of curing are the method of curing, weather during hardening, probable hardness of driving and the method of lifting and pitching.
- v. The Engineer-in-charge may fix up the exact period of curing for a particular project considering all the factors mentioned in Para (iv) above.

#### **20.4.9 Storing and Handling**

- i. After the expiry of 10 days from the date of casting, the piles are to be removed from the casting bed and shifted to the stacking yard where the piles shall be kept for a further period of 18 days i.e. 28 days after casting and later till they are carried for driving.
- ii. The piles shall be stored on a firm ground which will not liable for unequal subsidence or settlement under the weight of the stack of piles.
- iii. Timber sections of suitable size shall be placed over the level ground to stack the piles on top. The spacing between the timber sections shall be so adjusted that the piles are not subjected to undue bending stresses, while in stack.
- iv. Spaces shall be left around the piles in the stack so that they can be lifted without difficulty and necessary piles can be cured beyond 10 days.
- v. The order of stacking the piles shall be such that the older piles can be withdrawn without disturbing the newly placed piles. Separate stacks shall be provided for the piles of different lengths.
- vi. If ordered by the Engineer-in-Charge or if weather conditions so require arrangements for curing the piles for further period shall be made when the piles are stored in the stack.
- vii. Care shall be taken to see that the piles are not damaged or cracked at the time of lifting, handling transportation, etc.
- viii. While transporting the piles from the stocking yard to the site, the piles shall be supported at approximate lifting holes provided for the purpose. In case during transportation if the piles are to be unloaded temporarily they shall be placed on trestles or blocks located at the lifting points.

#### **20.4.10 Driving Piles**

- i. Though from the consideration of maintaining the time schedule and economy in construction, the pre-cast concrete piles have to be driven without any possible delay, still it shall be kept in mind that the piles chosen for driving should be thoroughly cured and are sufficiently hard. To achieve this proper schedule shall be followed, in the operations of casting, curing, stacking and transportation of piles to site.
- ii. The heads of the pre-cast concrete piles to be driven shall be protected with packing of resilient material against the possible damage due to the use of heavy hammers. Care shall be taken to see that packing is evenly spread and placed securely. On top of the packing a helmet should be placed and provided with a dolly of hardwood or any suitable material not thickens than the width of the pile.
- iii. The failure in the pile may occur by compression or tension when the blow of the hammer generates the stress waves which traverses the length of the pile. Failure due to compressive stresses mostly occurs at the heads. Head stresses are independent of ground conditions and mainly depend upon the weight of the hammer, its drop and the stiffness of the head cushion.
- iv. By using heaviest hammer and softest packing the maximum set for a given stress is obtained. The drop of the hammer however should; be adjusted to suit the allowable stress in the concrete.
- v. Optimum driving conditions can be maintained only by regular replacement of packing materials as prescribed in Para (ii) above, since the stiffness in head packing materials increases with repeated use.





- vi. Only in cases of exceptionally hard driving, where theoretically the compressive stresses of toe can reach twice the head stresses, failure in lower portions of the pile can occur. In practice, however, this rarely occurs as the compressive stresses to a great extent tend to be uniform over the considerable length of the pile.
- vii. Due to reflection of compressive wave to “free end”, the longitudinal tension is caused in the pile. This situation arises at a time when the ground resistance is low and/or when the hammer rebounds due to head conditions mainly because of the use of hard packing and light hammer. In addition, an unsupported long pile negotiating a hard stratum will be subjected to transverse or flexural vibrations in the pile in case the blow from the hammer becomes non-axial or if the pile is not restrained to reduce the effect of a long pile.
- viii. For driving a pile; any type of hammer can be used provided the pile penetrates to the prescribed depth or attain the specific resistance without getting damaged.
- ix. The hammer, helmets, dolly and the pile below should be co-axial and should sit perfectly one over the other. However, the heaviest possible hammer should preferably be used and the stroke should be so managed so as not to damage the pile.
- x. The choice of hammer mainly depends upon whether the pile is to be driven to a given resistance or to a given depth.
- xi. Normally, for a single acting or a drop hammer the stroke should be limited to 1.2 m but 1.0 m is preferable. Shorter stroke may be used in cases where there is a danger of damaging the pile, a few examples of which are described below:
  - a) Hard surface has to be penetrated in the early stages when a long pile has to be driven.
  - b) When there is a soft ground up to a considerable depth, a large penetration is achieved at each blow.
  - c) The pile suddenly reaches refusal when it meets with rock or other virtually impenetrable soil.
- xii. If a satisfactory set is achieved for ten consecutive blows with an appropriate hammer and drop the method of driving should be repeated with caution and long continued driving. However, after the pile has almost ceased to penetrate the driving should be stopped especially when the hammer with moderate weight is used.
- xiii. Sometimes it so happens that the rate of penetration suddenly changes without any satisfactory reasoning or soil conditions. Under such circumstances the pile driving should not be continued till real problem is investigated and remedy thought over.

#### **20.4.10.1 Jetting with Driving Pile**

- i. The jetting operation is effective only in the cohesion less soils such as sand, gravel and fine grained soils with very less percentage of clay. The jetting will be ineffective in clay soils.
- ii. The main purpose of jetting is to minimize or almost eliminate the resistance at the toe and last the same time the frictional resistance along the surface of the pile shaft also gets reduced.
- iii. Very hard driving and vibrations can be avoided when the toe resistance is eliminated and also the rate of penetration is increased considerably when compared to the normal driving methods without jetting.
- iv. Jetting operations shall be carried out only when specifically ordered by the Engineer-in- Charge. Jetting shall be carried in a manner that the stability of soil and the bearing capacity of piles already driven is not in any way impaired. Similarly, the safety of the adjoining structures shall be taken into consideration.



- v. For effective jetting the quantity of water required is directly related to the cross sectional area of the piles (including external jet pipes). In dense cohesion less soils the quantity of water up to 2 litres per minutes per sq.cm. of pile cross section may be required. Less quantity of water may be needed in loosely compacted soils.
- vi. The water pressure to be maintained is between 5.6 kgf/cm<sup>2</sup> to 10.6 kgf/cm<sup>2</sup> or more. In case large quantities of water are used the draining arrangement for the water that emerges on the ground shall have to be made otherwise the stagnant water may soften the ground endangering the piling equipment resting above.
- vii. To minimize the risk of blockages, the nozzle should not be positioned at the point of the toe. The arrangement of jets should be balanced to ascertain the penetration of the pile vertically. It is advisable to surge down an independent pile or two pipes may be attached to the opposite sides of the pile for effective jetting operation.
- viii. The pile shall be allowed to enter the ground gradually after operating the water under the weight of pile and the hammer. Acceptable verticality may be achieved by use of rigid leaders, duly controlling the rate of penetration with a pile winch.
- ix. On achieving maximum apparent penetration with light driving by the method prescribed above and when the water jets are running the further penetration may be attained in the cohesion less soils. The piles shall be driven to the final position or set when the jetting is complete.
- x. Before closing the driving operation, the jetting should be stopped and the driving shall be continued by ordinary driving methods. If due to the ground disturbances, the pile tips tend to be drawn towards the piles already driven, jetting should be stopped immediately.
- xi. The correct working of jets should be tested before the work on driving the pile is commenced. If the pile is not provided with as "built in jet arrangement" independent jet pipes down the outside the pile can be used and to achieve the best result jets working on several faces of the pile can be practical which will also assist maintaining the verticality.

#### 20.4.11 Stripping Pile Heads

- i. Stripping of pile shall be done in such a manner that a minimum 50 mm length of pile projects into the pile cap. Sufficient length of reinforcement from the pile shall be exposed for embedding the same inside the pile cap.
- ii. The stripping operation or exposing the reinforcement of the pile shall be done very carefully without damaging the pile proper. In case any portion of the concrete cracks, the defective portion shall be cut and the portion repaired with new concrete joining properly with old concrete.

#### 20.4.12 Lengthening Piles

- i. Sometimes the length of a pile has to be increased either before or during driving; this can be done by casing additional concrete over the old pile. In such cases the original head of the pile is cut to expose minimum 200 mm length of bar.
- ii. The exposed steel should be cleaned properly and shall be held in firm position, while full penetration butt welding is done.
- iii. In case the conditions on site are not favorable to attempt butt welding, a minimum length of 40 d (40 times the diameter of main bar) of the original pile shall be exposed and the new steel should be overlapped over the exposed steel. The overlap shall be spot welded.
- iv. On completion of welding/overlapping the reinforcement and tying the spirals, for the extended length of reinforcements the extra portion of the pile can be concreted thus extending the original pile.



#### 20.4.13 Risen Piles

- i. Sometimes due to ground heave there is a possibility that piles already driven to the final depth may start rising when adjacent piles are being driven; such rising shall be noted at frequent intervals till driving on adjacent piles is in progress.
- ii. On completion of driving the adjacent piles, the piles that are risen shall again be driven back either to their original level or up to a point of resistance.

#### 20.4.14 Pile Cap

As per clause 20.3.7.

#### 20.4.15 Grade Beam

As per clause 20.3.8.

#### 20.4.16 Measurement

Dimension shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured from top of shoe to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools, equipment for excavating and driving etc.

#### 20.4.17 Rate

The rate includes the cost of materials and labour involved in all the operations described above including pile embedded in pile cap, centering, shuttering except reinforcement, pile cap and grade beam.

### 20.5 LOAD TEST ON PILES

#### 20.5.1 General

The bearing capacity of a single or group of piles shall be determined from test loading. It is most direct method for determining safe load on pile and it is more reliable on account of its being in-situ test. The load test on a concrete pile shall not be carried out earlier than 28 days of its casting. Initial test shall be carried on test pile which is not used as working pile and Routine tests shall be carried out as a check on working pile. Routine test shall be one-half percent to two percent of total number of piles or as specified, applicable to vertical and lateral load. Load Test shall generally conform to provision made in IS 2911 (Part IV) which provides guidelines for determination of safe loads and conducting of different types of tests.

#### 20.5.2 Types of loadings/tests

- i. Vertical Load Test (Compression)
- ii. Cyclic Vertical Load Test
- iii. Lateral Load Test

#### 20.5.3 Vertical Load Test

**20.5.3.1 General:** Compression load shall be applied to the pile top by means of a hydraulic jack against suitable load frame which is capable of providing reaction and settlement is recorded by suitable dial gauges. The contractor shall apprise of Engineer-in-Charge before test is conducted.

**20.5.3.2 Preparation of Pile Head:** Pile head shall be chipped off to horizontal plane, projecting steel shall be cut or bent and top finished smooth and leveled with plaster of Paris or similar synthetic material as specified to give a plane surface which is normal to the axis of the pile. A bearing plate with a hole at the centers shall be placed on the head of pile for the jacks to rest.



**20.5.3.3 Loading Platform:** A proper loading platform is installed as specified. Contractor shall ensure that when the hydraulic jack and load measuring devices are mounted on pile head the whole system will be stable on the maximum specified load. For single pile two dial gauges shall be fixed to the pile and bear on surfaces on reference frame. The dial gauges shall be placed in diametrically opposite positions and be equidistant from the pile axis. Four dial gauges are used for groups, having 0.01 mm sensitivity. The arrangement shall be approved by the Engineer-in-charge.

**20.5.3.4 Application of Load:** The test is carried out by applying a series of downward incremental load (20 per cent of safe loads on pile). In this method application of increment of test load and taking of measurement or displacement in each stage is maintained till the rate of displacement is either 0.1 mm in first 30 minutes or 0.2 mm in first one hour or 2 hours, whichever occurs first. The test load shall be maintained for 24 hours. This method is applicable for both initial and routine test. For testing of raker piles the loading shall be along its axis. The safe working load on single pile for the initial test should be least of following:

- a. For piles up to and including 600 mm diameter:
  - i. Two-thirds of the final load at which the total displacement attains a value of 12 mm unless otherwise required in a given case on the basis of nature and type of structure in which case, the safe load should be corresponding to the stated total displacement permissible; and
  - ii. 50 percent of the final load at which the total displacement equal to 10 percent of the pile diameter in case of uniform diameter piles and 7.5 percent of bulb diameter in case of under-reamed piles.
- b. For piles more than 600 mm diameter:
  - i. Two-thirds of the final load at which the total displacement attains a value of 18 mm or maximum of 2 percent pile diameter whichever is less unless otherwise required in a given case on the basis of nature and type of structure in which case, the safe load should be corresponding to the stated total displacement permissible; and
  - ii. 50 percent of the final load at which the total displacement equal to 10 percent of the pile diameter in case of uniform diameter piles and 7.5 percent of bulb diameter in case of under-reamed piles.

However, routine test shall be carried for a test load of at least 1.5 times the working load; the maximum settlement at the test load being not greater than 12 mm for piles diameter up to and including 600 mm and 18 mm or 2 percent of pile diameter whichever is less for piles of diameter more than 600 mm.

Safe load on group of piles for initial test shall be least of the two

- i. Final load at which total displacement is 25 mm or as stated based on type of structure.
- ii. Two-thirds of final load at which the total displacement is 40 mm.

Routine test shall be carried for a test load equal to not less than working load, the maximum settlement not to exceed 25 mm.

**20.5.3.5 Maintained Load Method:** This is applicable for both initial and routine test. In this method, each stage of loading shall be maintained till the rate of movement of the pile top is not more than 0.2 mm/h or until 2 hours have elapsed, whichever is earlier subject to a minimum of 1 hour. The maximum test load shall be maintained for 24 hours.

Pile test data such as load, displacement and time shall be recorded in suitable prescribed tabular form. Results can be presented by suitable curves.



Test shall be carried out in proper manner and to the entire satisfaction of the Engineer-in-charge. After the test is completed the test cap shall be dismantled and pile surface shall be resorted to original shape.

**20.5.3.6 Measurement:** Each completed test shall be enumerated for initial test, routine test separately.

**20.5.3.7 Rate:** The rate includes the cost of labour, material and all the operations described above such as preparatory work including installation of loading platform, applying load, preparing pile head for load test, trimming of pile head etc. complete.

#### **20.5.4 Cyclic Vertical Load Testing**

**20.5.4.1 General:** This process shall be used in case of initial test to find out separately skin friction and point bearing load on single piles of uniform diameter in conformity of provisions of IS Code 2911 (Part 4) for conducting of the test.

**20.5.4.2 Preparatory Pile Head:** As per clause 20.5.3.2.

**20.5.4.3 Loading Platform:** As per clause 20.5.3.3

**20.5.4.4 Application of Load:** Relevant provision as per clause 20.5.3.4 shall be applicable. The test may be continued up to 50 per cent over the safe load.

**20.5.4.5** Test procedure given in Appendix E shall be followed.

Test shall be carried out in proper manner and to the entire satisfaction of the Engineer-in-charge.

After the test is completed, the test cap shall be dismantled and pile surface shall be restored to original shape.

**20.5.4.6 Measurement:** Each completed test shall be enumerated for different load ranges.

**20.5.4.7 Rate:** The rate includes the cost of labour, materials and all the operations described above such as preparatory work, trimming of pile head etc. complete.

#### **20.5.5 Lateral Load Testing**

**20.5.5.1 Load Platform:** A proper loading platform shall be installed as specified. Hydraulic jack is mounted with gauge between two piles or pile groups under test. Dial gauge tips shall rest on central portion of glass plate fixed on the side of pile.

**20.5.5.2 Application of Load:** Full load imposed by the jack shall be taken as lateral resistance on each pile or group. Load should be applied in increments of about 20 per cent of the estimated safe load. The next increment shall be applied after the rate of displacement is approximately equal to 0.1 mm per 30 minutes.

**20.5.5.3** The safe lateral load on pile; is least of the following:

- i. Fifty per cent of the final load at which total displacement increases to 12 mm.
- ii. Final load when total displacement is 5 mm.
- iii. Load corresponding to any other specified displacement as per performance requirement.

Pile group shall be tested as per actual conditions as far as possible.

**20.5.5.4 Displacements:** Displacement is read by at least two dial gauges of 0.1 mm sensitivity spaced at 30 cm and kept horizontally one above the other and displacement is interpolated at cut off level. One dial gauge placed diametrically opposite to jack shall directly measure displacement. Where, it is not possible to locate one of the dial gauges in the line of the jack axes, then two dial gauge may be kept at a distance of 30 cm at a suitable height and the displacement interpolated at load point from similar triangles.



**Note:** One of the methods of keeping dial gauge on pile surface is to chip off uneven concrete on the side of the pile and to fix a piece of glass 20 to 30 mm square. The dial gauge tips shall rest on the central portion of the glass plate.

Arrangement and test procedure shall be duly approved by the Engineer-in-Charge.

**20.5.5.5 Measurement:** Each completed test shall be enumerated for different load ranges.

**20.5.5.6 Rate:** The rate includes the costs of labour, materials and all the operations described above.

## **20.6 INTEGRITY TESTING OF PILE (PIT) USING LOW STRAIN/ SONIC INTEGRITY TEST/ SONIC ECHO TEST**

### **20.6.1 Integrity Testing**

It is a method of qualitative evaluation of the physical dimensions (cross sectional variation), soundness or defects of the piles concrete with respect to its continuity.

Pile integrity test covers the procedure for determining the integrity of individual vertical or inclined piles by measuring and analyzing the velocity (required) and force (optional) response of the pile induced by an (handheld hammer or other similar type) impact device usually applied axially and perpendicularly to the pile head surface.

Pile integrity test (PIT), or as ASTM D5882 refers to it as low strain impact integrity test, is a common non-destructive test method for the evaluation of pile integrity and/or pile length. Pile integrity test can be used for forensic evaluations on existing piles or quality assurance in the new construction.

Low strain impact integrity testing provides acceleration or velocity and force (optional) data on slender structural elements (structural columns, driven concrete piles, cast in place concrete piles, concrete filled steel pipe piles, timber piles, etc.).

The method works best on solid concrete sections, and has limited application to unfilled steel pipe piles and H piles. The test results can be used for evaluation of the pile cross-sectional area and length, the pile integrity and continuity, as well as consistency of the pile material. This evaluation practice is approximate and provides a rapid and simple way for evaluation of a large number of piles in a single working day.



**Fig 1: Equipment for pile integrity test**

### **20.6.2 Method of testing**

In this method of testing, a small metal/hard rubber hammer is used to produce a light tap on top of the pile. The shock traveling down the length of the pile is reflected back from the toe of the pile and recorded through a suitable transducer/accelerometer (also held on top of the pile close to the point of impact) in a computer disk or diskette for subsequent analysis.



The method of testing involves high skill and use of computerized equipment. Therefore, the tests should be performed and interpreted by trained and experienced personnel. The test should be done as per IS 14893:2001.

The pile head surface should be accessible, above water, and clean of loose concrete, soil or other foreign materials. Any type of contamination should be removed (using a grinder) to reach sound concrete surface. This step is so vital, because the sensor and concrete should in firm contact.

The location of the sensor should be away from the edges of the pile. The integrity testing should be performed no sooner than 7 days after casting of concrete.

A hammer is used for impacting pile top. Motion transducer should be capable of detecting and recording the reflected echos over the pile top. Acceleration, velocity, or displacement transducers can be used for this purpose. The distance between the impact location and the sensor should be no larger than 300 mm. Several impacts are applied to the top of the pile. The reflected echos are then recorded for each individual impact.

The primary shock wave which travels down the length of the pile is reflected from the toe by change in density between the concrete and the subsoil. However, if the pile has any defects or discontinuities within its length these will set up secondary reflections which will be added to the return signal.

#### **20.6.3 Measurement**

The integrity test shall be counted in numbers.

#### **20.6.4 Rate**

The rate includes input cost of pile integrity testing equipment including carriage at site, cost of technicians and all operations described above and submission of test report to engineer-in-charge.

#### **20.6.5 Limitation**

Pile integrity test provides an indication of soundness of concrete, however the test has certain limitations:

- a. Pile integrity test cannot be used over pile caps.
- b. It does not provide information regarding the pile bearing capacity.
- c. Test should be undertaken by persons experienced in the method and capable of interpreting the results.
- d. This test is not effective in piles with highly variable cross sections
- e. It is not effective in evaluating sections of piles below cracks that crosses the entire cross sectional area of the pile.



**BASIC PROPERTIES OF DRILLING MUD (BENTONITE)**  
**[Clause 20.2.2.2 & 20.3.3 (iv)]****A- 1 Properties**

A-1.1 The bentonite suspension used in bore holes is basically clay of montmorillonite group having exchangeable sodium cat ions. Because of the presence of sodium cat-ions, bentonite on dispersion will break down into small plate like particles having a negative charge on the surfaces and positive charge on the edges. When the dispersion is left to stand undisturbed, the particles become oriented building up a mechanical structure at its own. This mechanical structure held by electrical bond is observable as a jelly like mass or jell material. When jelly is agitated, the weak electrical bonds are broken and the dispersion becomes fluid.

**A -2 Functions**

A-2.2 In the case of granular soil, the bentonite suspension penetrates into the sides under positive pressure and after a while forms a jelly. The bentonite suspension gets deposited on the sides of the hole not penetrate into the soil, but deposits only a this film on the surface of the hole. Under such condition, stability is derived from the hydrostatic head of the suspensions.

**A – 3 Specification**

A-3.1 The bentonite suspension used for pilling work shall satisfy the following requirements:

1. The liquid limit of bentonite when tested in accordance with IS 2720 (Part V) 1985 shall be 400 percent or more.
2. The sand content of the bentonite powder shall not be greater than 7 per cent.
3. Note: The purpose of limiting the sand content is mainly to control and reduce the wear and tear of the pumping equipment.
4. Bentonite solution should be made by mixing it with fresh water using pump for circulation. The density of the bentonite solution should be between 1.03 to 1.10 gm/ml.
5. The mash viscosity when tested by a Marsh cone should be between 30 and 60 stoke.
6. The swelling index as measured by the swelled volume after 12 hours in abundant quantity of water shall be at least 2 times its dry volume.
7. The pH value of the bentonite suspension shall be between 9 and 11.5





## APPENDIX B

### EQUIPMENTS FOR UNDER-REAMED PILES (MANUAL CONSTRUCTION) (Clause 20.3.3)

#### **B – 1 Equipment**

**B-1.1** Normally the following equipment will be required in manual operation:

1. An auger;
2. An under-reamer;
3. A boring guide; and
4. Accessories like spare extensions, cutting tool, concreting funnel etc.

**B-1.1.1** For the piles of size larger than 30 cm and for larger depths additional equipment required will be portable tripod hoist with a manually operated winch.

**B-1.1.2** For piles in high ground water table and unstable soil conditions, boring and under-reaming shall be carried out with bentonite slurry using suitable equipment. Tremie pipe shall be used for concreting

1. Drop weight for driving the core assembly, and
2. Pipe or solid core.



## APPENDIX C

### PILE FRAME

#### Scope

Specification for pile frame shall be in conformity to the one laid in IS 6428. Contractor shall use the proper height of pile frame and which is able to take the weight of hammer safely.

Standard size of pile frame will assist the user in determining the type and size of frame. Damaged pile frame which cannot be used for want of spares shall be replaced with sound one.

#### Size

The size of pile frame shall be designated by its height and the weight of the hammer and the pile it can take.

The pile frame shall be as per the sizes given in table below:

S.No	Size	Height of Pile Frame	Weight of hammer	Weight of pile (Any Type) max
1	I	7.5	1.5	3
2	II	10.5	3	6
3	III	15	5	10
4	IV	20	6	12
5	V	25	6	12

**Extension Panels:** All pile frames shall be capable of being fixed with extension panels of 1.5, 3 and 4.5 m height without reduction in weight capacity.

**Performance:** Pile frames with or without extension panels shall be capable of placing piles at the maximum backward rake in 1 in 5 and the maximum forward rake 1 in 10.



**PILE BORING EQUIPMENT- GENERAL REQUIREMENT**  
(Clause 20.2.2)

**Scope**

Specification for pile boring equipment shall be as per IS 14362. Constructions of bored piles require careful selection of boring equipment. Choice of appropriate equipment will depend upon subsoil conditions, diameter of pile, their depths and other specific requirements of any particular work. Details of equipment and proposed methods of driving the pile shall be submitted by the tenderer for scrutiny and approval by the competent authority.

Equipment described herein refers to construction of bored piles on land and without the user of bentonite. The standard nominal diameter of piles shall be 450 mm, 500 mm, 600 mm and the like.

**Materials**

All materials used in the construction of pile boring equipment shall conform to the requirement of relevant Indian Standard IS 800 'Code of Practice' for general construction in steel.

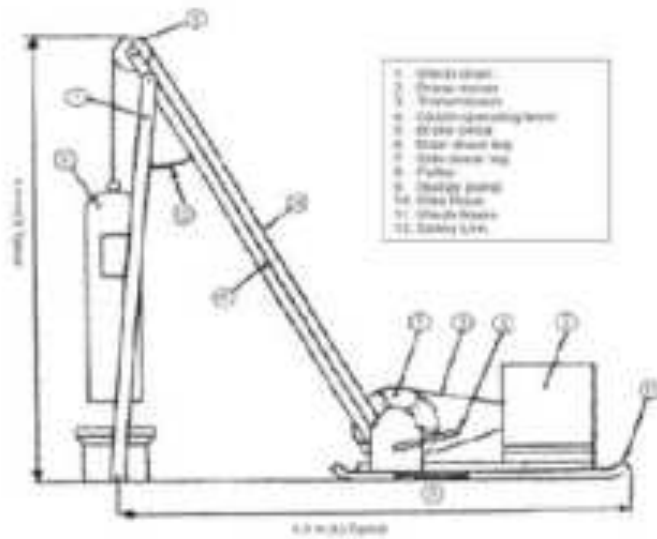
**Pile Boring Equipment****General**

The various items comprising pile boring equipment are:

- a. Winch
- b. Derrick
- c. Boring/chiseling tools
- d. Temporary casings
- e. Tremie arrangements, and
- f. Accessories

A typical piling winch consists of the following components as shown below in Fig. D1

- a. Winch drum,
- b. Prime mover,
- c. Transmission system,
- d. Clutch system,
- e. Brake system,
- f. Winch



### Figure D-1: Pile Boaring Equipment- General Requirement

**Winch Drum:** This standard capacities (drum rope pull) of the winch drum shall be 5 t. And the drum meter shall not be less than 20 times the diameter of the wire ropes used.

**Prime Mover:** The prime mover shall usually be a diesel engine of the air cooled type or an electric motor. A suitable reduction gear shall also be provided.

**Transmission:** The transmission system shall be one of the following :

- Geared drive
- Chain drive, and
- Belt drive (flat belt or V-belt)

The transmission system shall be provided with suitable guard cover.

**Clutch System:** The clutch system shall consist of a clutch wheel and friction plate(s) or a Friction cone operated by a lever.

**Brake System:** This shall consist of a brake band connected with the foot brake pedal or brake handle for hand operation.

**Winch Frame:** A typical winch frame shall be made from structural steel section and shall be either truck - mounted crawler-mounted or skid-mounted. A proper stabilizer shall be provided to transmit the load to the ground smoothly.

## Derrick

**General:** The standard derrick shall consist of the following components:

- Main shear leg,
- Side shear leg,
- Shear leg base,
- Pulley, and
- Safety link.



The hoisting capacity of the derrick shall be at least equal to the maximum drum rope pull and preferably more by 25%.

**Main Shear Leg:** The main shear leg shall be a box section fabricated according to IS 800-1984 either from two mild steel angle sections or two channel sections. The box section shall have minimum dimensions of 125 mm<sup>2</sup> and the minimum length of the leg shall be 5.6 m.

**Side Shear Legs:** The two sides shear legs shall have a minimum box section of 100 mm<sup>2</sup>. One of the two side legs shall be provided with suitable mild steel rings spaced 0.3 m apart up to the top. These legs shall be placed part at as distance of minimum of 3 m.

**Shear Leg Base:** These shall consist of as steel plate welded to the base of the leg. Additional plates shall be welded on all four sides of the leg for up to 15 mm above the bottom of the leg.

**Pulley:** The pulley shall be usually provided at the top of the main shear-leg and it shall have a diameter at least 20 times the diameter of the wire-rope used. The pulley shall have a suitable guard and shall be properly lubricated.

**Safety Link:** An interconnected steel -chain shall be provided near the top of the derrick so as to preclude any accidental increase in the distances between the legs.

### **Boring/Chiseling Tools**

The various tools shall be as follows:

- a. Sludge pump
- b. Bailers
- c. Chisels
- d. Casings
- e. Casing extractor plate
- f. Casing extractor bar
- g. Casing drive bar
- h. Tiller

**Sludge Pump:** Boring shall be usually advanced by using a sludge pump (also called shell) as shown in Fig. D-2. Weight of the sludge ump shall vary with the diameter but normally minimum weight shall be 7.5 kN. Sludge pump is a hollow cylindrical steel body with a cutting shoe at the bottom and a lifting hook at its top. It has hinged trap door immediately above the bottom cutting edged and it has an opening (window) near the top for muck removal. Above this window, lead or steel or concrete may be added to increase the weight of the sludge pump for effective boring.

**Bailer:** The bailer (see Fig. D -3) is used for removal of water or slush from the bore hole. It is made up of a hollow steel cylinder with a lifting hook at the top and a truncated base plate with perforation at the bottom. There is a plunger passing through a central hole of the base plate which acts as a plug valve. This plunger is about 20 cm long and has about 15 cm diameter steel plates welded at its top and bottom. This closes the central hole in the base plate of the plunger and thus retains the slush material for removal.

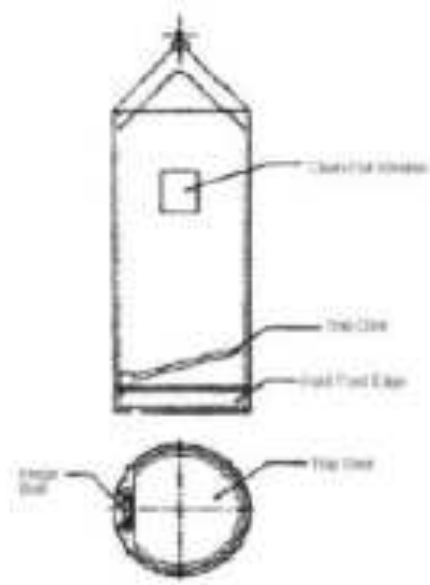


Figure D-2: Sludge Pump (shell)

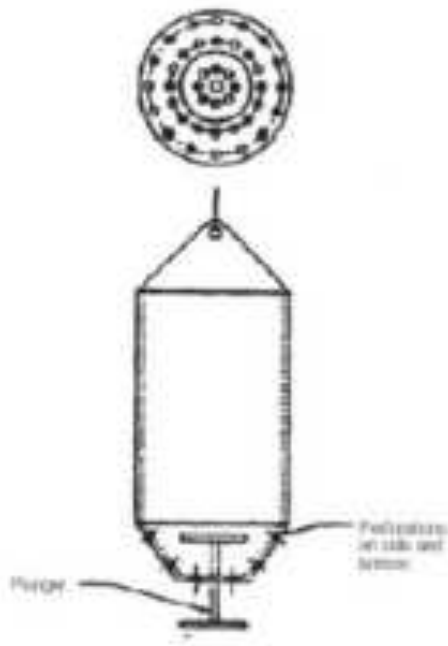


Figure D-3: Bailer

**Chisels:** Hard strata during boring shall be broken by chisels. The chisels shall be made of solid round bar with hard faced edged at the bottom. The chisel shall weigh at least 7.5 KN for 450 mm, 12.5 KN for 500 and 600 mm piles.



**Casing:** These shall be made from 16 mm thick plates and the standard length shall be 1.5 m. The casings shall be threaded on both sides and suitable collar shall be used to protect the threads.

**Casing Extractor Plate:** A steel plate of suitable size shall be used for the extraction casing after the boring operation is complete.

**Casing Extractor Bar:** This shall be a round of about 75 mm diameter. It shall be passed through the holes only sides of the casing and through the extractor plate, to enable extractor of casing.

**Casing Drive Bar:** This shall have a cross-section of at least 75 mm<sup>2</sup> and shall be used to drive the casing.

**Tiller:** This gadget shall be used to rotate the casing manually, whenever necessary.

### **Temporary Casing**

This shall consist of the following.

The casing collar shall be attached at the casing top to take the blows during casing driving. The main casing shall be made from 16 mm thick steel and shall be threaded at one end.

The casing shall be provided with as cutting edge at the bottom to facilitate driving.

### **Tremie Arrangements**

The tremie arrangements shall include the following:

- a. Concrete hopper
- b. Hopper plug
- c. Tremie pipe
- d. Holding clamp and
- e. Hoisting plug.

### **Accessories**

Accessories shall include the following:

- a. Concrete placer
- b. Wheel barrow
- c. Measuring chain
- d. Bailers
- e. Crowbars
- f. Dog-clamps with pins
- g. Steel measuring tape; and
- h. Mucking shovel.

**CYCLIC LOAD TEST METHOD**  
**(Clause 20.5.4.5)****E-1 Method**

**E-1.1** Alternate loading and unloading shall be carried out at each stage as in 20.5.3.5 and each loading stage shall be maintained as in 20.5.5.2 and each unloading stage shall be maintained for at least 15 minutes and the subsequent elastic rebound in the pile should be measured accurately by dial gauges as in 20.5.5.5. The test may be continued up to 50 per cent over the safe load.

**E-2 Analysis of Results for Frictional Resistance E-2.1 Graphical Method**

**E-2.1.1** Assuming that there is no compression in the pile, plot a graph relating total elastic recovery and load at the pile top.

**E-2.1.3** Draw a straight line parallel to the straight portion of curve I to divide the load into two parts and thereby obtained approximate values of point resistance and skin friction.

**E-2.1.4** From the approximate value of skin friction, and knowing the loads of top of pile, compute the elastic compression of the pile corresponding to these loads, by the following formula:

$$= \frac{\left(T - \frac{F}{2}\right)L}{AE}$$

Where

= Elastic compression of pile in cm,

T = Load on pile top in kgf,

F = Frictional resistance in kgf,

L = Length of the pile in cm,

A = Cross-sectional area of the pile in cm<sup>2</sup>, and

E = Modulus of elasticity of the pile material in kgf/cm<sup>3</sup>

(The value should normally be measured from an exposed portion of pile stem by means of compress meter during the load test itself.)

**E-2.1.5** Obtain values of the elastic compression of the sub grade by subtracting the elastic compression of the pile from the total elastic recovery of pile, and plot the graph relating these new values the negative value shall be ignored until the value is positive.

**E-2.1.6** Repeat the procedures given in E-2.1.3 to obtain new values of skin friction.

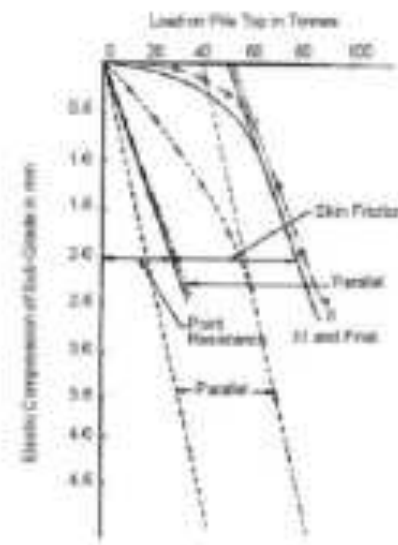
**E-2.1.7** The process of further approximations covered in E-2.1.6 may be repeated further to any desired extent, but usually the third curve would give sufficiently accurate values for skin friction for practical purposes.





## E-2.2 Analytical Method

Analysis of Cyclic Load Test Data for Separation of Skin Friction and Point Resistance.



**E-2.2.1** From straight line portion of curve calculate the value of constant from the equation.

$$m = \frac{s - \left(\frac{T}{AE}\right)}{T}$$

Where

$m$  = A constant;

$\Delta s$  = Change in total elastic settlement of pile

$\Delta T$  = Change in applied load =  $(T_b - T_a)$  in kgf

$L$  = length of pile in cm;

$A$  = cross-sectional area of pile in  $\text{cm}^2$

$E$  = elastic modulus of the material of pile in  $\text{kgf/cm}^2$

$T$  = Load on pile top in kgf.

**E-2.2.2** Calculate the corrected settlement for different load increment by equation (2)

$$S = mT$$

Where

$S$  = Corrected settlement in cm, and

$T$  = Total load on pile top in kgf.

**E-2.2.3** Knowing value of  $m$  and  $S$  compute skin friction and point bearing by solving simultaneous equation (3) and (4).

$$T = P + F$$

$$S = mP + (T - F/2)L/AE$$

Where

$P$  = point bearing in kgf, and  $F$  = skin friction in kgf.



**PILE DRIVING HAMMER**  
(Clause 20.1.2)

**Scope**

Specifications for driving hammer shall be in conformity to the one laid in IS 6426. Driving hammer of standard weight and strokes of different types be used.

The object should be to keep weights of hammers to a limited range and standardize weight interval and stroke to facilitate their use with piling rig & piling attachments of different plants.

Piles may be driven with any type of hammer, provided they penetrate to the prescribed depth or attain to ensure a final penetration of not more than 5 mm per blow.

**Classification**

It is preferable to employ the heaviest hammer practicable and to limit the stroke, so as not to damage the pile. Pile hammers shall be classified as given in the Table below:

Table No.	Classification of Pile Driving Hammers	
S. No.	Class	Weight Kg
(1)	(2)	(3)
(i)	Light Hammers	Up to 500
(ii)	Medium Hammers	Over 500 and up to 2500
(iii)	Heavy Hammers	Over 2500

**Sizes**

The recommended sizes (weight of ram or striking part) and stroke of different types shall be as given in Table below:

**TABLE**

Sizes (Weight of Ram or the Striking Part) and Stroke of Different Types of Hammers

S.No.	Type of Hammers	Light (upto 500 kg)	Medium (Over 500 up to 2500 kg)	Heavy (Over 2500 kg)
(1)	(2)	(3)	(4)	(5)
1	Drop Hammer	250 to 500 kg at multiples of 125	750 to 2500 kg at multiples of 250	2750 to 4500 kg at multiples of 250
2	Single acting capable of working on steam or air at 5.5 kg/cm <sup>2</sup> at the hammer	(a) 25 to 100 kg at multiples of 25 kg at maximum stroke of 20 cm (b) 100 to 500 kg at multiples of 100 kg at maximum stroke of 40 cm.	750 to 2500 kg at multiples of 250, at maximum stroke of 90 cm.	3000 to 7500 kg at multiples of 500 kg at maximum stroke at 120 cm.



3	Double acting capable of working on steam or air at 5.5 kg/cm <sup>2</sup> at the hammer	(a) 25 to 100 kg at multiples of 25 kg at maximum stroke of 20 cm (b) 100 to 500 kg at multiples of 100 kg at maximum stroke of 25 cm.	750 to 2500 kg at multiples of 500, at maximum stroke of 45 cm.	
4	Diesel Hammer	500 kg at maximum stroke of 250 cm	Over 500 up to 2500 kg at multiples of 500 kg at maximum stroke of 250 cm.	

## DIFFERENT TYPES OF PILE SHOES

Sub Head : Pile Work  
Clause : 20.7.1

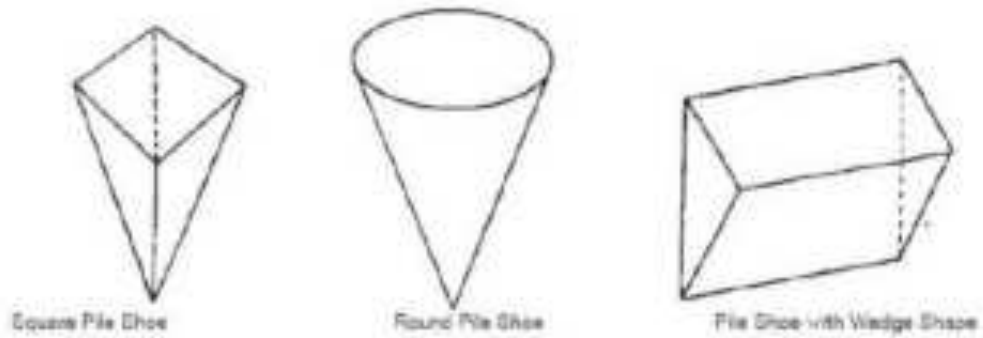


Figure 20.1 : Different Types of Pile Shoes

## PEDESTAL PILES

Sub Head : Pile Work  
Clause : 20.3.7

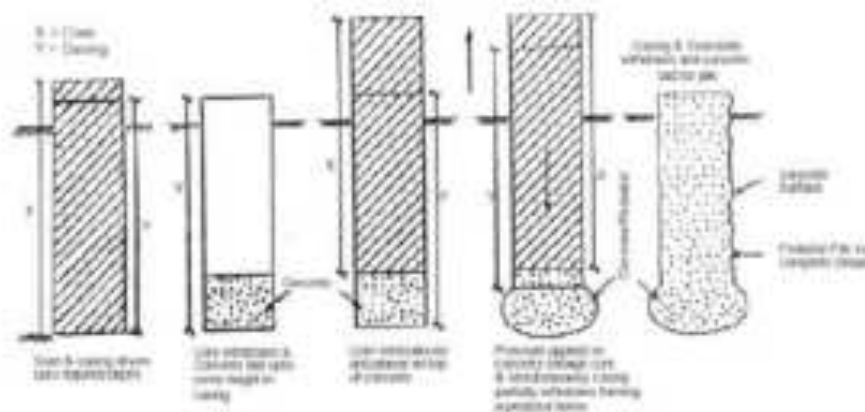


Figure 20.2 : Pedestal Piles





# ALUMINIUM WORK



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### LIST OF BUREAU OF INDIAN STANDARD CODES

Sl. No.	IS Code	Subject
1.	IS 733	Wrought Aluminium and Aluminium Alloys, Bars, Rods and Sections (For General Engineering Purposes) -Specification
2.	IS 737	Wrought Aluminium and Aluminium alloy sheet and strip for general engineering purposes -Specification
3.	IS 1285	Wrought Aluminium and Aluminium Alloy, Extruded Round Tube and Hollow sections (For General Engineering Purposes) - Specification
4.	IS 1868	Anodic coating on Aluminium and its Alloys-Specification
5.	IS 1948	Specification for Aluminium Doors, Windows and Ventilators
6.	IS 3908	Specification for Aluminium equal leg angles
7.	IS 3909	Specification for Aluminium unequal leg angles
8.	IS 3965	Dimensions for wrought Aluminium and Aluminium Alloys bars, rods and sections.
9.	IS 5523	Method of testing anodic coating on aluminium and its alloys.
10.	IS 6012	Measurement of coating thickness by Eddy Current Method
11.	IS 6315	Floor springs (Hydraulically regulated) for heavy doors-Specifications
12.	IS 6477	Dimensions of extruded hollow section and tolerances
13.	IS 12823	Wood products- Pre-laminated particle board –Specifications.
14.	IS 14900	Transparent Float glass- Specifications.



## 21 ALUMINIUM WORK

### 21.0 TERMINOLOGY

#### **Bar**

Any solid section, other than round, with at least one dimension of 10 mm or more.

#### **Rod**

Any round solid section with a diameter of 10 mm or greater.

#### **Extruded Round Tube**

A circular hollow extrusion of uniform wall thickness not subjected to cold drawing.

#### **Hollow Section**

An extruded shape other than round tube, the cross section of which completely encloses a void or voids and which is not subject to cold drawing.

#### **Anodized Aluminium**

Aluminium with an anodic coating, produced by an electrolytic oxidation process, in which the surface of the aluminium is covered with a coating, generally an oxide, to give protective and decorative properties.

#### **Pre-laminated Particle Board**

A particle board laminated on both surface by synthetic impregnated base papers under the influence of heat and pressure with finished foil under the pressure or pressure and heat depending on type of binder used.

#### **Floor Spring (Hydraulically Regulated)**

A device used to close the door so as to slow down its speed before it reaches its closed position.

#### **Single Action Floor Spring (Hydraulically Regulated)**

A device used to close the door in one direction only so as to slow down its speed before it reaches to its closed position.

#### **Double Action Floor Spring (Hydraulically Regulated)**

A device used to close the door in both directions so as to slow down its speed before it reaches its closed position.

#### **Shoe**

The device fixed to the bottom of the door leaf in order to hoist it to the floor spring.

#### **Top Centre Pivot**

The device to secure the upper portion of the door leaf and the door frame above.

#### **Right Hand Floor Spring**

A floor spring suitable for use on an anticlockwise door; an anticlockwise door is one which when viewed from above, rotates in anticlockwise direction about its hinge while opening.

#### **Left Hand Floor Spring**

The floor spring suitable for use on clockwise door a clockwise door is one which, when viewed from above, rotates in clockwise direction about its hinge while opening.



## **Sash**

It is a complete window unit whether fixed or open type.

## **Composite Window**

Window unit having two or more sashes joined together with one or more coupling members.

## **Centre – Hung Ventilator**

A ventilator horizontally pivoted at the centre on both sides. Top half opens inwards and bottom half opens outwards.

## **21.1 ALUMINIUM**

### **21.1.1 Aluminium Sections**

Aluminium sections used for fixed/openable windows, ventilators, partitions, frame work & doors etc. shall be suitable for use to meet architectural designs to relevant works and shall be subject to approval of the Engineer-in- Charge for technical, structural, functional and visual considerations. The aluminium extruded sections shall conform to IS 733 and IS 1285 for chemical composition and mechanical properties. The stainless steel screws shall be of grade AISI 304.

The permissible dimensional tolerances of the extruded sections shall be as per IS 6477 and shall be such as not to impair the proper and smooth functioning/operation and appearance of door and windows.

Aluminium glazed doors, windows etc. shall be of sizes, sections and details as shown in the drawings. The details shown in the drawings may be varied slightly to suit the standards adopted by the manufacturers of the aluminium work, with the approval of Engineer-in-Charge. Before proceeding with any fabrication work, the contractor shall prepare and submit, complete fabrication and installation drawings for each type of glazing doors, windows, ventilators and partition etc. for the approval of the Engineer-in- Charge. If the sections are varied, the contractor shall obtain prior approval of Engineer-in-Charge and nothing extra shall be paid on this account.

### **21.1.2 Anodising**

Standard aluminium extrusion sections are manufactured in various sizes and shapes in wide range of solid and hollow profiles with different functional shapes for architectural, structural glazing, curtain walls, doors, window & ventilators and various other purposes. The anodizing of these products is required to be done before the fabrication work by anodizing/electro coating plants which ensures uniform coating in uniform colour and shades. The extrusions are anodized up to 30 micron in different colours. The anodized extrusions are tested regularly under strict quality control adhering to Indian Standard.

### **21.1.3 Powder Coating**

**21.1.3.1 Material:** The powder used for powder coating shall be Epoxy/polyester powder of make approved by the Engineer- in-Charge. The contractor shall give detailed programme for powder coating in advance, to facilitate the inspection by Engineer-in-Charge or his authorized representative.

**21.1.3.2 Pre-treatment:** Each aluminium alloy extrusion or performed section shall be thoroughly cleaned by alkaline or acidic solutions under the conditions specified by chemical conversion coating supplier and then rinsed. A chemical conversion coating shall be applied by treatment with a solution containing essentially chromate ions or chromate and phosphate ions as the active components as applicable. The amount of the conversion coating deposited depends on the type used by the conversion coating chemical supplier. The conversion coating shall be thoroughly rinsed either with the solution specified by the conversion coating chemical supplier or with de-mineralized water and then dried at the temperature for the time specified by the conversion coating chemical supplier. The contractor shall submit the detail specifications and application procedure for application of conversion coating for approval of Engineer-



in-Charge. The metal surface after the conversion coating pretreatment and prior to the application of the coating shall be free from dust or powdery deposits.

**21.1.3.3 Process:** The polyester powder shall be applied by electrostatic powder spray method. Before start of powder coating the contractor shall submit detail specification for application of polyester powder from manufacturer of the polyester powder for approval of Engineer-in-Charge. The powder coating shall be applied as per the specification approved by Engineer-in-Charge.

**21.1.3.4 Thickness:** The thickness of the finished polyester powder coating measured by micron meter shall not be less than 50 micron nor more than 120 micron at any point.

**21.1.3.5 Performance Requirements for the Finish**

**Surface appearance:** The finish on significant surfaces shall show no scratches when illuminated and is examined at an oblique angle, no blisters, craters; pinholes or scratches shall be visible from a distance of about 1 m. There shall not be any visible variation in the colour of finished surfaces of different sections and between the colours of different surfaces of same section.

**Adhesion:** When a coated test piece is tested using a spacing of 2 mm between each of the six parallel cuts (the cut is made through the full depth of powder coating so that metal surface is visible) and a piece of adhesive tape, approximately 25 mm x 150 mm approved by the Engineer-in-Charge is applied firmly to the cut area and then removed rapidly by pulling at right angles to the test area, no pieces of the finish other than debris from the cutting operation shall be removed from the surface of the finish.

**21.1.3.6 Protection of Powder Coated / Anodizing Finish:** It is mandatory that all aluminium members shall be wrapped with self adhesive non-staining PVC tape, approved by Engineer-in-Charge.

**21.1.3.7 Measurement:** All the aluminium sections including snap beading fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment. (Weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

**21.1.3.8 Rate:** The rate shall include the cost of all the materials, labours involved in all the operations as described in nomenclature of item and particular specification.

## 21.2 PANELING MATERIAL

### 21.2.1 Pre-laminated Particle Board

A particles board laminated on both surfaces by synthetic resin impregnated base papers under heat and pressure. Pre-laminated particle boards shall be of two grades, namely, Grade I and II corresponding to IS 3087 & 12823. Each of the grades specified shall be of four types, namely, Types- I, II, III, and IV classified by the surface abrasion characteristics specified in Table 21.1. The grade and types of pre-laminated particle board shall be represented by symbols as follows:

Grade	Type	Designation
Grade 1	Type I	PLB-11
	Type II	PLB-12
	Type III	PLB-13
	Type IV	PLB-14
Grade 1	Type I	PLB-21



	Type II	PLB-22
	Type III	PLB-23
	Type IV	PLB-24

Sl. No.	Properties	Flat Pressed Three Layer, Multilayer and Graded	
		Grade-I	Grade-II
(i)	Density variation (Max.) Percent	± 10	± 10
(ii)	Water absorption (Max)		
	(a) 2 hours	7.0	15.0
	(b) 24 hours	15.0	30.0
(iii)	Thickness swelling (Max.), percent, 2 hours	5.0	8.0
(iv)	Modulus of rupture (Min) N/mm <sup>2</sup>		
	(a) Up to 20 mm thickness	15.0	11.0
	(b) Above 20 mm thickness	12.5	11.0
(v)	Tensile strength perpendicular to surface (Min.) N/m <sup>2</sup>		
	(a) Up to 20 mm thickness	0.45	0.3
	(b) Above 20 mm thickness	0.4	0.3
(vi)	Tensile strength perpendicular to surface (Min.) N/mm <sup>2</sup>		
	(a) After cyclic test*	0.2	-
	(b) After accelerated water resistance test**	0.15	-
(vii)	Screw withdrawal strength (Min.), N:		
	(a) Face	1250	1250
	(b) Edge	850	750
(viii)	Abrasion resistance (Min.) in number of revolutions		
	(a) Type I	450	450
	(b) Type II	250	250
	(c) Type III	80	80

\* **Cyclic Test:** Specimen are immersed in water at 27±2o C for a period of 72 hours, followed by drying in air at 27 ± 2o C for 24 hours and then heating in dry air at 70o C for 72 hours. Three such cycles are to be followed and then specimens are tested for tensile strength perpendicular to the surface.



**\*\* Accelerated Water Resistance Test:** Specimens are immersed in water at  $27 \pm 2^\circ \text{C}$  and water is brought to boiling and kept at boiling temperature for two hours. Specimens are then cooled in water to  $27 \pm 2^\circ \text{C}$  and tested for tensile strength perpendicular to the surface.

**Particle Board:** Synthetic resin bonded flat pressed three layers, multilayer and graded particle board defined in IS 3087 having superfine surface shall be used for production of prelaminated particle board. For ECO Marks the particle board shall also conform to the requirements of ECO Mark specified in IS 3087.

**Impregnated Base Paper:** Printed or plain coloured absorbent base paper having a weight of  $60 - 140 \text{ g/m}^2$  impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for pre-lamination on both surfaces of particle board.

**Impregnated Overlay:** An absorbent tissue, paper having a weight of  $18 - 40 \text{ g/m}^2$  impregnated in a suitable synthetic resin and dried to a volatile content of 4-8 per cent shall be used for the manufacture of pre-laminated particle board.

**Manufacture:** Particle boards having superfine and closed surface with high face strength and steep density gradient across the thickness is used for making prelaminated particle boards. Impregnated base papers rich in a synthetic resin are placed on either side of the particle board and the assembly is taken inside a short cycle single opening lamination press or a multi day light press. Under heat and pressure the resin flows and forms a permanent bond with particle board.

The top surface of impregnated paper comes in contact with special surface chromium plates or steel caul plates and takes the impression of surface finish of these cauls. Hot boards are extracted out of the short cycle press and cooled in air, whereas cooling of boards is done inside the dress in multiday light type. Care should be taken to keep cycle times low in the press to avoid heat penetration to the centre of the board edge.

The impregnated overlay paper may be used by placing it over the impregnated base paper (IBP) on one surface while using a normal IBP on the other surface and pressure. The impregnated overlay becomes transparent after pressing. Such boards are used for high surface abrasion application.

In case of finished foil particle boards, the finished foil is pasted on both surfaces of particle board after spreading suitable synthetic glue on board's surface and passing the assembly in a roller press or a flat press under the influence of pressure and/or heat depending on the type of binder used.

**Finish:** The finish of the paper overlaid board depends on the surface of caul plates used. Common surface finishes in use are glossy, matt textured (soft, Swede, wood pore and leather), etc. The surface finish of the foil finished boards depends on the original finish of the foil used.

**Dimensions and Tolerances:** Dimensions and tolerances shall conform to IS 12049.

**Testing:** One sample for every 100 sqm. or part thereof shall be taken and testing done as per IS 12823. For quantity less than 100 sqm, the test certificate from manufacturer shall be relied upon. The Engineer-in-charge may ask for testing even if the quantity is less than 100 sqm.

### 21.2.2 Aluminium Sheet

Aluminium Sheets for use as panels shall be 1.25 mm thick aluminium alloy sheet conforming to IS 737. Aluminium alloy sheet for use in general paneling work shall be of types and thickness as specified and conforming to the requirement of IS 737. Aluminium sheets shall be of approved make and manufacturer. Aluminium panel may be prefabricated units manufactured on modular or non- modular dimension.

**Fixing:** The required size of panel, keeping sufficient margin to be inserted inside the section, shall be cut to correct size and fixed firmly in the frame with CP brass or aluminium or stainless steel screws of star



headed, counter sunk and matching size groove. Joints sealed with epoxy resin or silicon sealant to make the unit water proof.

### 21.2.3 Float Glass

The glass shall be clear float glass and should be approved by the Engineer in Charge. It shall be clear, float transparent and free from cracks subject to allowable defects. The float glass shall conform to the IS 14900.

**Thickness:** The thickness of float glass shall depend on the size of panel. The tolerance in thickness shall be as under:

Nominal Thickness (in mm)	Tolerance (in mm)
4.0	± 0.3
5.0	± 0.3
6.0	± 0.3
8.0	± 0.6

**Allowable Defects:** The allowable defects shall be as per Table 21.3 below:

**TABLE 21.3**

Sl. No.	Defects	Central	Outer	Remarks
1.	Gaseous inclusion. Max size, mm	3.0	6.0	Separated by at least 30.0 cm
2.	Opaque gaseous inclusion. Max size. mm	3.0	6.0	Separated by at least 60.0 cm
3.	Knots, dirt and stones, Max size. mm	1.0	1.0	Separated by at least 30.0 cm
4.	Scratches, Rubs and Crush	Faint	Light	Separated by at least 30.0 cm
5.	Bow, percent. Max	0.5	0.5	See 21.2.4.3
6.	Reams, Strings and lines	Light	Light	See 21.2.4.4
7.	Waviness	Nil	Nil	See 21.2.4.5
8.	Sulphur stains	Nil	Nil	
9.	Corner breakage and chip	Not more than nominal thickness of float glass		

**Allowable Cluster of Defects:** The allowable cluster of defects mentioned under Sl. No. 1, 2 & 3 of Table 21.3 shall be as per IS 14900.

### 21.2.4 Tests





- 21.2.4.1 Thickness:** The thickness of float glass shall be measured with micrometers or a caliper which is graduated to 0.01 mm or with a measuring instrument having an equivalent capacity.
- 21.2.4.2 Scratches, Rubs and Crush:** Place the sample of float glass in a vertical position approximately 50 cm from the viewer's position and look through it using either day light without direct sunlight or a background light suitable for observing each type of defect.

**TABLE 21.4**

Intensity of Scratches, Rubs, Crush	Intensity Distance Limit
Faint	Shall not be detectable beyond 50 cm
Light	Detectable between 50-100 cm and not beyond 100 cm.

- 21.2.4.3 Bow:** Depending on the side on which bow is present, stand the sample vertically on a wooden plank. Stretch a thread edge to edge. Measure the longest perpendicular. Distance from the thread to the surface of float glass facing the thread and express it as percentage of the length of float glass from edge along the thread.
- 21.2.4.4 Reams, Strings and Lines:** Focus a light projector with a 500 W lamp and an objective lens with an approximate 5 cm aperture and about 30 cm focal length on a flat white projection screen placed about 760 cm from the light source in a dark room. Place the float glass in a vertical position parallel to the screen between the light and the screen. Move the glass slowly towards the screen with a vertical oscillating motion. The shadowgraph read out is the distance at which the distortion just blends with the general shadow of the glass on the screen.

**TABLE 21.4**

Intensity of Reams, Strings and Lines	Intensity Distance Limit
Light	7.5 cm
Medium	5.0 cm
Heavy	2.5 cm

- 21.2.4.5 Perspective Distortion:** When tested as per test procedure described below it shall not give distorted vision of straight stripe pattern.

#### **Test Procedure for Perspective Distortion**

Perspective distortion shall be examined by looking through the specimen glass which may be placed at about 4.5 m distance in such a direction that the incident angle to it is 50 degree (4 mm or above) and by observing a screen set up perpendicularly to the line of vision about 4.5 m further ahead of the specimen over the total width of about middle part of the specimen from the horizontal direction. The specimen glass shall be kept with the drawn direction at manufacture vertical and, on the surface of the screen, the strip pattern of white and black parallel straight lines of 25 mm width and inclined 45 degrees from the vertical shall be provided and its surface shall be luster less.

### **21.3 EPDM- GASKETS**

The EPDM Gaskets shall be of size and profile as shown in drawings and as called for, to render the glazing, doors, windows, ventilators etc. air and water tight. Samples of gaskets shall be submitted for approval and the EPDM gasket approved by Engineer- in- Charge shall only be used. The contractor shall submit documentary proof of using the above material in the work to the entire satisfaction of Engineer-in-Charge.

The EPDM gasket shall meet the requirements as given in Table 21.5 below:

**TABLE 21.5**

Sl. No.	Description	Standard Follow	Specification
1	Tensile strength Kg.f/cm <sup>2</sup>	ASTM-D 412	70 Min.
2	Elongation at break %	ASTM-D 412	250 Min.
3	Modulus 100% Kg.f/cm <sup>2</sup>	ASTM-D 412	22 Min.
4	Compression set % at 0 <sup>0</sup> CC 22 Hrs.	ASTM-D 395	50 Max.
5	Ozone resistance	ASTM-D 1149	No visible cracks

**21.4 SEALANT**

**21.4.1** The sealants of approved grade and colour shall only be used. The silicone for perimeter joints (between Aluminium section and RCC/Stone masonry) shall be of make approved by the Engineer in Charge.

**21.4.2 Method of Application**

**Surface Preparation:** Clean all joints and glazing pockets by removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealants or glazing compounds and protective coatings.

**21.4.3 Masking**

Areas adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall not be allowed to touch clean surfaces to which the silicone sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms and masking shall be removed immediately after tooling.

**21.4.4 Application**

Install backer rod of appropriate size and apply silicone sealant in a continuous operation using a positive pressure adequate to properly fill and seal the joint. The silicone sealant shall be tooled with light pressure to spread the sealant against backing material and the joint surfaces before a skin forms. A tool with convex profile shall be used to keep the sealant within the joint. Soap or water shall not be used as a tooling aid. Remove masking tape as soon as silicone joint is tooled.

**Tolerance:** A tolerance of + 3 mm shall be allowed in the width of silicone joints. The depth of the joints at throat shall not be less than 6 mm.

**21.5 REFLECTIVE GLASS****21.5.1 Definitions**

- (i) **Shading Coefficient:** The shading coefficient is the ratio of total solar transmittance to the transmittance through 3.2 mm (1/8") clear glass. Windows with low shading coefficient values improve comfort for building, lower the total cooling load of the building and help smooth out of the difference in cooling loads between perimeter & core zones.
- (ii) **Luminous Efficacy Constant (Ke)** indicates a windows relative performance in rejecting solar heat-while transmitting day light. It is the ratio of the visible transmittance to the shading coefficient; clear glass which lets in roughly equal amounts of visible light and solar near- infrared energy has a Ke close to 1.0. The solar radiation contains about 50% invisible near- infrared & ultra violet light. Therefore, a perfectly selective glazing, which would all allow visible light pass through while blocking all of the invisible near-infrared & ultraviolet light, would have Ke of about 2.0.



(iii) **Resistance to Heat Conduction (R-value):** It is a measure of resistance to heat flow that occurs because of temperature difference between the two sides of the windows. The inverse of R-value is termed as U-value.

### 21.5.2 Reflective Glass

This is an ordinary float glass with a metallic coat to reduce solar heat. Clear glass transmits most of the sunlight that shines upon it, and most of the solar heat as well; the metallic coated glass i.e. reflective glass has better shading coefficients because they reflect rather than absorb infrared energy. However, most of reflective glazing blocks day light more than solar heat.

**21.5.2.1 Types of Coatings:** There are two types of reflective glass, Pyrolytic (Hard) coated and vacuum (soft) coated.

1. **Pyrolytic:** It is a coating applied during glass manufacture. The coating is fused into the glass at 1200°C.
2. **Vacuum Coated Glass:** It involves the deposition of metal particles on the glass surface by a chain reaction in a vacuum vessel. It is often called a soft coat because the coating is more susceptible to damage than hard coat glass. Where toughening of product is required, the product must be toughened first & then vacuum coated. Vacuum coated products have better shading coefficient values than pyrolytic products.

**21.5.2.2 Performance of Reflective Glass:** The performance of reflective glass 6 mm of nominal thickness is given below:

Sl. No.	Parameter	Threshold Ratio In %age
1	Visible Light	
	Transmittance (%)	15-46
	Reflectance (%)	12-24
2	Total Solar Energy:	
	Transmittance (%)	16-24
	Reflectance (%)	8-12
3	Ultra Violet Rays:	
	- Transmittance (%)	2-10
4	U-Value	
	Summer	0.58
	Winter	0.45
5	Shading Coefficient	0.25-0.35

**21.5.2.3 Testing:** The reflective glass shall be tested for the followings:

1. **Physical/Field Test:** In a true reflective glass, when a pointed pencil is placed, then tip of pencil (physical) & image should coincide.
2. **Lab. Test:** In the lab, the reflective glass shall be tested for the parameter specified in 21.5.2.2 above.

**21.5.2.4** Fixing of glass shall be done as specified.

## 21.6 DOOR, WINDOW, VENTILATOR AND PARTITION FRAMES



### 21.6.1 Frame Work

First of all the shop drawings for each type of doors/windows/ventilators etc. shall be prepared by using suitable sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of glazed doors, windows, ventilators etc. The shop drawings shall also show the details of fittings and joints. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-Charge.

Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual door/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site. The frames shall be truly rectangular and flat with regular shape corners fabricated to true right angles. The frames shall be fabricated out of section which have been cut to length, mitered and jointed mechanically using appropriate machines. Mitered joints shall be corner crimped or fixed with self tapping stainless steel screws using extruded aluminium cleats of required length and profile. All aluminium work shall provide for replacing damaged/broken glass panes without having to remove or damage any member of exterior finishing material.

### 21.6.2 Fixing of Frames

The holes in concrete/masonry/wood/any other members for fixing anchor bolts/fasteners/screws shall be drilled with an appropriate electric drill. Windows/doors/ventilators etc. shall be placed in correct final position in the opening and fixed to Sal wood backing using stainless steel screws of star headed, counter sunk and matching size groove. of required size at spacing not more than 250 mm c/c or dash fastener. All joints shall be sealed with approved silicone sealants.

In the case of composite windows and doors, the different units are to be assembled first. The assembled composite units shall be checked for line, level and plumb before final fixing is done. Engineer -in-Charge in his sole discretion may allow the units to be assembled in their final location if the situation so warrants. Snap beadings and EPDM gasket shall be fixed as per the detail shown in the shop drawings.

Where aluminium comes into contact with stone masonry, brick work, concrete, plaster or dissimilar metal, it shall be coated with an approved insulation lacquer, paint or plastic tape to ensure that electrochemical corrosion is avoided. Insulation material shall be trimmed off to a clean flush line on completion.

The contractor shall be responsible for the doors, windows etc. being set straight, plumb, level and for their satisfactory operation after fixing is complete.

### 21.6.3 Measurements

All the aluminium sections including snap beadings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

### 21.6.4 Rate

The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification.

## 21.7 DOOR, WINDOWS AND VENTILATOR SHUTTERS

Material, fabrication and dimensions of aluminium doors, windows and ventilators manufactured from extruded aluminium alloy sections of standard sizes and designs complete with fittings, ready for being fixed into the building shall be as per IS 1948.



### 21.7.1 Terminology

The components of doors, windows and ventilators shall be defined as in Figure 21.1 below.

### 21.7.2 Standard Sizes, Tolerances and Designations

The types and the overall sizes of aluminium doors, windows and ventilators shall be as given in Figure 21.2. Their sizes are derived after allowing 1.25 mm clearances on all the four sides for the purpose of fitting the doors, windows and ventilators into modular openings.

### 21.7.3 Tolerances

The sizes for doors, windows and ventilators frames shall not vary by more than  $\pm 1.5$  mm.

### 21.7.4 Material

Aluminium alloy extruded sections used in the manufacture of extruded window sections shall conform to IS 733. Hollow aluminium alloy sections used shall conform to IS 1285. Dimension and weight per metre run of the extruded sections shall be as given in Figure 21.3.

### 21.7.5 Glass Panes

Glass panes shall weigh at least  $7.5 \text{ kg/m}^2$  and shall be free from flaws, specks or bubbles. All panes shall have properly squared corners and straight edges. The sizes of glass panes for use in doors, windows and ventilators shall be as given in Table 21.6.

### 21.7.6 Screws

Screws threads of machine screws used in the fabrication of aluminium doors, windows and ventilators shall conform to IS 1362.

**TABLE 21.6**

**Glass Sizes (Clearance Allowed) (Clause 21.7.5)**

Designation	Quantity	Glass size Width X Height cm
<b>No Glazing Bar Fixed Type</b>		
6NF6	1	53.0 x 53.0
10NF6	2	45.0 x 53.0
12NF6	2	55.0 x 53.0
15NF6	{2	45.0 x 53.0
	{1	47.5 x 53.0
18NF6	{2	55.0 x 53.0
	{1	57.5 x 53.0
6NF9	1	53.0 x 83.0
10NF9	2	45.0 x 83.0
12NF9	2	55.0 x 83.0
15NF9	{2	45.0 x 83.0
	{1	47.5 x 83.0



Designation	Quantity	Glass size Width X Height cm
18NF9	{2	55.0 x 83.0
	{1	57.5 x 83.0
6NF12	1	53.0 x 113.0
10NF12	2	45.0 x 113.0
12NF12	2	55.0 x 113.0
15NF12	{2	45.0 x 113.0
	{1	47.5 x 113.0
18NF12	{2	55.0 x 113.0
	{1	57.5 x 113.0
6NF15	{1	53.0 x 27.0
	{1	53.0 x 113.0
10NF15	{2	{45.0 x 27.0
	{2	{45.0 x 113.0
12NF15	{2	55.0 x 27.0
	{2	55.0 x 113.0
15NF15	{2	45.0 x 27.0
	{1	47.5 x 27.0
	{2	45.0 x 113.0
	{1	47.5 x 113.0
18NF15	{2	55.0 x 27.0
	{1	57.5 x 27.0
	{2	55.0 x 113.0
	{1	57.5 x 113.0
8NF6	1	73.0 x 53.0
6NF21	{1	53.0 x 84.5
	{1	53.0 x 27.5
	{1	53.0 x 56.0
<b>No Glazing Bar Top-Hung Type</b>		
6NT6	1	50.0 x 50.0
10NT6	2	44.5 x 50.0
12NT6	2	54.5 x 50.0
15NT6	{2	45.0 x 53.0



Designation	Quantity	Glass size Width X Height cm
	{1	45.5 x 50.0
18NT6	{2	55.0 x 53.0
	{1	54.5 x 50.0
8NT6	1	70.0 x 50.0
6NT9	{1	50.0 x 51.5
	{1	53.0 x 27.5
<b>No Glazing Bar Centre-Hung Type</b>		
6NC6	1	46.0 x 46.0
10NC6	2	42.5 x 46.0
12NC6	2	52.5 x 46.0
15NC6	{2	45.0 x 53.0
	{1	43.5 x 46.0
18NC6	{2	55.0 x 53.0
	{1	53.5 x 46.0
8NC6	1	66.0 x 46.0
<b>No Glazing Bar Side-Hung Type</b>		
6NS9	1	50.0 x 80.0
10NS9	2	43.5 x 80.0
12NS9	2	52.5 x 80.0
15NS9	{2	43.5 x 80.0
	{1	47.5 x 83.0
18NS9	{2	52.5 x 80.0
	{1	57.5 x 83.0
6NS12	1	50.0 x 110.0
10NS12	2	43.5 x 110.0
12NS12	2	52.5 x 110.0
15NS12	{2	43.5 x 110.0
	{1	47.5 x 113.0
18NS12	{2	53.0 x 27.0
	{1	50.0 x 110.0
6NS15	{1	53.0 x 27.0
	{1	50.0 x 110.0



Designation	Quantity	Glass size Width X Height cm
10NS15	{2	45.0 x 27.0
	{2	43.5 x 110.0
12NS15	{2	55.0 x 27.0
	{2	52.5 x 110.0
15NS15	{2	45.0 x 27.0
	{1	47.5 x 27.0
	{2	43.5 x 110.0
	{1	47.5 x 113.0
18NS15	{2	55.0 x 27.0
	{1	57.5 x 27.0
	{2	52.5 x 110.0
	{1	57.5 x 113.0
8NS21	{1	66.0 x 81.0
	{1	56.0 x 27.5
	{1	66.0 x 56.0
12NS21	{2	50.5 x 81.0
	{2	50.5 x 56.0
	{1	50.5 x 27.5
	{1	40.5 x 27.5
<b>Horizontal Glazing Bar Fixed Type</b>		
6HF6	2	53.0 x 26.0
10HF6	4	45.0 x 26.0
12HF6	4	55.0 x 26.0
15HF6	{4	45.0 x 26.0
	{2	47.5 x 26.0
18HF6	{4	55.0 x 26.0
	{2	57.5 x 26.0
6HF9	{2	53.0 x 27.5
	{1	53.0 x 26.0
10HF9	{4	45.0 x 27.5
	{2	45.0 x 26.0
12HF9	{4	55.0 x 27.5





Designation	Quantity	Glass size Width X Height cm
	{2	55.0 x 26.0
15HF9	{4	45.0 x 27.5
	{2	45.0 x 26.0
	{2	47.5 x 27.5
	{1	47.5 x 26.0
18HF9	{4	55.0 x 27.5
	{2	55.0 x 26.0
	{2	57.5 x 27.5
	{1	57.5 x 26.0
6HF12	4	53.0 x 27.5
10HF12	8	45.0 x 27.5
12HF12	8	55.0 x 27.5
15HF12	{8	45.0 x 27.5
	{4	47.5 x 27.5
18HF12	{8	55.0 x 27.5
	{4	57.5 x 27.5
6HF15	{1	53.0 x 27.0
	{4	53.0 x 27.5
10HF15	{2	45.0 x 27.0
	{8	45.0 x 27.5
12HF15	{2	55.0 x 27.0
	{8	55.0 x 27.5
15HF15	{2	45.0 x 27.0
	{1	47.5 x 27.0
	{8	45.0 x 27.5
	{4	47.5 x 27.5
18HF15	{2	55.0 x 27.0
	{1	57.5 x 27.0
	{8	55.0 x 27.5
	{4	57.5 x 27.5
8HF6	2	73.0 x 26.0



Designation	Quantity	Glass size Width X Height cm
6HF21	6	53.0 x 27.5
<b>Horizontal Glazing Bar Top-Hung Type</b>		
6HT6	2	50.0 x 24.5
10HT6	4	44.5 x 24.5
12HT6	4	54.5 x 24.5
15HT6	{4	45.0 x 26.0
	{2	44.5 x 24.5
18HT6	{4	55.0 x 26.0
	{2	54.5 x 24.5
6HT9	{1	50.0 x 26.0
	{1	50.0 x 24.5
	{1	53.0 x 27.5
8HT6	2	70.0 x 24.5
<b>Horizontal Glazing Bar Centre-Hung Type</b>		
6HC6	2	46.0 x 22.5
10HC6	4	42.5 x 22.5
12HC6	4	52.5 x 22.5
15HC6	{4	45.0 x 26.0
	{2	43.5 x 22.5
18HC6	{4	55.0 x 26.0
	{2	53.5 x 22.5
8HC6	2	66.0 x 22.5
<b>Horizontal Glazing Bar Side-Hung Type</b>		
6HS9	3	50.0 x 26.0
10HS9	6	43.5 x 26.0
12HS9	6	52.5 x 26.0
15HS9	{6	43.5 x 26.0
	{2	47.5 x 27.5
	{1	47.5 x 26.0
18HS9	{6	52.5 x 26.0



Designation	Quantity	Glass size Width X Height cm
	{2	57.5 x 27.5
	{1	57.5 x 26.0
6HS12	{2	50.0 x 26.0
	{2	50.0 x 27.5
10HS12	{4	43.5 x 26.0
	{4	43.5 x 27.5
12HS12	{4	52.5 x 26.0
	{4	52.5 x 27.5
15HS12	{4	43.5 x 26.0
	{4	43.5 x 27.5
	{4	47.5 x 27.5
18HS12	{4	52.5 x 26.0
	{4	52.5 x 27.5
	{4	57.5 x 27.5
6HS15	{1	53.0 x 27.0
	{2	50.0 x 26.0
	{2	50.0 x 27.5
10HS15	{2	45.0 x 27.0
	{4	43.5 x 26.0
	{4	43.5 x 27.5
12HS15	{2	55.0 x 27.0
	{4	52.5 x 26.0
	{4	52.5 x 27.5
15HS15	{2	45.0 x 27.0
	{1	47.5 x 27.0
	{4	43.5 x 26.0
	{4	43.5 x 27.5
	{4	47.5 x 27.5
18HS15	{2	55.0 x 27.0
	{1	57.5 x 27.0
	{4	52.5 x 26.0
	{4	52.5 x 27.5



Designation	Quantity	Glass size Width X Height cm
	{4	57.5 x 27.5
8HS21	{1	66.0 x 24.0
	{4	66.0 x 27.5
	{1	56.0 x 27.5
12HS21	{2	50.5 x 24.0
	{9	50.5 x 27.5
	{1	40.5 x 27.5
6HC6	2	46.0 x 22.5
10HC6	4	42.5 x 22.5
12HC6	4	52.5 x 22.5
15HC6	{4	45.0 x 26.0
	{2	43.5 x 22.5
18HC6	{4	55.0 x 26.0
	{2	53.5 x 22.5
8HC6	2	66.0 x 22.5
<b>Horizontal Glazing Bar Side-Hung Type</b>		
6HS9	3	50.0 x 26.0
10HS9	6	43.5 x 26.0
12HS9	6	52.5 x 26.0
15HS9	{6	43.5 x 26.0
	{2	47.5 x 27.5
	{1	47.5 x 26.0
18HS9	{6	52.5 x 26.0
	{2	57.5 x 27.5
	{1	57.5 x 26.0
6HS12	{2	50.0 x 26.0
	{2	50.0 x 27.5
10HS12	{4	43.5 x 26.0
	{4	43.5 x 27.5
12HS12	{4	52.5 x 26.0
	{4	52.5 x 27.5
15HS12	{4	43.5 x 26.0



Designation	Quantity	Glass size Width X Height cm
	{4	43.5 x 27.5
	{4	47.5 x 27.5
18HS12	{4	52.5 x 26.0
	{4	52.5 x 27.5
	{4	57.5 x 27.5
6HS15	{1	53.0 x 27.0
	{2	50.0 x 26.0
	{2	50.0 x 27.5
10HS15	{2	45.0 x 27.0
	{4	43.5 x 26.0
	{4	43.5 x 27.5
12HS15	{2	55.0 x 27.0
	{4	52.5 x 26.0
	{4	52.5 x 27.5
15HS15	{2	45.0 x 27.0
	{1	47.5 x 27.0
	{4	43.5 x 26.0
	{4	43.5 x 27.5
	{4	47.5 x 27.5
18HS15	{2	55.0 x 27.0
	{1	57.5 x 27.0
	{4	52.5 x 26.0
	{4	52.5 x 27.5
	{4	57.5 x 27.5
8HS21	{1	66.0 x 24.0
	{4	66.0 x 27.5
	{1	56.0 x 27.5
12HS21	{2	50.5 x 24.0
	{9	50.5 x 27.5
	{1	40.5 x 27.5

### 21.7.7 Fabrication



**Frames:** Frames shall be square and flat, the corners of the frame being fabricated to a true right angle. Both the fixed and opening frames shall be constructed of sections which have been cut to length, mitered and welded at the corners. Where hollow sections are used with welded joints, argon- arc welding or flash butt welding shall be employed (gas welding or brazing not to be done). Subdividing bars of units shall be tenoned and riveted into the frame.

The location of the parts and details of construction of the doors, windows and ventilators are indicated in Fig. 21.4 to 21.11.

### 21.7.8 Side-hung Shutters

For fixing aluminium alloy hinges, slots shall be cut in the fixed frame and the hinges inserted inside and may be riveted to the frame. The hinges shall normally be of the projecting type 67 mm wide (Fig. 21.12). The aluminium alloy for cast hinges shall conform to IS Designation A-5-M of IS 617. Specification for Aluminium and Aluminium Alloy Ingots and Castings for General Engineering Purpose and for extruded section of hinges to IS Designation HE10-WP or HE30-WP of IS 733. The pins for hinges shall be of stainless steel of non-magnetic type or aluminium alloy HR30. Irrespective of hinges being anodized or not, the aluminium alloy pins shall be anodized to a minimum film thickness of 0.025 mm shall be sealed with oil, wax or lanolin. Non- projecting types of hinges may also be used where ever required. (Fig. 21.13).

Frictions hinges may be provided for side-hung shutter windows, in which case peg stay may not be required. The working principle of the friction hinges is illustrated in Fig. 21.14.

The handle for side- hung shutters shall be of cast aluminium conforming to IS Designation A-5-M of IS 617 and mounted on a handle plate welded or riveted to the opening frame in such a way that it could be fixed before the shutter is glazed. The handle should have anodized finish with minimum anodic film thickness of 0.015 mm. The handle shall have a two points nose which shall engage with an aluminium striking plate on the fixed frame in a slightly open position as well as in a fast position (Fig. 21.15). The height of the handles in each type of side-hung shutters shall be fixed in approximate position as indicated in Fig. 21.16.

The peg stay shall be either of cast aluminium conforming to IS 617 or folded from IS Designation NS4 aluminium alloy sheet conforming to IS:737 specification for wrought aluminium and aluminium alloys, Sheet and strip. It shall be 300 mm long, complete with peg and locking brackets (Fig. 21.17). The stay shall have holes for keeping the shutter open in three different positions. The peg and locking bracket shall be riveted or welded to the fixed frame.

Alternatively, and if specifically required by the purchaser, side- hung shutters may be fitted with an internal removable fly screen of 0.375 mm wire and equivalent to IS Sieve 100 in a 0.900 mm aluminium alloy sheet conforming to IS Designation NS3-1/2H of IS 737 applied to the outer frame of the shutter by case or extruded aluminium alloy turn-buckle at the jambs (Fig. 21.18) and by aluminium or plated bronze shoes at the sill to allow of the screen being readily removed, and with a rotor operator at the sill to permit the operation of the shutter through an angle of 90° (Fig. 21.19). On fly- screened shutters the peg stay is omitted and the normal handle shall be replaced by a locking handle to hold the shutter in the fast position.

### 21.7.9 Top-Hung Ventilators

The aluminium hinges for top- hung ventilators shall be either cast or fabricated out of extruded sections and shall be riveted to the fixed rail after cutting a slot in it. The aluminium alloy for cast hinges shall conform to IS Designation A-5-M of IS 617 and the extruded section of hinge to IS Designation HE10-WP or HE30\_WP of IS 733

The pegs stay shall be 300 mm long as in side-hung shutter (Fig. 21.17). The locking bracket shall be fixed to the fixed frame.

### 21.7.10 Centre-Hung Ventilators (Fig.21.20)



Centre hung ventilators shall be hung on two pairs of cup pivots of aluminium alloy to IS Designation NS-4 of IS 737 and IS Designation A-5- M of IS 617 or on brass or bronze cup pivots which should be either chromium or cadmium plated and riveted to the inner and outer frames of the ventilators to permit the ventilator to swing through an angle of approximately 85°. The opening portion of the ventilator shall be so balanced that it remains open at any desired angle under normal weather condition.

Cast aluminium conforming to IS Designation A-5-M of IS 617 or bronze which shall be either chromium-plated or cadmium-plated spring catch shall be fitted in the centre of the top bar of the ventilators for the operation of the ventilator. This spring catch shall be secured to the frame and shall close into aluminium catch plate riveted or welded to the outside of the outer ventilator frame bar (Fig. 21.21).

Aluminium or cadmium plated brass cord pulley -wheel in an aluminium bracket shall be fitted at the sill of the ventilator with aluminium or galvanized or cadmium plated steel screw or, alternatively, welded together with an aluminium cord eye riveted or welded to the bottom inner frame bar of the ventilator in a position corresponding to that of pulley (Fig. 21.22).

### 21.7.11 Doors

The outer fixed frame shall be of section A1-FX8. The shutter frame shall be of either hollow sections A1-HFX5 and A1-HFX6 (Fig. 21.3 and Fig. 21.11).

The kick panels shall be of 1.25 mm aluminium alloy sheet conforming to IS Designation NS3-1/2H of IS 737 specification for Wrought Aluminium and Aluminium Alloys, Sheet and strip and shall be screwed to the frame and the glazing bar.

**Hinges** –Cast of extruded aluminium alloy hinges for doors shall be of the same type as in the windows but of larger size. The hinges shall normally be of the 50 mm projecting type (Fig. 21.23). Non-projecting type of hinges may also be used (Fig. 21.24).

The handle for doors may be of the design indicated in Fig. 21.25.

A suitable lock for the door operable either from inside or outside shall be provided.

**Note:** From the point of view of security, the lock which is operable from only one side is better and in the case of such locks, a bolt shall be provided to make them inoperable from the other side.

In double shutter doors the first closing shutter shall have a concealed aluminium alloy bolt at top and bottom (Fig. 21.26). It shall be so constructed as not to work loose or drop by its own weight.

Single and double shutter doors may be provided with a three-way bolting device (Fig. 21.27). Where this is provided in the case of double shutter door, concealed aluminium bolts may not be provided.

### 21.7.12 Composite Units

The doors shall be coupled to windows or side-lights by extruded aluminium sections made from aluminium alloy conforming to IS Designation HE9-WP of IS 733. The coupling member should conform to the dimensions indicated in Fig. 21.28.

### 21.7.13 Weather Bar

Where a coupling member is fitted over an external opening shutter, the coupling member should incorporate an integrally extruded weather bar (Fig. 21.9).

### 21.7.14 Position of Bolts, Fixing Screws and Lugs

Outer frames shall be provided with fixing holes centrally in the web of the sections in the position (Fig. 21.29). Moreover, any steel lugs coming in contact with aluminium should be either galvanized or given one coat of bituminous paint.

The fixing screws and lugs shall be as given in Table 21.7

**TABLE 21.7**

Sl. No	Place of Fixing	Size of Screw or Lug
(i)	To wooden frames rebated on the outside	30 mm x No. 10 galvanized woodscrews.
(ii)	To plugs in concrete, stone or brick work rebated on the outside	-Do-
(iii)	To plugs in concrete, stone or brick work not rebated on the outside (that is plain or square jambs)	45 mm X No. galvanized wood-screws
(iv)	Direct to brick work or masonry (that is plain or square jambs)	Slotted steel adjustable lugs (natural finish) not less than 100 x 16 x 3 mm countersunk galvanized machine screws and nuts 19.0 x 6.3 mm
(v)	To steel work	Standard clips and 8 mm galvanized bolts with hexagonal nuts.

**21.7.15 Finish**

Aluminium doors, windows and ventilators may be supplied in either matt, scratch-brush or polished finish. They may, additionally, also be anodized, if so required by the Engineer-in-charge. If colour anodizing is to be done then only approved light-fast shades should be used.

A thick layer of clear transparent lacquer based on methacrylates or cellulose butyrate, shall be applied on aluminium doors, windows and ventilators by the supplier to protect the surface from wet cement during installation. This lacquer coating shall be removed after installation is completed.

**21.7.16 Glazing**

Glazing shall be provided on the outside of the frames. If required, glazing clips may be provided as extra fittings. Four glazing clips may be provided per glass pane, except for door type 8HS21 where the glazing clips shall be six per glass pane. In case of doors, windows and ventilators without horizontal glazing bars the glazing clips shall be spaced according to the slots in the vertical members, otherwise the spacing shall be 30 cm.

**Note:** Glazing clips are not usually provided for normal size glass panes. Where large size glass panes are required to be used or where the door or the window is located in heavily exposed situation, holes for glazing clips have to be drilled prior to fabrication and cannot be done at any later stage. Use of glazing clips, where necessary, shall be specified while placing the order.

**21.7.17 Packing**

All doors, windows and ventilators shall be dispatched with the opening parts suitably secured to preserve alignment when fixing and glazing.

Fixing lugs, coupling fittings and all hardware shall be dispatched separately. Composite windows shall be dispatched uncoupled.

**21.7.18 Marking**

All doors, windows and ventilators shall be suitably marked on the frames with a mark identifying the manufacturer and the type.





The units may also be marked with the BIS Certification Mark.

## **21.8 FITTINGS**

### **21.8.1 Stainless Steel Friction Stay**

The stainless steel friction stays of make approved by the Engineer-in-Charge shall be used. The SS friction stays shall be of grade AISI-304 and of sizes specified in nomenclature of item.

### **21.8.2 Lockable Handles**

The lockable handle shall be of make approved by the Engineer-in-Charge and of required colour to match the colour of powder coated /anodized aluminium window sections.

### **21.8.3 Hydraulic Floor Spring**

The hydraulic floor spring shall be heavy duty double action floor spring of make approved by the Engineer-in-Charge suitable for door leaf of weight minimum 100 kg. The top cover plate shall be of stainless steel, flushing with floor finish level. The contractor shall cut the floor properly with stone cutting machine to exact size & shape. The spindle of suitable length to accommodate the floor finish shall be used. The contractor shall give the guarantee duly supported by the company for proper functioning of floor spring at least for 10 years.

### **21.8.4 Tubular Handle**

The tubular handle bar shall be aluminium polyester powder coated minimum 50 micron to required colour/anodized AC 15. Outer dia of tube shall be 32 mm, tube thickness 3.0 mm and centre to centre length 2115 mm  $\pm$  5 mm.

### **21.8.5 Measurement**

Refer Para 21.6.3.

### **21.8.6 Rate**

Refer Para 21.6.4.

## **21.9 LOUVERS**

Aluminium extruded sections (anodized or power coated) are used for providing Louvers in aluminium door, window & partition for ventilation.

### **21.9.1 Fabrication**

Refer Para 21.6.1.

### **21.9.2 Measurements**

Refer Para 21.6.3.

### **21.9.3 Rate**

Refer Para 21.6.4.

## **21.10 HERMETICALLY SEALED UNIT**

Insulating glass shall be a double glazed unit comprising two sheets of float glass panes separated by a spacer, hermetically sealed using primary and secondary sealants. The design of insulating glass system shall consist of:

### **a. Hollow Spacer Bar**



The hollow aluminium spacer bar shall be of required size and shape and shall be colour anodized. The spacer bar shall have two lines of perforations in the inner surface.

**b. Desiccant**

The desiccant shall be Neftomol 3 A Chemetall or equivalent.

The desiccant filled in the aluminium spacer bar shall be synthesized crystalline compounds of Aluminium Hydroxide, Caustic Soda and Sodium Silicate which absorbs water molecules. The desiccant shall be of 3 A size (A means Angstrom). The quantity of desiccant used shall not be less than 35 gm/m length of spacer bar. Filled spacer bar frame shall not be stored for more

than 6 hours before assembly and sealing of the unit to ensure proper functioning of the desiccant. The contractor shall submit documentary proof of using the above material in the work.

**c. Primary Sealant**

The primary sealant shall be single component approved by the Engineer in Charge, thermo plastic solvent free sealing compound based on polysosutylene. The sealant surface shall be free from cavities, depression and other defects. The contractor shall submit documentary proof of using the above material in this work.

**d. Secondary Sealant**

The secondary sealant in double glazed unit shall be silicone sealant approved by the Engineer in Charge. The contractor shall submit documentary proof of using the above material in this work to the entire satisfaction of Engineer-in-Charge. Before application of silicone/ polysulphide, the surface must be cleaned and free from oil, grease, dust and other loose matter. The surfaces shall be cleaned with alcohol or other suitable solvents. Detergent or soap shall not be used to clean the surfaces. The polysulphide shall be mixed and applied mechanically using automatic mixing machine in the manner approved by Engineer-in-Charge.

**21.10.1 Measurement**

The height and width of double glazed/single glazed unit (the area of glass unit outside the snap beading shall only be measured) as fixed in place shall be measured correct to one centimeter and area calculated in sqm. correct to second place of decimal shall be taken for payment.

**21.10.2 Rate**

The rate shall include the cost of all the materials, labours involved in all the operations as described in nomenclature of item and particular specification.

**21.11 BRASS LOCK**

This should generally conform to IS-2209. The size of the lock shall be denoted by the length of the body towards the face and it shall be 100 mm. the measured length shall not vary more than 3 mm from the specified length. Ordinary lever mechanism with not less than 2 levers shall be provided. False lever shall not be used. Lever shall be fitted with one spring of phosphor- bronze or steel wire and shall withstand the test as provided in IS-2209. Locking-bolt spring and strike plate shall conform to IS 2209. Two keys shall be provided with each lock.

**21.12 MACHINE MOULDED ALUMINIUM COVERING OVER EXPANSION**

**21.12.1 Material**

The material to be used shall be wrought aluminium and aluminium alloy sheet confirming to IS 737 having anodic coating of AC-15 as per IS 1868 and epoxy/ polyester powder coating of minimum 50 microns and



not more than 120 microns at any point. The anodic coating and epoxy/ polyester powder coating shall be of approved colour and shade as directed by the Engineer-in-charge.

The cover plate should be made of wrought aluminium and aluminium alloy sheet of thickness not less than 2.5mm. The covering sheet should be moulded aluminium, machine cut and machine holed for receiving dash fasteners with single or double anti slip serrations ready to accommodate horizontal thermal movement of approved size, shape, pattern and design fixed over expansion joints on vertical surfaces/ ceilings/ floors.

Standard protective coating should be placed on aluminium surfaces which are coming in contact with cementitious material as per manufacturers specification.

### **21.12.2 Installations**

The substrates should be prepared as per drawing, instructions of the manufacturer and should account for anchors, fasteners and other accessories to cover the expansion joint. The sheet to be fixed to cover the expansion joint should be brought at site in required shade, size, shape, mould, design and pattern properly cut, milled and drilled holes in one row on one side to accommodate designated stainless steel dash fasteners of 8mm dia and 75mm long bolt including aluminium washers 2mm thick and 15mm dia at a staggered pitch of 200mm centre to centre in the receiving surface and providing expandable plastic sleeves in holes etc. complete as per direction of the Engineer-in-charge.

1. Necessary repairs with shrinkage resistant grout as required shall be used for preparing the surfaces on which the expansion joint covering is to be installed/ fixed.
2. True alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
3. Adjustments should be made for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation.
4. Fix ends to accommodate thermal expansion and contraction without buckling.
5. Fix stainless steel dash fasteners of 8mm dia and 75mm long with aluminium washers 2mm thick and 15mm dia at a staggered pitch of 200mm centre to centre.
6. Provide in continuous lengths for straight sections.
7. Install with hairline mitered corners where expansion joint cover assemblies change direction of abut other materials.
8. Terminate exposed ends of expansion joint cover as per direction of Engineer-in-charge.

### **21.12.3 Measurement**

The finished length and breadth of the aluminium sheet shall be measured correct to milimetres and area calculated in Sqm correct to second place of decimal. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing).

### **21.12.4 Rate**

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

## **21.13 ANODISED ALUMINIUM GRILL**

### **21.13.1 Material**



The aluminium grill should be of approved design and pattern as directed by the Engineer-in-charge. Standard aluminium section conforming to IS 733 and IS1285 for chemical composition and mechanical properties shall be used to meet the architectural requirements and designed to relevant works and shall be subject to approval of the Engineer-in-charge for technical, structural, functional and visual considerations. The stainless steel screws to be used shall be of grade AISI 304. The anodic coating shall be of grade AC15 and shall conform to IS 6012. The permissible dimensional tolerances of aluminium sections shall be as per IS 6477 and shall be such that in no case it impairs the proper and smooth functioning/ operation and appearance of the door and window.

#### **21.13.2 Fixing of Aluminium Grill**

The shop drawings for each type of openings shall be prepared by using suitable approved sections based on architectural drawings, adequate to meet the requirement/ specifications and by taking into consideration varying profiles of aluminium sections being extruded by approved manufacturers. The shop drawings shall show full size sections of doors, windows, ventilators and other openings etc. The shop drawings shall also show the details of fitting and the openings to be made for the smooth operations of that fittings. Before start of the work, all the shop drawings shall be got approved from the Engineer-in-charge.

Actual measurement of openings left at site for different type of door/window etc. shall be taken. The fabrication of the individual doors/windows/ventilators etc. shall be done as per the actual sizes of the opening left at site.

The anodised aluminium grill shall be of approved design and pattern with standard section from the approved manufacturer. The grill of required size keeping sufficient margin to be inserted inside the section shall be cut to correct size and fixed firmly in the frame with approved CP brass, aluminium or stainless steel screws of star head, counter sunk and matching size. Screws threads used in the fabrication shall conform to IS1362. Proper opening of the size appropriate for fixing and operation of handles and other fittings shall be made by cutting the grill to the size as per direction of the Engineer-in-charge.

#### **21.13.3 Measurement**

The length and breadth of the grill shall be measured correct to millimetres and area calculated in Sqm correct to second place of decimal. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing).

#### **21.13.4 Rate**

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

### **21.14 12MM THICK FRAMELESS TOUGHENED GLASS DOOR SHUTTER**

#### **21.14.1 Material**

This is a clear 12mm toughened safety glass frameless shutter having a consulate top and bottom self closer mechanism with a pivot connecting to a discrete metal patch fitting at the top and bottom corners to the door.

#### **21.14.2 Application**

The 12mm thick clear toughened safety glass frameless shutter is fixed with the help of corner patch fittings. The corner patch fittings are simply a bolt through glass metal fitting requiring a corner cut out and hole in the glass. These discrete corner patch fittings provide a sleek and clean frameless look. The lock body patch fitting can also be installed where there is a necessity to provide locking arrangements for frameless shutter. The maximum size of frameless doors shutters using corner patch fittings should not



exceed from 1000mm X 2400mm. Bigger size doors should not be fixed with these fittings. The figure 21.18.1 shows the fixing of frameless door shutters with top and bottom corner patch fittings.

#### **21.14.3 Installation**

The frameless toughened glass door shutters of required thickness as specified in the item should be installed with the help of 304 grade stainless steel patch fittings of approved brand and manufacturer. These fittings should be complete in all respect with top and bottom pivots and double action hydraulic floor spring types fixing arrangement. These fittings should be based on a modular system, consisting of a base unit, functional inserts, and clip-on covers in a wide range of finishes. The fittings should be suitable to support the weight of the complete glass door in such a way that the movement of the door is smooth and free. The fittings should be got approved from the engineer-in-charge and all the fixings etc. shall be done as per manufacturer specification and corresponding codes described in the description of the fitting.

#### **21.14.4 Measurement**

The finished final length/ height and width of the glass door should be measured correct to two places of decimal and overall area in sqm correct to two places of decimal should be calculated for payment.

#### **21.14.5 Rate**

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.

**Note:** Only toughened glass to be used for glass doors. Marking to be done on glass walls to grab attention to prevent accidental collision. Additionally Push/Pull sticking shall be done in English/regional language.

### **21.15 NON SAG ELASTOMERIC POLYURETHANE SEALANT**

#### **21.15.1 Material**

A weather protective non sag elastomeric construction sealant should be one component all purpose, moisture cured, polyurethane premium grade sealant confirming to ASTM C 920 type S, grade NS, class 35. This is to be used as specified in the nomenclature of the item in accordance with the product manufacturers specifications and as directed by the Engineer-in-charge.

#### **21.15.2 Preparation of surface**

All surfaces, joints, walls must be sound, clean, dry, frost-free, and free of oil, grease and any other contaminants.

No priming is required or necessary usually. Priming is only required on the substrates which indicates the need of priming under testing conditions. In the situation where priming seems to be necessary after conducting the tests the manufacturer's technical representative should be consulted.

#### **21.15.3 Masking**

Area adjacent to joints shall be masked to ensure neat sealant lines. Masking tape shall be allowed to touch clean surfaces to which the sealant is to adhere. Tooling shall be completed in one continuous stroke immediately after sealant application and before a skin forms and masking shall be removed immediately after tooling.

#### **21.15.4 Application**

The closed cell backer rod of appropriate size shall be installed and the sealant should be applied in continuous operation with positive pressure adequate to fill and seal the joint. Polyurethane sealant should be gunned into joint when joint slot is at mid-point of its designed expansion and contraction. Place nozzle of gun into bottom of the joint and fill entire joint. Keep the nozzle in the joint, continue on with a steady flow of sealant preceding the nozzle to avoid air entrapment. The cartridge once opened should be used



and consumed the very same day. Avoid overlapping of sealant to eliminate entrapment of air. Tool with convex profile as required and closed cell backer rod of approved quality and size is recommended to ensure full contact with joints, walls and to remove air entrapment. Remove masking tape as soon as sealant is tooled.

The closed cell backer rod is primarily a foam material with a surface skin. Make sure that backer rod is 25% larger than joint width (under compression) to offer good tooling base. The sealant should be applied by the caulking gun by putting the cartridge into the gun and putting the nozzle to the base of the joint.

**Tolerance:** A tolerance of + 3mm shall be allowed in sealant for joint filling.

#### **21.15.5 Curing**

Allow one week to cure the polyurethane construction sealant under standard condition. The contact with alcohol other solvent cleaners during cure should be avoided.

#### **21.15.6 Measurement**

The length should be measured in metres correct two places of decimal.

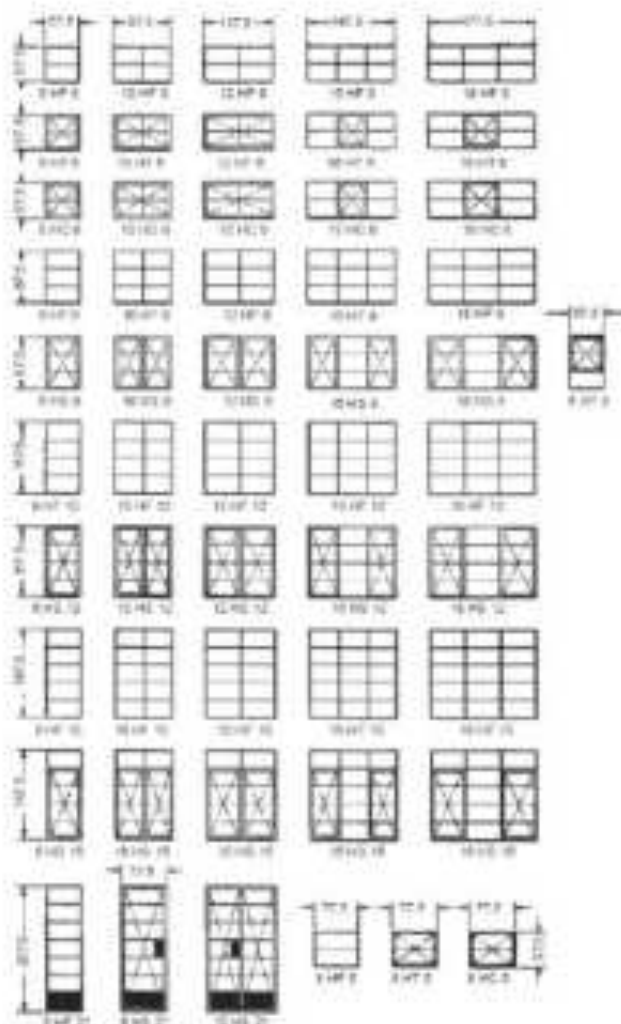
#### **21.15.7 Rate**

The rate shall include the cost of all the materials, labours involved in all the operations above and as described in the nomenclature of item and particular specification.



## TYPES AND SIZES OF ALUMINIUM DOOR, WINDOW AND VENTILATOR

Sub Head : Aluminium Work  
Clause : 21.7.2





## EXTRUDED ALUMINIUM DOOR, WINDOW AND VENTILATOR

Sub Head : Aluminium Work  
Clause : 21.7.4

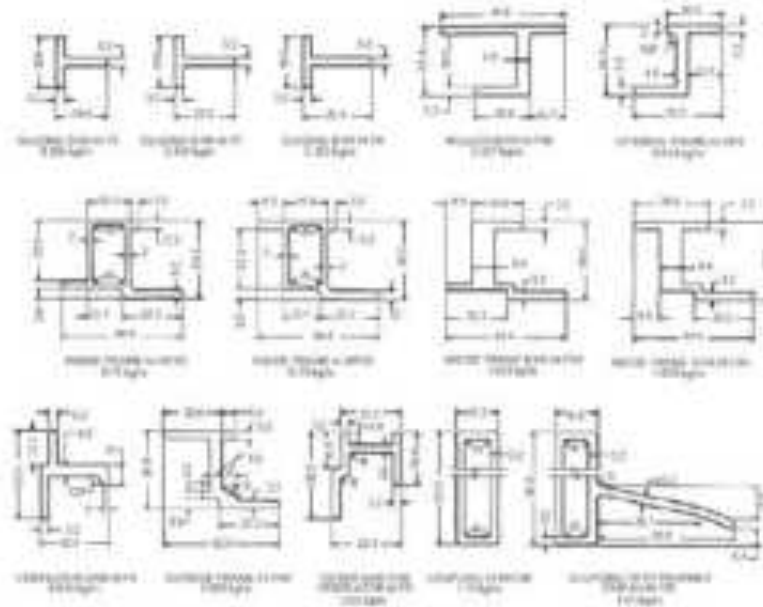


Figure 21.3 : Extruded Aluminium Door, Window and Ventilator

Note:

1. All radii  $R = 1.6 \text{ mm}$
2. The weight of sections per meter length as indicated are nominal.

All dimensions are in mm.

## LOCATION OF PARTS OF ALUMINIUM DOOR, WINDOW AND VENTILATOR

Sub Head : Aluminium Work  
Clause : 21.7.7

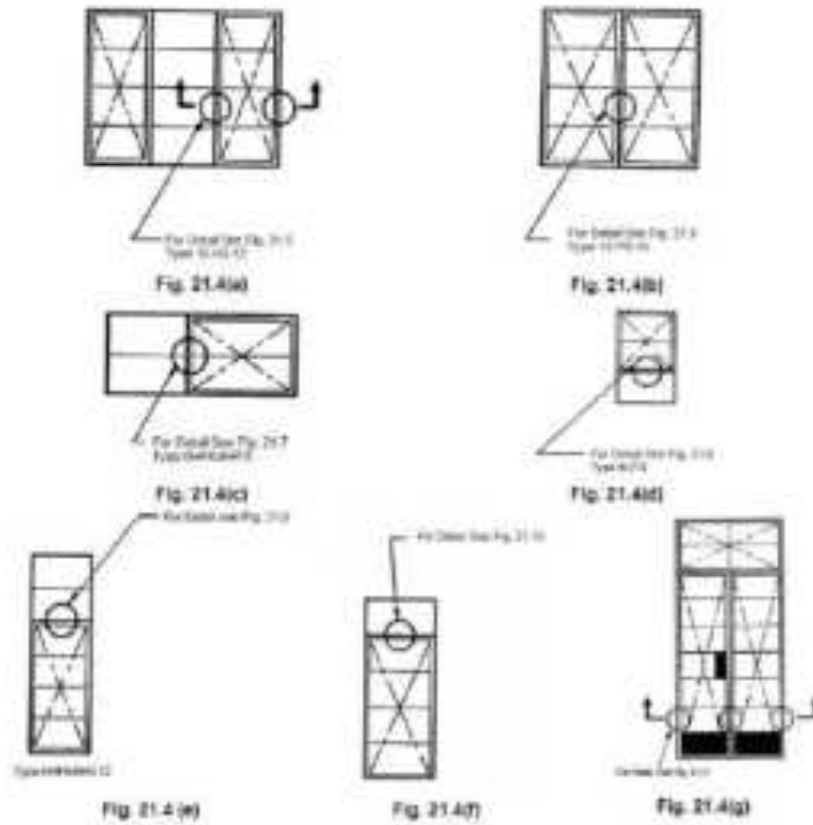


Figure 21.4 : Location OF Parts of Aluminium Door, Window and Ventilator

## MULLION FIXED GLASS ON ONE SIDE AND SIDE HUNG ON OTHER SIDE

Sub Head : Aluminium Work  
Clause : 21.7.7

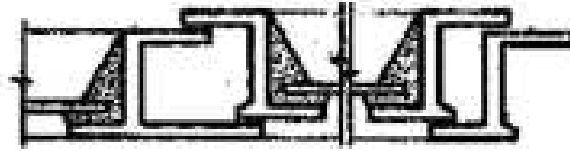


Figure 21.5 : Mullion Fixed Glass on One Side and Side hung on Other Side

## MULLION WITH SIDE HUNG SHUTTER BOTH SIDE

Sub Head : Aluminium Work  
Clause : 21.7.7

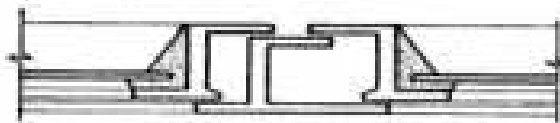


Figure 21.6 : Mullion with Side Hung Shutter Both Side

## COUPLING SECTION EXTRUDED FOR COUPLING WINDOWS SIDE BY SIDE

Sub Head : Aluminium Work  
Clause : 21.7.7

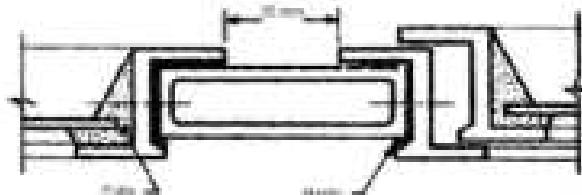


Figure 21.7 : Coupling Section Extruded for Coupling Windows Side By Side

## DETAIL THROUGH BOTTOM OF TOP HUNG VENTILATOR

Sub Head : Aluminium Work  
Clause : 21.7.7

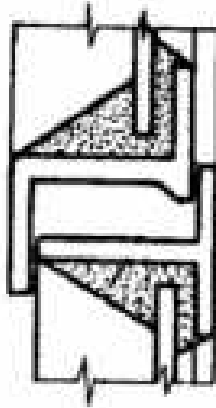


Figure 21.8 : Detail through Bottom of Top Hung Ventilator

## COUPLING SECTION EXTRUDED HAVING WEATHER BAR FITTED WITH VENTILATORS ON TOP OF WINDOW

Sub Head : Aluminium Work  
Clause : 21.7.7

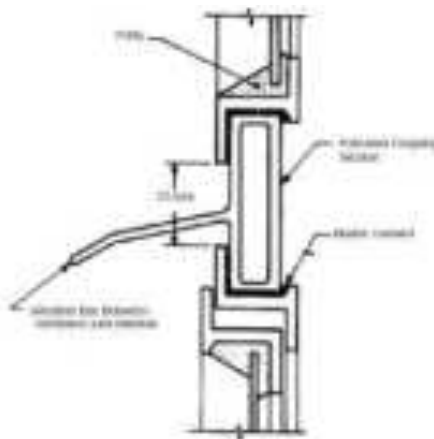


Figure 21.9 : Coupling Section Extruded having Weather Bar Fitted with Ventilator on Top of Window

## WEATHER BAR OVER EXTRUDED OPENING SHUTTER WITH FIXED LIGHT ABOVE

Sub Head : Aluminium Work  
Clause : 21.7.7

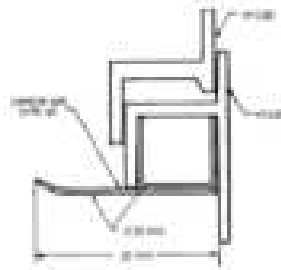


Figure 21.10 : Weather Bar over Extruded Opening Shutter with Fixed Light Above

## DETAILS OF ALUMINIUM DOUBLE SHUTTER DOOR

Sub Head : Aluminium Work  
Clause : 21.7.7

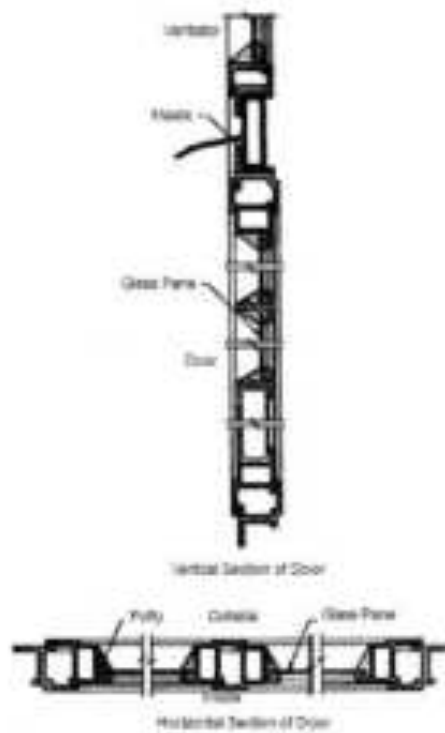


Figure 21.11 : Details of Aluminium Double Shutter Door

## TYPICAL PROJECTING TYPE HINGE FOR SIDE HUNG SHUTTER

Sub Head : Aluminium Work  
Clause : 21.7.8

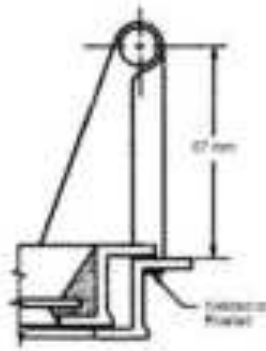


Figure 21.12 : Typical Projecting Type Hinge for Side Hung Shutter

## TYPICAL NON PROJECTING TYPE HINGE FOR SIDE HUNG SHUTTER

Sub Head : Aluminium Work  
Clause : 21.7.8

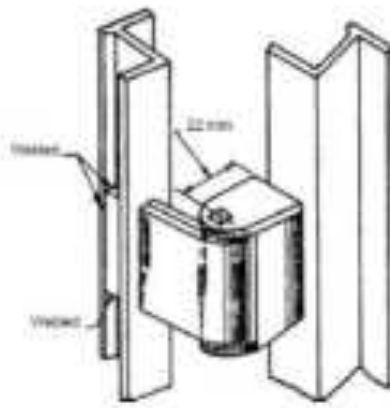


Figure 21.13 : Typical Non Projecting Type Hinge for Side Hung Shutter

## ILLUSTRATION SHOWING WORKING PRINCIPAL OF FRICTION STAY

Sub Head : Aluminium Work  
Clause : 21.7.8



Figure 21.14 : Illustration Showing Working Principal of Friction Stay

## TYPICAL HANDLE FOR SIDE HUNG SHUTTER

Sub Head : Aluminium Work  
Clause : 21.7.8

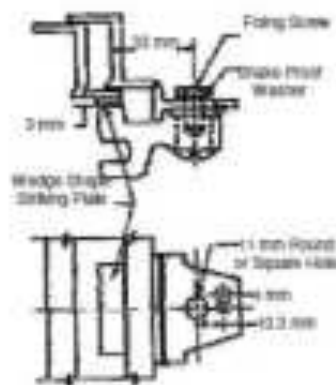


Figure 21.15 : Typical Handle for Side Hung Shutter

## POSITION OF HANDLE PLATE IN RELATION TO HEIGHT OF 'HS' TYPE WINDOW

Sub Head : Aluminium Work  
Clause : 21.7.8

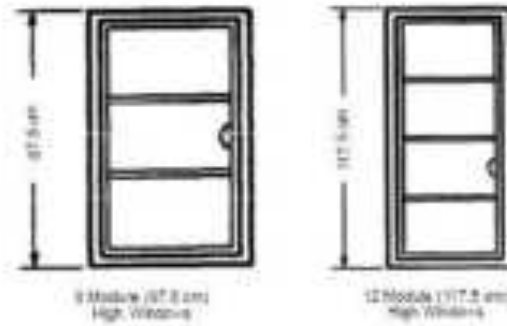


Figure 21.16 : Position of Handle Plate in Relation to Height of 'HS' Type Window

## TYPICAL PEG STAY FOR SIDE HUNG SHUTTERS AND TOP HUNG VENTILATOR

Sub Head : Aluminium Work  
Clause : 21.7.8

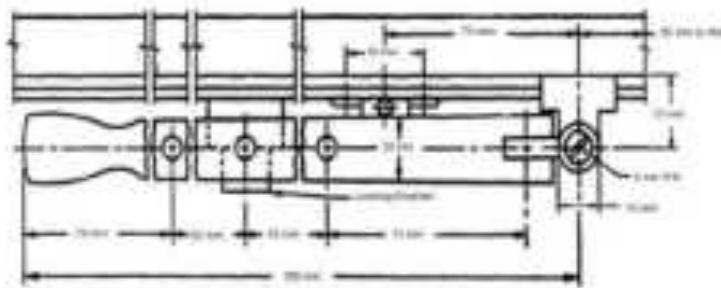


Figure 21.17 : Typical Peg Stay for Side Hung Shutters and Top Hung Ventilator



## DETAILS THROUGH JAMB SHOWING TURNBUCKLE

Sub Head : Aluminium Work  
Clause : 21.7.8

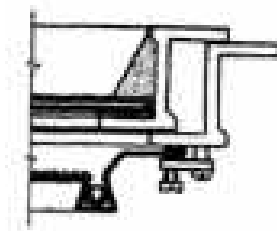


Figure 21.18 : Details through Jamb Showing Turnbuckle

## TYPICAL ROTOR OPERATOR FOR SIDE HUNG SHUTTERS FILLED WITH FLY SCREENS

Sub Head : Aluminium Work  
Clause : 21.7.8

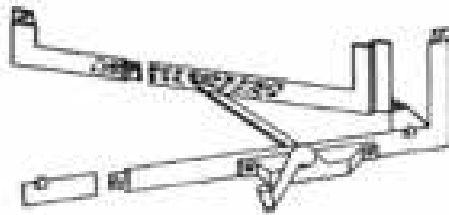


Figure 21.19 : Typical Rotor Operator for Side Hung Shutters Filled with Fly Screens

## DETAIL OF HORIZONTAL CENTRE-HUNG VENTILATOR

Sub Head : Aluminium Work  
Clause : 21.7.10

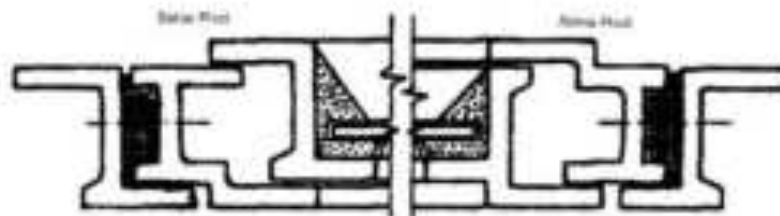


Figure 21.20 : Detail of Horizontal Centre Hung Ventilator



### TYPICAL NON PROJECTING TYPE HINGE FOR DOOR

Sub Head : Aluminium Work  
Clause : 21.7.11

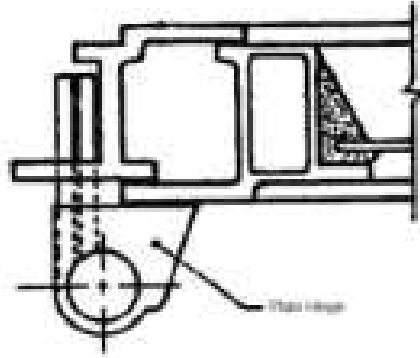


Figure 21.24 : Typical Non Projecting Type Hinge for Door

### TYPICAL DOOR HANDLE

Sub Head : Aluminium Work  
Clause : 21.7.11

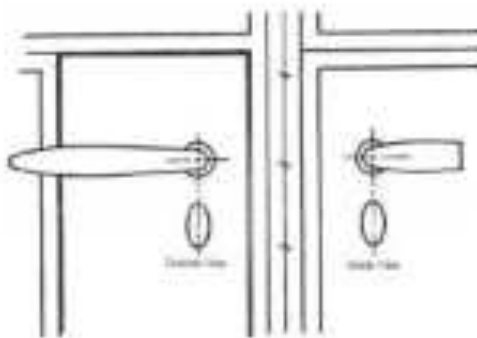


Figure 21.25 : Typical Door Handle

## TYPICAL THREE-WAY BOLTING DEVICE FOR DOORS

Sub Head : Aluminium Work  
Clause : 21.7.11

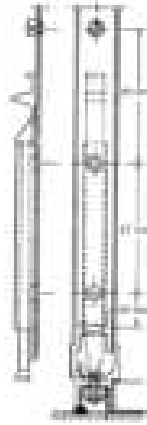


Figure 21.26 : Typical Three Way Bolting Device for Doors

## TYPICAL THREE-WAY BOLTING DEVICE FOR DOORS

Sub Head : Aluminium Work  
Clause : 21.7.11

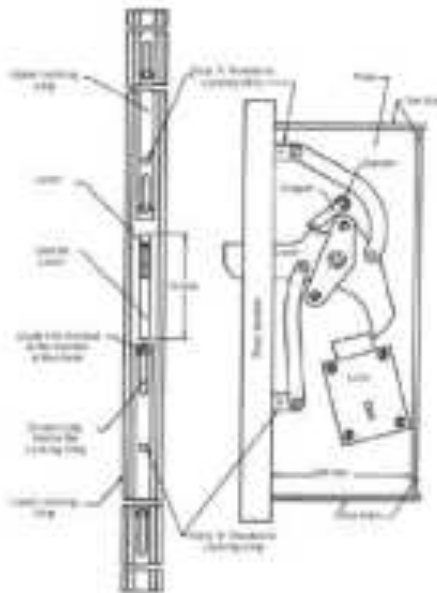


Figure 21.27 : Typical Three Way Bolting Device for Doors

## COUPLING SECTION EXTRUDED FOR COUPLING DOOR TO WINDOW OR SIDE LIGHT

Sub Head : Aluminium Work  
Clause : 21.7.11

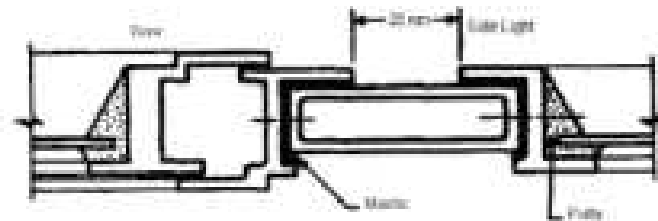


Figure 21.28 : Coupling Section Extruded for Coupling Door to Window or Side Light

## CHART SHOWING APPROXIMATE POSITION OF FIXING HOLES AND NUMBER OF FIXING LUGS

Sub Head : Aluminium Work  
Clause : 21.7.11

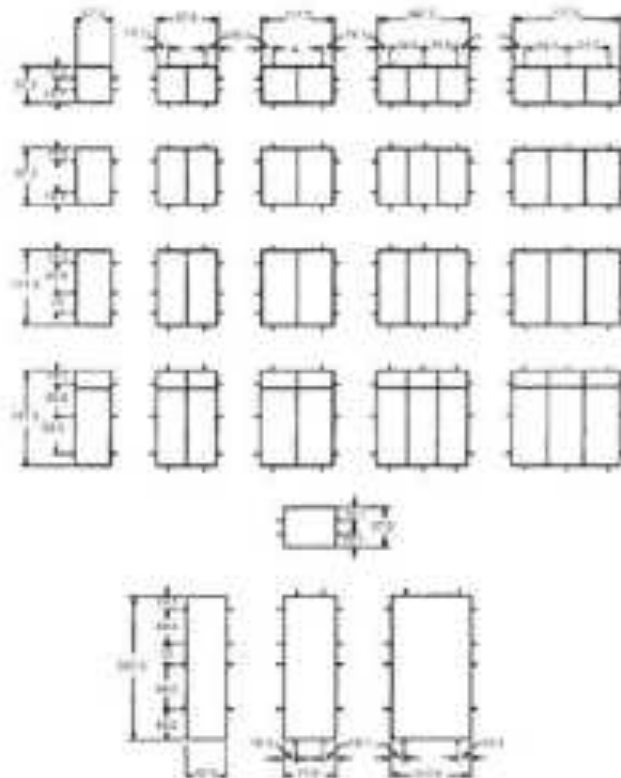


Figure 21.29 : Chart Showing Approximate Position of Fixing Holes and Number for Fixing Lugs

## FRAMELESS DOOR SHUTTER

Sub Head : Aluminium Work  
Clause : 21.14.2



Figure 21.30 : Frameless Door Shutter



## WATER PROOFING





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### LIST OF BUREAU OF INDIAN STANDARDS CODES

Sl. No.	IS No.	Subject
1.	IS 73	Paving Bitumen Specifications
2.	IS 702	Specifications for Industrial Bitumen
3.	IS 1322	Specifications for Bitumen felts for Water Proofing and Damp Proofing.
4.	IS 2645	Specifications for Integral Cement Water Proofing Compounds
5.	IS 3370 (Part -1)	Code of Practice for Concrete Structures for the Storage of Liquid: Part -1 General Requirements.
6.	IS 3384	Specifications for Bitumen Primer for Water Proofing and Damp Proofing
7.	IS 7193	Specification for Glass Fibre Bitumen Felts
8.	IS 12200	Provision of Water Stops at Transfers Construction Joints in Masonry and Concrete Dams - Code of Practice.
9.	IS 12432 (Part-3)	Application for Spray Applied Insulation - Code of Practice Part-3 Polyurethane/ Polyisocyanurate



## 22 WATER PROOFING TREATMENT

### 22.0 TERMINOLOGY

#### **Water Bars**

Water bars are preformed strips of impermeable materials which are embedded in the concrete during construction.

#### **Low Partition Walls**

Parapet walls of height less than 45 cm.

#### **Expansion Joints**

Joints provided in the structure to allow for thermal expansion/construction.

#### **Blended Cement**

Cement mixed with water proofing compound in liquid or powder form.

### 22.1 INTEGRAL CEMENT BASED TREATMENT FOR WATER PROOFING ON HORIZONTAL SURFACE OF UNDER-GROUND STRUCTURE AT ALL DEPTH

#### 22.1.1 Water Proofing of Horizontal Internal Surfaces of Under-ground Structure (Fig. 22.1)

##### **i. Preparation of Surface**

The Water Proofing Treatment over the lean concrete/levelling course surface should adhere to the surface firmly, the surface of levelling course should be roughened properly when the concrete is still green. In case the surface is not made rough before the concrete is set, the work of water proofing should not be executed till proper key is provided for the base layer of Cement Mortar 1:3.

##### **ii. Blending Cement/Water with Water Proofing Compound**

The required quantity of cement bags to be used for a particular portion of work should be emptied on a dry platform. Water proofing compound bearing ISI mark and conforming to IS 2645 should then be mixed properly with the cement. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding 3% by weight of cement. The quantity of cement and water proofing compound thus mixed should be thoroughly blended and the blended cement should again be packed in bags.

For the water proofing compound in liquid form, the blending is to be done with water. This can be done by taking the just required quantity of water to be mixed in the particular batch of dry cement mortar.

The required quantity of water thus collected per batch of dry cement mortar to be prepared should be mixed with liquid water proofing compound from sealed tins with ISI mark. The water thus mixed with water proofing compound shall be thoroughly stirred so that the water is blended with water proofing compound properly.

##### **iii. Rough Kota Stone 22 to 25 mm Thick**

The stone slabs to be used for this item shall be in thickness of 22 mm to 25 mm. Larger size of stone slabs i.e. 550 mm x 550 mm or 550 mm x 850 mm shall be used to minimise the number of joints.

General requirement of Kota stone shall be as laid down in Specifications of Kota Stone flooring.

##### **iv. Preparation of Cement Slurry**



Cement slurry shall be prepared by using 2.2 kg of blended cement per sqm. area. Each time only that much quantity shall be prepared which can be covered on the surface and the surface in turn would be covered with 25 mm thick cement mortar base within half an hour. Slurry prepared and remained unused for more than half an hour shall be totally rejected

**v. Preparation of Cement Mortar**

Cement mortar 1:3 (1 blended cement: 3 coarse sand) shall be prepared with cement/ water duly blended as explained in clause 22.1.1 (i). Only that much quantity of cement mortar which can be consumed within half

**vi. Laying Water Proofing Course**

Before laying the base course of cement mortar 1:3, the lean concrete surface shall be cleaned neatly with water. Cement slurry prepared as per clause 22.1.1 (i), shall be applied only on the area of the concrete surface, that can be covered with the cement mortar (1:3) base course within half an hour. The cement slurry should cover every spot of the surface and no place shall remain uncovered. Just after the application of cement slurry on the surface, the cement mortar prepared as per clause 22.1.1 (v) should be used for laying the base course. Base Course should be laid to a perfect level with wooden/aluminium straight edge of at least 2 mtrs. long. The top surface of cement mortar should be finished neatly and later scratched when green with a suitable instrument before the base course dries and gets hard that is just before the base course takes up initial set.

When the 25 mm thick base course is just getting set the cement slurry prepared as per clause 22.1.1 (iv) should be spread over the base course upto the area that shall be covered with just two to three stone slabs. The cement slurry shall be spread in such a way that the area of base course to be covered immediately shall be covered with slurry without any gap or dry spots. Immediately on applying cement slurry on the base course the Rough Kota Stone slab shall be laid over the base course and pressed gently so that the air gap can be removed. The slurry applied on the surface which gets spread when the stone slab is pressed shall get accumulated in the joints of adjacent stone slabs and if any gap still remains between the stone slabs the same should also be filled with additional quantity of cement slurry. For laying the stone slabs in perfect level, two stone slabs at adjacent concerns/ends shall be fixed firmly to the required level and a string stretched over the two slabs, the intermediate slabs shall then be set to the level of the string.

After filling all the joints of the Rough Kota stone Slabs with cement slurry the area of stone slab shall be laid with cement mortar 1:3. The surface of stone slabs shall be cleaned and lightly watered. Cement mortar 1: 3 prepared as per clause 22.1.1 (iv) shall be used for laying this course. For laying this course 25 mm high wooden strips shall be used and the top surface shall be finished smooth without using additional cement or slurry.

After laying 3rd course and before the mortar layer takes the initial set, Stone aggregate of 10 mm to 12 mm nominal size shall be uniformly spread and lightly pressed into the finished surface @ 8 cu dm./sqm. The aggregates shall not be embedded totally inside the mortar and shall be visible on the top surface.

In cases where slope is to be provided for the water proofing layer, grading with additional cement concrete/cement mortar shall be provided and then the water proofing layer shall be laid on the graded surface. Extra payment shall however be made for the grading course.

**vii. Curing**

Immediately after completing the fourth layer, arrangements shall be made for the top RCC slab as quickly as possible and in the mean time till the top slab is casted the water proofing treatment shall



be kept wet continuously. In case the concreting of slab gets delayed for more than 2 weeks the curing can be stopped after 14 days.

**viii. Measurement**

Length and breadth shall be measured along the finished surface correct to a cm and the area shall be worked out to nearest 0.01 sqm.

**ix. Rate**

The rate shall include the cost of all labour & materials involved in all the operations described above. The cost of grading with cement concrete / cement mortar shall be paid for separately.

**22.1.2 Water Proofing of Internal Horizontal Surfaces of Under- ground Structure (Fig. 22.2)**

Same as in 22.1.1 above except that water proofing courses will be laid on R.C.C. Slab.

**22.2 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT ON THE VERTICAL SURFACE OF UNDER GROUND STRUCTURES:**

**i. Preparing the Surface**

The surface of the structure to be treated shall be roughed either by raking of joints in case of brick/ stone masonry or by hacking the cement concrete surface with a specifically made hacking tool just after removing shuttering. Alternately, the surface should be roughened by providing spatter dash key as explained under clause 22.1.1 (i). While doing water proofing to vertical faces from inside, it shall be ensured that water proofing treatment of floor slab is not damaged. Preferably, water proofing of vertical surface shall be done before that of horizontal surface.

**ii. Blending** Cement/Water with Water Proofing Compound Same as under clause 22.1.1 (i).

**iii. Rough Kota Stone Slab**

Same as explained under clause 22.1.1 (iii).

**iv. Preparation** of Cement Slurry

Same as explained under clause 22.1.1(iv).

**v. Preparation** of Cement Mortar

Same as explained under clause 22.1.1 (v).

**vi. Laying** Water Proofing Course

Same as explained under clause 22.1.1 (vi). Further rough kota stone are not sufficiently rough to remain in vertical position held by cement slurry. Therefore, the grip for the stone slab has to be increased and this can be done by planting 12 mm to 15 mm nominal size stone aggregate fixed with araldite on surface of each sand stone slab.

**vii. Curing**

Same as explained under clause 22.1.1 (vii). Further till the water proofing work on vertical face is in progress, the water proofing work done on floor slab shall be kept wet for a minimum period of 14 days. Immediately after completion of water proofing on vertical faces of side walls, the water tank shall be gradually filled with water for testing.

**viii. Measurement**

Same as explained under clause 22.1.1 (viii).

**ix. Rate**



Same as explained under clause 22.1.1 (ix).

## **22.3 WATER PROOFING TREATMENT TO VERTICAL AND HORIZONTAL SURFACE OF DEPRESSED PORTION OF WC, KITCHEN AND THE LIKE**

### **22.3.1 Before the Water Proofing Treatment**

Before the water proofing treatment, the internal plaster of ceiling and walls of WC block leaving the portion for dado/skirting should be completed. Grooving / chasing for doing the concealed work of GI/CI pipes/Electrical conduits should be completed. Cleaning the depressed/sunken portion of WC of all debris, extra mortar sticking to the vertical and horizontal surface etc. Necessary holes for 'P' trap/Nhani trap/Water escape pipe etc should be completed.

### **22.3.2 Preparing Surface and Fixing Pipes and Fittings**

Before the water proofing treatment work, proper key in the concrete surface should be provided. The depressed/sunken portion should be hacked by a hacking tool, after the concrete slab is cast and when this concrete is still green.

The vertical surfaces of the depressed /sunken portion should be hacked with a hacking tool just after the shuttering is removed. In case of old work, the water proofing treatment on such surfaces shall be permitted after making proper spatter dash key.

Fixing the 'P' trap in position and all other pipes work including the water escape pipe shall be fixed properly and the holes should be plugged carefully before taking up the water proofing work.

### **22.3.3 1st Course**

Cement duly blended with water proofing compound as explained in clause 22.1 shall be used for preparing the cement slurry.

The consistency of the slurry should be such that 4.4 kg. of blended cement with water proofing compound is used per sq. metre area of surface to be treated. The slurry should be started from the vertical faces towards the bottom of the floor as shown in Fig. 22.4. Particular care should be taken to see that the slurry is applied to corners without leaving any gap.

### **22.3.4 2nd Course**

Immediately on applying the blended cement slurry on the surface to be treated cement plaster 20 mm thick in CM 1:3 (1 blended cement: 3 coarse sand) shall be applied both on vertical and horizontal surfaces taking particular care to complete the entire depressed/ sunken portion of WC within a day so that the plaster can be done without any joint. Junctions shall be properly rounded. The surfaces of the plaster shall be left rough but finished in one plain and cured for a week. On completion of the curing period both horizontal and vertical surfaces shall be cleaned properly and gently and allowed to dry.

### **22.3.5 3rd Course**

Only after the surface is completely dried the blown or residual bitumen shall be applied @ 1.7 kg. of bitumen per sqm area.

### **22.3.6 4th Course**

PVC sheet 400 micron thick shall be spread evenly without any kink immediately, so that the PVC sheet sticks to the surface firmly. PVC sheet shall be continued to be laid over the main slab upto 100 mm.

Overlapping of PVC sheet should be done with a minimum overlap of 100 mm, duly pasting the overlapped sheet with an application of bitumen @ 1.7 kg./ sqm. The projections of pipes and 'P' trap outlet etc. inside the depressed/sunken portion of WC shall also be cladded with water proofing treatment layer upto a height of 150 mm, using a coat of bitumen with PVC sheet complete. The surfaces of depressed/sunken



portion of WC shall not be left without covering with specified filling material and base concrete, otherwise the PVC sheet layer may be tampered by the labour working in the vicinity. Fixing up of WC pan, filling specified material and the top base concrete should be done as early as possible and the top horizontal layer of water proofing may be taken up later i.e. just before laying the floor tiles.

#### 22.3.7 Measurement

Length and breadth shall be measured along the finished surface correct to a cm. and area shall be worked out to nearest 0.01 sqm. No payment however shall be made for the 100 mm overlap of PVC Sheet over the roof slab.

#### 22.3.8 Rate

The rate shall include the cost of labour and materials involved in all operations described above.

### 22.4 PROVIDING WATER STOPS

**22.4.1** Water stops conforming to IS 12200 for construction/expansion joints should be fabrication from a plastic compound, the basic resin of which shall be polyvinyl chloride. The compound shall contain additional resin/ plasticizer inhibitors or other materials such that when the materials is compounded it shall meet the requirement given in IS 15058.

#### 22.4.2 Type of Joints for which Water Bars are Provided

The water bars are provided only for the movement of joints in a water retaining structure. Different types of movement joints are as described below:

**Complete Contraction Joint:** This is a movement joint with deliberate discontinuity both in concrete as well as the reinforcement but no initial gap is maintained between the concrete on either side of the joint. This joint is intended to accommodate the contraction of the concrete.

**Partial Contraction Joint:** This is a movement joint with deliberate discontinuity in concrete but no water bar is provided and no discontinuity is provided in steel. No initial gap is maintained between the concrete on either side of joint.

**Expansion Joint:** This is also a movement joint with complete discontinuity in both reinforcement and concrete. It is intended to accommodate either expansion or contraction of the structure. In general such joint requires the provision of an initial gap between the adjoining parts of the structure which accommodates expansion or contraction of the structure.

#### 22.4.3 Types and Performance of Water Bars

Water bars are performed strips of impermeable material which are embedded in the concrete during construction so as to span across the joints and provide a permanent water tight seal during the whole range of joint movement.

The most usual form of water bars are strip with a longitudinal corrugation as shown in Fig. 22.5. Another form of water bar of metallic type is Z shaped strip.

Water bars of copper, sheet lead, natural or synthetic rubber and plastic such as polyvinyl chloride (PVC) are also used. These bars comprise of central longitudinal hollow tube with thin walls and stiff wings of about 150 mm width.

Out of the metals available copper is most suitable as regards ductility, resistance to corrosion in air, water and concrete. However, it may be attacked by some wastes. If sheet lead is used it should be insulated from concrete by a good coat of bituminous or suitable composition. Natural synthetic rubber and plastics have very considerable advantage in handling, splicing and in making intersections.





Galvanized iron sheets may also be used with the specific permission of the Engineer-in-charge provided the liquid stored or the atmosphere around the liquid retaining structure is not excessively corrosive i.e. sewage.

The strip water bars described as above, while placing in position has to be passed through the end shutter of the first placed concrete with the result the shuttering at this point should be perfectly water tight otherwise cement slurry may escape from the concrete being laid and will ultimately weaken the structure. Therefore to avoid the above problem one can prefer moulded type of water bar.

The design of the moulded water bar with several projections need to be passed through the end shutter while placing the same in position. Another main advantage of this water bar is that since it occupies bigger proportion of the thickness of the joint it would lengthen the shortest alternative water path through the concrete.

**22.4.4** It is important to ensure proper compaction of concrete around the water bar. Proper cover to all the reinforcement shall be maintained. Sometimes to increase the bond the holes are provided in the copper water bars but in the long run it proves to be disadvantageous as it shortens the path of water through concrete. Water bars should be placed at the centre of the wall or if it is to be provided away from the centre its distance from either face of the wall shall not be less than half of the width of water bar or as specified/directed by the Engineer-in-charge.

#### **22.4.5 Covers Plates for Joint**

Sometimes joint cover plates have to be used for expansion joints mainly to avoid the risk of a fault in the water bar which is embedded. The plates to be used should be either copper or sheet lead. In case the copper plates are to be used, it should be clamped to the concrete face on each side of the joint. To ensure water tightness suitable gasket shall be used. Joint cover plates of sheet lead are also used and fixed on the joints. In this case the edges may return into grooves formed in the concrete and can be made completely water tight by lead caulking. Faces of the concrete to which sheet lead is to be fixed should be painted with bituminous or other suitable composition and the lead sheet should be similarly coated before fixing.

#### **22.4.6 Spacing of Joints**

In Reinforced Concrete floors movement joints should be spaced at not more than 7.5 m apart in two directions at right angles. The wall and floor joints should occur at the base of the wall in which case corresponding vertical joint is not important.

In concrete walls, the vertical movement joints should normally be placed at a maximum spacing of 0.75 m in reinforced walls. The maximum length desirable between vertical movement joints will depend upon the tensile strength of the walls and may be increased by suitable reinforcements.

Amongst the movement joints in floors and walls as mentioned above, expansion joint should be normally be provided at spacing of not more than 30 m between successive expansion joints or between the end of the structure and the next expansion joint, all other joints being of the contraction type.

In case of expansion joints the filling of these with bitumen filler, bitumen felt or any such material etc. shall be paid for separately in running metre. The measurement shall be taken upto two places of decimal stating the depth and width of joint.

In case joint cover plates either of copper or sheet lead with ancillaries are provided, these shall be measured and paid for separately.

#### **22.4.7 Measurement**

Length shall be measured correct to a cm and net quantities shall be calculated upto two places of decimal.



Each category of water stops/bar such as PVC, copper specifying width, thickness shall be measured and paid for separately.

#### **22.4.8 Rate**

The rate shall include all labour and materials in all the operations described above.

### **22.5 WATER PROOFING TREATMENT IN SUNKEN PORTION OF WCs, BATHROOMS ETC.**

#### **22.5.1 Preliminaries to be Attended**

The preliminaries shall be attended as described in clause 22.3.1.

#### **22.5.2 Preparing Surface, Fixing Pipes and Fittings**

In this case, unlike as described in clause 22.3.2, no hacking of surface need be made, but only extra mortar sticking to the surface should be removed and the surface should be cleaned thoroughly. Fixing 'P' trap etc. shall be done as described in Clause 22.3.2.

#### **22.5.3 Providing and Laying of Slurry for First Layer**

The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area.

On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application.

The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.

#### **22.5.4 Providing and Laying of Slurry for Second Layer**

The quantity of slurry required for second application to be covered within an hour of mixing shall be prepared with 0.242 kg. cement + 0.126 kg. water proofing compound + y litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for second application.

The application of 2nd layer of slurry is same as for first layer as detailed in clause 22.5.3. The applied surface shall be allowed to air cure for 4 hours and thereafter water curing shall be done for full 48 hours.

In case no further work as described above is to be taken up immediately on completion of water proofing treatment due to any reason it is recommended to protect the treated portion with cement plaster 1:4 as a protective layer for which separate payment shall be made to the contractor.

#### **22.5.5 Measurement**

Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm.

#### **22.5.6 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above. The cost of plastering shall be measured and paid for separately.

### **22.6 WATER PROOFING TREATMENT ON ROOF SLABS**

**22.6.1** Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to tack the fibre cloth layer, fixing



up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

#### **22.6.2 Preparing Surface**

There is no necessity of hacking the surface but the surface to be treated shall be cleaned including removing the mortar dropping from the surface.

#### **22.6.3 Providing and Laying of Cement Slurry**

The procedure to prepare and apply the cement slurry shall be same as detailed in clause 22.5.3 except that over projected pipes etc. slurry shall be applied just upto 100 mm height instead of 150 mm height. The slurry shall be applied upto a height of 300 mm on parapet walls and in the groove where the fibre glass cloth is to be tucked.

#### **22.6.4 Providing and Laying of Fibre Glass Cloth (2nd Layer)**

The fibre glass cloth shall be of approved brand and shall be thin, flexible uniformly bonded mat composed of chemically resistant borosilicate glass fibre distributed in random open porous structure bonded together with a thermosetting resin.

Immediately on applying the slurry on a sufficiently workable area as detailed above in clause 22.6.3 when the slurry applied is still green the fibre glass as specified shall be spread evenly on the surface without any kink and pressed in such a way that no air spaces exist. The fibre glass cloth shall be taken upto a height of 30 cm on parapet walls and tucked in the groove specially prepared at that height.

A minimum overlap of 100 mm width shall be provided when the fibre cloth has to be joined. The joining of 100 mm overlap shall be done with the same slurry used for the application on surface as first layer. The fibre cloth shall also be extended upto a height of 100 mm over pipes projecting from the surface.

#### **22.6.5 Providing and Laying of Cement Slurry for Third Layer**

The quantity of water required to prepare slurry which can cover one sqm. area of the surface to be treated shall be calculated as described in clause 22.5.3 and consider this quantity as say x litres/sqm.

On deciding the correct quantity of water required, the slurry shall be prepared by mixing 1.289 kg/m<sup>2</sup> of grey cement + 0.67 kg./sqm. of Water Proofing Compound + 1.289 kg./sqm. of coarse sand + x litres of water. Slurry shall be prepared for the area to be covered within half an hour of mixing.

The consistency of the slurry shall be such that in one application with a brush 1.5 mm thickness of slurry can be coated on the fibre glass cloth surface. This slurry shall be applied evenly on the entire surface covered with fibre glass cloth so that a layer of 1.50 mm thickness of slurry is formed. The application of slurry shall be continued over the 300 mm portion of parapet wall and also the portion tucked in the groove on top. The entire surface shall be allowed for air curing for 4 hours and later the surface shall be cured with clean water for 7 days. On completion of curing the grooves where the fibre glass cloth is tucked shall be closed neatly with cement mortar mixed with water proofing compound and the repaired surface should be cured by clean water for 7 days. Fourth and final layer of brick tiling if required shall be laid and paid for separately.

#### **22.6.6 Measurement**

Length and breadth shall be measured along the finished surface correct to a cm and area shall be worked out to nearest 0.01 sqm. Overlaps and tucking in a flashing grooves shall not be measured.

No deductions shall be made for openings or recess or chimney stack, roof lights or Khurras of area upto 0.40 sqm, nor anything extra shall be paid for forming such openings, recess etc. For area exceeding 0.40 sqm. deduction will be made in the measurement for the full opening and nothing extra shall be paid for making such opening.



#### **22.6.7 Rate**

The rate shall include the cost of labour and material involved in all the operations described above, however the cost of brick layer with cement mortar shall be paid for separately.

### **22.7 INTEGRAL CEMENT BASED WATER PROOFING TREATMENT WITH BRICK BAT COBA (Fig. 22.6)**

**22.7.1** Before taking up the work the preliminaries to be attended shall be exactly same as described in clause 22.6.1.

#### **22.7.2 Preparing the Surface**

The surface of the slab should be roughened by scrapping when the slab concrete is still green, however, the surface need not be hacked. In case the slab is already cast and surface fairly finished, the same shall be cleaned neatly of all mortar droppings, loose materials etc with brooms/cloth.

#### **22.7.3 Providing and Laying of Slurry under Base Coat**

The quantity of water required to prepare the slurry with 2.75 kg. of blended cement to be painted over an area of 1 sqm. shall be calculated exactly as described in clause 22.5.3.

Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 kg. blended cement + water per sqm. area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within half an hour of preparation i.e. before the initial setting time of cement.

The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc.

The application of the slurry should continue upto a height of 300 mm on the parapet wall and also the groove as shown in Fig. 22.6. The slurry should also be applied upto a height of 150 mm over pipe projections etc.

#### **22.7.4 Laying Base Coat 20 mm thick**

Immediately after the application of slurry and when the application is still green, 20 mm thick cement plaster as base coat with cement mortar 1:5 (1 blended cement : 5 coarse sand) shall be evenly applied over the concrete surface taking particular care to see that all the corners and joints are properly packed and the application of the base coat shall be continued upto a height of 300 mm over the parapet wall.

#### **22.7.5 Laying Brick Bat Coba**

Brick bat of size 25 mm to 115 mm out of well burnt bricks shall be used for the purpose of brick bat coba. The brick bats shall be properly dampened for six hours before laying.

Brick bats shall be laid to required slope/gradient over the base coat of mortar leaving 15-25 mm gap between two bats. Cement mortar 1:5 (1 blended cement: 5 coarse sand) shall be poured over the brick bats and joints filled properly. Under no circumstances dry brick bats should be laid over the base coat. The haunches/gola at the junction of parapet wall and the roof shall be formed only with brick bat coba as shown in Fig. 22.6.

In case the brick bat coba is laid on the base coat immediately on initial set there will be no necessity of applying cement slurry over the base coat before laying the brick bat coba. However, if the brick bat coba is to be laid on the subsequent day, cement slurry prepared as described in clause 22.7.3 shall be applied over the top surface of the base coat, then only the brick bat coba shall be laid.

#### **22.7.6 Application of Slurry over Brick Bat Coba**



After two days of curing of brick bat coba cement slurry prepared as per clause 22.7.3 shall be applied on the surface of brick bat coba. The application of slurry shall be the same as described in clause 22.5.3 which should cover the haunches/gola, and the remaining small portion of parapet wall and also inside the groove as shown in the figure.

#### **22.7.7 Laying Finishing Layer (Protective Coat)**

Immediately on applying the cement slurry over the surface of the brick bat coba and when the slurry applied is still green, the fibre glass cloth as specified in clause 22.6.4 shall be spread evenly on the surface without any kink & pressed to see that no air spaces exist. The fibre glass cloth shall be taken up to a height of 300 mm on parapet walls & tucked in the groove specially prepared at that height. 20 mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 blended cement: 4 coarse sand) over the entire fibre glass cloth including the haunches/gola and the small portion on the parapet wall. The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove.

The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry prepared as per clause 22.7.3. The finished surface shall be allowed to dry for a while and then pattern of 300 mm x 300 mm groove, 8 mm deep shall be made over the entire surface.

#### **22.7.8 Curing and Testing the Treatment**

The entire surface thus treated shall be flooded with water by making kiaries with weak cement mortar, for a minimum period of two weeks.

#### **22.7.9 Measurement**

The measurement shall be taken along the finished surface of treatment including the rounded and tapered portion at junction of parapet wall. Length and breadth shall be measured correct to a cm and area shall be worked out to nearest 0.01 sqm. No deduction in measurement shall be made for openings or recesses or chimney stacks, roof lights or khurras of area upto 0.40 sqm., nor anything extra shall be paid for making such openings, recesses etc. For areas exceeding 0.40 sqm., deduction will be made in the measurements for the full openings and nothing extra shall be paid for making such openings.

#### **22.7.10 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.

### **22.8 WATER PROOFING TREATMENT WITH BITUMEN FELT**

**22.8.1** Water proofing treatment with self-finished felt shall be four courses or six courses as described in the item. Four course water proofing treatment with self-finished felt is a normal duty treatment suitable for buildings where the cost of roof treatment is required to be restricted.

Six course water proofing treatment with self-finished felt is a heavy duty treatment suitable for important structures.

#### **22.8.2 Materials**

**22.8.2.1** Self-finished felt (Appendix A and B) shall conform to the type and grade given in the description of the item. This shall be one of the following types:

- i. Type 3 grade 1 hessian base felt conforming in all respects to IS 1322.
- ii. Type 2 grade 1 fibre base bitumen felt conforming to IS 1322.
- iii. Type 2 grade 2 glass fibre base felt conforming in all respects to IS 7193.

**22.8.2.2 Bonding Materials:** This shall consist of blown type petroleum bitumen conforming to IS 702 or residual petroleum bitumen conforming to IS 73. The bonding material shall be so selected as to withstand the



local condition of temperature and gradient satisfactorily. The penetration of bitumen used shall not exceed 40 in any case. Suitable residual type petroleum bitumen of penetration 30/40 (IS grade S-35), residual type petroleum bitumen with higher penetration and low softening point and suitable blown type petroleum bitumen of IS grade 85/25 or 90/15 of approved quality shall be used.

Where proprietary brands of bonding materials are proposed to be used they shall conform in all respects to the specifications in the preceding paras.

Sl. No	Description	1st course	3rd course	5th course
		kg/sqm	kg/sqm	kg/sqm
I.	Four course treatment:	1.45	1.45	-
II.	Six course treatment:			
	(a) With type 3 grade 1 hessian base self finished bitumen felt.	1.45	1.20	1.45
	(b) With felts other than type 3 grade 1 hessian base.	1.45	1.20	1.70

**22.8.2.3 Stone Grit and Pea- sized Gravel:** Stone grit shall be 6 mm and downsize. Where pea- sized gravel is used it shall be hard, round and free from dust, dirt etc. The stone grit or pea-sized gravel shall not be spread over vertical and sloping faces of flashings and at drain mouths. At these places the surface shall be painted with two coats of bituminous solution.

The quantity of stone grit or pea-sized gravel required for the final course of four or six course treatment with hessian base self finished bitumen felt type 3 grade 1 shall be 6 cubic decimeter/ sqm.

### 22.8.3 Preparation of Surface

**22.8.3.1** The surface to be treated shall have a minimum slope of 1 in 120. This grading shall be carried out with cement concrete or cement plaster with coarse sand, as per direction of Engineer-in- charge, to the average thickness required and finished smooth. Such grading shall be paid for separately.

**22.8.3.2** Junctions between the roof and vertical faces of parapet walls, chimneys etc. shall be cased by running triangular fillets 7.5 x 7.5 cm size, in cement concrete. At the drain mouths, the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water. Cement concrete where used shall be 1:2:4 mix (1 cement: 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The provision of fillets shall be deemed to be covered by the item of water proofing and shall not be measured or paid for separately.

**22.8.3.3** In existing roof where gola and drip course are provided at the junction of roof and vertical face of parapet wall, chimney stacks etc., these shall be dressed suitably and finished smooth so as to ensure an easy and gradual turning of the flashing. Any dismantlement or forming and finishing smooth the junction for forming the base of the flashing shall not be measured or paid for separately and shall be deemed to form part of the preparation of the surface in the water proofing treatment.

**22.8.3.4** While the grading of roof surface is being done, it shall be ensured that the outlet drain pipe have been fixed and mouth at the entrance have been eased and rounded off properly for easy flow of water.

**22.8.3.5** When any pipe passes through the roof to be treated, angular fillet of shape shown in Fig. 22.7 shall be built around it for the water proofing treatment to be taken over it. These fillets shall not be measured or paid for separately.

**22.8.3.6** For carrying over and tucking in the water proofing felts into the parapet walls, chimney stacks etc. a horizontal groove 6.5 cm deep, 7.5 cm wide section with its lower edge at not less than 15 cm above the





graded roof surface shall be left on the inner face of the same during construction if possible. When such groove has not been left, the same shall be cut out neatly and the base at rear of the groove shall be finished smooth with cement plaster 1:4 (1 cement: 4 coarse sand). Such cutting of the groove and its finishing smooth shall be deemed to be part of the water proofing item and shall not be measured or paid for separately. No deduction shall be made either for not making the groove or when the later has already been left in the masonry by the construction agency.

- 22.8.3.7** Tucking in the water proofing felt will be required where the parapet wall exceeds 45 cm in the height from the graded surface. Where the height is 45 cm or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness. In the case of low dividing walls of height 30 cm or less, outlets therein shall be cut open for full height and the bottom and sides shall be rendered smooth and corners rounded and such treatment shall not be measured and paid for separately.
- 22.8.3.8** Where expansion joints are left in the slab, the provision of dwarf walls and/or RCC slabs for covering them and finishing the surface smooth shall be the responsibility of the construction agency, which had laid the roof slab and will not be included the operation of water proofing.
- 22.8.3.9** The graded surface of the roof and concrete fillets and the faces of walls shall be thoroughly cleaned with wire brushes and all loose scales etc. removed. The surface shall then be dusted off. Any crack in the roof shall be cut to 'V' section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement: 4 coarse sand) or blown type petroleum bitumen of IS grade 85/25, or approved quality conforming to IS 702. Such cleaning of the surface or treating the cracks shall not be paid for separately.

#### **22.8.4 Priming Coat**

Where so specified, or required by the Engineer- in-Charge for example under slightly damp conditions a priming coat consisting of a bitumen primer conforming to IS 3384 should be applied with brush on the roof and wall surface at 0.24 litres per sqm to assist adhesion of the bonding material (i.e. bitumen).

Such application of primer shall be paid for separately, unless specifically included in the water proofing item.

#### **22.8.5 Underlay**

Where a floating treatment of water proofing with self finished bitumen felt is required i.e. where water proofing treatment is required to be isolated from the roof structure, a layer of bitumen saturated felt (underlay) shall be spread over the roof surface and tucked into the flashing groove. No bonding material shall be used below the underlay in order to keep the underlay free of the structure. The adjoining strips of the underlay shall overlap to a minimum of 7.5 cm at sides and 10 cm at ends. The overlaps shall be sealed with the same bonding material as used for the self finished felt treatment. Unless specifically included in the water proofing item, the underlay treatment shall be paid for separately.

The underlay shall be of type 1 saturated felt conforming to IS 1322 in all respects and having a total minimum weight of the finished bitumen felt in dry condition with mica dusting powder @ 6.8 kg per 10 sqm. The roll shall not be damaged or crack on being unrolled on a fairly smooth and flat surface.

#### **22.8.6 Treatment**

- 22.8.6.1** The water proofing shall consist of a four or six course treatment, as given in the description of the item, each layer of bonding materials, self finished bitumen felt or stone grit or pea sized gravel being counted as a course.
- 22.8.6.2** The choice of a four or six course treatment will depend on the climatic condition, the importance of the building, the durability required, cost and other relevant considerations.
- 22.8.6.3** A four course treatment shall consist of the following layers:



- a) Initial layer of bonding material applied hot at specified weight per unit area.
- b) 2nd layer of self finished bitumen felt conforming to the type and grade given in the description of the item.
- c) Third layer of bonding material.
- d) Final layer of stone grit of pea sized gravel spread at specified volume of material per unit area.

**22.8.6.4** In a six course treatment, the first, second and third layer shall be of the same as in the four course treatment. The fourth and fifth layer shall consist of self finished felt and bonding material respectively. The sixth layer shall consist of stone grit or pea sized gravel.

**22.8.6.5** The primer or underlay where required to be provided shall not count against the number of courses specified.

### **22.8.7 Laying**

**22.8.7.1** Bitumen bonding material of required grade shall be heated to the working temperature specified for the particular grade by the bitumen manufacturers and conveyed to the roof in buckets or pouring canes in weighed quantities.

- a) Suitable working temperature for different grades of bitumen are as under:
- b) Blown type petroleum bitumen of IS grade 85/25 or 90/15 - 180 degree C.
- c) Residual type petroleum bitumen of penetration 30/40 - 180 degree to 190 degree C (IS grade S- 35).

**22.8.7.2** Drain outlets shall be given a four or six course treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.

**22.8.7.3** The self finished felt shall be cut to the required length, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The felt shall normally be laid in length at right angles to the direction of the slope and laying shall be commenced at the lowest level and worked upto crest. The felt shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m are suitable lengths. The roof surface shall be cleaned and dried before the felt treatment is begun. Each length of felt shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be levelled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner. Each strip shall overlap the preceeding one by at least 7.5 cm at the longitudinal edges and 10 cm at the ends. All overlaps shall be firmly bonded with hot bitumen. Streaks and trailings of bitumen near edges of laps shall be levelled by heating the overlap with a blow lamp and levelling down unevenness.

The third layer of bonding material in the four course treatment shall be carried out in a similar manner after the flashing has been completed.

**22.8.7.4** In a six course treatment the third and fourth layers of bonding material and self finished felt shall be laid in the manner already described, taking care that laps in the felt are staggered from those in the second layer. The fifth layer of bonding material shall be carried out after the flashing is done (See Fig. 22.7).

**22.8.7.5 High Parapet Walls, Chimney Stacks etc.:** Felts shall be laid as flashings wherever junctions of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The lower layer of flashing felt in a six





course treatment shall overlap the roof water proofing by not less than 20 cm while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing felt in four course specification over the roofing felt shall be 10 cm.

The flashing shall consist of the same four or six course treatment as for the roof except that the final course of stone grit or pea-sized gravel shall be replaced by an application of bituminous solution of approved quality in two coats on the vertical and sloping faces only, of the flashing. The overlap along the length of flashing shall stagger with those in the second layer of flashing felt (in a six course treatment and with the joints in the roof felt).

The upper edge of the flashing felt shall be well tucked into the flashing grooves in the parapet, chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing (see Fig. 22.7).

After the top flashing felt layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing felt and the horizontal overlaps and vertical and sloping surfaces of the flashings at the specified rate. Stone grit or pea sized gravel shall then be spread uniformly over the hot bonding material on the horizontal roof surface at the specified quantity per unit area and pressed into it with a wooden roller.

**22.8.7.6 Low Parapet Walls:** Where parapet walls are of height 45 cm or less, bitumen felt flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried upto the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm (see Fig. 22.7).

**22.8.7.7 Low Dividing Walls:** Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carried down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls (see Fig. 22.7).

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

**22.8.7.8 Expansion Joints:** Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precast RCC cover slabs as given in Fig. 22.7. The coverslabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.

The formation of the expansion joints and provision of cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the junction fillers or for the sealing of the cross joints in the cover slab with 15 cm width of bitumen strips.



**22.8.7.9 Pipes:** Where vertical pipe outlets are met with 7.5 x 7.5 cm fillets of lime or cement concrete of the type and section shown in Fig. 22.7 shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid.

The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

**22.8.7.10 Terrace:** Where roof surfaces are expected to be used precast cement concrete tiles or 40 mm thick cement concrete shall be laid on the water proofing treatment. In such cases, the final course of stone grit or pea sized gravel shall not be laid in the water proofing treatment. Suitable adjustment in the rates will be effected for not providing the stone grit or pea sized gravel layer. Cement concrete in situ flooring shall be laid in panel not exceeding 0.4 square metres each. Precast tiles or in situ concrete flooring where laid shall be paid for separately unless included in the description of the water proofing item.

## **22.8.8 Measurements**

Length and breadth shall be measured correct to a cm. The area shall be calculated in square metres correct to two places of decimal.

Measurements shall be taken over the entire exposed area of roofing and flashing treatment including flashing over low parapet walls, low dividing walls and expansion joints and at pipe projections etc. Overlaps and tucking into flashing grooves shall not be measured.

Vertical and sloping surfaces of water proofing treatment shall also be measured under the four or six course treatment as the case may be, irrespective of the fact that the final course of grit or pea sized gravel is replaced by bitumen primer.

Primer or saturated felt underlay, where provided, shall also be measured in the same manner as the water proofing treatment and paid for separately. No deduction in measurements shall be made for either openings or recesses for chimney stacks, roof lights and the like, for areas upto 40 square decimetre (0.4 sqm) nor anything shall be paid for forming such openings.

For similar areas exceeding 40 sq. decimetre deductions will be made in measurements for full opening and nothing extra shall be paid for forming such openings.

## **22.8.9 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above and the particular specifications given under the different items, with the corrections noted in the relevant sub-paras.

## **22.9 GRADING ROOF WITH CEMENT CONCRETE 1:2:4**

### **22.9.1 Materials**

Cement, coarse sand and graded stone aggregate 20 mm nominal size, shall be used as specified in the item.

The specifications for the materials and method of preparation of concrete shall conform in general to the specification described in sub-head 4.0 of IOCL Civil Specifications 2023.

**22.9.1.1 Laying:** Before laying cement concrete for grading, the level markings to the required slope/gradient shall be made only with cement concrete on the surface of the slab at suitable spacing with the help of string and steel tape (Measuring tape) so that the mason can lay the concrete to the required thickness, slope / gradient easily in between the two level markings. On getting the level marking approved by the Site Engineer the surface should be sprinkled with thick cement slurry and the concrete should be laid



carefully, without throwing from height, in predetermined strips. The concrete should be consolidated by specially made wooden tamping. After the tamping is done the surface should be finished to required slope/gradient with wooden trowels without leaving any spots of loose aggregates etc. The mixed cement concrete must be laid in position, within half an hour of its mixing. In case any quantity of concrete remains unused for more than half an hour the same should be rejected and removed from the site.

**22.9.1.2 Finishing:** The slope of finished terrace shall not be more than 1 in 120 unless a steeper slope is desired by the Engineer-in-Charge. The minimum thickness of the concrete at its junction with Khurra or parapets shall be 5 cm. The concrete shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/gola/filler at the junction of the parapet wall and the roof slab as shown in Fig. 22.8. The finished concrete surface shall present a smooth surface with correct slopes and uniform rounding. The concrete should be free from cracks. Excess trowelling shall be avoided.

**22.9.1.3 Thickness:** Average thickness shall be as per clause 22.9.1.2 as shown in Fig. 22.8.

**22.9.1.4 Curing:** Curing shall be done either by spreading straw/Hessian cloth over the graded surface, keeping the same wet for full 10 days or flooding the graded area with water by making kiaries with weak cement mortar, for 10 days. Occasional curing by simply spraying water now and then shall not be permitted under any circumstances.

**22.9.1.5 Measurement:** Length and breadth shall be measured correct to a cm. Area shall be worked out to nearest 0.01 sqm. and the cubical contents shall be worked out to nearest 0.001 cum. No deduction shall be made for either opening or recesses for chimney stacks, roof lights etc., Khurra for area upto 0.1 sqm. Nothing extra shall be paid either for any extra material or labour involved in forming such opening or recess or in rounding the concrete function of roof with parapet walls, chimney stack, khurra etc.

**22.9.1.6 Rate:** The rate shall include the cost of all the materials and labour involved in all the operations described above.

## **22.10 GRADING ROOF WITH CEMENT MORTAR**

### **22.10.1 Materials**

Cement and coarse sand shall be as specified in the item of work or as described in sub-head 3.0 of IOCL Civil Specifications 2023.

**22.10.1.1 Cement Mortar:** Cement mortar 1:3 (1 cement: 3 coarse sand) /1:4(1 cement: 4 coarse sand) specified in the item of work shall conform to the specification described in sub-head 3.0 of IOCL Specifications.

**22.10.1.2 Preparation of the Surface:** The surface shall be cleaned properly with brooms brush, cloth to remove all dirt, dust, mortar droppings.

**22.10.1.3 Laying:** Same as described in clause 22.9.1.1, except that cement mortar shall be tamped with wooden and steel trowels and surface finished with steel trowel.

### **22.10.1.4 Finishing**

- i. The slope of finished surface shall not be more than 1 in 120 unless a steeper slope is specified in the item of work.
- ii. The finished surface of the grading shall present a smooth surface with correct slopes and uniform roundings wherever they are provided. The mortar surface shall be free of cracks. Excess trowelling shall be avoided.

**22.10.1.5 Thickness:** The minimum thickness of cement mortar grading at the junction with khurra or parapet wall shall be 20 mm. The cement mortar shall be rounded at the junction of roof slab and parapet. It is desirable to provide a haunch/gola/filler at the junction of parapet wall and the roof slab. The maximum thickness that shall be adopted for grading with cement mortar shall be 50 mm. It is not at all desirable to lay the



cement mortar grading for greater thickness and in that case it is advised to go in for grading with Cement Concrete. The average thickness shall be as shown in Fig. 22.9 and 22.10.

**22.10.1.6 Curing:** Curing for the grading with cement mortar shall be done exactly as described in clause 22.9.1.4.

**22.10.1.7 Measurement:** Same as specified in clause 22.9.1.5.

**22.10.1.8 Rate:** The rate shall include the cost of all the labour and material involved in all the operations described above.

**22.11 WATER PROOFING TREATMENT WITH AAP (ATACTIC POLYPROPYLENE POLYMERIC): (Shifted to 14.49)**

Clause shifted to Sub Head 14 (Repairs to Buildings) as clause no. 14.49

**22.12 FIVE LAYERED WATER PROOFING TREATMENT WITH ATACTIC POLYPROPYLENE POLYMERIC): (Shifted to 14.50)**

Clause shifted to Sub Head 14 (Repairs to Buildings) as clause no. 14.50

**22.13 EXTRA FOR COVERING OF ATACTIC POLYPROPYLENE MODIFIED PREFABRICATED MEMBRENE WITH GEOTEXTILE: (Shifted to 14.51)**

Clause shifted to Sub Head 14 (Repairs to Buildings) as clause no. 14.51

**22.14 WATER PROOFING TREATMENT WITH INTERGRAL CRYSTALLINE ADMIXTURE**

**22.14.1 General**

One method that can simplify the protective process is to make concrete with Integral Crystalline Admixtures that reduce its permeability in effect to make the concrete itself waterproof. Apart from the regular workability admixtures, Integral Crystalline Durability admixtures shall be added to all concrete, structural and otherwise, to waterproof & enhance the Concrete Durability. The Crystalline Admixture shall be added either at the time of batching at the batching plant or in the drum of the transit mixer, when the concrete arrives the point of pouring.

The concrete water proofing industry redefined their terminology a short time ago. American Concrete Institute (ACI) 212-3R-10 "Report on Chemical Admixture for Concrete" documents devoted chapter 15 / page 46 to permeability reducing admixtures (PRA's) that outlines PRAH & PRAN classification or

differentiates between those suitable for concrete exposed to Non Hydrostatic Conditions (PRAN) and concrete exposed to Hydrostatic Conditions (PRAH). Besides reducing permeability some PRA's impart other beneficial characteristics such as reduced drying shrinkage, reduced chloride-ion penetration, improved freeze thaw resistance and enhanced autogenous sealing.

**22.14.2 Material**

Integral crystalline water-proofing admixture is one part cementitious powder added to the concrete mix at the time of batching. Integral crystalline water-proofing admixture consists of hydrophilic chemicals such as Portland cement, very fine treated silica sand and various active, proprietary chemicals. These active chemicals react with moisture in fresh concrete and with the by-products of cement hydration to cause a catalytic reaction, which generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete. Thus, the concrete becomes permanently sealed against the penetration of water or liquids from any direction. The concrete is also protected from deterioration due to harsh environmental conditions. Integral crystalline water-proofing admixture is specially formulated to meet varying project and temperature conditions. This reaction continuous over the life of the concrete serving to seal not only initial shrinkage cracks, but also cracks that occur over time.

**22.14.3 Technical Specifications / Parameters**



The specifications of the materials should match or exceed the requirements mentioned in nomenclature of the item the product should be stored under dry condition. The shelf life of the integral crystalline admixture should be treated as one year when stored under normal conditions.

The water proofing compound used in integral crystalline water proofing treatment shall satisfy all the requirements indicated in relevant standards or as specified in concerned relevant codes etc. and the same shall be got tested and get approved from the Engineer-in-charge before its use.

The integral crystalline waterproofing admixtures of hydrophilic in nature shall confirm to the following requirements:

1. Dosage as specified in the item or higher as recommended by manufacturer's specification, material shall fulfill the requirements of American Concrete Institute Guidelines ACI-212- 3R- 10 Chapter 15 and fall under PRAH (Permeability reducing Admixtures for HYDROSTATIC conditions) and must reduce Coefficient of Permeability of concrete by more than 90% (preferably ZERO Permeability), when compared to control concrete and tested as per DIN 1048 Part 5 by carrying out 4 cycles each of 5 bar hydrostatic pressure for 72 hours and drying for 48 hours between the cycles & co-efficient of Permeability calculated as per Darcy's Formula/ Valenta equation by incorporating penetration values obtained at the end of fourth cycle pressure.
2. The crystalline admixture shall be compatible with any other concrete admixture confirming to ASTM C494 and IS 9103.
3. The performance of the crystalline admixture must not be restricted by water-cement ratio of concrete mix. In other words, the crystalline admixture must perform at any water-cement ratio of the concrete mix.
4. The integral crystalline admixture shall possess CE mark approval as per EN934-2 and shall be procured from CE mark approved manufacturing unit. It shall also possess approval certificate from any national apex institution mandated to issue design codes. The product has no corrosion effect on reinforcement steel according to test norm DIN V18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.
5. In addition to recognizing the use of Integrate Crystalline Admixtures. ACI 212-3R-10 has also provided some guideline in para 15.3-"Selection and Evaluation" to select the best quality PRAH's materials as maximum permeability reducing admixtures at maximum Hydrostatic Pressure. Para 15.3 stated that the effect of the admixture can be evaluated by testing the permeability of concrete both directly and indirect methods. The US Army Corps of Engineers CRC C48-92 (1992) test method is a direct measurement of concrete permeability resistance during exposure to water under 200 psi or 13.8 bars or 1.38 MPa of hydrostatic pressure.
6. The integral crystalline admixture must reduce Chloride diffusion Co-efficient by minimum 45% when tested as per ASTM C 1556-4 and compared with the controlled concrete, thereby prolonging the durability & service life of the treated concrete structure.
7. The integral crystalline admixture must be capable of self-healing of cracks up to a width of 0.5mm.
8. The integral crystalline admixture performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.
9. The integral crystalline admixture shall be non-toxic and shall confirm to NSF-61 USA or any other similar certification from reputable international or local third party or declaration of performance certificate supervised by a reputable European/US third party.
10. The integral crystalline admixture when used in the concrete will have no detrimental side effect in terms of Alkali Silica Reaction (ASR) and corrosion of steel reinforcement etc.
11. The manufacturer shall submit guarantee in respect of crystalline admixture performance for 10 years against any leakage.



**Note:** The manufacturer shall produce relevant test certificates of Integral Crystalline Admixture Material from reputed laboratories as per relevant codes stated above. To support the claim of crystal formation, national/ international test report of scanning electrons microscopic (SEM) Photographs dandified and mature crystal formation to plug all the capillary track and pores of the concrete shall be provided.

Total quantity of Integral Crystalline Admixture Material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified

requirements. Contractor shall associate himself with anyone of the specialist firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

#### 22.14.4 Recommended uses

Foundations/Rafts	Reservoirs, Bridges and Dams
Sewage and Water Treatment Plants	Secondary Containment Structures
Tunnels and Subway Systems	Underground Vaults
Parking Structures	Swimming Pools and water tank
Pre-Cast, Cast-in-Place and Shotcrete applications	Basement Retaining Walls

#### 22.14.5 Dosage

0.8% (minimum) to the weight of cement content per cubic meter of concrete or higher dosage as recommended by the manufacturer's specification.

#### 22.14.6 Mixing

The integral crystalline admixture shall be used @ 0.8% (minimum) to the weight of cement content per cum of concrete or higher as recommended by the manufacturer's specification desired to meet water proofing and durability criteria. Integral crystalline Admixture must be added to the concrete at the time of batching at the batching plant or in the drum of the transit mixer, when the concrete arrives the point of pouring.

The sequence of procedures for addition will vary according to the type of batch plant operation and equipment. The mixing shall be followed as below unless & until specified otherwise. For any detailing and mixing guidelines the manufacturer's specifications should be followed.

##### 22.14.6.1 Ready mix plant- Dry batch operation

Add integral crystalline admixture in power form to the drum of the ready-mix truck under the batch plant and add 60%- 70% of the required water, along with required aggregate. Mix the materials for 2-3 minutes to ensure that the integral crystalline admixture is distributed evenly throughout the mix water. Add the balance of materials to the ready-mix truck in accordance with standard batching practices.

##### 22.14.6.2 Ready mix plant- Central mix operation

Mix integral crystalline admixture with water to form a very thin slurry (e.g. 18kg of powder mixed with 22.7 litre of water). Pour the required amount of material into the drum of the ready-mix truck. The aggregate, cement, sand and water should be batched and mixed in the plant in accordance with standard practices (taking into account the quality of water that has already been placed in the ready-mix truck). Pour the concrete into the truck and mix for at least 5 minutes to ensure even distribution of integral crystalline admixture throughout the concrete.

##### 22.14.6.3 Precast batch plant





Add integral crystalline admixture to the aggregate and sand, then mix thoroughly for 2-3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.

It is important to obtain a homogeneous mixture of integral crystalline admixture with the concrete. Therefore dry integral crystalline admixture powder should never be mixed directly to wet concrete as this may cause clumping and hence thorough dispersion in the concrete mix may not occur.

#### **22.14.6.4 Setting time and strength**

The setting time of concrete mix is directly affected by the chemical and physical composition of ingredients, temperature of the concrete and prevailing climatic conditions. Retardation of set may occur when using integral crystalline admixture. The amount of retardation will depend upon the concrete mix design and the dosage rate of integral crystalline admixture. However, under normal conditions, integral crystalline admixture will provide a normal set concrete. Concrete containing integral crystalline admixture may develop higher ultimate strengths than plain concrete. Trial mixes of the concrete should be carried out under project conditions to determine setting time and strength of the concrete.

#### **22.14.7 Application**

Concrete treated with Integral Crystalline Admixture should be placed and finished in accordance with good concrete practices. ACI guidelines and recommendations should be observed.

#### **22.14.8 Precaution / Special Consideration**

It is important to obtain a homogeneous mixture of Crystalline Admixture with the concrete. Therefore, do not add dry Crystalline Admixture power directly to wet concrete as this may cause clumping and through dispersion will not occur. When incorporating Integral Crystalline Admixture, the temperature of the concrete mix should be above 4° C.

#### **22.14.9 Storage / Shelf Life**

Integral Crystalline Admixture must be stored dry at a minimum temperature of 7° C and its shelf life is one year when stored under proper conditions.

#### **22.14.10 Measurement**

The quantity of Integral Crystalline Admixture will be measured in kg correct to two places of decimal as per the dosage as specified to the weight of cement content per cubic meter of reinforced cement concrete. The total weight of cement in kg is to be calculated as per the mix design of reinforced cement concrete.

#### **22.14.11 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.

### **22.15 FIBRE REINFORCED ELASTOMERIC LIQUID WATER PROOFING MEMBRANE HAVING SUN REFLECTIVITY INDEX (SRI) OF 105**

#### **22.15.1 Material**

Fibre reinforced elastomeric liquid water proofing membrane is a ready-to-use waterproofing, white product, with high solar reflectance and thermal index SRI of 105, for external applications. This is made from resilient acrylic polymers and synthetic resins in water dispersion, and when dry forms a continuous, flexible waterproofing membrane. This is resistant to all atmospheric conditions and UV rays, and guarantees long-lasting protection for the substrate.

#### **22.15.2 Technical Specification/ Parameters:**

1. Fibre reinforced elastomeric liquid water proofing membrane with fibers in water emulsion with high reflectance and emissivity with a solar reflectance index SRI of 105 should comply with the requirements of EN 1504-9 ("Products and systems for protecting and repairing concrete



structures: definitions, requirements, quality control and conformity assessment. General principles for the use of products and systems”) EN 1504-2 coating (C) principles PI, MC and IR (“Concrete surface protection systems”).

2. This should possess a paste like consistency having highly reflective white colour.
3. This should have density of 1.35 with dry solid content of 61.4%.
4. This should have minimum tensile strength of 1.0N/mm<sup>2</sup> as per ISO 37 or ASTM D-412.
5. This should conform to results after testing as per EN1062-11 for exposure to artificial weather conditions.
6. The Sun Reflectivity Index when tested as per ASTM E1980 should be 105 minimum.
7. Elongation at break (% age) of 150 % minimum as per ASTM D-412.
8. Adhesion strength is more than 1.0 N/mm<sup>2</sup> as per ASTM D-4541.

### 22.15.3 Applications

It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces to form a string, flexible, tack-free dry surface, suitable for occasional light foot traffic. This can withstand normal expansion and contraction stresses caused by temperature variations due to its flexibility. This also helps lower the working temperature of roofs and guarantees good energy performance properties of all the layers of the roof. The SRI value of 105 helps in reducing the heat island effect of roofs.

### 22.15.4 Preparation of Surface

All the substrates, whether they are new or old, must be sound, clean, dry and free of all traces of oil, grease, old paint, rust, mould and any other material which could compromise the bond.

Concrete and in general mineral substrates must be sound and dry with no rising damp. Any loose parts must be removed. All wax, water-repellent treatments, etc. must be removed from the surface of ceramic substrates with a suitable detergent and/ or by sanding. Any hollows and gaps in the surface must be repaired properly with appropriate material as described and instructed by the manufacturer of this product. The tools to be used must be properly cleaned.

### 22.15.5 Application Procedure

All the area of operation shall be thoroughly cleaned as described in para 22.22A.2 above. Mix the content in such a manner that they are perfectly blended into a homogenous state of liquid which can be applied by long haired roller or airless spray. For applying 1<sup>st</sup> coat of self priming elastomeric water proofing liquid the material should be diluted with water in the ratio of 3:1 (3 parts of elastomeric water proofing liquid and 1 part of water). Wait until the 1<sup>st</sup> coat is completely dry and becomes slightly darker in colour. After the 1<sup>st</sup> coat has dried completely apply 2<sup>nd</sup> coat with undiluted elastomeric water proofing liquid in a criss cross direction to the previous coat. After the drying of 2<sup>nd</sup> coat completely apply the final coat of undiluted elastomeric water proofing liquid in a direction perpendicular to previous coat. The minimum thickness of the dry film of complete application should not be less than that as specified in the manufacturer's specification. The overall dry thickness should not be in any case less than 500 microns. Protect the membrane from rain unless it is completely dry. The overall consumption of the material should be as per nomenclature of the item and should also adhere to the specifications detailed in the approved schedule of the manufacturer.

### 22.15.6 Measurement





The length and breadth/ height should be measured correct to two places of decimal and the area of applications should be measured in sqm correct to two places of decimal.

#### **22.15.7 Rate**

The rate shall be per sqm and include the cost of all the labour and material involved in all the operations described above.

### **22.16 WATER PROOFING TREATMENT WITH INTEGRAL CRYSTALLINE WATER PROOFING COATING / SLURRY**

#### **22.16.0 General**

This Integral crystalline water proofing coating / slurry of hydrophilic in nature is applied to surface of the concrete to water proof and protect the concrete in-depth. It consists of Portland cement, specially treated quartz sand and a compound of active chemicals. Integral crystalline water proofing coating material needs only to be mixed with water prior to application.

When integral crystalline water proofing material is applied to a concrete surface, the active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction that generates an insoluble, crystalline structure. These crystals fill the pores and minor shrinkage cracks in the concrete to prevent any further water ingress (even under pressure). However, integral crystalline water proofing material will still allow the passage of vapor through the structure (i.e. the concrete will be able to “breathe”). Even after the concrete has cured, integral crystalline water proofing material remains dormant in the concrete and will reactivate in the presence of moisture to seal capillary tracts and hairline cracks.

In addition to water proofing the structure, integral crystalline water proofing Slurry protects concrete against seawater, wastewater, aggressive groundwater and many other aggressive chemical solutions. Integral crystalline water proofing material is approved for use in contact with potable water and is therefore suitable for use in water storage tanks, reservoirs, water treatment plants, etc. Integral Crystalline Slurry is not a decorative material.

#### **22.16.1 Material:**

This Integral crystalline water proofing material consists of Portland cement, specially treated quartz sand and a compound of active chemicals.

The water proofing compound used in integral crystalline water proofing treatment shall satisfy all the requirements indicated in relevant standards or as specified in concerned relevant codes etc. and the same shall be got tested and get approved from the Engineer-in-charge before its use.

#### **22.16.1.1 Technical Specification/ Parameters:**

The integral crystalline slurry / coating material of hydrophilic in natural shall confirm to the following requirements:

1. Dosage as specified or at the manufacturer's recommended reduction of co-efficient of Permeability of concrete more than 90% at 56 days curing, when tested as per DIN 1048 Part 5 (after applying 4 cycle each 5 bar hydrostatic pressure) and permeability co-efficient calculated as per Valenta / Darcy's formula. It shall confirm to EN1504-3 (For structural repairs-R3, Compressive Strength > 25 Mpa) supplied from an approved manufacturing unit having CE approval confirming to EN1504-3R3.
2. The product has no corrosion effect on reinforcement steel according to test norm DIN V18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%. The material must be capable of withstanding high hydrostatic pressure. It is important that the civil contractor chooses the best material available in the market and the product meeting all the required criteria and demonstrating highest resistance to the high hydrostatic will be given preference.



3. The Integral Crystalline Slurry must be capable of self-healing of cracks up to a width of 0.5mm. Product must possess third party assurance, confirming that the product, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.
4. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer. Potable Water Compatibility: Nontoxic & suitable for use in potable water facilities- NSF listed as per ANSI 61 listing.

**Note:** The manufacturer shall produce relevant test certificates of Integral Crystalline water proofing slurry material from reputed laboratories as per relevant codes as stated above.

Total quantity of the Integral Crystalline water proofing slurry material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall associate himself with anyone of the specialist firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

#### 22.16.2 Recommended uses

Foundations/Rafts	Reservoirs, Bridges and Dams
Sewage and Water Treatment Plants	Secondary Containment Structures
Tunnels and Subway Systems	Underground Vaults
Parking Structures	Swimming Pools and water tanks
Pre-Cast, Cast-in-Place and Shotcrete applications	Basement Retaining Walls

#### 22.16.3 Preparation of surface

All concrete to be treated with integral crystalline water proofing slurry material must be clean and have an "open" capillary surface. Remove laitance, dirt, grease, etc. by means of high pressure water jetting, wet sandblasting or wire brushing. Faulty concrete in the form of cracks, honeycombing, etc. must be chased out, treated with the same material and filled flush with the mortar mixture as specified by the manufacturer. Surface must be carefully pre-watered prior to the application of integral crystalline water proofing material. The concrete surface must be damp but with no wet sheen on the surface.

#### 22.16.4 Mixing

Integral crystalline water proofing slurry / coating material should be mechanically mixed with clean water to a creamy consistency resembling to thick oil. Only that much material should be mix as can be used within 20 minutes and mixture should be stirred frequently. The mixture should not be allowed to set, if it happens, simply re-stir to restore workability but no more water should be added to it. The ratio of integral crystalline water proofing material with water should be as below

- i. **Vertical surface:** For applying with brush the ratio should be 5 parts of integral crystalline water proofing material to 2 parts of water.  
  
For applying with spray the ratio should be 5 parts of Integral Crystalline water proofing coating material to 2.75 – 3.25 parts of water.
- ii. **Horizontal surface:** The ratio should be 3 parts of Integral Crystalline water proofing coating material to 1 part of water. This should be applied by brush only.

#### 22.16.5 Application Procedure

The slurry mix of the Integral Crystalline water proofing slurry material shall be applied in one or two coats as specified/ required according to work situation in the item. After preparation of surface as described in



para 22.23.2 and making the surface saturated with water before application of Crystalline Slurry, then first coat of the slurry mix shall be applied by the brush or appropriate power spray equipment. The second coat as specified shall be applied while the first coat is still green.

The other method of application known as Dry powder consistency can also be applied on horizontal surfaces only. The specified amount of integral crystalline water proofing material is distributed in powder form through a sieve or a semi mechanical barrow spreader and troweled into the freshly placed concrete as this reaches the initial set.

The integral crystalline water proofing material to be used shall be as following:-

- i. **Vertical surface:** - Two coats of integral crystalline water proofing material slurry coat shall be applied @ of 0.70 kg per sqm. per coat or as specified.
- ii. **Horizontal surface:** - One coat of integral crystalline water proofing material slurry coat shall be applied @ of 1.10 kg per sqm or as specified by the manufacturer to harden concrete. Alternatively integral crystalline water proofing material mix can be dry sprinkled @ of 1.00 kg per sqm and trowel applied to fresh concrete when it has reached initial set.
- iii. **Construction joint:** - Integral crystalline water proofing material mix shall be applied either as slurry coat or dry powder consistency immediately prior to placing the next lift/ bay of concrete @ 1.60 kg per sqm. or as specified.
- iv. **Binding concrete:** - Integral crystalline water proofing material mix shall be applied either as slurry coat or dry powder consistency immediately prior to placing the overlying concrete slab.

#### 22.16.6 Curing

The treated surfaces should be kept damp for a period of five days and must be protected against direct sun, wind and frost, by covering with polyethylene sheeting, damp burlap or similar material.

#### 22.16.7 Precaution / Special Consideration

Do not apply Integral Crystalline Slurry at temperatures at or below freezing or to frozen or freezing surfaces. Integral Crystalline slurry cannot be used as an additive to concrete or plasters. (Integral Crystalline Admixture should be considered for these applications).

#### 22.16.8 Storage / Shelf Life

When properly stored in a dry place in unopened and undamaged original packaging its shelf life is 12 months.

#### 22.16.9 Measurement

The quantity of Integral Crystalline Slurry coat will be measured in sqm. The Length & breadth/height of the coated area by Integral Crystalline Slurry shall be measured correct to a centimeter. The area shall be calculated in sqm correct to two place of decimal.

#### 22.16.10 Rate

The rate shall include the cost of all the labour, material and equipments involved in all the operations described above.

### 22.17 FLEXIBLE CEMENTATION NEGATIVE SIDE WATERPROOFING COATING WITH ELASTIC WATERPROOFING POLYMERS

#### 22.17.1 Material

Flexible cementations negative side waterproofing coating with elastic waterproofing polymer is a one-component, concentrated liquid admixture used to enhance the performance of cementations repair



mortars, plasters, stuccos, concrete mixes and toppings for restoration of horizontal, vertical and overhead concrete; concrete masonry units (CMU); and masonry surfaces.

#### **22.17.1.1 Technical Specification/ Parameters:**

Flexible cementations negative side waterproofing coating with elastic waterproofing polymer shall confirm the following requirements:

1. Flexible cementations negative side waterproofing coating with elastic waterproofing polymer should have PH value of 7 and consist of liquid state with the application temperature range of 7°C to 35°C.
2. This should have the density of 1.02 gm per ml.
3. This should possess the property of application in undiluted as well as diluted form.
4. This should be non-reemulsifiable.

#### **22.17.2 Applications**

It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces to form a string, flexible, tack-free dry surface. This is easy to use and control in construction works for water proofing of the surface and optimizes bond to concrete substrates. It also improves resistance to abrasion and freeze/ thaw cycles.

#### **22.17.3 Preparation of Surface**

All substrates must be structurally sound, stable and solid, with all loose material removed. Thoroughly clean the surface of any substance that could interfere with the bond of the installation material, including dirt, paint, tar, asphalt, wax, oil, grease, latex compounds, from release agents, laitance, loose toppings, foreign substances and any other residues. Concrete surfaces must be mechanically profiled and prepared by shotblasting, sandblasting, diamond-grinding, water-jetting, scarifying or other engineer-approved methods to obtain an acceptable profile. Concrete substrate and ambient room temperatures must be maintained between 45°F and 95°F (7°C and 35°C) before application. Temperatures must be maintained within this range for at least of 72 hours after the application coating.

#### **22.17.4 Application Procedure**

Apply the coating on to this sound and dry surface using a long-haired roller, brush or spray. The dilution of the compound the water should be done in a clean mixing pail. The ratio of mixing with water is to be done in accordance with the nomenclature of the item along with corresponding coats and manufacturer specifications. The number of coats to be applied should be as directed under the nomenclature of the item and the total material used in complete process should not be less than 14.35 kg per 10 sqm under any circumstances. The 1<sup>st</sup> coat should be applied on to the properly prepared and dried surface. More coats should be applied when the coat below is still wet. All the coats should be applied in perpendicular direction to each other. The final surface is to be protective from excessive heat or draft conditions during the first 24 to 72 hours. Final surface should be cured for at least 5 to 7 days. Use of damp burlap, polyethylene sheeting or water-based curing compound is also recommended to be used for curing.

#### **22.17.5 Measurement**

The length and breadth/ height should be measured correct to two places of decimal and the area of applications should be measured in sqm correct to two places of decimal.

Rate

The rate shall be per sqm and include the cost of all the labour and material involved in all the operations described above.



## 22.18 WATER PROOFING TREATMENT WITH INTEGRAL CRYSTALLINE WATER PROOFING DRY-SHAKE

### 22.18.1 General

Crystalline water proofing dry-shake of hydrophilic in nature is a unique Integral Crystalline chemical treatment for the waterproofing and protection of concrete. Crystalline water proofing dry-shake has been formulated for dry-shake applications on horizontal concrete surfaces where greater impact and abrasion resistance is required.

### 22.18.2 Material

Integral Crystalline water proofing dry-shake (dry powder) compound consists of Portland cement, various active proprietary chemicals, and a synthetic aggregate hardener that has been crushed and graded to particle sizes suitable for concrete floors.

Crystalline water proofing dry-shake becomes an integral part of the concrete surface, thereby eliminating problems normally associated with coatings (e.g. scaling, dusting, flaking and delaminating). The active chemicals react with the moisture in the fresh concrete causing a catalytic reaction that generates a non-soluble crystalline formation within the pores and capillary tracts of the concrete.

#### 22.18.2.1 Technical Specification/ Parameters:

The Integral Crystalline dry shake material of hydrophilic in nature shall confirm to the following requirements:

1. Dosage as specified or at the manufacturer's recommended reduction of co-efficient of Permeability of concrete more than 90% at 56 days curing, when tested as per DIN 1048 Part 5 (after applying 4 cycle each 5 bar hydrostatic pressure) and permeability co-efficient calculated as per Valenta / Darcy's formula.
2. It shall confirm to EN1504-3 (For structural repairs-R3, Compressive Strength > 25 Mpa) supplied from an approved manufacturing unit having CE approval confirming to EN 1504-3R3.
3. The product has no corrosion effect on reinforcement steel according to test norm DIN V18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.
4. The material must be capable of withstanding high hydrostatic pressure. It is important that the civil contractor chooses the best material available in the market and the product meeting all the required criteria and demonstrating highest resistance to the high hydrostatic will be given preference.
5. The Integral Crystalline dry shake must be capable of self-healing of cracks up to a width of 0.5mm.
6. Product must possess third party assurance, confirming that the product, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.
7. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.
8. Potable Water Compatibility: Nontoxic & suitable for use in potable water facilities- NSF listed as per ANSI 61 listing.

**Note:** The manufacturer shall produce relevant test certificates of Integral Crystalline water proofing dry shake material from reputed laboratories as per relevant codes as state above.

Total quantity of the Integral Crystalline water proofing dry shake material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall



associate himself with anyone of the specialist firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

#### 22.18.3 Application Rate (Dose)

Crystalline water proofing dry-shake material to be used under normal conditions should cover the application surface @ minimum 0.60 kg per sqm. depending upon of the degree of abrasion resistance required.

If the surface is to be used under heavy traffic conditions or where greater abrasion resistance is required, the manufacturers recommendation should be taken into account while applying crystalline water proofing dry-shake on the concrete surface.

#### 22.18.4 Application Procedure

- i. After fresh concrete is placed. Consolidated and leveled, wait until concrete can be walked on leaving an indentation of 6-8mm.
- ii. Concrete should be free of bleed water and be able to support the weight of a power trowel. Float open the surface.
- iii. Immediately after floating open the surface and within one hour of finishing the concrete, apply one-half of the Integral Crystalline water proofing dry-shake material by hand or mechanical spreader, in one direction only. The Integral Crystalline water proofing dry-shake material must be spread evenly.
- iv. As soon as the Integral Crystalline water proofing dry-shake material has absorbed moisture from the base slab, it should be power floated to the surface.
- v. Immediately after power floating, apply remaining Integral Crystalline water proofing dry-shake material at right angles to the first application.
- vi. Allow remaining Integral Crystalline water proofing dry-shake material to absorb moisture from the base slab and then power float the material into the surface. When concrete has hardened sufficiently, power trowel surface to the required finish.

#### 22.18.5 Curing

Curing is important and shall begin as soon as final set has occurred but before surface starts to dry. Conventional moist curing procedures such as water spray, wet burlap or plastic covers may be used. Curing should continue for at least 48 hours. In hot dry sunny or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab conditions due consultations should be made from the technical representatives of the manufacturer for specific instructions. In lieu of moist curing, concrete sealers and curing compounds may be used. In all cases, recommended guidelines for proper curing should be followed.

#### 22.18.6 Recommended uses

Foundations /Rafts Slabs	Water tank base slab
Sewage and Water Treatment Plants	Below Grade Structures
Warehouses Floors	Traffic Bearing Surfaces Parking Structures

#### 22.18.7 Precaution / Special Consideration

For the best results when applying Integral Crystalline dry shake materials, the air content of the concrete shall not exceed 3% (a high air content can make it difficult to achieve a proper application).

In hot, dry, or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab.





Chronic moving cracks or joints will require a suitable flexible sealant.

#### **22.18.8 Storage / Shelf Life**

Integral Crystalline dry shake must be stored dry at a minimum temperature of 7° C and its shelf life is one year when stored under proper conditions.

#### **22.18.9 Measurement**

The quantity of Integral Crystalline dry shake sprinkled area shall be calculated in sqm correct to two places of decimal. The Length & breadth/height of the Integral Crystalline dry shake sprinkled area shall be correct to a centimetre.

#### **22.18.10 Rate**

The rate shall include the cost of all the labour, material and equipments involved in all the operations described above.

### **22.19 CRYSTALLINE WATER PROOFING MORTAR**

#### **22.19.1 Material**

Crystalline water proofing mortar consists of Portland cement, specially treated quartz sand and a compound of active chemicals.

The active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction, which generates an insoluble integral crystalline complex. These crystalline complexes grow in the presence of water and block the capillaries of the concrete and minor shrinkage cracks, thus water proofing the concrete. Chemicals activation begins when the powder is mixed with water and may take several days to completely block the capillaries, depending on ambient temperature and environmental conditions. It can be applied to the positive or negative water pressure sides of a structure.

#### **22.19.2 Technical Specification/ Parameters:**

1. It shall conform to EN1504-3 (For structural repairs-R3, Compressive Strength > 25 Mpa) supplied from an approved manufacturing unit having CE approval confirming to EN 1504-3R3.
2. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.
3. Product must possess third party assurance, confirming that the product, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.
4. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.
5. Potable Water Compatibility: Nontoxic & suitable for use in potable water facilities- NSF listed as per ANSI 61 listing.
6. The manufacturer shall submit guarantee in respect of crystalline water proofing mortar performance for 10 years against any leakage.

Note: The manufacturer shall produce relevant test certificates of Crystalline Mortar from reputed laboratories as per relevant codes as state above.

Total quantity of the water proofing Crystalline Mortar material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall



associate himself with anyone of the specialist firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

### 22.19.3 Recommended Uses

This material can be applied in conjunction with crystalline water proofing coating for:

- i. Installation of seal strips, reglets and coves at joints to assure water tightness
- ii. Patching and filling / sealing of routed out cracks.
- iii. Patching of tie holes and faulty construction joints.
- iv. Repairing of spalled and honeycombed area.

### 22.19.4 Preparation of Surface

All surfaces to be patched, repaired or sealed with crystalline water proofing mortar must be clean and sound. **Crack** should be routed out to a U-shaped configuration, approximately 25 mm wide and a minimum of 25 mm deep. **Tie holes** should be roughened prior to filling. **Spalled and honeycombed area** must be thoroughly cleaned and chiseled back to sound concrete prior to repair. Remove all dirt, cement laitance, form release agents, curing compounds, paints, coating, etc. by means of wet or dry sandblasting, high pressure water jet or other approved mechanical means. Surfaces must be well moistened to a dull dampness at the time of application. The concrete should be damp with no wet sheen on the surface.

### 22.19.5 Mixing

- i. **For routed cracks, coves and non-moving joints:** Add water to crystalline water proofing mortar powder until a medium stiff, trowelable consistency reached. The texture of the mix should be pliable enough to be trowelled into the cracks with some pressure, but not so pliable that it would run out or sag out of the crack.

Approximate mixing ratio (by volume) is 4.5 parts crystalline water proofing mortar powder to 1 part water. Alternatively, 450gm of crystalline water proofing mortar powder to 100 ml of water is to be mixed.

- ii. **Tie holes and pointing applications:** Add only a small amount of water. Mixed consistency should be that of "dry earth," holding a shape when squeezed in your hand but easily crumbled when pressed between fingers. Mix only as much material as can be used within 20 minutes.

### 22.19.6 Application Procedure

- i. **For sealing cracks and faulty construction joints,** routed out/making U-shape groove size 25x25mm and then priming the surface with integral crystalline slurry @0.05 kg per running meter and while the surface is tacky filled the cavity upto surface crystalline mortar @1.50 kg per running meter. Once crystalline mortar is touch dry then finally applying two coats of integral crystalline slurry @0.05 kg per running meter per coat.
- ii. **For repairing spalled & honeycombed areas,** prepared the surface and chiesel back upto sound concrete and then primed the area with integral crystalline slurry @0.70 kg per sqm. and while the surface is tacky repair and level the honeycomb area with crystalline mortar @ 22.70 kg per sqm. for an average thickness of 10mm. Once crystalline mortar is touch dry then finally two coats of integral crystalline slurry @ 0.70kg per sqm. per coat.
- iii. **For patching of tie rod holes,** prepared tie rod hole surface and primed the area with integral crystalline slurry @ 0.07 kg per sqm and while the surface is tacky repair and filled the tie rod holes with crystalline mortar @ 0.040 kg per hole. The crystalline mortar shall be tightly rodded into tie holes or packed tightly. For 25x25x25 mm hole, use 0.040 kg per hole to fill the tie hole.





#### 22.19.7 Curing

Provide protection against extreme weather conditions, such as heavy rain or freezing conditions, during the setting period. Curing is not normally required except during hot, low humidity weather. In these conditions, a light mist of water approximately 25 hours after the repair is completed will help to ensure a controlled cure. In extreme dry heat, water misting may be carried out at required intervals more frequently.

#### 22.19.8 Precaution / Special Consideration

Crystalline mortar shall not applied at temperatures below 40°F (4°C), to a frozen substrate or if temperatures will drop below freezing during the curing period (approximately 24 hours). This product is not recommended for use in expansion or construction joints. Crystalline mortar can be applied in (13 mm) layers not exceeding 2.5 inch (approximately 6.5 cm) to prevent shrinkage cracks in the mortar.

#### 22.19.9 Storage / Shelf Life

Crystalline mortar shall be stored in a dry enclosed area off the ground at a minimum temperature of 7°C. Shelf life when stored in proper conditions in unopened, undamaged packaging is 12 months.

#### 22.19.10 Measurement

Faulty construction joint will be measured by measuring the length in running meter correct to a centimetre. Repair of honeycombed area will be measured in square meter correct to two places of decimal by measuring the length and width of treated area correct to a centimetre. Repair of tie rod holes will be measured in numbers.

#### 22.19.11 Rate

The rate includes the cost of all the labour and material involved in all the operations described above.

### 22.20 SWELLABLE TYPE WATER STOP TAPE

#### 22.20.1 General

Swellable type water stop tape of size 19 mm x 25 mm is a unique sealing compound designed to expand rapidly when exposed to moisture, making it a self-healing joint material for construction joint applications / treatment.

#### 22.20.2 Material

This is a swellable type sealing compound which expand rapidly after coming in to contact or exposed to moisture. This acts as a self healing material and is used for applications in construction joints.

#### 22.20.3 Physical Properties

- i. Specific gravity (ASTM D71):  $1.35 \pm 0.05$  (ASTM D-71)
- ii. Volatile matter: 1% maximum (ASTM D-6)
- iii. Penetration, 150g cone at 25°C, 5sec :  $40 \pm 5$ mm (ASTM D-217)
- iv. Rate of Rapid Expansion:
  - a. Fresh Water Exposure: 24 Hours-140%, 48 Hours- 175%, 72 Hours-190% & 120 Hours-210%
  - b. Salt Water Exposure: 24 Hours-7%, 48 Hours-12%, 72 Hours-14%, 120 Hours-18%

The water stop material should meet the requirements to EU REACH Regulation (EC) No 1907/2006.

#### 22.20.4 Physical Properties of Swellable Waterstop Primer

- a) % Solid: Min 20%



- b) Flash Point: 93 deg C
- c) Dry Time: 25 deg C: 10 min
- d) Dry Time: 4 deg C : 60 min

#### 22.20.5 Recommended Uses

Typical applications for swellable type waterstop tape include building foundations, slabs, retaining walls, storage tanks, and similar non-moving cold construction joints

#### 22.20.6 Application

- i. The entire surface length where the water stop is to be applied is cleaned thoroughly by using blower and brush. Apply one coat of required primer throughout the length of the joint @ 3.78 litre per 240 running metre. Allow the primer to dry for 10 to 15 minutes at the temperature of 25°C. This should be allowed to dry for some longer time in the areas where the temperature are low.
- ii. By using the heel of the hand and moderate pressure, press the self expanding joint material firmly into the position on the structure on the entire area which has been primed and dried. Make sure that the product has bonded with the primed area.
- iii. Where required, splice ends to form a continuous, uninterrupted seal. For best results, cut each end at opposite 45deg. angles and tightly butt ends together. DO NOT OVERLAP ENDS. Gently knead the spliced ends creating an uninterrupted seal.
- iv. Peel the protective covering from the exposed side of the installed expandable joints sealing compound.
- v. Pour the matting structural member in position.

**Notes:** Always use swellable type waterstop primer to avoid displacement of the swellable type waterstop tape during concrete pouring. It may be necessary to utilize masonry nails or other mechanical means to hold the sealant in place on vertical surfaces.

Place swellable type waterstop tape so that it is not closer than 5 cm away from the outer surface of poured structure. If a Keyway is utilized, place the swellable type waterstop tape into the bottom of the formed Keyway area.

#### 22.20.7 Precaution / Special Consideration

Always use swellable type waterstop primer to ensure tight adhesion and to aid in preventing swellable type waterstop tape from moving during the concrete pour. For vertical surfaces, nails may be used to hold the product in place in conjunction with swellable type waterstop primer. Swellable type waterstop tape shall be used at a minimum depth of 50 mm inside the concrete. When used on pipes and other structural penetrations, swellable type waterstop tape shall be cut to measured length and placed around the penetration with ends butted. In all cases, swellable type waterstop tape shall be in direct contact with the substrate along the entire length of the installation. Swellable type waterstop tape is not an expansion joint sealant and only suitable for non-moving concrete joints. Swellable type waterstop tape should not be installed in standing water or on frozen or icy surfaces

#### 22.20.8 Storage / Shelf Life

When stored in a dry enclosed area off the ground at a minimum temperature of 45°F (7°C) in unopened, undamaged cartons, its shelf life is unlimited.

#### 22.20.9 Measurement

The measurement shall be taken by measuring the length of swellable type waterstop tape in running meter correct to a centimeter. Length shall be measured in metres correct to two places of decimal. Measurement shall be made in metres.



**22.20.10 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above.



## APPENDIX A

### BITUMEN FELTS (FIBRE HESSIAN BASE) (Clause 22.8.1.1)

#### A1 – Weights

The weights of the ingredients used in the manufacture of bitumen felts per 10 sqm shall be not less than those specified in Table A-I

TABLE A-I

Minimum Weights of Bitumen Felts

S. No.	Type of felt	For 10 sqm				
		Untreated Base	Saturated	Coatant	Bitumen content	Total weight of the finished bitumen felt in dry condition with mica dusting powder Min.
		Kg	Kg	Kg	Kg	Kg
	Fibre Base					
(i)	Type 2 grade 1 Hessian Base	5.0	4.5	12.9	12	22.6
(ii)	Type 3 Grade 1	2.3	1.8	17.7	12.1	23
(iii)	Type 3 Grade 2	2.3	1.8	31.8	20.2	37.1

Notes:

1. The weight of the untreated base shall be taken as in the dry condition.
2. Includes allowance for 1.2 kg minimum mica dusting powder in dry condition.



## A2 – Testing

**A-2.1** Frequency of test shall be decided by the Engineer -in-charge depending on quantum of work. From each of the rolls one piece 3 m long and the full width of the felt shall be cut out for preparing test specimens. The first 2M. of the roll shall not be selected for this purpose. The lengths of felt so selected shall be free from abnormal defects and shall be truly representative of the whole consignment. The selected pieces of felt shall be dispatched without breakage or distortion, wrapped up in water proof paper or other similar materials so as to cause no damage to the material during transit. In case the material has stuck together, no heat shall be applied to separate the layer but the whole roll shall be sent for testing and the fact shall be reported.

The samples, when tested as per IS1322 shall conform to the requirements given in Table A-II.

**TABLE A-II**

Sl. No	Type of Felt	Breaking strength kg	Pliability Test	Storage sticking tests	Heat Resistance Test	Pressure head test	Water absorption test Max.
1	Type 2 (all grades)	95 / 60	The roll shall not show cracks on unrolling  Consider any surface rupture exceeding 5 mm in length as failure	The test pieces shall be examined after cooling  After release of the load, the layers of felt shall be capable of being separated without damaging the coatant in any way	The test pieces shall show no sign of melting of the bitumen compound  -	The test pieces shall show no sign of leakage  -	5.0%
2	Type 3 (all grades)	135/ 90	The roll shall not show cracks on unrolling  Consider any surface rupture exceeding 5 mm in length as failure	The test pieces shall be examined after cooling  After release of the load, the layer of felt shall be capable of being separated without damaging the coatant in any way	The test pieces shall show no sign of melting of the bitumen compound-	The test pieces shall show no sign of leakage	2.0%

**APPENDIX B****GLASS FIBRE BASE BITUMEN FELT  
(Clause 22.8.1.1)****B1 – Weight**

The weight of the ingredients used in the manufacture of glass fibre felts for 10 square metre shall be not less than those specified in Table B-I

**TABLE B-I****Minimum Weight of Bitumen Glass Fibre Base Felt For 10 Square Metre**

S. No.	Type of Felt	Untreated Base	Treated Base	Coatant	Total weight in dry condition including surfacing materials
		(kg)	(kg)	(kg)	(kg)
1	Type 2 Gr. I	--	0.4	15.3	18.0

**B2 - Tests**

The sample, when tested as per IS 7193 shall conform to the requirements given in Table B-II.

**TABLE B-II****Requirements of Glass Fibre Felts**

S. No.	Properties	Requirements
(i)	Breaking strength, Min kg	Warp 50 Weft 30
(ii)	Pliability test	Roll shall not show cracks on unrolling Consider any surface rupture exceeding 5 mm in length as failure.
(iii)	Storage sticking	The test pieces shall be examined after cooling. After release of load, the layers of felt be capable of being separated without damaging.
(iv)	Pressure head	The test pieces shall show no sign of leakage.
(v)	Heat resistance	The test pieces shall show no sign of melting of bitumen compound.
(vi)	Water absorption	2 per cent

## WATERPROOFING OF HORIZONTAL SURFACES OF U.G. STRUCTURE

Sub Head: Water Proofing Treatment

Clause: 22.1

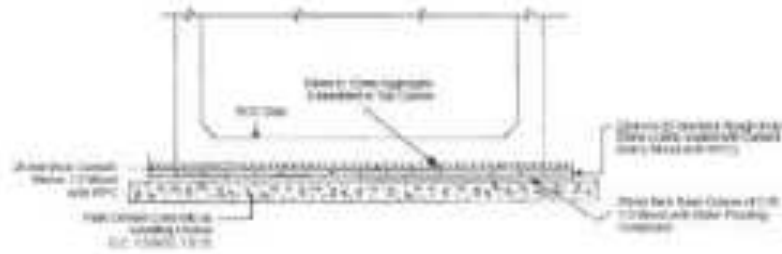


Figure 22.1 : Waterproofing of Horizontal Surfaces of U.G. Structure



Figure 22.2 : Waterproofing of Horizontal Surfaces from Inside of a U.G. Structure





## TYPICAL CROSS SECTION OF PVC WATER STOP

Sub Head : Water Proofing Treatment  
Clause : 22.4

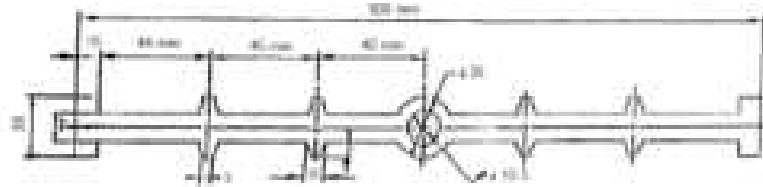


Figure 22.5 : Typical Cross Section of PVC Water Stop

## INTEGRAL CEMENT BASED WATERPROOFING TREATMENT WITH BRICK BAT COBA OVER A RCC SLAB

Sub Head : Water Proofing Treatment  
Clause : 22.7

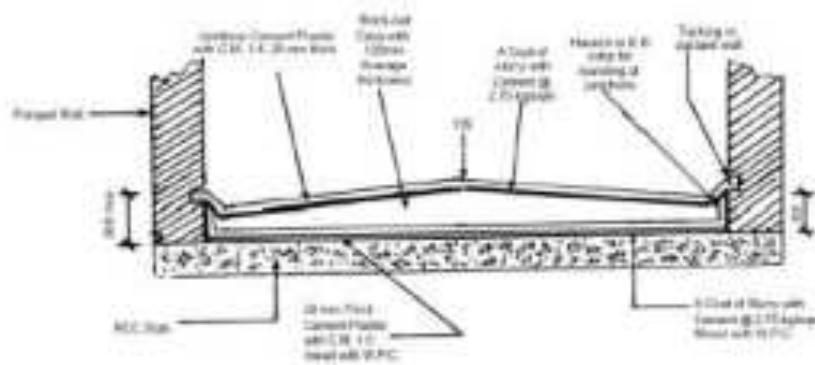


Figure 22.6 : Integral Cement Based Water Waterproofing Treatment with Brick Bat Coba over a RCC Slab

## WATER PROOFING

Sub Head : Water Proofing Treatment

Clause : 22.8

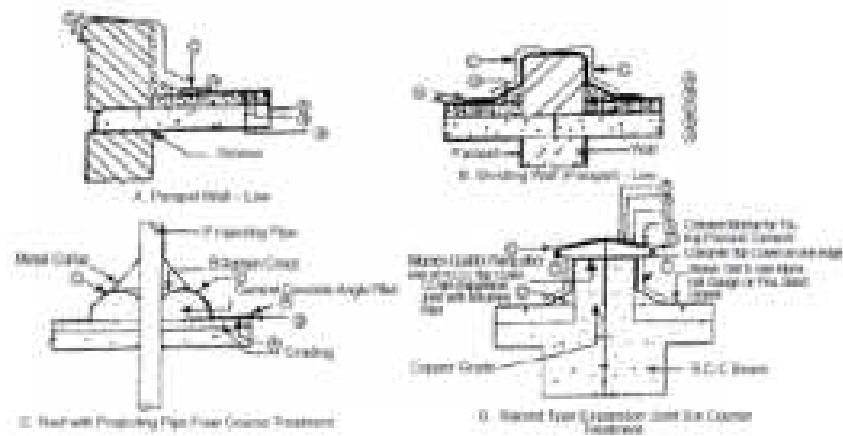


Figure 22.7 : Water Proofing

## GRADING ROOF SLAB WITH CEMENT CONCRETE

Sub Head : Water Proofing Treatment

Clause : 22.9

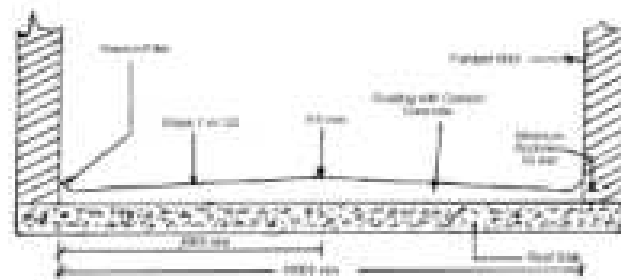


Figure 22.8 : Grading Roof Slab with Cement Concrete

## GRADING ROOF SLAB WITH CEMENT MORTAR 1:3/1:4

Sub Head : Water Proofing Treatment  
Clause : 22.10

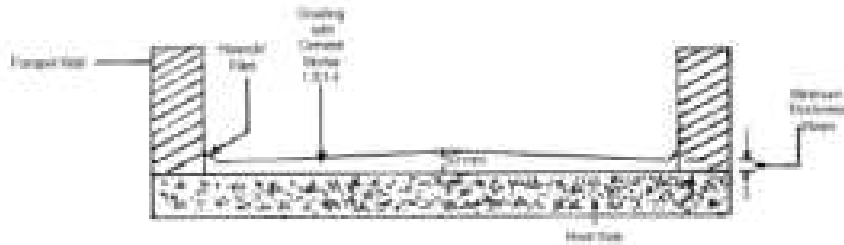


Figure 22.9 : Grading Roof Slab with Cement Mortar 1:3/1:4

## GRADING CHAJJA WITH CEMENT MORTAR 1:3/1:4

Sub Head : Water Proofing Treatment  
Clause : 22.10

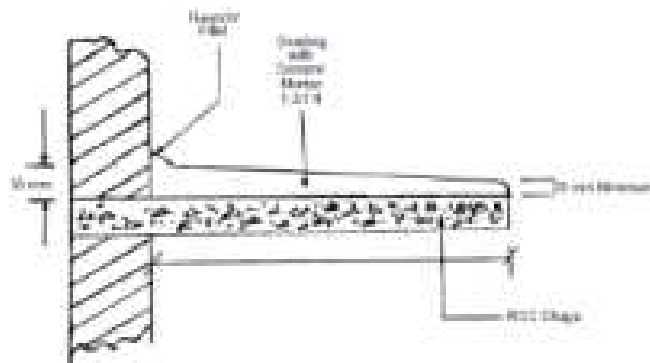


Figure 22.10 : Grading Chajja with Cement Mortar 1:3/1:4



# RAIN WATER HARVESTING & TUBEWELL

LOREMEEF



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### LIST OF BUREAU OF INDIAN STANDARDS CODES

S. No.	IS Code	Subject
1.	IS 226:1975	Structural Steel
2.	IS 460:1985 (Part-1)	Code of practice for particle size distribution
3.	1239 (Part I):1990	Mild steel tubes, tubulars and other wrought steel fittings: Part I Mild steel tubes (fifth revision)
4.	2800 (Part I): 1991	Code of Practice for Construction and Testing of Tubewells/ Borewells
5.	3589 :1991	Seamless or electrically welded steel pipes for water, gas and sewage (1683 to 2032 mm outside diameter) (second
6.	4097: 1967	Gravel for use as pack in tubewells
7.	4270 : 2001	Steel tubes used for water wells(second revisions)
8.	8110 : 1985	Well Screens and Slotted Pipes
9.	9439 : 1980	Glossary of terms used in water-well drilling technology
10.	10500 : 1983	Drinking water
11.	10151 : 1982	Polyvinyl chloride (PVC) and its copolymers for its safe use in contact with foodstuffs, pharmaceuticals and drinking water
12.	11189 : 1985	Methods for tubewell development
13.	12818 : 2010	Unplasticized PVC ribbed screen casing and plain casing pipes for bore/ tubewells – Specification



## 23 RAIN WATER HARVESTING & TUBEWELLS

### 23.0 TERMINOLOGY

#### **Acidizing**

The process of introducing acid into the pore spaces of acid soluble formations to enlarge the pore space by dissolving the surrounding formation. Acidizing also refers to the removal of encrustation from well screens and gravel pack, and dissolving cementations materials.

#### **Additive**

An auxiliary agent added for conditioning of drilling fluid to obtain desired physical properties.

#### **Air Drilling**

The drilling process in which air or gas is used as a medium for removal of cuttings.

#### **Air Line**

The small diameter vertical pipe inserted in the tube wells with or without the ejector for cleaning and developing tube wells by airlift method.

#### **Air Line Lubricator (In-Line Oiler)**

An apparatus that feeds a small controllable quantity of lubricating oil into the air stream to provide lubrication for pneumatic components/accessories of machines.

#### **Air Rotary Drilling**

A process similar to direct circulation rotary drilling except that compressed air is used as a drilling fluid instead of drilling mud.

#### **Annular Space**

The space between drill pipe and wall of the hole, or Casing and wall of the hole, or Drill pipe and casing.

#### **Annular Velocity**

The up-hole return velocity of fluid or air in the annulus, usually expressed in m/min.

#### **Antifoam**

An agent added to acid to prevent or retard foaming during the acid reaction.

#### **API (American Petroleum Institute)**

The designation given to equipment or parts of equipment standardized by the American Petroleum Institute, such as drill pipe threads.

#### **Aquifer**

An aquifer is a geological formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

#### **Artesian**

Artesian is synonymous with confined artesian water and artesian water bodies are' equivalent respectively to confined ground water and confined water body. An artesian well is a well deriving its water from an artesian or confined water body. The water level in an artesian well stands above the top of the artesian water body it taps.



**Artesian Well**

A Well tapping confined or artesian aquifer in which the static water level stands above the water table, in which case those wells with water level above the water table are said to have positive artesian head (pressure) and those with water level below the water table, negative artesian head.

**Bailer**

A tube fitted with a valve at its base, which is lowered into a bore hole to remove cuttings and water. **Barrel:** Unit of measurement consisting of 42 US gallons.

**Barite**

Barium sulphate, the commercial product contains small amounts of iron oxide, silica, and other minerals. It is used to make mud heavier.

**Barytes**

Natural barium sulphates, used as a basic material for weighing agents.

**Bentonite**

A finely powdered, highly plastic, colloidal material used in preparing drilling mud.

**Bit**

The cutting element attached to the bottom of the drill stem. Can be of various types - for example, Rock roller, Drag, Diamond, Tungsten carbide tipped, etc.

**Bit Breaker**

A heavy plate, which fits in the rotary table and holds the bit while it is being unscrewed from the drill stem.

**Bit Nozzle**

A fluid port in the bit.

**Blocks, Crown and Travelling**

An assembly of a pulley(s) mounted to rotate on an axis, with a hook or eye for anchoring or attaching to load. Pulley(s) are grooved for the wire rope. It is used to raise or lower the drill string.

**Blowout**

A sudden escape of violent escape of gas, oil or water from a drilling well when high pressures are encountered and efforts to prevent or control the escape are unsuccessful.

**Bore Hole**

Any hole bored/drilled in the ground for prospecting of oil, minerals or ground water.

**Blowout Preventor**

A device attached immediately above the casing to control pressures and prevent escape of fluids from the annular space between the drill pipe and casing or to shut off the hole if no drill pipe is in the hole, should a kick or blowout occur.

**Breakout**

The act or process of unscrewing a threaded joint - especially in case of drill pipes while it is being withdrawn from the well bore.

**Bridge**



An obstruction to circulation between the annular space of the well. A bridge is usually formed by caving of the wall of the well bore or by the intrusion of a large boulder

### **Cable Tool Percussion Drilling**

A spudding process in which drilling is carried out by lifting and dropping a heavy string of drilling tools at regular intervals, resulting in crushing or loosening rock formations. The reciprocating action of the tools mixes the crushed or loosened particles with water to form a slurry or sludge. Necessary water is put into the borehole if no water is present in the formation being penetrated. The slurry is removed at intervals from the borehole by means of a sand pump or a bailer.

### **Casing Pipe**

Piping used to support the sides of borehole.

### **Casing Shoe**

A heavy-walled steel coupling or band at the lower extremity of the casing. It clears the way for casing.

### **Cathead**

An auxiliary hoisting device used for handling light loads and for alternately lifting and dropping tools such as drive block or bumper. Its use requires a line of manila/wire rope carried on a separate sheave at the top of the derrick. It is also used for making and breaking the joints.

### **Catline**

A hoisting or pulling line used in conjunction with the cathead to lift heavy equipment or tools.

### **Catwalk**

A ramp on the side of the drilling rig, fitted to the derrick floor, where the pipes are laid using the catline.

### **Cementing**

The process of placing the cement slurry to provide a seal against subsurface water.

### **Cement Plug**

The hardened cement slurry left in the lower portion of the casing and later drilled out after the cement has set.

### **Cement Slurry**

A pumpable mixture of cement and water.

### **Circulate (Normal)**

To pump drilling fluid from the pit, through the drill pipe and back to the surface through the annulus. The term generally applies to the operation carried out when drilling is temporarily suspended, to obtain samples from the bottom or to keep the hole in condition while awaiting other operations.

### **Circulation, Direct (Drilling)**

The drilling fluid movement from the mud pit to the annular space in the hole, drill pipe, kelly water swivel, suction hose, centrifugal or jet pump, settling pit and back to mud pit.

### **Co-efficient of permeability**

It is the velocity of flow through a permeable material at hydraulic gradient unity.

### **Collapse Strength**

It is the strength of screen to withstand surrounding hydrostatic pressure on outside surface.

**Control Console**

A horizontal or vertical panel on which the entire operator's controls are located.

**Coring**

The act of procuring a sample of the formation being drilled for geological investigation. Coring is done using a core barrel.

**Crown Block**

An assembly of wire line sheaves mounted on the uppermost portion of the derrick/mast.

**Cuttings**

Particles of formations obtained from the well during drilling operations. These can be brought to the surface by the circulating fluid or air in rotary drilling or bailed out in case of cable tool drilling.

**Deadline**

Refers to the end of the drilling line, which is not related on the run. This end is usually anchored to the mast substructure and does not move as the block moves up or down during various operations.

**Die Overshot**

A long tapered die of heat-treated steel designed to fit over the top of the lost drill pipe and cuts thread when rotated. The tool is fluted to permit the escape of metal cuttings and fluids.

**Dilution**

The use of more water in the cement slurry than is necessary to produce pumpable slurry.

**Direct Circulation Rotary Drilling**

This process consists of drilling a borehole by means of a rotating bit and removing the cuttings by continuous circulation of drilling fluid as the bit penetrates the formation materials. The drilling fluid flows from the mud pit, through the pump, stand pipe, hose, drill pipe, annular space in the hole, and settling pit, back to the mud pit.

**Directional Drilling**

An operation in which a hole is purposely deviated in a controlled direction and angle.

**Down-the-Hole Drilling**

A method of drilling using down-the-hole hammers.

**Down-the-Hole Hammer**

A percussive air operated tool attached to the end of the drill string used in down-the-hole drilling. Tungsten carbide tipped bits are normally used with down-the-hole hammers.

**Drag Bit**

A rotary bit, which has two or more cutting blades, or wings with hard faced cutting edges.

**Drawdown**

Lowering of water level caused by pumping. It is a measure for a given quantity of water pumped during a specified period, or after the pumping level has stabilized.

**Draw-Works**



A power-driven winch or winches, usually equipped with clutch and brake for hoisting or lowering a drilling string.

**Drill Bit**

Drilling tool deployed in drilling operations and attached at the end of the drill string.

**Drill Collar**

A heavy drill pipe used immediately above the drill bits to put weight on the drill bit and minimize deviation of the hole.

**Driller**

A person who operates the drilling machines or rigs.

**Drill Pipe**

Special pipe, with threaded tool joints at both ends, used to transmit rotation from the rotating mechanism, thrust and weight to the bit and convey fluid, which removes cuttings from the hole and cools the bit.

**Drill String**

Components including subs, adaptors, drill pipe, drill collar, bit etc, joined together to form a drill string depending upon the type of rig used for drilling the hole.

**Drive Bushing**

Device used to transmit torque from the rotary table /drill head to the kelly but allow vertical movement of the Kelly while drilling.

**Drive Head**

A sub fastened to the top of pipe or casing to take the blow of drive weight.

**Drive Pipe**

A pipe or casing driven through over-burden.

**Drive Weight**

Normally used in percussion drilling to give blows on top of casing to drive it. Also called drive hammer or drive block.

**Dry Hole or Duster**

A well drilled. which produces neither oil nor gas nor water of significant quantity.

**Dust Collector**

Used to control the dust and/or collect the cuttings which are discharged from the hole being drilled by air drilling.

**Dust Diverter**

Collar and hose used to divert dust and cuttings away from the operator and the machinery.

**Elevators**

Devices which latch around the drill pipe/casings attached by links to the travelling block that raises or lowers the pipe/casing from the hole.

**End Rings**

These are rings or couplers welded at both ends of screen to facilitate joining with other pipes.

**Expansion Reamer**

A device or tool having cutters that can be expanded or contracted by hydraulic or mechanical means and used to enlarge or ream bore hole below the casing or drive pipe. Also known as adjustable or under reamer.

**Feed**

The process of applying required pressure on the cutting tool to achieve the downward movement.

**Fish**

Debris in the hole such as broken bits, drill pipe, casing tools, etc, which may have broken off and lodged in the hole.

**Fishing**

The act of attempting to recover a fish.

**Fishing Magnet**

A special powerful magnet attached to a rope or drill string to fish out magnetic material.

**Fishing Tap**

A tap of heat-treated steel designed to fit to the top of the lost drill pipe and cuts thread when rotated. The tap is fluted to permit the escape of the metal cuttings and fluids.

**Fishing Tools**

Special tools used to retrieve fish from the hole.

**Fluid, Drilling**

The medium, liquid or gas used for flushing cuttings from the hole being drilled for cooling the bit and for lubricating the bit.

**Foam Flushing**

A liquid chemical added to the flushing water to stabilize the hole walls and to remove the drill cuttings effectively.

**Gel Strength**

A measure of the effect of the forces between the particles while the mud is at rest.

**Hoisting Line**

Wire rope used on the draw-works to hoist and lower the drill string.

**Hole**

Usually refers to the well bore.

**Hook Load**

The load, which may be applied to the hook, attached to the travelling block on a drill rig.

**Hydraulics**

That branch of engineering that deals with liquids in motion. It is the know- how about the effects of fluid velocities and pressures and the power involved.

**Hydraulic Percussion Drilling**



This is also known as hollow-rod drilling method. It employs a chisel shaped bit. A ball check valve is provided between the bit and lower end of the drill pipe string. Drilling is done by lifting and dropping the drill rods/ bit with quick short strokes. The drilling fluid is supplied at the surface in the annular space. It enters the ball check valve during downward stroke of drill pipe. When the bit is picked up, the ball check valve closes and traps the fluid inside the drill pipe. Continuous reciprocating motion produces a pumping action to lift the fluid to the top of the string of drill pipe where it discharges into a settling tank.

**Idler**

In machinery an idler pulley or sprocket is used in connection with belt drive and chain drive respectively to maintain desired tension in the belt or chain.

**Impression Block**

This block has many forms and designs and often used to obtain an impression of the top of the fish before attempting fishing operations.

**Jet**

A directed, rapid flow of fluid from a nozzle.

**Jet Percussion Drilling**

In this method, a chisel-shaped bit is attached to the lower end of string of pipe. Holes on each side of the blades of the bit serve as nozzles that help in loosening the material being drilled and keep the bit clean. The drill rods are rotated by hand to make the drill cut a round hole. The drilling fluid flows from the mud pit through the pump, stand pipe, hose, drill pipe and comes out through nozzles in the bit. It then flows through the annular space to settling pit and back to mud pit. With fluid circulation maintained, the drill rods are lifted and dropped in a manner similar to cable tool drilling but with shorter strokes. The bore hole is thus drilled by chopping action of the bit combined with washing action of water jets.

**Kelly**

A formed or machined section of hollow drill steel which is joined directly to the swivel at the top and to the drill pipe below. The flats or flutes of the Kelly engage the rotary table so that the rotation of the rotary table is transmitted to the kelly, which, in turn, transmits it to the drill pipe and consequently to the rotary bit.

**Laminar Flow**

Movement of fluid particles in essentially parallel paths.

**Loss of Circulation**

The loss of drilling fluid into formation pores or crevices.

**Making a Joint/Connection**

The act of screwing a joint of the drill pipe on to the drill stem suspended above the well bore.

**Making Hole**

Drilling ahead.

**Mast**

A structure on the rig used to support the crown block, top drive, pull down chains, hoisting lines, etc. It is also called Derrick or Tower.

**Marsh Funnel**

A calibrated funnel commonly used in field tests to determine the viscosity of drilling mud.

**Master Bushing**

Adaptor used to reduce the size of the rotary table opening to accommodate various sizes of bushings, slips, etc.

**Mud Balance**

An instrument consisting of a cup and a graduated arm with a sliding weight and resting on a fulcrum used to measure weight of the mud.

**Mud Gun**

A pipe that shoots a jet of drilling mud under high pressure into the mud pit to mix the additives and to stir the mud for other reasons.

**Mud Mixing**

Preparation of drilling fluid from a mixture of water or other fluids and one or more of various dry mud making materials such as clay, weighing materials, chemicals, etc.

**Mud (Slush) Pump**

A large single acting triplex or double acting duplex pump used to circulate mud down the drill pipe and up the annulus, under normal operations.

**Nozzle**

A small spout to direct the flow of fluid efficiently.

**Penetration, Rate of**

The rate at which the bit proceeds in the deepening of the well bore.

**Penetration**

It is the amount of penetration between profile wire and support rod after fusion welding.

**Percentage Open Area**

It is the open area available for entry of water as percentage of total outside surface area of pipe.

**Permeability**

Permeability or hydraulic conductivity of a medium is indicative of the ease with which water can flow through it. It depends on the properties of the medium affecting flow including porosity, packing, shape, and grain size distribution.

**Pipe Handling Equipment**

The equipment for storing, adding and removing lengths of drill pipe.

**Power- Take-Off**

The means of transmitting power from the engine of the power package, or a truck or tractor, to the other components of a drilling rig. This is usually accomplished by a separate shifting arrangement in the transmission.

**Profile Wire**

Shaped wire which is spirally wound.

**Pull Down**



Thrust or weight applied to the bit through the drill string, and the mechanism, which provides either, the hoisting or pulling power.

**Push Strength**

It is the maximum separating force that weld joint between profile wire and support rod can withstand.

**Ratio of Submergence**

This is the ratio between the length of the airline under water to the total length of airline.

**Reamer**

Cutting tool used to enlarge a bore hole.

**Reaming**

The operation of smoothening the well bore, enlarging the hole to the desired size.

**Reverse Circulation Rotary Drilling**

In this drilling process, a string of drill pipes with a drill bit at the bottom is rotated by mechanical means. Plain water or a fluid of gelling quality is circulated to prevent the hole from caving in and for sucking up the drill cuttings through drill pipes. The flow of drilling fluid takes place from the mud pit to the annular space then through the opening in the bit to the drill pipe, a centrifugal pump or jet ejector, settling pit and back to mud pit.

**Rig**

A drilling machine used for drilling a borehole.

**Rotary Drive**

Use of a power shaft to transmit driving power to the rotating element.

**Rotary Hose**

The air or mud hose that leads from the stand pipe to the swivel. also known as the 'fluid (air) or swivel hose.

**Rotary Table, Power Swivel, and/or the Rotation Drive**

The means of transmitting rotation to the drill string and bit.

**Safety Hook**

A hoisting hook with a spring-loaded latch that prevents the load from accidentally slipping off the hook.

**Sand Content**

The percentage bulk volume of sand in a drilling fluid,

**Shale Shaker**

A vibrating screen that removes coarser cuttings from the circulating fluid before it flows into the return pit.

**Sheaves**

Disc type or wheel type parts of the travelling blocks or crown block with the circumference grooved for a selected diameter of drilling lines, These can be mounted on bushings' or bearings.

**Slips**





Wedge or wedges used to prevent the drill pipe or casing pipe from slipping through the opening in the rotary table when the bit is off the bottom during trip or when adding or taking off a section of drill pipe. These may be hand or power-actuated.

**Slotted Pipes**

Slotted pipes are pipes with slots cut into them in a pattern suitable to the basic material of the pipe.

**Slot Opening**

It is the width of opening for entry of water.

**Slurry**

A mixture of cement and water that is pumped into the well to cement casing.

**Slush (Mud) Pit**

Pit used for mixing the drilling fluids and to act as a storage/settling tank for the return cuttings.

**Specific Capacity**

The ratio of the discharge to the drawdown it produces measured under the well (l/min/m of drawdown).

**Stabilizer**

Fixed to the drill string to provide stability to the drill string - can be spaced out over the entire length of the string.

**Stand Pipe**

A vertical pipe or hose carrying either air or mud to approximately the middle of the mast where it is connected to the mud, rotary or swivel hose.

**Sub**

A substitute, or adaptor, which is used to connect from one type or size of threaded connection to another.

**Support Rods**

The longitudinal shaped/circular rods supporting the profile wire.

**Swivel**

The mechanism, which permits the passage of mud or air from a stationary hose into a rotating member, such as the kelly or drill pipe.

**Tensile Strength**

It is the strength of the screen to withstand tensile load.

**Thinner**

A substance that reduces the apparent viscosity and get development of mud without lowering the density. The addition of thinner affects the colloidal clay fraction of mud.

**Thread Protector**

A coupling type device which is screwed onto or into both ends of a pipe to protect the threads from damage during transportation, storage or moving around the drill site.

**Tongs**

The tools used in making or breaking a joint of pipe during a drilling operation. Their action is much the same as that of a pipe wrench.

**Tool Joint**

Threaded portions of the drill string, which may be either box or pin type.

**Tower**

See Mast.

**Transfer Case**

A transmission to distribute power from the engine to other rig components.

**Tube well efficiency**

The formation loss (head loss) required to produce flow divided by the total drawdown observed in the well.

**Wall Hook**

A simple tool that can be made from steel casing, shaped with a cutting torch. A reducing sub connects the top end of the tool to the drill stem. Also used to straighten the lost drill pipe in the hole in preparation for removal by the tap or overshot tools.

**Water Injection System**

Used for adding water to the down-hole air stream, thereby increasing the efficiency of the cleaning action. Also used for controlling dust in the hole.

**Water Table**

That underground level at which water is found.

**Water-Well**

Term used for any type of ground water structure providing space for accommodating water lifting device for drawl of ground water.

**Well Development**

Development of aquifers by compressed air or any other suitable method.

**Wetting Agent**

An additive that reduces surface tension.

**Well Development**

It is a treatment of a well to establish the maximum rate of usable water yield without sand.

**Well Screens**

Well screens are specially fabricated screen pipes from different materials which can have wider range of slot opening from much finer to coarse compared to slotted pipes.

**23.1 GENERAL REQUIREMENTS**

- 23.1.1** Rainwater harvesting is the collection of rainfall. In most cases, a roof is used for this purpose. The rainwater then flows through the gutters, into a collection tank. The collected water can be used for small scale irrigation (of vegetable gardens etc.), clothes washing, bathing and after treatment also for drinking and food preparation.
- 23.1.2** Rainwater offers advantages in water quality for both irrigation and domestic use. Rainwater is naturally soft (unlike well water), contains almost no dissolved minerals or salts, is free of chemical treatment, and is a relatively reliable source of water for households.



**23.1.3** A rooftop rainwater harvesting system consists the following elements:

- a) Collection area
- b) Conveyance/piping system,
- c) Filtration /treatment
- d) Storage
- e) Usage/ Recharge

**23.1.4** The collection area in most cases is the roof of a house or a building. The effective roof area and the material used in constructing the roof influence the efficiency of collection and the water quality.

**23.1.5** A conveyance system usually consists of gutters or pipes that deliver rainwater falling on the rooftop to manholes or other storage vessels. Both drainpipes and roof surfaces should be constructed of chemically inert materials such as wood, plastic, aluminum, or fiberglass, clay tiles etc in order to avoid adverse effects on water quality.

**23.1.6** The water ultimately is stored in a storage tank, which should also be constructed of an inert material. Reinforced concrete, Brick masonry, fiberglass, or stainless steel are suitable materials. Storage tanks may be constructed as part of the building or may be built as a separate unit located some distance away from the building.

**23.1.7** Design of various component of systems for Rain Water Harvesting are covered in the CPWD Rain Water Harvesting and conservation Manual.

**23.1.8** The specifications of various types of piping systems used in RWH, manholes, manhole covers, Open surface drains, road gully chamber, Dispersion trenches, soak pits are provided in the specifications Sub Head: Drainage.

**23.1.9** The Specifications for Storage tanks/Underground sumps shall be followed as per IS 2470: 1986 (Part I & II).

**23.1.10** The recharge wells/pits are provided with the bore wells to recharge the ground water table directly draining rainwater through filter media to the aquifer.

**23.1.11** The recharge wells/pits are also used for drawing water from the aquifer by making deep tub well in the or near the recharge pit.

**23.1.12** The specifications for tube well for the withdrawal of underground water are also provided in this chapter.

## **23.2 TYPE OF TUBEWELLS:**

### **23.2.1 Type 1 (Cavity Well)**

Cavity wells are generally shallow wells drilled in alluvial formations (see Fig. 1A and Fig. 1B). These are wells with casings resting in thick, hard impervious clay layer above the aquifer. It is a pre-requisite that the impervious clay layer should be of adequate thickness to support the well and should not disintegrate when water is pumped out.

### **23.2.2 Type 2 (Tubewell)**

Tubewells are generally constructed in alluvial formations comprising a casing pipe, housing pipe (if need be) and an intake section either screen or slotted pipe with or without gravel packing ( artificially packed or naturally packed wells as shown in Fig. 2A and Fig. 2B). These wells may be either under water table conditions or under artesian conditions (see Fig. 2C).

### **23.2.3 Type 3 ( Borewell in Hard Rock Formation)**



The over-burden in such wells is encased to eliminate the risk of caving in. Drilling is further carried out in rock formation and the bore is left normally unsupported to allow the water to flow from crevices and fishers into the bore except in -cases where caving formations are encountered (see Fig. 3).

### **23.3 DRILLING METHODS:**

The various terms of water well drilling are to be read as per IS 9439 : 2002. The various methods of drilling as per IS 2800 (Part-I) : 1991 are as below:

#### **23.3.1 Auger Drilling**

The drilling is done with a spiral or worm auger connected to square rods turned manually with rod tillers, the cuttings produced as a result of drilling are removed with a sand shell. Steel casing pipes with drive shoes at the bottom are lowered as the drilling progresses. This method is employed where very shallow drilling in alluvium formation is involved (see Fig. 23.7 and Fig. 23.8).

#### **23.3.2 Water Jet Boring**

A drill bit with nozzles is attached to the drill pipes at its bottom and through which water is pumped at high pressure. The water on its return flow through the annular space between the bore and the drill pipe, brings out the cutting along with it to the surface. 'Casing pipe is simultaneously used to avoid caving in. The method is suitable for drilling shallow wells in loose sandy formations (see Fig. 23.9).

#### **23.3.3 Calyx Drilling**

A bit made from hollow steel tube with two inclined slots called 'shot bit' is connected below another tube (core barrel) which is further connected to the drill rods. These are rotated mechanically. Chilled shots are fed to the bottom of the bit through the drill string along with water. These are ground by the shot bit to form abrasive material with sharp edges which cuts into the consolidated formation forming an annular ring to form a core inside the core barrel, which is then taken out from well by grouting the core with quartz chips, etc.: This method is successful for shallow tubewells drilling in consolidated formations with large diameter holes.

#### **23.3.4 Percussion Drill Hog**

A heavy bit attached with a drill stem, a drilling jar to a cable is given up and down spudding motion, either manually or by power. Water is added to dissolve the cuttings which are lifted out by means of a bailer. Steel casing pipes with drive shoes are used as the hole progresses. This method of drilling is suitable for drilling in boulder formations.

#### **23.3.5 Rotary Drilling**

##### **23.3.5.1 Direct Circulation Method**

A drill bit is rotated mechanically by means of drill pipes, through which drilling mud (usually bentonite mixed with other suitable material) is circulated under pressure. This process of circulation lubricates the bit, carries the cutting in suspension to the surface and also plasters the wall of the hole to prevent it from caving-in. Very deep wells can be constructed in alluvium formations by this method.

The accessories commonly used for tubewell construction, their description/ functions and the typical material for their manufacture are given in Table 1.

##### **23.3.5.2 Reverse Circulation Method**

A starting of drill pipes with a drill bit at the bottom is rotated by mechanical means. Plain water or a fluid of gelling quality depending on the strata conditions, is allowed to flow into

the bore hole, when drill cuttings along with water are sucked through the drill pipes by a centrifugal pump and thrown into the setting pit. The hole remains intact under the - hydrostatic pressure of the drilling fluid,



the level of which is maintained continuously. Large diameter holes can be drilled in alluvium formations by this method.

### 23.3.6 Down the Hole Hammer (DTH) Drilling

The method is used for fast and economical drilling in hard formations. Compressed air is utilized for rapid impacting action by the hammer to the bit thus crushing the formation into small chips which are flushed out through the annular space between the bore and the drill pipes by the upcoming compressed air.

**Note:** The drilling bits generally used during the drilling by direct circulation method and by reverse circulation method are tricone rock roller bits, diamond drilling bits, reaming bits and thin wall core bits. Their use depends upon the type of soil formations such as soft, medium hard and hard formations. The bits used for percussion drilling are California pattern bits and for DTH drilling are button bits and drag bits.

### 23.4 ACCESSORIES TO BE USED IN TUBEWELL CONSTRUCTION

A typical drawing showing details of bail plug, bail plug hook, centralizer, taper reducer, mild steel clamp, well cap and notch plate, is given in Fig. 6.

The description, functions and the material of accessories commonly used for tubewell construction is given in Table-1.

### 23.5 INFORMATION TO BE FURNISHED BY THE OWNER OF THE TUBEWELL:

The owner shall furnish the following information to the drilling agency:

- a) Information regarding tubewells and dug well existing near his land such as their depth, formation encountered and discharge, etc. may be furnished as far as possible;
- b) Static water level;
- c) Expected yield;
- d) Purpose for which the water is needed, such as irrigation, industrial or domestic purpose, etc; and
- e) Any other information.

### 23.6 INFORMATION TO BE FURNISHED BY DRILLING AGENCY:

When offering to sink a tubewell, the drilling agency shall furnish the owner with the following information:

- a) Suitability of the site proposed by the owner -( if a more suitable site, other than the one proposed by the owner is available, it should be suggested );
- b) Whether a test bore hole is proposed and if so, its diameter and depth, and also depth of production tubewell proposed;
- c) Likelihood of increase or decrease of the depth given at (b) above;
- d) Method of drilling with size of bore in different depths;
- e) Types of plain pipe with size, wall thickness and slotted/strainer pipes with opening, may be mentioned;
- f) Guarantee with regard to the verticality of tubewell and sand content (ppm) in the discharge from the well at the time of handing over;
- g) Development methods to be adopted may be stated; and
- h) Any other information and conditions.



**TABLE 23.1**  
**Nomenclature of Tubewell Parts**  
**(Clause 23.4 and Fig. 1, 2 and 3)**

Sl. No.	Name of Part	Description/ Function of Part	Typical Materials
(1)	(2)	(3)	(4)
1)	Bail plug or bottom plug	A closed socket provided at the bottom most end of the pipe assembly. A simple mild steel plate welded at the bottom end.	IS 226 : 1975
2)	Bail plug hook	Inverted 'U' hook attached to the bottom plug or a bar fitted across the blind pipe.	IS 226 : 1975
3)	Casing pipe	Placed against strata from which water is not to be tapped.	IS 4270 : 2001 or IS 12818 : 2010
4)	Screens/slotted pipes	Has openings to permit entrance of water from the aquifer.	IS 8110 : 1985
5)	Centralizer	The centralizing guides are fitted to the well assembly except -the housing pipe at suitable spacing to keep the assembly in the centre of the hole So that an even thickness of ravel pack.	IS 226 : 1975
6)	Taper/ reducer	A taper/reducer is intended to connect the housing pipe with lower diameter assembly down below.	IS 226: 1975
7)	Housing pipe	This is the upper portion of 'the case section of the well and serves as a housing for the pumping equipment and is a vertical conduit through which water flows from 'the aquifer to the pump. It is water tight and extends from to a depth below the anticipated pumping water level.	IS 226 : 1975
8)	Clamp	Fixed at the top of the tubewell for supporting the well assembly.	IS 226 : 1975
9)	Well cap	Used to keep the tubewell closed after its completion until the pump set is installed. It is either threaded to be screwed to top of the housing or simply a plate is spot welded so as to be easily removed when required.	IS 226: 1975

### 23.7 DESIGN AND LOWERING OF PIPE ASSEMBLY



### 23.7.1 Design of Pipe Sizes and Lengths

The length and diameter of the casing pipe is selected on basis of static water level, the draw down, the discharge expected from the well and the size of pump to be installed. The size and length of slotted/strainer pipes are selected according to the actual requirement according to the strata met with the expected discharge and the depth of tubewell, the casing pipes shall generally conform to IS 4270 : 1983, the slotted/strainer pipes shall conform to IS 8110 : 1985 and the u-PVC casing pipes and screen shall conform to IS 12818 : 2010.

### 23.7.2 Design of Screen Slots

The entry of water in the tube well shall be either through screens or slotted pipes. Following are the various types of well screens and slotted pipes used in water wells depending upon the type and size of well:

- a) Plain slotted pipe,
- b) Bridge slotted pipes,
- c) Mesh -wrapped screens,
- d) Cage type wire wound screens,
- e) Pre-packed resin bonded gravel screens,
- f) Brass screens.
- g) u-PVC pipes

The design, selection and type of screen or slotted pipe size and distribution of slots shall be as specified in IS 8110 : 1985.

## 23.8 GRAVEL PACKING

**23.8.1** All gravel to be used as pack in tubewell construction for water supply shall be as specified in IS 4097: 1967. The thickness of the gravel shroud around the screen shall generally be not less than 10 cm.

**23.8.2** The gravel selected for packing tubewells shall consist of hard quartz (about 96 percent SiO<sub>2</sub>) or other suitable material, with an average specific gravity of not less than 2.5. Not more than 10 percent by weight of the material shall have a specific gravity of less than 2.25. The gravel shall contain not more than two percent by weight of thin flat or elongated pieces. In the case of such pieces, the larger dimensions shall not be more than 3 times the smallest dimensions. The quartz shall be of sub-rounded to rounded grains with minimum angular features.

**23.8.3** The gravel for use as pack shall be free from impurities, such as shale, mica, feldspar, clay, sand, dirt, loam, and hematite and organic materials.

**23.8.4** The porosity of the gravel when laid as a pack shall not be less than 25 percent.

**23.8.5 Gravel Sizes:** The gravel conforming to this standard as per IS 4097 : 1967 shall be of the following grades:

Sl.N o.	Grade	Pack	Particle Size Range Mm	IS Sieves (see IS:460-1962*)
1	A	Fine Gravel	Over 2.0 to 3.35	2.0 , 3.35
2	B	Fine Gravel	Over 3.35 to 4.75	3.35 , 4.75
3	C	Medium Gravel	Over 4.75 to 6.3	4.75 , 6.3



4	D	Medium Gravel	Over 6.3 to 8.0	6.3 , 8.0
5	E	Coarse Gravel	Over 8.0 to 12.5	8.0 , 12.5

Note: The particle size distribution of gravel shall be determined by screening through standard sieves in accordance with IS: 460-1985. The percentage distribution of the sizes shall be determined from a graph in which the percentage of material passing through each sieve is plotted against the standard aperture of that sieve. Any size, say D20, will thus

indicate that the cumulative weight of all the grains smaller than this size is 20 percent of the total weight of the test sample. The uniformity coefficient of the gravel, that is, the ratio of its D<sub>20</sub> to D<sub>10</sub> sizes shall not exceed 2. A material with uniformity coefficient less than 2 shall be classified as uniform and if greater than 2 it shall be taken as non-uniform. The limiting sizes given in above table are the minima and maxima, and the stacks containing smaller or bigger sizes as shown by sieve analysis shall be rejected.

**23.8.6** The gravel shall have a hardness of not less than 5 in Moh's scale.

**23.8.7** The pack aquifer ratio (P/A ratio) is defined as the ratio of 50 percent size (D<sub>50</sub>) of the gravel pack to the 50 percent size of the aquifer. The size of gravel when used as pack in tubewells shall be decided in accordance with the size of the aquifer material proposed to be tapped. The gravel size shall be limited as below:

- a) Uniform aquifer with uniform gravel pack. Pack aquifer ratio — 9 to 12.5
- b) Non-uniform aquifer with uniform gravel pack. Pack aquifer ratio — 11 to 15.5

Note: The thickness of gravel pack shall be limited to 13 to 18 cm.

Note: However, artificial gravel pack may not be necessary if the effective size (D<sub>10</sub>) of the aquifer is greater than 0.3 mm and its uniformity coefficient is greater than 5. For artificial gravel pack, pl see Fig. 2B.

**23.8.8** For sampling and packing, corresponding provisions of IS 4097 : 1967 may be referred.

Note1: In percussion method of drilling, gravel is fed into the annular space between the casing pipe and the assembly pipe up to 3 m above the bottom of the slotted pipe. The well is developed using compressed air or by bailers and as the water becomes clear, surging or backwashing is done to make the development more perfect. More gravel is fed, if necessary, and when the water becomes free from sand, the casing pipe is jacked up to some height, and the process is repeated until all the aquifers are gravel packed.

Note2: In rotary method, the pipe -assembly is lowered into position and gravel packing may be done up to a suitable depth below the bottom of the housing pipe in the first instance. There after the gravel packing up to the required depth is completed after keeping the housing pipe vertical within limits. To achieve uniform gravel packing around the pipe assembly inverted cones should be used.

Note3: A provision for a well base to eliminate the possibilities of subsidence of the well structure may be incorporated. If the bottom of the well is in a soft formation, the well should be provided with an artificial base for the casing and screen by over drilling the hole about 1 to 2 m and filling the extra depth with concrete or gravel.

## 23.9 DEVELOPMENT OF TUBE WELL

**23.9.1** The drilled well shall be developed by any of the methods specified in IS 11189: 1985 depending upon the site conditions in order to get maximum sand free yield. The development process shall be continued until the stabilization of sand and gravel pack has taken place.

**23.9.2** The development shall be started as far as possible, from the bottom of the screen because with this the compaction takes place as the work progresses upwards and the overlaying material can move





downwards, without much possibility of bridging and should a bridge develop, the development action would usually break it up.

- 23.9.3** The development of the tubewell by over pumping should be done at 15 percent to 25 percent higher discharge than the expected discharge from the tubewell, The final discharge should be free from sand with a maximum tolerance of 20 parts of sand in one million parts of water by volume after 20 minutes of starting the pump.
- 23.9.4** In case of tubewell for drinking water, the discharge shall be totally sand free. If the discharge is not sand free after 20 minutes of starting the pump, the well shall be redeveloped. In case the discharge is still not sand free even after re-development, the pump set of lesser discharge capacity may be installed to get sand free water suitable for drinking. The turbidity and hardness of water of wells used for drinking purposes, shall be as specified in IS 10500: 1983.

#### **23.9.5 Methods of Development:**

- 23.9.5.1** Numerous methods of development are available. An important factor in any method is that the development work be started slowly and gently and increased in vigor as the well is developed. All but one method of well development require the application of sufficient energy to disturb the natural formation or filter pack so as to free the fines and allow them to be drawn into the well, and to cause the coarser fractions to settle around and stabilize the screen. This is usually accomplished by the, surging of water into and out of the well and the formation. The exception is hydraulic jetting; which depends upon a high velocity water jet discharging through the screen. The jets disturb both-filter and formation and the water, following the path of least resistance, returns to the well above and below the jets, carrying the fines into the well.
- 23.9.5.2** Determination of the adequacy of *development* is largely a matter of experience and judgment but as a general rule if interrupted over pumping or raw hiding is used as a final method of development the degree of development may be estimated from sand samples on each resumption of pumping On initiation of interrupted pumping, samples shall be taken as frequently as possible as soon as discharge starts at each new rate of pruning. Sampling of this type at each rate of discharge will show the time required for maximum sand content to occur and will serve as a guide to subsequent sampling and development.
- 23.9.5.3** Shortly after the period in which maximum sand content Occurs in the discharge for each new rate of pumping, the discharge will become practically sand free until the well is again surged. As raw hiding continues, the maximum amount of sand content will decrease at each discharge time interval until water of low sand content is discharged.

The known methods of well development are listed as follows:

- a) Over pumping,
- b) Compressored air,
- c) High velocity jetting,
- d) Surge block, and
- e) Explosives.

#### **23.9.5.4 Over Pumping**

- 23.9.5.4.1 *Continuous over pumping-*** The simplest and most common method is removing fines from the formation close to the well screen is by over pumping. By this it is meant, pumping the well at higher capacity than it will be pumped when in regular service say not less than 50 percent above the designed discharge.



When the water is pumped out of the well, there is a tendency of the sand to move in the direction of the well end, and with steady pull in this direction, the finer sand grains will wedge against each other and bridge across openings or voids between coarse grains to a very considerable degree. The only way in which this can be prevented is by 'back washing' which is keeping the water as agitated as far as possible. The method consist in starting and stopping the pump intermittently to produce relatively rapid charges in the pressure heads in the well. This shall be done more effectively with the help of turbine pumps.

The pump is operated with the fullest capacity until it has produced maximum draw- down. It is then stopped, the water recedes rapidly out of the column of the pump and the well is permitted to return to its normal static water level. The procedure is repeated many times until the well is sand free.

**Note:-** Care shall be taken not to start the pump when the shaft is rotating in reverse direction, as this is likely to cause damage to the pump shafts.

**23.9.5.4.2 Interrupted over pumping** - The development process shall include development by interrupted pumping. The pumping shall be done with a pump capable of pumping at rates up to two times the design capacity. The pumping should be carried out in at least five steps. These steps shall include pumping with no check valve or foot valve present. Pumping shall be conducted in five minute cycles, and shall continue a minimum of two hours or until such time as acceptable standards are attained.

**23.9.5.5 Compressed Air-** One of the most commonly used method of developing a tube well is by compressed air. It shall be used either by back-washing method or by open well or surging method,

#### **23.9.5.5.1 Back Washing Method:**

In the back washing method a 3-way valve is turned to deliver air down the air-line, with the air cock usually open. This pumps water out of the well through the discharge pipe. When the water becomes clear, the supply of air is cut off and the water in the well is allowed to regain its static level. The air cock is then closed and the 3- way valve is turned, so that the air supply is directed down the bypass to the top of the well. This forces the water down out of the casing and back through the screen, breaking down the 'Bridge' of the sand grains. When the water has lowered to the bottom of the drop-pipe, it will not go further, because the air will escape out through the pipe.

When the air is heard escaping out of the discharge pipe, or when the pressure stops increasing, the supply of air is cut off, and the air cock is opened again to allow the water to reach static level. The 3-way valve is turned and the air supply again directed down the air line to pump the well. This procedure is repeated until the well is thoroughly developed. It is advisable to run a bailer, if practicable. for final cleaning of the well before installing the pump.

The diameter of the drop pipe is usually kept about 5 cm less than that of the well pipe and that of the air line usually varies from 2 to 6 cm.

The hook-up of the equipment for closed well method is shown in Fig. 7.

#### **23.9.5.5.2 Open well method:**

This method of development is a combination of surging and pumping. Large volume of air is released suddenly into the well pipe which produces a strong surging action. Pumping is done as with an ordinary air lift. The success of this method depends on the skillful application of alternating the surging and pumping as per requirements of the well.

The necessary equipments for this method of development consists of:

Air compressor with air receiver of adequate size

Drop-pipe and airline in well with suitable means for raising and lowering each independently of the other.



Normally the well pipe itself is used in place of drop pipe but as the washed material has also to be pumped out along with the water, if required a separate discharge/educator pipe may be used so that velocity of water pumped out may be sufficiently great to carry with it all the clogged material from the well. Use of drop pipe becomes necessary in case of deep wells:

Flexible high pressure hose and pipe line to connect between tank and airline in well

The compressor should be fitted with unloaded and the tank must have a relief valve to safeguard against accidental overloading and

Miscellaneous small fitting, such as pressure gauge and a quick-opening valve at the outlet of the tank.

In order that development by this method may be fully successful, it is necessary to have a ratio of submergence of at least 60 percent. The efficiency of development reduces rapidly with submergence less than 80 percent should the air line be too deeper submerged in proportion to the net height of the lift, an uneconomically high pressure will be required to force the air out.

The discharge of the compressor shall be piped direct to the tank without any valve in the line. The discharge from the tank to the well shall be the full size of the airline in the well, or if long, the next larger size, and shall be fitted with a quick opening valve near the tank. A high-pressure hose is used between the discharge pipe from the tank and the airline in the well. This hose shall be at least 4.5 to 6 m long to allow sufficient space for moving the drop pipe and air line up and down.

Before blowing water or drilling mud out of the well, the air-lift shall be operated slowly for a time to make sure that the screen is sufficiently open so that water will come into the well freely, otherwise damage to the screen may take place.

At the start of development the drop pipe is lowered within 600 mm or so of the bottom of the screen, and the airline is placed, so that it is inside the drop pipe by 300

mm or more. If there is plenty of submergence airline needs to be lowered only for enough to get 60 or 70 percent sub-mergence. The air is turned into the airline and the well is pumped in the manner of a regular air lift, until the water appears to be free from sand. The valve between the tank and the airline is then closed, allowing the tank to be pumped full of air up to required pressure. In the meantime, the airline is lowered so that it is 300 mm or so below the drop pipe. The quick opening valve is then thrown open, allowing the air in the tank to rush into the well. There will be a brief but forceful surge of the water and then a 'head' of water will 'shoot' partly from the drop pipe. If the airline is pulled back into the drop pipes as soon as the first heavy load of air has been shot into the well, it will produce a strong reversal of flow up the drop pipe which will quite *effectively* agitate the water-bearing formation.

The well is then allowed to pump as an air lift for a short time, and then another 'head' is shot. repeating until the absence of further sand, etc, shows that the development is complete at this point. This procedure may be repeated in stages at convenient places in the screens, which will complete the work and clean out loose sand which might have settled at the bottom of the well.

The compressor shall be capable of developing sufficient pressure to overcome initial head of water in the air line. The recommended size of pumping pipe, and the size of the airline with the pumping rate is given below for guidance.

Pumping Rate Litre/min	Size of Pumping Pipe mm	Size of Airline mm
450-700	100	30
700-900	125	40
1125-1800	150	50



1800-3200	200	65
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This method has its own limitations where the yield is very weak and the draw down rapid or where submergence is low.

Hook-up for open well method is shown in Fig. 8.

#### 23.9.5.6 High Velocity Jetting:

Jet development is a recent addition to other common methods of developing wells. In this method water jets projected at high velocity out through well screen openings effectively loosen fine sand, silt and drilling mud from the water bearing formation. The loosen material moves inside the well screen and is removed from the well by pumping or bailing.

The jetting tool consists of an attachment fitted with two or more evenly spaced horizontal nozzles having 6.2, 9.5 or 12.7 mm orifices. The bottom of the tool is closed and the depth of setting, the choice of the nozzle depends largely on the capacity of the high pressure pump. The main item of equipment needed for this method are the jetting tool, high pressure pump, hoses and connections, 5 cm dia pipe line and a source of water. The size of the pipe for feeding water to the nozzles should be large enough to keep friction losses to a reasonable value. It generally ranges from 4.0 to 7.5 cm depending upon the length of the pipe and discharge it has to carry.

The diameter of the jetting tool shall be about 25mm less than the inside diameter of the screen. The normal jet discharge (per nozzle) and velocity is as indicated below:

Nozzle	Pressure 7kgf/cm <sup>2</sup>		Pressure 14kgf/cm <sup>2</sup>		Pressure 17.6kgf/cm <sup>2</sup>	
Orifice	Velocity	Discharge	Velocity	Discharge	Velocity	Discharge
mm	m/sec	lt/min	m/sec	lt/min	m/sec	lt/min
6.20	33.50	17	46	118	55	90
9.50	33.50	172	46	255	55	280
12.70	33.50	305	46	450	55	500

The procedure consists of operating a horizontal water jet inside the well in such a way that the high velocity stream of water shoot out through the screen openings. By slowly rotating the jetting tool and gradually raising and lowering it, the entire surface on the outside of screen gets the vigorous action of the jet. Fine sand, slit and clay are washed out of the water-bearing formation and the turbulence created by the jet rings these fine materials back into the well through screen openings above and below the point of operation. Wherever possible, it is desirable to pump the well lightly at the same time as the high velocity jet is working by using air compressor. The water so pumped can be reused for jet-development after pumping it into a setting tank.

#### 23.9.5.7 Surge Blocks:

23.9.5.7.1 An effective method for developing the well is surging created by the rapid up and down motion of a plunger, operated in the casing pipe provided above the screened portion of the well. The rapid motion of the plunger causes forceful reversal of the movement of water, which prevents the bridging of finer particles. The repeated application of the surging force draws fine particles from the aquifer and thus porosity and permeability of the zone around the screen is increased.

A surge plunger is most used tool for development particularly in wells drilled by cable tool methods and tubewells of natural gravel pack well where strainers have been used.



23.9.5.7.2 Yet there is another method which is called 'Swabbing' in which the swab is lowered into the casing to any selected point and then pulled upwards to produce an inward flow. Swabbing therefore, helps in taking out the fine material drill in consolidated rock aquifers, but are very seldom used in screened wells. Sand pumps may also accomplish effective development of shallow wells with cable tool methods.

23.9.5.7.3 Where the aquifer contains many clay streaks use of plunger block is not recommended because this can cause the clay to plaster over the strainer surface and thus clog the strainer resulting in reduced discharge. Sometimes the strainer give away due to high differential pressure when the strainer is clogged with clay.

After the sand has been drawn in by the surge block the well is cleaned by using a hailer and the process is repeated till the well is totally sand free. Total time involved for developing may range from four hours for a small well to 3-4 days on large well with longer screen.

The size of the plunger shall be kept such that it does not fit in the casing pipe. It shall be able to pass within the pipe and its fittings freely. The plunger may be run on a continuous string of pipe or a part string with a cable adopter at the top. The surging plunger is lowered into the casing about five metres below the water. The movement of the plunger should be restricted in the portion above the screen in the casing pipe. After lowering, it is stroked to produce surging effect. The stroking may come off the beam of a percussion drill or off a cat head or by hand tripping. Some time, hoisting mechanism is used for this. Initially, the surging shall be started slightly and gradually increased till it reaches the maximum limit of the system. Through bailing between the runs of the plunger is very important for efficient development. The surging and bailing out is carried out till little sand is driven into the well. In case of wells with long screens, surge plunger may, however, be operated inside the screen for effective development. A typical surge block has been shown in Fig. 9.

23.9.5.7.4 **Explosives** - These are sometimes employed to develop and enlarge cervices and fissures in tubewells drilled in hard rocks. Charges of 14 to 230 kg are used according to the hardness of the rock and the depth at which the charge is to be detonated.

**23.9.6** Criteria for Proper Development of Tubewells- Development work is an essential operation in the completion of drilling job. It consists of steps to remove the finer material and opening up the passage in the formation so that water can enter the well through the screen more freely. Proper development is said to have been satisfactorily done when

- a) The stabilization of the sand formation has taken place, that is, there is no further sinking of gravel and the discharge is sand free; and
- b) Permeability of the formation is increased by removing finers utilizing proper development method.

**23.9.7** After completion of development by over- pumping, the well shall be tested for its performance that is yield characteristics and efficiency. This shall be achieved by conducting a step draw down test-determine draw downs at the end of the hour by pumping at 3 to 4 different rates of discharge.

## **23.10 DISINFECTION**

**23.10.1** The well shall be disinfected after completion of test for yield. All the exterior parts of the pump 'coming in contact with the water shall be thoroughly cleaned and dusted with powdered chlorine compound. In fact it should be disinfected every time a new pump is installed or the one replaced after repairs.

**23.10.2** A stock solution of chlorine may be prepared by dissolving free chlorinated lime. For obtaining an applied standard concentration of 50 ppm. One litre of the stock solution should be used to treat 300 litres of water.

**23.10.3** In -case of water-wells for drinking water purposes, the quality of water should be as laid down in IS 10500: 1983.

## **23.11 GROUTING AND SEALING**



**23.11.1** Grouting and sealing of tubewell may be done, if required by the owner, depending upon the site conditions and quality of the discharge of the strata encountered. To ensure that the grout will provide a satisfactory seal, it should be applied in one continuous operation. Sealing of the tubewell may be done by grouting the annular space between bore and the housing pipe, thickness of grouting depending upon the quality of water. In case of tubewells for drinking purposes, grouting and sealing shall always be done to ensure safe sanitary conditions.

**23.11.2** It is desirable to plan an oversize bore hole of 7.5 to 15 mm more than the diameter of the well casing to an adequate depth during the design of well itself. The depth to be grouted varies with geologic and site conditions but a depth of 3 to 4.5 m from the surface is generally adequate.

**23.11.3** Surface Apron -An apron around the well and sloping away from it protects the well from pollution caused by contaminated water flowing back into it and prevents muddy pools of standing water forming around the well.

### **23.12 HANDING OVER OF THE TUBEWELL**

**23.12.1** The tubewell should be handed over to the owner in a complete shape. The housing pipe should be closed by a well cap for the period between the completion of the tubewell and the installation of the pump set.

**23.12.2** The following information shall be furnished by the drilling agency on completion of the tubewell:

- a) Total depth of tubewell drilled,
- b) Strata chart of the tubewell indicating different type of soil formations met with at different depths and indicating the depth of each type of soil formation,
- c) Samples of strata collected, neatly packed and correctly marked in sample bays,
- d) Position of every joint in well assembly,
- e) Method used for development,
- f) Total hours of development done,
- g) Developed discharge in LPS,
- h) Discharge is totally sand free or presence of sand particles is there,
- i) P.P.M. and turbidity after development,
- j) Pumping water level at developed discharge, and
- k) Static water level.

**23.12.3** A typical proforma is given in Annex A to furnish the details given in 23.12.2.



## Annexure A

### INFORMATION TO BE FURNISHED BY DRILLING AGENCY TO OWNER ON COMPLETION OF TUBEWELL (As per para 23.12.2)

1. Agency drilling the tubewell.....
2. Location of the tubewell.....
3. Method of drilling adopted.....
4. Date of starting.....
5. Date of completion.....
6. Pilot hole or test hole..... Bit size..... Bit type..... Hours..... from..... to.....
7. Coring done..... Bit size..... bit..... from..... to.....
8. Reaming..... Bit size..... Bit type..... Hours..... from..... to.....
9. Lithological data.  

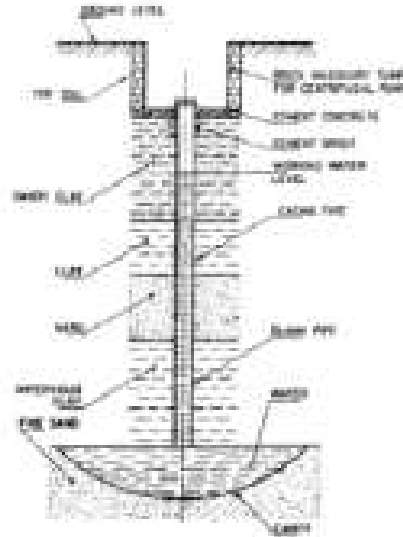
From	To	Formations
.....	.....	.....
.....	.....	.....
10. Total depth of tubewell drilled.....
11. Assembly of production well.....size.....length.....Type.....  
 Perforation per meter.....  
 Housing pipe.....  
 Blind pipe.....  
 Strainer.....  
 Bail plug.....
12. Top of tubewell above / below ground level.....
13. Size of gravel.      Quantity      used      before      development.....Quantity      used      during development.....
14. Method used for development.....  
 Total hours of testing.....
15. Development discharge.....
16. Turbidity.....  
 Further details appended :  
 Samples of strata, neatly packed in sample bags.  
 Chart of pipe assembly lowered, and  
 Results of mechanical analysis of samples of unconsolidated strata.  
 Remarks :  
 Owner    Driller.



## CAVITY WELL & TUBE WELL

**Sub Head : Rain water Harvesting & Tube wells**

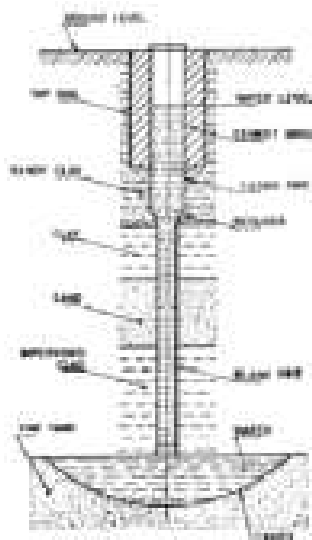
**Clause : 23.2**



### Figure 23.1 : Cavity Well (For Centrifugal Pump)

**Sub Head : Rain water Harvesting & Tube wells**

**Clause : 23.2**



### Figure 23.2 : Cavity Well (For Turbine Submersible Pump)



Sub Head : Rain water Harvesting & Tube wells  
Clause : 23.2

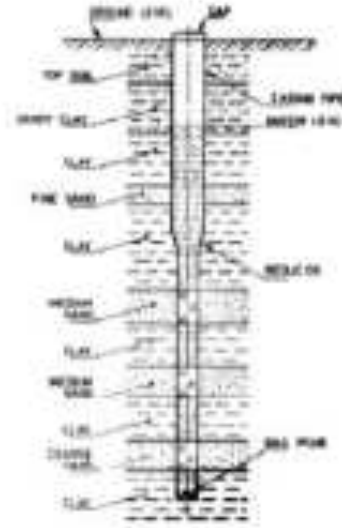


Figure 23.3 : Tubewell (Natural Gravel Pack)

Sub Head : Rain water Harvesting & Tube wells  
Clause : 23.2

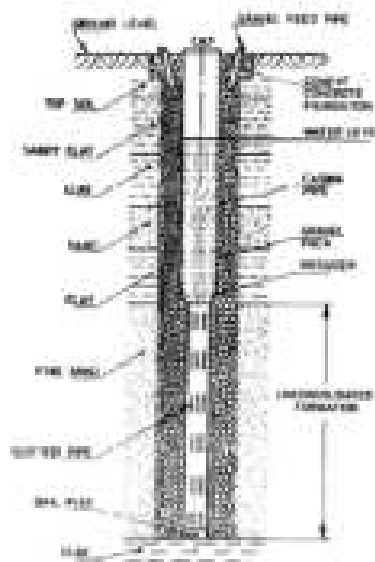


Figure 23.4 : Tubewell (For Artificial Gravel Pack)

## TUBE WELL & BORE WELL

Sub Head : Rain water Harvesting & Tube wells  
Clause : 23.2.2 & 23.2.3

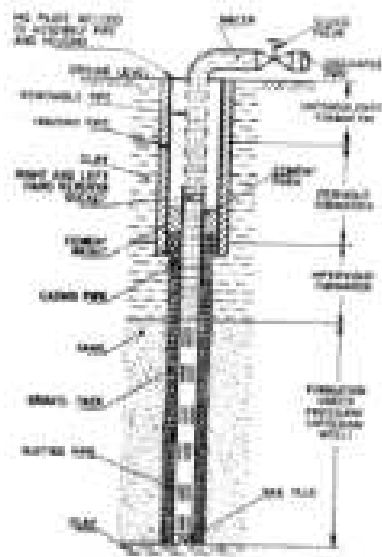


Figure 23.5 : Tubewell (Artesian Flowing)

Sub Head : Rain water Harvesting & Tube wells  
Clause : 23.2.2 & 23.2.3

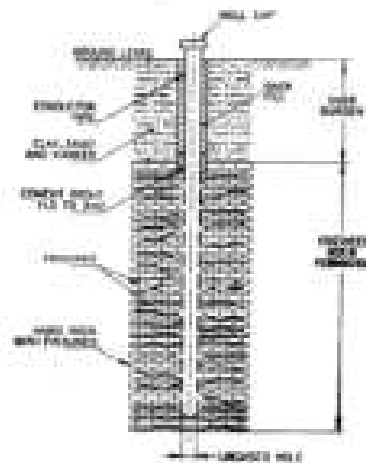


Figure 23.6 : Borewell in Hard Rock

## AUGERS

Sub Head : Rain water Harvesting & Tubewells  
Clause : 23.3.1

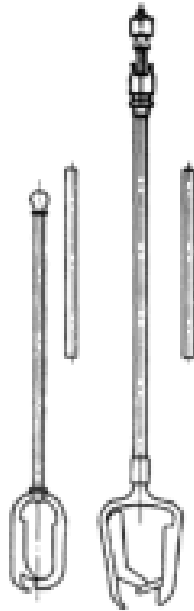


Figure 23.7 : Hand Auger



Figure 23.8 : Spiral Auger or Ram's Horn



# TYPICAL DETAILS OF TAPER REDUCERS, WELL CAP, V-NOTCH PLATE, CENTRALIZING GUIDE, BAIL PLUG AND CLAMP

Sub Head : Rain water Harvesting & Tubewells  
Clause : 23.3.2

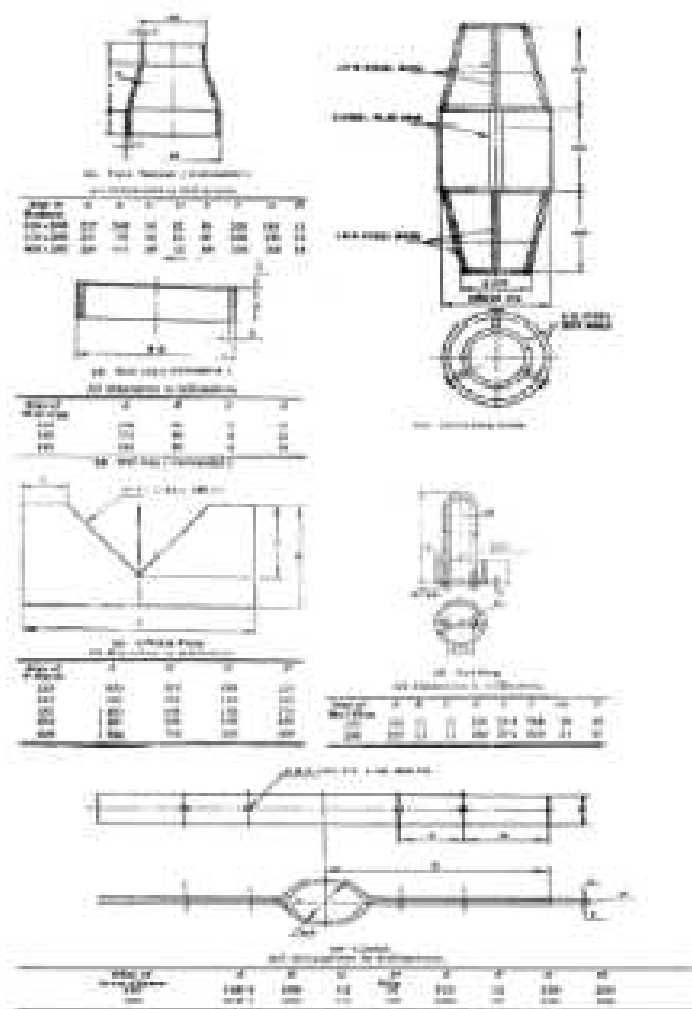


Figure 23.10 : Typical Details of Taper Reducers Well Cap, V Notch Plate, Centralizing Guide, Bail Plug and Clamp

## CLOSED WELL DEVELOPMENT WITH AIR COMPRESSOR

Sub Head : Rain water Harvesting & Tubewells

Clause : 23.9.5.1

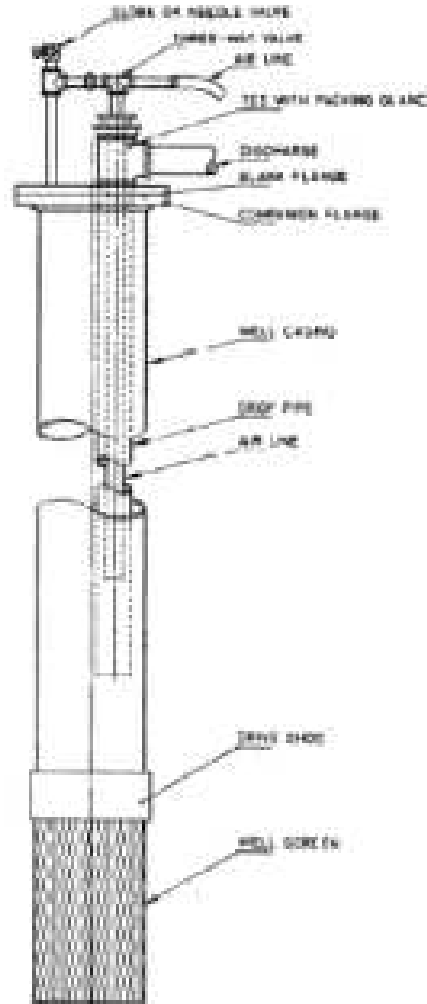


Figure 23.11 : Closed Well Development with Air Compressor

## OPEN WELL DEVELOPMENT WITH AIR COMPRESSOR

Sub Head : Rain water Harvesting & Tubewells

Clause : 23.9.5.2

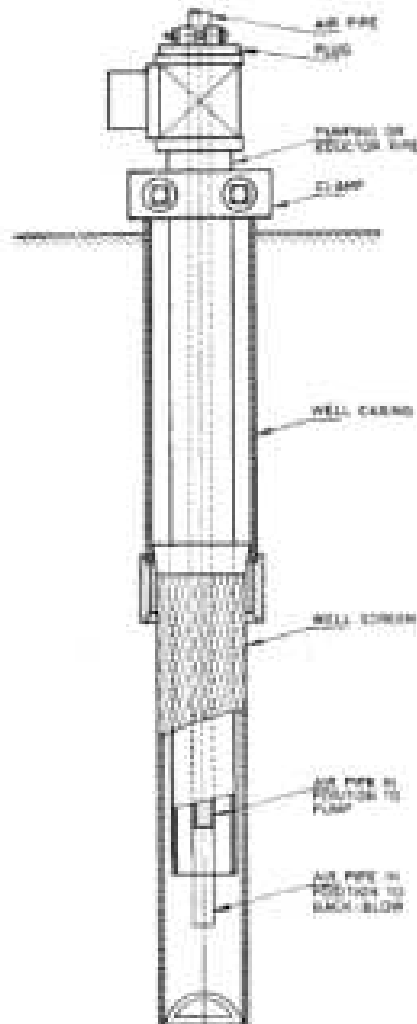


Figure 23.12 : Open Well Development with Air Compressor

## SURGE BLOCK

Sub Head : Rain water Harvesting & Tubewells

Clause : 23.9.5.7

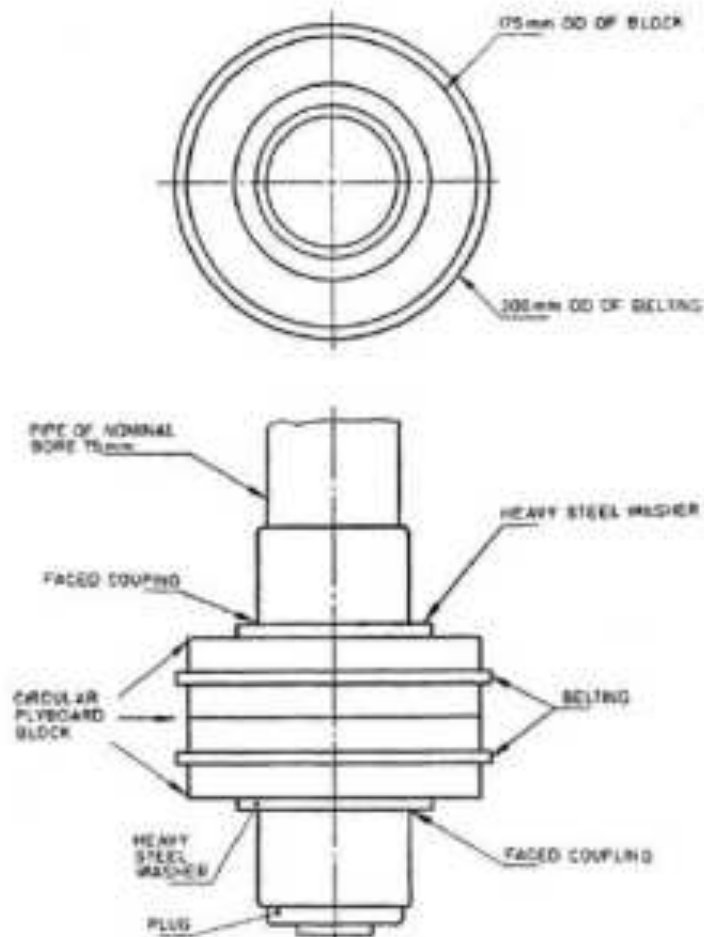


Figure 23.13 : Surge Block





# CONSERVATION OF HERITAGE BUILDING

BOIEDING



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## 24 CONSERVATION OF HERITAGE BUILDINGS

The rich cultural heritage of the country ranging over millenniums is testimony to our glorious history and one of the most ancient civilizations of the world. These historical buildings and monuments located through length and breadth of the country symbolizing the social, religious and cultural developments during different periods of history are made of different building materials having specific structural design. The built cultural heritage located in different parts of the country exposed to different climatic conditions is equally varied in its range and content. There are rock- shelters; rock- cut caves, monasteries made of adobe, brick structures, monuments made in ashler masonry, temple, fort, palatial buildings of Mughal architecture and so on. In addition there are structures buried in the earth, some of which have been exposed.

The ravages of time and various weathering agencies through physical - chemical processes by interaction between the environment and mineral compounds of the substratum have been responsible for the deterioration of built cultural heritage. The synergic human factors combined with changes in the environmental scenario around monuments located in the urban and semi urban areas have added new challenges in the conservation field. In view of diverse nature of problems and their varying magnitude in different cases, the maintenance and conservation of monuments is a challenging job.

### **Ethics of conservation:**

A careful preservation and protection of something is its conservation. The objective of conservation is to prolong the life of cultural inherited property and if possible, to clarify the artistic and historical message therein without the loss of authenticity. The Engineer in Charge related to the conservation should have a flexible pragmatic approach based on cultural consciousness, proper training, sound judgment and a sense of proportion with an understanding of the community needs.

### **Conservation of cultural heritage:**

It involves protection and restoration using “any methods that prove effective in keeping that property in as close to its original condition as possible for as long as possible.

Conservation of cultural heritage applies simple ethical guidelines:

- ✓ Minimal intervention;
- ✓ Appropriate materials and reversible methods;
- ✓ Full documentation of all work undertaken.

### **Aim of Conservation:**

Aim of conservation is not to produce what has been defaced or destroyed but to save what is left from further injury or decay and to preserve it as a national heirloom.

### **Basic Principals of Conservation of Heritage Structures:**

Approach to the conservation works to be carried out is laid down as under:

- i. Hypothetical restorations are unwarranted, unless they are essential for the stability of a building/ structure.
- ii. Every original member of a building/ structure should be preserved intact and dismantling and reconstruction should be undertaken only if a structure cannot be otherwise maintained.
- iii. Restoration of carved stone, carved wood or plaster molding should be undertaken only if artisans are able to attain the excellence of old.



## **24.1 RAKING OF JOINTS**

### **24.1.1 Preparation of Surface:**

The purpose of surface preparation is to remove all kinds of loose material, debris, leaves, paper etc. from the surface where raking of the joints is to be carried out for re-plastering or re-pointing the stone masonry as the case may be.

**24.1.1.1** The surface should be cleaned with brooms to remove of any loose material like dirt and dust. Now, the surface should be cleaned by using high pressure Jet machines having dual benefit of removal of the loose material and softening of the mortar in the stone masonry. Every effort should be made to avoid dust nuisance.

### **24.1.2 Safety:**

Contractor shall be advised to ensure that all workers should wear helmets, safety belts, proper shoes, tight clothes etc. while working at all heights including working on domes etc. Every effort should be made to avoid free falling of the material and necessary protection should be provided along the scaffolding (if any).

Care shall be taken by the agency to avoid any damage to the heritage building. If any structural or aesthetic damage is caused to the building the same shall be made good by the agency at its own cost and nothing extra shall be paid for this.

### **24.1.3 Tools and Plants (T&P)**

Agency will provide all the requisite tools and plants like hammer & chisel for manual raking and Power or Pneumatically driven mechanical mortar raking equipments of approved manufacturers' as per site conditions and as per directions of the Engineer-in-charge.

The agency will take prior permission of the Engineer-in-Charge to use Power or pneumatically driven mechanical mortar rakers depending upon the noise level that can be approved in the area where work is to be carried out. The work should be carried out in most professional manner so that no interference is caused to the working of various offices/residences housed in or in the vicinity of the heritage building.

Mechanical Jet Spray machines of requisite power shall be procured by the Agency and also shall make own arrangement of the water for the purpose.

To ensure efficient and effective functioning, all T&P must be checked on-site at regular intervals and work must not hold up for want of repairs of the T&P.

### **24.1.4 Skilled Site Personnel**

Only skilled workers shall be employed by the contractor. They must possess knowledge of working in heritage buildings and must have required special training and/or practical experience in executing such works. At least the supervisory staff and major workers should have requisite expertise in the field.

### **24.1.5 Scaffolding**

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work.

**24.1.5.1** Double Scaffolding: Where the joints in the masonry of heritage building are to be exposed by raking, manual or mechanical, double scaffolding system (cup & lock type) shall be provided in the interior as well as exterior side of the building wherever it is feasible/ required to provide the scaffolding system. The scaffolding system shall be stiffened with bracings, runners, and connectors etc. to secure it to the building. Size of the members shall be dependent upon the height at which raking of the joints is to be done.



#### **24.1.6 Raking of Joints**

Proper working space/platform shall be provided to the workers by providing scaffolding (if required) so that raking of the joints could be done easily. The surface where raking of joints is to be done, shall be clearly marked with chalk or any other material, so that it can be easily distinguished.

Raking with hand tools like hammer and chisel shall be resorted to in case the location is not easily accessible for mechanical equipments, sufficient power supply is not ensured or the area is too small to be economical for mechanical raking.

Raking of joints should progress from one end to other first raking the one horizontal joint at a time to the requisite depth as decided by the Engineer-in-Charge. Then next horizontal joint is taken up and so on. Once all horizontal joints are raked up vertical joints shall be raked from either ends. The raked joints are then cleaned by brushing and watering.

The debris/rubbish shall be collected in most professional manner and disposed of to the dumping ground up to 50metres lead or as per direction of the Engineer-in-Charge.

The whole process shall be considered complete if approved from the Engineer-in-Charge.

#### **24.1.7 Measurements**

1. Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres up to two places of decimal.
2. For jambs, soffits, sills etc. for opening not exceeding 0.5 sqm each in area, ends of joists, beams, posts, girders, steps etc. not exceeding 0.5 sqm each in area and opening not exceeding 3 sqm each deductions and additions shall be made in the following way, in case of raking on external face only.
  - (a) No deduction shall be made for ends of joists, beams, posts etc. and openings not exceeding 0.5Sqm each, and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings.
  - (b) Deductions for openings exceeding 0.5 sqm but not exceeding 3 sqm each shall be made as follows and no additions shall be made for reveals, jambs, soffits, sills, etc. for these openings.
  - (c) When both the faces of the wall are raked deduction shall be made for one face only.
  - (d) When only one face is raked deduction shall be made from one side of frame for doors, windows, etc. on which the width of the reveal is less than that on the other side, but no deduction shall be made from the other side.
  - (e) Where width of reveals on both faces of wall is equal, deduction of 50% of area of opening on each face shall be made from the raked area.
  - (f) For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each pointed face of wall.
3. In case of openings of area above 3 sqm each, deduction shall be made for the openings, but jambs, soffits and sills shall be measured.

#### **24.1.8 Rates**

The rate shall include the cost of all materials and labour/equipments involved in all the operations described above except Scaffolding which if required and provided shall be paid for separately).

#### **24.2 DOUBLE SCAFFOLDING SYSTEM (CUP LOCK TYPE)**

The specifications shall be same as Clause 14.33 read with Clause 5.2.3.2 of this Specification document.

#### **24.3 CHEMICAL CLEANING OF THE STONE MASONRY**



Clean and well maintained heritage buildings are always admired by all. With the passage of time, staining of heritage buildings are caused by a number of elements such as metals, asphalt, smoke, oil, grease, bird droppings, organic growth etc. due to which they appear neglected. In order to maintain the buildings important and attractive from heritage point of view these need to be cleaned of the stains. It should however be kept in mind that the heritage/historic buildings are there not for our use and enjoyment but also for the future generations. The overriding consideration should always be to limit the cleaning to the bare minimum. Much damage has been done to the building by over cleaning. The gentlest means of cleaning should therefore be adopted.

Cleaning help to preserve masonry by eliminating heavy accumulation of surface dirt which stop evaporation of moisture from within the masonry, thus, from within the masonry. Careful cleaning procedure can remove harmful atmospheric deposits and help to slow the decay. Careful cleaning can make the existing damage more visible therefore, corrective measures can be taken.

#### **24.3.1 Material**

Cleaning the stone masonry can be done by the following three ways: Water cleaning

Chemical Cleaning Abrasive Cleaning

All these methods can be combined to attain optimum results. The selection of materials to be used depends upon the type of masonry.

##### **24.3.1.1 Acidic Cleaners:**

Hydrofluoric acid (HF) is the only acid that does not form dangerous soluble salts during the cleaning process. However, acidic cleaners as suggested by ASI or as approved by Engineer-in- Charge can be used. These are exceptionally dangerous to use and have to be handled with extreme care. Gloves and full body protection must be worn. These should never be used at concentrations exceeding 5 percent. Acidic cleaners are used on Strong sand stones. These should never be used on polished stones like granite, glass and marble.

##### **24.3.1.2 Alkaline Cleaners**

Ammonium Hydroxide (Ammonia in water solution) is an alkaline cleaner which can be used on calcareous material like marble. Many other commercial cleaners are based on Sodium Hydroxide (Caustic Soda) are available in Market can also be used.

##### **24.3.1.3 Abrasive Cleaners**

This involves wet or dry sand or grit blasting, dry brushing and manual abrasion. Excessive pressure and lack of precision and control may result in the destruction of the surface. Hence, wet grit/sand blasting methods should be used with skill and care to get the desired results.

#### **24.3.2 Tools and Plants**

High Pressure Jet Machine with accurate Pressure regulators and gauges is required to produce nebulized water mist through its nozzle, plastic or soft bristle brushes, brooms etc. The water pressure should be controlled by gauges and regulators depending upon the type of stone.

#### **24.3.3 Chemical Cleaning**

The chemical cleaning should first be tested on a small area to establish the amount of cleaning required and feasibility of the system and optimal strength and combination of various components. The test area should be so selected that it represents the requisite soiling or staining. The occupants of the building should be forewarned. Sufficient provision for safe scaffolding, plant, clean water supply, safe storage of the materials and removal of debris be made at site before commencement of the chemical cleaning.



Glass, painted and polished surfaces should be protected by applying peelable plastic compound, polythene sheets or hardboard sealed at the edges.

The washing should start by mixing requisite quantity of Ammonia chemical not more than 5% concentration or Teepol or any other chemical approved by ASI and/or Engineer-in-Charge mixed with fine sand/silica. The pressure of the Machine should be maintained so that misting (which uses little water) is achieved. The spray should be applied at an angle so that it removes the stains easily. Right Angled jets destroy the surface, hence, better to avoid. The jet should be applied till the requisite cleaning is not obtained.

After Chemical cleaning the surface should be rinsed with clean water. Efforts should be made to remove all the chemicals to avoid damage to the masonry. Any splashes on doors, windows, polished etc. shall be made good by the agency at own cost and nothing extra shall be payable on this account.

#### **24.3.4 Measurements**

Length and breadth of the surface of stone masonry cleaned shall be measured correct to a cm and its area shall be calculated in square metres up to two places of decimal. No deduction is to be made for any openings in the range of 0.5 Sqm and nothing extra shall be payable for providing protective films on doors, windows etc.

No deduction shall be made for the jali work as well.

Nothing extra shall be paid for ornamental work of any nature up to a radius of 3.00 Metre.

#### **24.3.5 Rates**

The rate shall include the cost of all materials and labour/equipments involved in all the operations described above (Scaffolding, if required to be provided, shall be paid for separately).

### **24.4 ANTI-FUNGAL WASH OF THE STONE MASONRY**

Bio-deterioration prevailing in stone monuments and historical buildings is a well recognized problem existing in tropical regions or environment like India, where due to environmental factors in the form of high temperature, high relative humidity levels and also to the some extent heavy rainfall causes the bio-deterioration and bio-weathering favour the growth and simultaneously allows living various organism (micro and macro) to remain on stone surfaces because there are no natural or environmental treatment is found so far to protect the stone unless and until the monuments are given chemical treatment for sustainability.

In order to avoid attack by fungus on the heritage buildings anti-fungal wash treatment is done using 3% solution of sodium penta-chloro-phenate of reputed brand and manufacturer on cleaned stone masonry. Sodium penta-chloro-phenate is a chlorine compound having herbicidal, fungicidal and bactericidal applications.

#### **24.4.1 Materials:**

Sodium penta-chloro-phenate is a white or tan, powdered solid. It is soluble in water and may burn, but it is not easily ignited. Sodium penta-chloro-phenate of approved brand and manufacture as approved by the Engineer-in-Charge shall be procured for application as biocide over stone masonry in heritage/historical buildings.

#### **24.4.2 Application**

The Sodium penta-chloro-phenate shall be applied with spray guns avoiding contact with bare skin altogether. The chemical should be diluted such that it should not be have concentration more than 3% in the solvent.





During spraying the spray gun shall be held perpendicular to the surface of the stone masonry and shall be passed over the stone masonry in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application.

#### **24.4.3 Precautions:**

Sodium penta-chloro-phenate may be toxic by ingestion, inhalation and skin absorption. Requisite safety precautions must be taken while applying this chemical. Good quality mask shall be borne by the worker to protect from chemical poisoning.

#### **24.4.4 Measurements**

Length and breadth of the treated area shall be measured correct to a cm and its area shall be calculated in square metres up to two places of decimal. No deduction is to be made for any openings in the range of 0.5 Sqm and nothing extra shall be payable for providing protective films on doors, windows etc.

No deduction shall be made for the jali work as well.

Nothing extra shall be paid for ornamental work of any nature up to a radius of 3.00 Metre.

#### **24.4.5 Rates**

The rate shall include the cost of all materials and labour/equipments involved in all the operations described above. Scaffolding, if required and provided, shall be paid for separately.

### **24.5 RULED / FLUSH POINTING ON RED SAND STONE WORK**

**24.5.0** Pointing shall be as per existing pattern or as decided by the Engineer-in-Charge. A sample patch shall be prepared for pointing and got approved from the Engineer-in-Charge. The further work shall be taken up only after the approval of the sample work by the Engineer in charge. The work executed should match exactly to the sample patch.

#### **24.5.1 Scaffolding**

For all exposed Red Sand stone work independent double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong tied together with horizontal pieces over which scaffolding planks shall be fixed. For all other work in building, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in the header course for the purpose. Only one header for each pole shall be left out. Such holes for scaffolding shall, however, not to be allowed in pillars/columns having width less than one metre, or immediately near the skew backs of arches. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

The scaffolding material will be stacked at designated place decided by the Engineer-in-Charge and shall be removed after execution of the work and nothing extra shall be payable on this account.

The scaffolding shall be got approved from Engineer-in-Charge before start of work.

#### **24.5.2 Preparation of surface**

Joints shall be raked out as per item No. 24.1

#### **24.5.3 Mortar**

Mortar should be weaker than the masonry to accommodate movement in heritage buildings to the extent possible. The mortars used in the old heritage buildings were usually lime based being water resistant and flexible. Mortar mix as specified in DSR item 3.19 shall be used for reference purpose only. It should be lime, Surkhi (50% red and 50% light yellow) and marble dust in proportion of 1:1.5: 0.5. However, efforts shall be made to duplicate original mortar mix and match the existing mortar joint.



#### 24.5.4 Application and Finishing

**24.5.4.1** The surface should be thoroughly cleaned and wet before application of the mortar. It should be ensured that adjoining stones should also be made wet so that the mortar dries slowly. If required, tarpaulin shall be used to make the surface shady during sunny weather. The mortar shall be pressed into the raked-out joints carefully with a pointing trowel, either flush, sunk or raised, according to the type of pointing required. The pointing lines shall be truly horizontal and vertical except where the joints are slanting in the existing heritage structural masonry. Lines of joints from different directions should meet neatly at the junctions instead of crossing beyond.

The mortar shall not be spread over the corner, edges or surface of the masonry. The pointing shall then be finished with the proper tool, in the manner described below:

**24.5.4.2** Flush Pointing: The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of Red Sand stone masonry, so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge.

**24.5.4.3** Ruled Pointing: The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as per existing pattern or as shown in drawings or as instructed by the Engineer-in-Charge, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions or to the existing pattern of the heritage building true with the horizontal lines and shall not project beyond the same.

**24.5.4.4** Cut or Weather Struck Pointing: The mortar as specified above shall first be pressed into the joints. The top of the horizontal joints shall then be neatly pressed back about 3 mm or as directed by the Engineer-in-Charge, with the pointing tool so that the joints are sloping from top to bottom. The vertical joints shall be ruled pointed. The junctions of vertical joints with the horizontal joints shall be at true right angles or to the shape of the existing heritage building structure.

**24.5.4.5** The superfluous mortar shall then be cut off from the edges of the lines and the surface of the Red Sand Stone masonry shall also be cleaned off all mortar. The finish shall be such that the pointing is to the exact size and shape required and the edges are straight, neat and clean.

#### 24.5.5 Curing

The pointing shall be kept wet for seven days. Treated area should preferably be covered/ wrapped with hessian cloth, which is kept wet for the entire curing period. During this period, it shall be suitably protected from direct sun and all damages.

#### 24.5.6 Measurements:

**24.5.6.1** Length and breadth of the area of stone work treated shall be measured correct to a cm and its area shall be calculated in square metres up to two places of decimal.

**24.5.6.2** The various types of pointing for example, struck, keyed, flush, tuck, etc. shall each be measured separately.

**24.5.6.3** For jambs, soffits, sills etc. for opening not exceeding 0.5 sqm each in area, ends of joists, beams, posts, girders, steps etc. not exceeding 0.5 sqm each in area and opening not exceeding 3 sqm each deductions and additions shall be made in the following way, in case of pointing on external face only.

(a) No deduction shall be made for ends of joists, beams, posts etc. and openings not exceeding

(b) 0.5 sqm each, and no addition shall be made for reveals, jambs, soffits, sills, etc. of these openings.



(c) Deductions for openings exceeding 0.5 sqm but not exceeding 3 sqm each shall be made as follows and no additions shall be made for reveals, jambs, soffits, sills, etc. for these openings.

- i. When both the faces of the wall are pointed with the same pointing deduction shall be made for one face only.
- ii. When two faces of wall are pointed with different pointings or if one face is plastered and other is pointed or plastered, deduction shall be made from the plaster or pointing on the side of frames for doors, windows, etc. on which the width of the reveal is less than that on the other side, but no deduction shall be made from the other side.
- iii. Where widths of reveals on both faces of wall are equal, deduction of 50% of area of opening on each face shall be made from area of pointing or plaster as the case may be.
- iv. For opening having door frame equal to or projecting beyond thickness of wall, full deduction for opening shall be made from each pointed face of wall.

**24.5.6.4** In case of openings of area above 3 sqm each, deduction shall be made for the openings, but jambs, soffits and sills shall be measured separately.

#### **24.5.7 Rate**

The rate shall include the cost of all materials and labour/equipments involved in all the operations described above. Raking of joints and Scaffolding if required & provided shall be paid for separately.

### **24.6 RULED / FLUSH POINTING ON WHITE SAND STONE MASONRY**

**24.6.0** Pointing shall be as per existing pattern or as decided by the Engineer-in-Charge.

#### **24.6.1 Scaffolding**

Same as 24.5.1 above.

#### **24.6.2 24.6.2 Preparation of surface**

Joints shall be raked out as per item No. 24.1

#### **24.6.3 24.6.3 Mortar**

Mortar mix as specified in DSR item 3.19 shall be used with slight variation to the contents of Surkhi. It should be lime, Surkhi (15% dark red and 85% light yellow or as approved by the Engineer in Charge) and marble dust in the proportion of 1:1.5:0.5.

#### **24.6.4 Application and Finishing**

Same as 25.5.4 above

#### **24.6.5 Curing**

Same as 25.5.5 above

#### **24.6.6 Measurements:**

Same as 25.5.6 above

#### **24.6.7 Rate**

Same as 25.5.7 above

### **24.7 STONE SURFACE STRENGTHENING BY USING CHEMICALS**

**24.7.0** Deterioration of heritage/historical buildings is caused by weathering conditions like atmospheric pollution, salty water or winds and effect of pollutants from rainwater. This deterioration process can be delayed by



application of chemical solvents over the surface of the stone masonry. The solvent/chemical coating enhances the compressive strength of the stone particularly sand stone. The chemical fill the pores of the stone masonry and creates a protective cover thereby preventing the absorption of the water containing harmful pollutants.

#### **24.7.1 Material**

The most commonly used stone surface strengthening chemical is Ethyl Silicate. Ethyl Silicate has very good compatibility with stone having silicate-based composition like Sand Stones. The chemical shall be of approved brand and manufacture. However, the choice of the chemical depends upon the prevailing climate conditions and type of stone masonry. Therefore, the chemical shall be got approved from ASI and/or Engineer- in- Charge before application.

#### **24.7.2 Tools and Plants**

The chemical is to be applied with simple painting brushes or with spray gun as decided by the Engineer-in-Charge.

#### **24.7.3 Surface Application**

A sample patch of 5 Sqm or of the size decided by the Engineer-in-Charge shall be prepared to know the number of strokes/coats required for achieving “apparent refusal” i.e. no further absorption by the stone masonry. The further work shall be taken up after approval and requisite number of coats as decided in the test patch shall be applied. The decision of the Engineer in charge shall be final and binding in this regard.

The chemical should be applied only on clean and dried stone masonry. In no case the surface should be wet before application of the chemical. As far as possible the chemical should be applied with brushes as it offers good penetration and good efficiency of the chemical application. The chemical can be applied with spray gun for sites where time is limited. Where sufficient time is available brushing offers a good methodology for application of the chemical to desired penetration. Spraying delivers high quantity of the chemical at a time causing a large runoff and lesser penetration.

The chemicals should be uniformly applied with brushes or spray on the existing stone masonry until there is “apparent refusal” i.e. no further absorption by the stone masonry. Over deposition of the chemical at a place shall be avoided altogether. After application of the first coat, second coat shall be applied once the first is dried or at least a gap of 10 minutes is to be made.

The stone masonry surface where the chemical is to be provided shall be protected from direct sun light, rain, snow or heavy winds.

#### **24.7.4 Measurements**

Measurements shall be same as described in para 24.1.6

#### **24.7.5 Rates**

The rate shall include the cost of all materials and labour/equipments involved in all the operations described above. Scaffolding if required & provided shall be paid for separately.

### **24.8 REDUCTION OF MOISTURE ABSORPTION BY STONE MASONRY BY APPLICATION OF SEALERS**

**24.8.0** Mortar and masonry tend to readily absorb water due to their pore and capillary structure. The damage to the heritage structure can be prevented by application of a water repellent sealer which reduces the absorption of the moisture by sand stone masonry or mortar.

#### **24.8.1 Materials:**



Silanes and Siloxanes are the two most common type of water repellents derived from the silicone molecule. Silicone is a generic name for a wide variety of polymeric chains constructed around a molecular backbone of Silicon-oxygen-silicon.

Silanes and Siloxanes are penetrating type sealers which allow the heritage stone masonry to breathe, moisture vapour to escape while repelling water from the outside. Moreover, these do not impart any gloss to the stone masonry and there is little change to the appearance of the heritage structure.

When applied, Silane water repellents penetrate the stone masonry and react chemically with Calcium Hydroxide (CaOH) to form a hydrophobic, water repellent resin within the pores and on the surface. Silanes act only if the pH of the stone masonry is high and also must contain Calcium Hydroxide.

On the contrary Siloxanes react with atmospheric moisture as well as any moisture in the existing masonry to form the hydrophobic resin. Siloxanes are ideal for stone masonry. However, the type of chemical to be used shall be approved by ASI and/or the Engineer in Charge.

**Silanes or Siloxanes:** Silanes and Siloxanes of approved brand and manufacture as approved by ASI and/or by the Engineer-in-Charge shall be used as per manufacturer's specifications.

**Turpentine:** Mineral turpentine i.e. petroleum distillate which has the same rate of evaporation as vegetable turpentine (distillate product of oleoresin of conifers) shall be used. It shall have no grease or other residue when allowed to evaporate. It shall conform to IS 533. Turpentine oil recommended by the manufacturer or as approved by the Engineer-in-Charge shall be used.

#### **24.8.2 Tools and Plants**

Silanes and Siloxanes can be applied with good quality of brush, roller or spray as decided by the Engineer in Charge.

#### **24.8.3 Preparation of surface**

The surface of stone masonry shall be cleaned properly by using any methods decided by the Engineer-in-Charge. The surface shall be cleaned for any dirt, dust etc. by application of broom, vacuum cleaner or any other method. The surface shall be dry before application of the Silanes and Siloxanes.

#### **24.8.4 Mixing of the Chemicals:**

The Silanes and Siloxanes of approved brand and manufacture shall be applied by diluting with mineral Turpentine oil in the ratio of 1:12 i.e. one part of the approved chemical and 12 parts of mineral turpentine oil. The chemicals shall be properly mixed before application in a clean container.

#### **24.8.5 Surface Application**

When the stone masonry is dry the chemicals are sprayed in uniform and even layers to the required number of coats as decided by the Engineer in Charge. Each coat shall be allowed to dry for 3-4 hours before application of the next coat.

Spraying should be done only when dry condition prevails. During spraying the spray gun shall be held perpendicular to the surface to be coated and shall be passed over the stone masonry in a uniform sweeping motion. Different air pressures and fan adjustment shall be tried so as to obtain the best application. The Air pressure shall not be kept too high as otherwise the chemical will fog up and will be wasted.

At the end of the job, the spray gun shall be cleaned thoroughly so as to be free from dirt or chemical. Incorrect adjustments shall be set right, as otherwise they will result in variable spray patterns, runs, sags and uneven coats.

#### **24.8.6 Measurements**



Measurements shall be same as described in para 24.1.6

#### **24.8.7 Rates**

The rate shall include the cost of all materials and labour/equipments involved in all the operations described above. Scaffolding if required and provided shall be paid for separately.



# STRUCTURAL GLAZING ALUMINIUM COMPOSITE PANEL

ALUMINIUM COMPOSITE PANEL





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## 25 STRUCTURAL GLAZING ALUMINIUM COMPOSITE PANEL

### 25.1 MATERIAL (GENERAL)

**25.1.1** Materials and components used shall be of the first / superior quality and suitable for the purpose

**25.1.2** All materials shall be free from any defects that may impair the strength, functioning/ performance or appearance of the curtain wall or adjacent construction.

#### 25.1.3 Fasteners

**25.1.3.1** The type, size, alloy, quantity and spacing of all anchor fasteners and/or anchorage devices shall be as required for the specified performance standards.

**25.1.3.2** Bolts, anchors and other fastening devices like screws, nuts, washers etc. shall be of approved types as required for the strength of the connections, shall be self-locking, unless otherwise specified. These shall be of austenitic stainless steel of specified grade and shall be torque tightened, wherever required, to achieve the maximum torque tension relationship in the fasteners. Washers, nuts and all accessory items shall be of the same material as fasteners. The rivets/ nuts, bolts and washers for fixing insulation layer to the shadow box or with fire-stops (barriers)-cum-smoke seal shall be stainless steel of approved grade.

#### 25.1.3.3 Type of fasteners

- a) Anchor fasteners
- b) Screws, Nuts, Bolts, Washers Rivets, toggles and the like
- c) Grade of stainless steel
- d) Stainless steel grade 316
- e) Stainless steel grade 304
- f) Stainless steel grade 304

**25.1.3.4** The anchor fasteners shall not be provided using PVC sleeves. Only expandable type self locking fasteners shall be provided.

#### 25.1.4 Aluminium extrusions

**25.1.4.1** In general aluminium alloy for extrusions shall be 6063 T5 or T6 grade as per B.S.1474.

However, the grade and tempering specifications shall be as recommended by the supplier for each application.

**25.1.4.2** All extruded aluminium sections shall be anodized in approved colour to a minimum thickness of 20 microns or shall be PVDF coil / spray coated in approved colour and shade with metallic colours to a minimum thickness of 35 microns. The colour and the finish shall be uniform and free of streaks. The aluminium sections, before coating, shall be suitably cleaned, rinsed, buffed properly and sealed and protected after anodizing / PVDF coating, till the completion of the work.

**25.1.4.3** All surfaces of the aluminium sections designed to receive the sealants shall be finished properly to match the finish of the parent section as used for initial testing of sealant and aluminium surface adhesion. Further, it shall be ensured that the entire aluminium surface has adequate sealant contact and adhesion.

Sill sheets, plates and extrusions shall be visually flat under all lighting conditions.

**25.1.4.4** The members of aluminium extruded sections for mullions, transoms, members of sub frames & sash frames shall be in single piece and not be splice jointed in the panel length and height.

#### 25.1.5 Aluminium flashing



**25.1.5.1** All flashings shall be made from 1.0 mm thick solid aluminium sheet transparent anodized to a minimum thickness of 10 microns. It shall be fixed using stainless steel screws dipped in weather silicone sealant.

#### **25.1.6 Aluminium composite panels**

**25.1.6.1** The soffits of the canopies /walkways / entrance canopies etc., required as per the architectural drawings, shall be covered with aluminium composite panel material. The top of the canopies / walkways / entrance canopies shall be covered with zincalume sheets. The aluminium composite panel and zincalume sheets shall be bent to the required profile and fixed as per the approved shop drawings prepared on the basis of architectural drawings.

#### **25.1.7 Brackets**

**25.1.7.1** The brackets shall be fixed with high degree of accuracy to achieve the elevation as per the architectural drawing. The brackets shall have suitable lengths and sections to align curtain glazing in one face, as required as per the architectural drawings. Nothing extra shall be payable on this account. The brackets shall be fabricated from M.S rolled sections / plates to have the design strength.

The quality of the weld shall also be ensured as per the standards. These shall be provided corrosion protection treatment by Hot Dipped Galvanizing. The mass of the zinc coating to be not less than 610 gm. per sqm of steel area to be galvanized. Slots of elliptical or circular shape in the brackets shall be pre-drilled / machine punched and not flame cut and it shall be done before galvanizing. The surface of the brackets shall be serrated for additional grip before galvanizing. Washers made of serrated plates of the corresponding material shall also be provided for additional grip. The directions of the serration and the slot shall be such that they allow movements as per the design requirement and at the same time prevent any movement in the other direction. Each bracket shall be fixed to the R.C.C using anchor fasteners of suitable capacities and in numbers as required as per the design requirements. The brackets shall be fixed to the structural steel members of the building using stainless steel bolts & nuts / fasteners of required capacity and in numbers as per the design requirement.

The holes of the required sizes shall be pre- drilled in RCC/ structural steel for fixing anchor fasteners/ bolts etc. Nothing extra shall be payable on this account.

#### **25.1.8 Fittings**

**25.1.8.1** All hardware and fittings such as patch fittings, handles, locks, stay-arms, floor springs, friction stays etc. for doors, windows and open able panels shall be heavy duty and of approved make as specified.

**25.1.8.2** Hinges for open able panels shall be heavy duty top hung stainless steel friction hinges selected for specified wind load and dead loads.

**25.1.8.3** All fittings and locks shall be as specified.

**25.1.8.4** Each open able panel of the Curtain glazing shall be provided with the fittings as specified in item nomenclature.

### **25.2 SEALANTS & GASKETS**

#### **25.2.1 Selection of sealants**

**25.2.1.1** The compatibility and sequence of installation for all sealants must be carefully considered in all proposals in order to ensure the required curing and performance.

**25.2.1.2** Sealants must not degrade and / or fail under any or all design conditions including wind, thermal and seismic movements, exposure to water and humidity, ultraviolet exposure and / or other adverse environmental conditions.

**25.2.1.3** The designations of sealant types specified herein are intended for general design guidance only.



**25.2.1.4** Final selection for the sealant types shall be based on their conformity with the Performance Requirements specified herein and as per the recommendations of the sealant manufacturer. It may use sealant of equivalent grade and characteristics, manufactured by the manufacturer other than those specified herein, based on recommendations of those sealant manufacturers for specified use but with the prior approval of the Engineer-in-Charge. The contractor shall submit the documentary evidence in this regard.

**25.2.1.5** All precautions shall be taken during design of structural silicone bite and also during fabrication of the curtain glazing system to prevent failure of sealant during the guarantee period of 10 years after the date of completion of work and even beyond, upto the expected service life of the curtain wall.

**25.2.1.6** Sealants and gaskets shall not leach, discolour, stain or dry.

#### **25.2.2 Structural silicone sealant**

**25.2.2.1** The sealant manufacturer shall design the silicone bite for the design loads as specified and likely to come during the life of the curtain glazing system for arriving at bite size of the structural silicone sealant.

**25.2.2.2** The structural silicone sealant bite as designed by the sealant manufacturer and as per the approved shop drawings shall be provided.

**25.2.2.3** The Structural sealant shall be two part pump-filled Silicone sealant DC 983 of Dow Corning or equivalent recommended by manufacturer. The weather silicone sealant shall be one-part Silicone sealant DC 795 of Dow Corning or equivalent of other approved brand as per the list of approved materials.

**25.2.2.4** The structural sealant to be used as specified for all exposed and concealed metal to metal (including tight or butt type metal to metal assembly prior to assembly) or glass to glass shall be 2-part silicone sealant, conforming to the manufacturer's recommendations for the specific uses and performance criteria. The sealant shall be applied using two-part pump for the same. All the sealing shall be done in a clean and controlled environment as specified by the silicone sealant manufacturer.

#### **25.2.3 Weather silicone sealant**

**25.2.3.1** The grade of weather silicone sealants wherever required like for concealed metal to metal, metal to glass and metal to concrete/ masonry such as embedment and lapping of flashings etc. where elements are to be installed or embedded, the weather sealant shall be of grade 795 of Dow Corning or equivalent for the other approved brand, as per the recommendations of the sealant manufacturers. Also, the gap between the aluminum sections and the glass, if so required, shall be filled with weather sealant as specified above including providing and fixing backer rod wherever required as per the approved shop drawings. The weather silicone sealant shall be of approved colour and shade. The weather silicone sealant for fixing the butt jointed glass for the fixed partitions shall be transparent in colour DC 791 of Dow Corning or equivalent of other approved brands.

#### **25.2.4 Compatibility**

**25.2.4.1** All sealants must be non-staining and compatible with adjoining sealants, backup materials, substrate materials and their respective finishes and/or applied colour coatings. Care shall be taken to ensure that two different types of sealant should not come in contact with each other unless compatibility is satisfied as per manufacturer's specifications.

#### **25.2.5 Caulking compound**

**25.2.5.1** Dow Corning weather silicone sealant - 795 or equivalent as approved by the Engineer-in-Charge, ( of approved colour and shade to match adjacent material wherever exposed and visible) for use around frame/ flashings or between frame/ flashing and RCC/ masonry surface.

#### **25.2.6 Gaskets**



**25.2.6.1** Gaskets and seals shall be of approved quality compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets, which are UV resistant. They shall not degenerate, discolour or leach on exposure to solar radiations/ rains/ pollutants etc.

**25.2.6.2** Manufacturers' test Certificate shall be submitted as specified.

### **25.3 GLASS**

#### **25.3.1 General**

**25.3.1.1** All glass and glazing materials shall be as specified.

**25.3.1.2** Vision and spandrel glass shall have characteristics as specified.

The performance characteristics of glass panels, have to be ensured within the constraints of aesthetic requirements like colour, shade, reflectivity etc. And performance requirements like light transmission, U value, shading coefficient, relative heat gain etc. as specified. Minor variations in the characteristics of glass on superior side may be allowed, but without any extra cost to the Department on this account.

#### **25.3.2 Installation**

**25.3.2.1** Install glass panels and carry out glazing work as indicated on the drawings and as specified herein.

**25.3.2.2** All glass panels shall be of accurate sizes as required.

**25.3.2.3** All glass panels shall have clear undamaged edges and surfaces, which are not disfigured.

**25.3.2.4** Any glass panel that does not fit in the curtain glazing system shall be rejected. Therefore, all care and precautions shall be taken while procuring the glass panels from the manufacturer / processors of the glass. No claims of any kind or any hindrance shall be entertained from the contractor on this account.

**25.3.2.5** Glass panels shall not be in direct contact with the aluminum framework.

#### **25.3.3 Identification**

**25.3.3.1** Permanent identification marking on glass shall be accomplished by a technique selected by the manufacturer. The location of the marking shall be proposed by the Manufacturer and approved by the Engineer - in - Charge. All glass shall be delivered to site with the manufacturer's / processor's label of identification attached.

#### **25.3.4 Selection of Glass**

**25.3.4.1** Each type of glass shall be obtained from only one manufacturer and preferably in one lot.

#### **25.3.5 Insulated Glazed Units (IGUs) in the vision panels**

**25.3.5.1** Insulated glazed units shall be obtained only from approved manufacturers/ processors as per the approved list.

**25.3.5.2** Insulated units shall be factory assembled, with multiple panes, hermetically sealed, separated by and sealed to spacer tubes perforated on inner exposed face forming airtight dehydrated airspace inside the insulated units. The IGUs shall be assembled (prepared) by the manufacturer/ processor of the glass as per the approved list, in their dedicated workshops/ factory.

#### **25.3.6 Laminating units**

**25.3.6.1** The glasses shall be laminated with interlayer of Polyvinyl butyral (PVB) sheet of specified thickness

**25.3.6.2** The interlayer material (PVB) shall be clear or as specified with no tendency to bubble, discolour or lose physical and mechanical properties after laminating glasses.



**25.3.6.3** The laminated panels shall be free of foreign substances, air or glass pockets and shall not delaminate at edges.

#### **25.3.7 Precaution in storing and handling glasses**

**25.3.7.1** The glass manufacturer/ processor shall take necessary precautions as stated below besides any other precautions not specifically mentioned herein:

25.3.7.1.1 The reflective/ low E coating on the glass shall be protected against scratches, surface corrosion, staining and/ or any other abrasion.

25.3.7.1.2 The glasses shall not be stored without a clean inter-leaving material. Also they should not slide against each other.

25.3.7.1.3 The glass shall be protected from weld or grinding splatter.

25.3.7.1.4 The reflective/ low E coating shall be protected against contact with acids or strong alkalies. The cleaners to be used for cleaning the surface shall be as per the manufacturer's recommendations. The glass shall be protected against moisture from humidity, which can stain glass as well as coating.

25.3.7.1.5 Reflective/ low E coating shall also be protected against splashes from paints etc.

#### **25.4 METAL COATINGS**

##### **25.4.1 Anodizing / PVDF coating**

**25.4.1.1** Aluminium extruded sections shall be satin finish colour anodized to minimum 20 microns thickness, as per the approved colour and shade or PDF coil / spray coated to approved metallic colour and shade to minimum 35 microns thickness.

##### **25.4.2 Galvanizing**

**25.4.2.1** The brackets for the curtain glazing system shall be hot dipped galvanized. The mass of the zinc coating to be not less than 610 gm. per sqm of steel area to be galvanized.

##### **25.4.3 Samples**

**25.4.3.1** Three samples shall be prepared, which shall define the colour and gloss of anodizing and submit them for approval.

##### **25.4.4 Matching of finish**

**25.4.4.1** Wherever the same colour finish is specified for extruded aluminium sections and composite aluminium sheets. It shall be ensured that the colour of both is matched as closely as possible.

#### **25.5 STANDARDS**

**25.5.1** In general, it shall be followed either of the latest Indian/ International Standards as applicable for this sub head.

#### **25.6 DESIGN**

**25.6.1** Architectural drawings and specifications only indicate the required basic dimensions, and performance criteria.

**25.6.2** It shall be ensured that proper structural analysis and design for various load cases and their combination. This shall include designing and proper sizing of all sections meeting structural and architectural requirements. The anchor assemblies shall meet the performance and design requirements including installation of all inserts, fasteners, clips, bracing and framework as required for the proper anchorage to the structure, unless otherwise specified.

**25.6.3** Design of the curtain glazing system shall comply with all Government codes and regulations.



The Contractor shall design the entire curtain glazing system for dead loads, wind loads, seismic loads, storm, air pollution, thermal stresses, building movements and consequent deflections without compromising the performance characteristic. Further, the individual members of the structural framing shall not deflect beyond permissible limits as specified. The design shall comply with the requirements of the relevant National Building Code and Indian Standard Code/ International Standards, unless specified otherwise.

- 25.6.4** The curtain glazing system and its elements shall not sustain permanent deformation or failure under loading equivalent to 1.5 times the design wind pressure.
- 25.6.5** The specified deflections must be reduced if they are in any way detrimental to curtain glazing system and building.
- 25.6.6** It shall be ensured that the elevations are strictly as per the architectural drawings and that the intent of the architectural design is retained. Visual appearance shall be a key consideration for acceptance of work.

## **25.7 SHOP DRAWINGS**

### **25.7.1 Submittals**

- 25.7.1.1** The contractor shall prepare shop drawings based on approved design and submit the same to the Engineer -in-charge for approval.
- 25.7.1.2** The review of the shop drawings shall be limited to their conformity to the architectural and structural design concept & specifications.
- 25.7.1.3** No fabrication shall be taken up until the shop drawings and all other related submittals, documentation, certification, samples and the mock-up for that work have been reviewed and approved by the Engineer-in-charge.

### **25.7.2 Scope of shop drawings**

- 25.7.2.1** Shop drawings shall incorporate scaled and dimensioned plans, elevations, sections and complete size details for all the works.
- 25.7.2.2** The shop drawings shall indicate the required dimensional profiles and modules, function, design and performance standards and in general cover all dimensions and details required to fabricate and install the curtain glazing system.
- 25.7.2.3** The contractor shall verify and co-ordinate the shop drawings with all applicable and interrelated trades, drawings and specifications.
- 25.7.2.4** All dimensions / modules, etc., shall be field checked and the drawings shall be modified, if required, based on actual measurements at site.
- 25.7.2.5** Details shall show and specify all metal sections, types of finishes, areas to be sealed and sealant materials, gaskets, applicable construction materials including fasteners and welds, all anchorage assemblies and components, fabrication and erection tolerances for the work.
- 25.7.2.6** All details shall be subject to the approval of the Engineer-in-Charge, after incorporating all the modifications suggested by the Engineer-in-Charge.

### **25.7.3 Section profiles**

- 25.7.3.1** Profile adjustments, if required as per the site conditions may be allowed by the Engineer-in-Charge subject to meeting the architectural / performance requirements. However, this shall be carried out only with the written approval of the Engineer-in-charge provided that the general design and intent of the drawings and specifications are also maintained. Also, if any new / non-standard aluminium extruded section is required as per the site requirement and / or the architectural drawings for functional and / or aesthetic reasons, the contractor shall procure the same from the approved manufacturers for the





aluminium sections, even if it entails preparing new die, etc. Nothing extra shall be payable on this account.

## **25.8 DOCUMENTATION AND CERTIFICATION**

### **25.8.1 The manufacturer's certificate for compliance of the various components/ materials for the works (under this sub head) as per the manufacturer's specifications for the various characteristics.**

A copy of the manufacturer's test report for each lot of material procured and supplied for the work shall also be obtained from the respective manufacturers and submitted to the Engineer-in-Charge for the record

#### **25.8.1.1 Glass and glazing documentation**

25.8.1.1.1 Before taking up the work, the glass manufacturer / processor shall submit written certification for the review of the Engineer-in-Charge and record, stating that all glass (properties as specified such as U value, shading coefficient, light transmission, solar factor, relative heat gain etc.) and glazing requirements (including heat strengthening/ toughening, reflective soft coating, low E coating, lamination, fabrication of IGUs including sealants) as per the shop drawings are recommended by them for use related to their specific applications and design parameters and that they are in conformity with the specifications.

25.8.1.1.2 Tests shall be carried out for glass, including properties after processing, for each lot supplied, by the glass manufacturer / processor in his factory /laboratory or any other accredited laboratory and the copies of the test results shall be obtained by the contractor and submitted to the Engineer-in-Charge for the record.

#### **25.8.1.2 Sealant Documentation**

25.8.1.2.1 All sealant applications must be clearly designated on shop drawings.

#### **25.8.1.3 Quality control documentation**

25.8.1.3.1 The methodology and quality assurance statement shall be submitted for quality control procedures for the review and approval of the Engineer-in-Charge before taking up the work to ensure the design integrity and performance of the curtain glazing, aluminium composite panel cladding and aluminium work (PVDF coated).

25.8.1.3.2 The Engineer-in-Charge or his authorized representatives may visit the plant / workshop / factory to inspect material, fabrication and quality assurance procedures.

## **25.9 SAMPLES AND MOCK-UP AT SITE**

### **25.9.1 Submittals**

The samples of the following materials together with detailed technical data / catalogues shall be submitted for review and approval of the Engineer-in-Charge along with the shop drawings.

**25.9.1.1** Aluminium Composite Panel: Each type and thickness 600mmx600mm

**25.9.1.2** Aluminium extrusions: Each section: 500mm long.

**25.9.1.3** Glass: Each type 600 mm × 600 mm.

**25.9.1.4** Gaskets, separators, glass setting blocks / spacer tape, etc: Each section or unit, backer rods, 300mm long or unit.

**25.9.1.5** Bracket, fasteners and Connecting devices: Each type and size.

**25.9.1.6** Finish samples: After approval of the final finish coating, the Engineer-in-Charge shall be provided with three (3) approved samples.





**25.9.1.7** Ironmongery and accessories, as applicable.

**25.9.1.8** Finished flashing samples

**25.9.1.9** Finished samples of shadow boxes, fire stop (barrier)-cum smoke seals

**25.9.1.10** Structural and weather silicone sealant

**25.9.2 Mock-up at site**

Before the fabrication and site installation is taken up and after the approval of shop drawings by the Engineer-in-Charge, a mock-up shall be prepared of his proposed curtain glazing system for a size of panel not exceeding 6 sqm. The mock-up shall be essentially put up at site for final approval of all materials and installation details by the Engineer-in-Charge. The mock up shall not form part of the work and shall not be paid for. It shall be dismantled and taken away by the contractor at his own cost, with the prior permission of the Engineer-in-Charge. Nothing extra shall be payable on this account.

**25.10 STORAGE, PROTECTION AND PROGRAMME**

**25.10.1** A schedule of procedure shall be submitted for inspection during installation so as to control and assure quality on the job site.

**25.10.2** A detailed method statement shall be submitted for the protection of the surface of the curtain glazing, aluminium composite panel cladding and aluminium work (PVDF coated), etc during delivery and erection, with description as to when the protection can be removed. The protection paper shall be kept for a period as recommended by Engineer-in-Charge and shall be replaced with the fresh protection paper, if so required. Further, it shall not have acid content, which in any manner may affect the substrate.

**25.10.3** Delivery and Storage of Materials: All materials delivered to site shall be stored in allocated spaces where the stored materials shall not get exposed to rainwater, moisture or damage, and shall permit easy access to and handling of the materials. Materials shall be stored neatly and properly stacked.

**25.10.3.1** Factory made glazing units and/or their components shall be transported, handled and stored in a manner to preclude damage of any nature.

**25.10.3.2** Necessary materials, required for erection at the site shall be delivered in labeled containers by the manufacturer / supplier.

**25.10.3.3** All units or components, which are cracked, bent, chipped, scratched or otherwise defective and unsuitable for installation shall be removed and replaced by the contractor. Nothing extra shall be payable on this account.

**25.11 PERFORMANCE REQUIREMENTS**

All components, assemblies and completed work shall conform to the various performance standards as applicable in respect of thermal movement of the curtain glazing, allowance for vertical and horizontal expansion and building movement and related building tolerance etc. The design and installation of the curtain glazing system shall accommodate all inherent building movements and deflections and the fabrication and installation tolerances of all related work not involved in this section without the loss of, or any detrimental effect to, the performance requirements herein specified. The contractor shall verify and coordinate all such movements and tolerances with the Engineer-in-Charge before designing the components of the curtain glazing system so that movements and deflections in the structure do not at any time affect the integrity and safety of curtain glazing system and vice versa.

**25.11.1 Thermal property**

**25.11.1.1** All insulation materials, fire-stops (barriers)-cum-smoke seal shall comply with the current requirements of the Fire Officer, MIDC and other authorities.

**25.11.2 Structural properties**



**25.11.2.1** The curtain glazing system shall be anchored to the R.C.C floor through serrated Hot Dipped Galvanized M.S brackets. As far as possible, the contractor shall take all precautions to avoid cutting through any reinforcement bars while fixing the brackets. The cost includes provision of sleeves/ leave slots at appropriate locations during casting of the concrete itself for making provision for fixing brackets for the curtain glazing system and to avoid chipping dismantling of concrete. The slot shall be filled up with concrete of the same grade in a workman like manner, after fixing the brackets. Any defect in alignment/ plumb in the building face shall be rectified by chipping/ dismantling of the concrete/ masonry and repairing the same as specified to achieve the required alignment of the curtain wall as specified. Any change in lengths of bracket/s required on this account and the consequent requirement of their sections and sizes shall be carried out. Nothing extra shall be payable on this account.

**25.11.2.2** No holes shall be burned, filed or drilled in any structural steel/ RCC members unless expressly approved by the Engineer - in - Charge.

**25.11.2.3** Member shapes and/or profiles if schematically shown on the Architectural drawings are not necessarily the exact shapes required or best suited for the particular conditions. Final shapes and locations shall be as designed by the contractor and are subject to the review and approval of the Engineer - in - Charge

**25.11.2.4** All framing members shall be shop fabricated and finished as specified.

### **25.11.3 Concrete tolerances**

**25.11.3.1** While fixing the brackets for curtain glazing system, the contractor shall take into account the variation in the concrete and the masonry faces to which the structural framework of the curtain glazing system is to be fixed and such variations shall be adjusted in the lengths of brackets to align them in perfect plumb. The bracket shall be designed accordingly. Nothing extra shall be payable on this account.

### **25.11.4 Fire stops (barriers)-cum-smoke seal and interface with building**

**25.11.4.1** Gaps between the building face and the curtain glazing system at soffit level between the successive floors shall be closed as specified with fire-stops (barriers)-cum-smoke seal. It shall have the required fire resistance to be approved by Fire Officer. Suitable gap for accommodating deflections of the aluminium framing of curtain glazing system as per the approved shop drawings shall be maintained between the fire-stops (barriers)-cum-smoke seal and the curtain glazing system. This smoke seal shall however be provided using backer rod and weather silicone sealant as specified and as approved by the Engineer-in-Charge.

**25.11.4.2** The fire-stops (barriers)-cum-smoke seal shall consist of 1 mm thick plain G.I. sheet tray with 100 mm thick layer of non inflammable heat insulating material, rock wool, having density of minimum 64 Kg. per Cum. of the make as approved by the Engineer-in-Charge. The rock wool layer shall be attached to GI sheet using stainless steel rivets/ nuts, bolts and washers. The tray shall be fixed to the RCC / Masonry surface by using stainless steel screws dipped in weather silicone sealant as per the approved shop drawings. Screws with plastic sleeves shall not be allowed to be used for the above fixing.

**25.11.4.3** An aluminium flashing of 1.0 mm thick shall be permitted transparent anodized (10 micron thickness) solid aluminium sheet of the approved design and profile at the window sill level and also fill the gap between the aluminum flashing and the curtain glazing using weather silicone sealant as specified and as approved by the Engineer-in-Charge. Also, the fasteners/ screws to be used for fixing flashing shall be dipped in weather silicone sealant before using.

### **25.11.5 Acoustics**

**25.11.5.1** Gaps between the mullions and the partitions of the cabins shall be suitably closed by double skin partition as directed by the Engineer-in-Charge including allowing for permissible deflections of mullions as per design requirements but without affecting the partitions and the curtain glazing system. The payment for this partition work shall be made under relevant item.



**25.11.5.2** Provisions shall also be made to prevent metal to metal rubbing, any rattling, noise due to thermal changes and wind pressure by using Teflon separators and shims.

#### **25.11.6 Visual appearance**

**25.11.6.1** It shall be ensured that the elevations are strictly as per the Architectural drawings and that the intent of the architectural design is retained. Visual appearance shall be a key consideration for acceptance of work

### **25.12 CURTAIN GLAZING AND ALUMINIUM COMPOSITE PANEL CLADDING SYSTEMS**

#### **25.12.1 General**

**25.12.1.1** Movement of building components to which the curtain glazing system is attached including long term and short term movements due to thermal effect, structural effect, wind pressure, seismic forces, erection or dead loads, creep, column shortening, deflection, torsion and vibrations etc shall be free and noiseless. This shall be achieved without any strain or stress being transferred to the glass, without buckling of any components, without excessive stress to any members or assemblies and without compromising on any of the performance requirement of the curtain wall.

#### **25.12.2 Waterproofing**

**25.12.2.1** Following precautions shall be taken by the contractor to ensure that the curtain glazing system is completely water tight during its guarantee period as well as expected service life besides any other precautions not specifically mentioned herein:

25.12.2.1.1A drainage system must be incorporated into the curtain glazing system. The curtain glazing system shall have provision for air pressure equalization (all the internal spaces shall be vented by acceptable means to ensure air pressure equalization) so that water leakage and condensation, if any shall be drained or discharged to exterior face of the curtain glazing.

25.12.2.1.2Care should be taken that the sections of the aluminum extrusions used for structural framing of curtain glazing provide for proper drainage of water that in-filters into the system by gravity and for this the section should have proper slope and weep holes as required. These shall be clearly indicated on the shop drawings.

25.12.2.1.3Movement of water on exposed faces must be controlled to ensure that water is not retained and that elements will not be damaged or corroded by water and to minimize the potential for algae and fungal growth as a result of standing or trapped water.

25.12.2.1.4EPDM gaskets of the quality as specified and of required size and thickness shall be provided at all required locations to prevent ingress of water or moisture. The same shall be indicated on the shop drawings also.

25.12.2.1.5EPDM gaskets of the quality as specified and of required size and thickness shall be provided at all required locations to prevent ingress of water or moisture. The same shall be indicated on the shop drawings also.

25.12.2.1.6Aluminium sheet flashing using 1.0mm thick transparent anodized (10 microns) aluminium sheet wherever required shall be provided including sealing the gap between the flashing and the other material like RCC, masonry, aluminium etc. by using weather silicone sealant as specified.

#### **25.12.3 Mullions and transoms**

**25.12.3.1** The sections of mullions and transoms shall be designed to restrict deflection under dead loads, wind load, seismic loads etc. as specified and shall be rigid and stable enough to support and retain the in-fill panels in position under all conditions. The mullions and transoms shall also be designed for additional horizontal loads from the cleaning equipment and process besides horizontal live loads as specified.



#### **25.12.4 Spandrel units**

**25.12.4.1** Spandrel shall be of glass having same colour matching with vision areas after using a shadow box as specified.

**25.12.4.2** Structural spandrel wall, fins, slab or beam, aluminium frame work, anchor fasteners, brackets, shadow boxes, fire stop(barrier)-cum-smoke seals and other construction shall not be visible through the glass in the spandrel portion of the curtain glazing from the exterior and shall be fully concealed behind the shadow box.

**25.12.4.3** A shadow box shall be provided at a distance of minimum 50 mm behind the spandrel glass panel to ensure that the insulation panel material does not come in contact with the soft coating of the spandrel glass to prevent any damage to the coating on account of any chemical reaction or otherwise. It shall consist of an approved black fibre glass non-woven tissue stuck on surface #1 of 50 mm thick semi-rigid fibre glass wool insulation panel of minimum density of 48 kg per cum., and 1.5 mm thick transparent anodized (10 microns) solid aluminium sheet tray, on surface #2 by using suitable stainless steel rivets/nuts, bolts and washers to hold the insulation panel in position. The periphery shall be properly sealed. Surface #1 shall be adequately protected against damage until spandrel glazing is done. Further, care shall be taken that the aluminium sheet backing of the shadow box does not heave or warp due to thermal stresses and/or its self-weight. Proper gaps at the edges of the tray shall be provided to accommodate movements on account of thermal stresses besides making elliptical slots if required to facilitate movements. The shadow box shall be fixed to the structural framing of the curtain glazing by using stainless steel screws. The fixing arrangement shall be as per the approved shop drawings.

#### **25.12.5 Ventilators, open able windows and doors**

**25.12.5.1** Ventilators, openable windows and doors shall be provided at positions as shown on the architectural drawings. The openable panels when in closed position shall remain watertight under all weather conditions and pass the water tightness tests as specified. Besides, the openable panels shall appear similar to the fixed ones from outside.

**25.12.5.2** All hardware and accessories shall be provided and fixed by the contractor and shall be as specified.

#### **25.12.6 Coping and soffit trimmer**

**25.12.6.1** All coping and soffit panels shall have aluminium structural frame fixed rigidly to the structure.

**25.12.6.2** Effective drainage system shall be provided to drain out the water that may penetrate through the joints, on to the exterior face of the curtain glazing.

**25.12.6.3** Coping and soffits shall be visibly flat in all lighting conditions.

#### **25.13 MEASUREMENTS**

All the aluminium sections including snap beadings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts

The height and width of double glazed/single glazed unit (the area of glass unit outside the snap beading shall only be measured) as fixed in place shall be measured correct to one centimeter and area calculated in sqm. correct to second place of decimal shall be taken for payment.

#### **25.14 RATE**

**25.14.1** Rate shall includes cost of all inputs of labour, materials including wastages, T&P, equipments, other enabling temporary structures and services and all other incidental charges, if any, not specifically mentioned here, but as required for complete design, proof checking, engineering, fabrication, assembling,



delivery, anchorage, installation, protection of curtain glazing, aluminium composite panel cladding and aluminium work (PVDF coated), etc. and making the system water tight (wherever specified), all complete, all in accordance with the true intent and meaning of the specifications and the drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings and / or described in the specifications, provided that the same can be reasonably inferred there from. The curtain glazing, aluminium composite panel cladding and aluminium work (PVDF coated) shall have framing which shall be structurally and mechanically designed to achieve the architectural elevations as well as performance parameters specified herein. Anchorage shall include all supporting brackets & anchor fasteners, as required to rigidly secure the structural framing to the RCC / Masonry / structural steel members of the building.

**25.14.2** The curtain glazing, aluminium composite panel cladding and aluminium work (PVDF coated), etc. work shall include but will not necessarily be limited to the following:

**25.14.2.1** Frames fixed glazed / vision panels, spandrels, hard wares, open able panels, as in the drawings inclusive of all accessories and fittings. Glass wool Insulation panel (shadow box), fire stop barrier) - cum - smoke seals, splice plates, connectors, sleeves, anti-buckling clips etc.

**25.14.2.2** Anodized aluminium work for framing of curtain glazing as well as other aluminium work PDF coated) for trellis, louvers, fins, box sections, capping, strip etc wherever indicated in the schedule of quantities and drawings. Glazes doors.

**25.14.2.3** Structural, weather and other silicone sealants within and all round the perimeter of all the work under this sub head for fabricating IGUs, holding the glass to the aluminium & glass to glass and to provide water tightness to the curtain glazing.

**25.14.2.4** EPDM / silicone gaskets, trims, shims, setting blocks, double sided spacer tape, spacer blocks. weathering strips etc.

**25.14.2.5** All sealing and flashings including sealing at junctions with the building members.

**25.14.2.6** All brackets. anchor fasteners, screws, inserts, nuts, bolts & washers, and attachments required for complete installation and fixing to the RCC, masonry and/or the structural steel members of the building

**25.14.2.7** All accessories, fasteners, screws, nuts and bolts, toggles, rivets etc. and other items implied in the drawings and the specifications though are not specifically indicated.

**25.14.2.8** Isolation of all dissimilar metal surfaces as well as moving surfaces by use of TEFLON (PTFE) separators.

**25.14.2.9** Engineering proposals, design, drawings and Architectural data.

**25.14.2.10** Shop drawings, engineering data and structural calculations (analysis & design) of all systems including aluminium structural framing, fasteners, sealants etc.

**25.14.2.11** Scheduling and monitoring of the work.

**25.14.2.12** Cost of all samples of the individual components, mock-ups at site and field tests.

**25.14.2.13** Coordination with work of other agencies.

**25.14.2.14** Protection during storage and construction until handing over the building for occupation etc.

**25.14.2.15** All final exterior and interior cleaning of the curtain glazing, aluminium composite panel cladding and aluminium work (PDF coated) etc. Before handing over the building for occupation.

**25.14.2.16** Hoisting, staging, scaffolding and temporary enabling structural work/services, cranes and cradles etc.

**25.14.2.17** Specified tests, inclusive of necessary records, reports, logbook etc.

**25.14.2.18** Design and performance guarantee in the enclosed format.



**25.14.2.19** Construction monitoring for regular quality control and technical inspection to ensure the work conforms to the approved shop drawings and details (including any modifications made after field testing) and acceptable standards of quality including monitoring the progress of the work.



## NEW TECHNOLOGIES & MATERIALS

INTERVIEW





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## 26 NEW TECHNOLOGIES & MATERIALS

### 26.1 PHENOL BONDED BAMBOOWOOD FLOORING

#### 26.1.1 MATERIAL

**26.1.1.1 Frame:** The base frame shall be of strong, dry concrete or as specified like plywood or wooden of treated and seasoned and frame shall be leveled and smooth. The Bamboowood flooring tiles shall be fixed with tongue and groove interlocking system, with underlayment of 4mm thick expanded poly ethylene foam sheets having density 40kg/cum, over prepared surface.

#### 26.1.1.2 Flooring Tiles:

The Bamboowood flooring shall be of 14mm thick with tongue and groove inter locking system of micro beveled edges, eco-friendly bamboowood tiles high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Flooring Tiles shall be of size 1800mm length (minimum) and 130mm wide (minimum of 14mm thickness). The Bamboowood planks shall have minimum density of 1000 Kg/m<sup>2</sup> & minimum Hardness 1000 Kgf. The Bamboowood flooring tiles shall have Eco friendly UV coating in approved colour, texture and factory finished, having Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The flooring tiles shall have necessary quarter round planks of size 1900mm x 18mm and door reducer of size 1900mm x 44mm, wherever required.

The Bamboowood flooring tiles characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980 - 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test, scratch resistance as per Hamburger test of  $\geq 20$  N, abrasion resistance as per DIN EN 438-2 of  $> 100$  cycle & ASTM D 4060 of  $> 6000$  cycle & ISO 15184 of  $\geq 1$  H, impact resistance as per DIN EN 438 P2-12 of  $\geq 2$  Newton, Indentation Resistant DIN EN 438 P-14 of  $\geq 1$  Newton, Chemical Resistance DIN 68861 Part 1 of 5, In flammability DIN 4102 Part 14 of B1, Heat Resistance DIN 68861 Part 6 of 6A.

#### 26.1.1.3 Base Material:

Expanded polyethylene foam sheets of 4mm thickness and having density 40kg/m<sup>3</sup>.

#### 26.1.2 Fixing of base work and tiles:

The expanded poly ethylene foam sheets of 4mm thickness and having density 40kg/m<sup>3</sup> of available width and running length as underlayment. Place the foam sheet and seal joints with min. 50 mm width masking tape so that it should not overlap. This foam will take undulation and act as cushion for flooring tiles. Open the boxes of tiles and keep tiles in room for normalizing for 72hrs prior to installation. First check the dimensions with meter tape to calculate the expansion gap to be left for sides. For standard room 12ft x 12ft, the expansion gap shall be 15mm and above to this add 0.5mm for each layer; for width above 25ft gap shall be 30mm. Ends shall have standard 15mm expansion gap all times. Make a right angle along the longer side of area where flooring to be laid by placing marking line and use guide strips as specified above. Then start laying down flooring tiles one after another end to end. Place them against the guide strips along with right angle marking line. Take D-3 category water resistant glue and apply above tongue with a conical shape glue applicator for even layer. And place second line of tiles and push in with first layer from sides and match end to end of this layer. If last tile is longer; then trim the excess and take that to first piece in next layer. Repeat same again and again till complete laying of flooring in whole area. Keep cleaning the excess glue coming up on tile surface with moist cloth. Use Silicon based joint sealant of approved quality for the joints of the tiles. Place door reduce at entrance in last.

#### 26.1.3 Precautions:



- a) Base concrete must be strong, levelled and dried prior to flooring tiles installation work.
- b) Bamboowood flooring tiles are ready to use as factory finished hence should be the last job to be carried out in new or under renovation area.
- c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work. Electrical chasing or drawing lines & cables, etc should be completed prior to start the flooring works.
- d) No unauthorized work shall be carried out after flooring is laid.

#### 26.1.4 Maintenance Guidelines

Bamboowood flooring shall be maintained by hardwood floor cleaners as recommended to ensure that floor stays looking good. It shall be ensured that hardwood floor cleaners are water based, nontoxic cleaners which have been designed for finished hardwood floors. Cleaner shall be used as per manufacturer's instructions.

Types of Drying Methods for the Floors are as follows:

- a) Dry mop: Dirt and grit shall always be removed prior to cleaning Bamboowood floors with an electrostatic dust control mop/ soft mop/ vacuum cleaner. Bristle broom shall be avoided.
- b) Dry spray: The area of floor or the cleaning pad shall be mist with the hardwood floor cleaner.
- c) Wipe: The floor shall be cleaned with a microfiber cloth or mop using a back and forth motion until it is dry. Soiled mop or cloth shall be replaced once it becomes soiled to avoid streaking.

#### Do's and Don'ts: Do's

The floor shall be cleaned regularly. Recommendations for cleaning the floor as a guide shall be as follows:

- a) Low frequented area (residential) - about every 2-4 weeks
- b) Medium frequented area (offices) - about every 1-2 weeks
- c) High frequented area (public places) - about every 1-2 days
- d) Spills shall be removed promptly
- e) Mats at exterior and interior doors shall be placed to trap sand 13 and grit from incoming traffic
- f) Heavy furniture or appliances shall always be picked rather than sliding them across the floor
- g) Any minor scratches or damage shall be repaired using hardwood flooring cleaners

#### Don'ts

Do not steam mop or wet mop floor surface area after installation. Excess water can cause swelling Do not let sand, dirt or grit build up. They act like sandpaper and actually abrade and dull the floor finish

**26.1.5 Measurements:** Length & breadth of the finished flooring shall be measured correct to a centimeter from wall to wall. The area shall be calculated in square meter correct to two decimal places. Expansion joint area shall not be deducted. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

**26.1.6 Rates:** The rate shall include cost of all the materials and labour involved in all the operation described above, including.



## 26.2 PHENOL BONDED BAMBOO WOOD IN WALL SKIRTING

### 26.2.1 MATERIAL

**26.2.1.1 Frame:** The base frame shall be of strong, dry concrete or as specified like plywood or wood treated and seasoned, frame leveled and smooth. The Bamboowood Wall Skirting tiles shall be fixed with SS screws including rawl plug, with underlayment of 4mm thick expanded polyethylene foam sheets having density 40kg/cum, over prepared surface.

#### 26.2.1.2 Wall Skirting Tiles:

The Bamboowood Wall Skirting shall be of 14mm thick with one side quarter rounded of micro bevelled edges, eco-friendly bamboowood high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Wall Skirting Tiles shall be of size 1900mm length (minimum) and 85mm wide (minimum of 14mm thickness). The Bamboowood planks shall have minimum density of 1000 Kg/m<sup>3</sup> & minimum Hardness 1000 Kgf. The Bamboowood Wall Skirting tiles shall have Eco friendly UV coating in approved colour, texture and factory finish, having Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC).

The Bamboowood wall skirting tiles shall be characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980  $\leq 0.50$  W/ -K, termite resistant as per 6months termite mound test and borer resistant as per box test, scratch resistance as per Hamburger test of  $\geq 20$  N, abrasion resistance as per DIN EN 438-2 of  $> 100$  cycle & AST D 4060 of  $> 6000$  cycle & ISO 15184 of  $\geq 1H$ , impact resistance as per DIN EN 438 P2-12 of  $\geq 2$  Newton, Indentation Resistant DIN EN 438 P -14 of  $\geq 1$  Newton, Chemical Resistance DIN 68861 Part 1 of 5, Inflammability DIN 4102 Part 14 of B1, Heat Resistance DIN 68861 Part 6 of 6A.

#### 26.2.1.3 Base Material:

Expanded polyethylene foam sheets of 4mm thickness and having density 40kg/m<sup>3</sup> of available with and running length.

### 26.2.2 Fixing of base work and tiles:

Place the foam sheet and seal joints with masking tape so that it should not overlap. This foam will take undulation and act as cushion for skirting tiles. Open the boxes of tiles and keep tiles in room for normalizing for 72hrs prior to installation. Place the wall skirting 2mm above the bamboowood tiles flooring surface. Use drill machine to make suitable holes in tiles at both ends and accordingly make holes for rawl plug in wall. Place the rawl plug and then foam and over that place wall skirting tiles and held in place by 50mm SS screws at both ends. Repeat same for entire area. Wall Skirting used to cover the small area expansion gaps. For larger area expansion gaps need quarter round as shoe to cover the expansion gap on all sides. Use Silicon based joint sealant of approved quality for the joints of the tiles.

### 26.2.3 Precautions

- Base concrete must be strong, leveled and dried prior to flooring tiles installation work.
- Bamboowood wall skirting tiles are ready to use as factory finished hence should be the last job to be carried out in new or under renovation area.
- All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, flooring, wall cladding etc should be completed prior to start of skirting works.
- No unauthorized work shall be carried out after flooring laid



#### 26.2.4 Measurements:

Length & breadth of the finished Wall Skirting shall be measured correct to a centimeter. The length & breadth shall be calculated in running meter correct to two decimal places. All sides length & breadth where wall skirting is installed shall be measured. No deduction will be made for openings of areas upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

**26.2.5 Rates:** The rate shall include cost of all the materials and labour involved in all the operation described above.

### 26.3 PHENOL BONDED BAMBOOWOOD WALL CLADDING

#### 26.3.1 MATERIAL

**26.3.1.1 Frame:** The frame shall be made of second class teak wood of treated and seasoned of size 20x15mm in centre of each tile and bottom and top of work height, 40x15mm placed at ends of each tile. The frame shall be fixed to wall with 50mm SS screws and raw plug. The Bamboowood wall cladding shall be laid over back layment of 1.00mm thick expanded poly ethylene foam of density 40kg/cum in two layers first layer on wall surface before fixing wooden frame and second layer on frame under cladding.

#### 26.3.1.2 Wall Cladding Tiles:

The Bamboowood Wall Cladding tiles shall be of 10mm thick with profiled edges. Eco friendly bamboowood wall cladding tiles high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Wall Cladding Tiles shall be of size 1800mm length (minimum) and 130mm wide (minimum) of 10mm thickness. The Bamboowood planks shall have minimum density of 1000 Kg/m<sup>3</sup> & minimum Hardness 1000 Kgf. The Bamboowood wall cladding tiles shall have Eco friendly UV coating in approved colour, texture and factory finish, having Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The wall cladding tiles shall have necessary threshold of size 1900mm x 44mm and T mold of size 1900mm x44mm wherever required.

The Bamboowood wall cladding tiles shall be characterized with density, hardness, modulus of rupture, modulus of elasticity and thermal conductivity as per IS: 3346-1980 < 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test, scratch resistance as per Hamburger test of 2 20 N, abrasion resistance as per DIN EN 438-2 of > 100cycle & AST D 4060 of > 6000 cycle & ISO 15184 of > 1H, impact resistance as per DIN EN 438 P2-12 of > 2 Newton, Indentation Resistant DIN EN 438 P -14 of > 1 Newton, Chemical Resistance DIN 68861 Part 1 of 5, In flammability DIN 4102 Part 14 of B1, Heat Resistance DIN 68861 Part 6 of 6A.

#### 26.3.1.3 Base Material:

Expanded poly ethylene foam sheets of 1mm thickness and having density 40kg/m<sup>3</sup> and second class teak wood of treated and seasoned.

#### 26.3.2 Fixing of base work and tiles:

The expanded poly ethylene foam sheets of 1mm thickness and having density 40kg/m<sup>2</sup> of available width and running length as backlayment. Place the foam sheet and seal joints with masking tape so that it should not overlap. The frame shall be made of second class teak wood of treated and seasoned of size 20x15mm in centre of each tile and bottom and top of work height, 40x15mm placed at ends of each tile. The frame shall be fixed to wall with 50mm SS screws and rawl plug. The frame shall be laid over first layer of foam. Open the boxes of tiles and keep tiles in room for normalizing for 72hrs prior to installation. Make a right angle along the length and height of wall by keeping a 10mm gap with all. The Bamboowood



wall cladding shall be laid over backlayment of 1.00mm thick expanded poly ethylene foam of density 40kg/cum on frame under cladding. Use pneumatic installation gun and tools of pressure 7bar and use BR18G nails. Place wall cladding tile and hit in head and toe and in centre to pace it. Keep a gap of minimum 3.00mm between two wall cladding tiles and continue laying as explained above. One can increase gap between tiles as per their requirement as well. Use T-mold to join two tiles at the ends and threshold in top and bottom of wall cladding to give a pleasing looks.

#### **26.3.3 Precautions:**

- a) Base concrete must be strong, leveled and dried prior to flooring tiles installation work.
- b) Bamboowood wall cladding tiles are ready to use as factory finished hence should be the last job to be carried out in new or under renovation area
- c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to start of cladding works.
- d) No unauthorized work shall be carried out after wall cladding installation.

#### **26.3.4 Measurements:**

Height & breadth of the finished Wall cladding shall be measured correct to a centimeter from wall to wall. The area shall be calculated in square meter correct to two decimal places. Expansion area shall not be deducted. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings. For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

**26.3.5 Rates:** The rate shall include cost of all the materials and labour involved in all the operation described above, including Frame work mentioned in para above including material & hardware consumed /utilized.

### **26.4 PHENOL BONDED BAMBOOWOOD PANELLED OR PANELLED AND GLAZED SHUTTERS FOR DOORS WINDOWS, CLERESTOREY WINDOWS**

#### **26.4.1 MATERIAL**

**26.4.1.1** Frame: The door frame (chowkhat) shall be of wooden of treated and seasoned or Bamboowood or as specified material. The opening for Shutter of door shall be levelled and smooth. The Shutter for door shall have profiled interlocking system and be fixed with bamboo pins in position. The Shutter shall fix to door frame with SS hinges and screws.

#### **26.4.1.2** Shutters of doors:

The Bamboowood Shutters of doors shall be of 30mm thick with pre - molded planks having inter locking system of micro bevelled edges, eco-friendly bamboowood of high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Shutters of doors shall be of 30mm thick bamboowood planks. The Bamboowood planks shall have minimum density of 1000 Kg/m<sup>3</sup> & minimum Hardness 1000Kgf. The bamboowood shutters of doors shall have approved coating in approved colour, texture and factory finished. The bamboowood shall have Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC). The shutter of doors shall have necessary profile to fit in panelling as required.

The Bamboowood planks pre - molded into shutters of doors characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980  $\leq 0.50$  W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test.

#### **26.4.1.3** Base Material:

Door frame of wood or metal or Bamboowood or aluminum or others as specified.





#### 26.4.2 Fixing of Shutter of doors:

The pre-molded planks of Bamboowood shutters of doors shall have 10mm wide and 25mm deep grooves to fit in panels. These planks shall be in vertical and horizontal (middle, top and bottom) rails. The panels shall fit in rails and all these planks shall fixed together and held in place by bamboo pins. Doors accessories shall be of adequate metal such as stainless steel butt hinges of size 125x65x1.9mm and minimum 4nos with minimum 4 screws per hand, making &screws per hinge to be used. Another fittings like door handle, lock and bolts etc as specified. Normalize doors prior to installation for 72hrs. First check the dimensions of door frame opening with meter tape and match same with shutter of door at site; accordingly take installation of shutters of door in frame forward.

There should be a movement gap left between shutter and door frame. Trained carpenter can work easily on Bamboowood shutters of doors. The carpenter shall use modern hand tools and machines for better results.

The gap between the frame (chowkhat) and the adjacent face of wall, panelling etc. shall be filled by using black silicon material to completely close the interface.

#### 26.4.3 Precautions:-

- a) Frame of Door shall be fixed properly with concrete and must be strong, levelled and dried prior to shutter door installation work.
- b) Bamboowood shutters of doors are ready to use as factory finished hence precautions should be carried out in new or under renovation area
- c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to installation of doors works.
- d) No unauthorized work shall be carried out after shutter of doors in place at that area.

#### 26.4.4 Measurements:

Length & breadth of the shutters of doors shall be measured correct to a centimeter in fixed position (overlapping not to be measured in case of double leaved shutters) and the area calculated in square meter corrected to two place of decimal. No deduction shall be made to form panel openings or louvers. No extra payments shall be made for shape, joints and labours included in all operation describe above.

**26.4.5 Rates:** The rate shall include cost of all the materials and labour involved in all the operation described above, including Frame work mentioned in para above including material & hardware consumed /utilized.

### 26.5 PHENOL BONDED BAMBOO WOOD PANELING

#### 26.5.1 MATERIAL

**26.5.1.1 Frame:** The shutters of doors shall be of Bamboowood planks. The shutter of door shall have 10mm grooves for panelling to fit in and be leveled and smooth. The panelling for shutters of doors shall have profiled interlocking system and be fixed with shutters of doors.

#### 26.5.1.2 Panelling for shutters of doors:

The Bamboowood panelling for shutters of doors shall be of 10mm thick with pre - molded planks having inter locking system of micro beveled edges, eco-friendly bamboowood, high in density and hardness, made from bamboo grass, a renewable source of raw material.

The panelling for shutters of doors shall be of 10mm thick bamboowood planks. The Bamboowood panel tiles shall have minimum density of 1000 Kg/m<sup>3</sup> & minimum Hardness 1000Kgf. The bamboowood panel tiles for shutters of doors shall have approved coating in approved colour, texture and factory finished. The bamboowood panels shall have Performance Appraisal Certificate (PAC) issued by Building Materials



& Technology Promotion Council (BMTPC). The shutter of doors shall have necessary profile to fit in paneling as required.

The Bamboowood panels pre-molded to fit in shutters of doors characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980  $\leq 0.50$  W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test.

#### **26.5.1.3 Base Material:**

Shutters of door shall be made of Bamboowood to fit in panelling.

#### **26.5.2 Fixing of Panelling for shutter of doors:**

The pre-molded panels of Bamboowood shutters of doors shall have 10mm thickness. The shutters of doors shall have 10mm wide and 25mm deep groove to fit in panelling. The panels shall fit in rails and all these panels shall be fixed together to smooth level and whole shutter of door with panel locked in and held in place by bamboo pins. Normalize doors prior to installation for 72hrs. First check the dimensions of door frame opening with meter tape and match same with shutter of door at site; accordingly take installation of panelled shutters of door to fix in frame of door. There should be a movement gap left between shutter and door frame. Trained carpenter can work easily on Bamboowood panelled shutter doors. The carpenter shall use modern hand tools and machines for better results.

#### **26.5.3 Precautions:**

- a) Frame of Door shall be fixed properly with concrete and must be strong, leveled and dried prior to shutter door installation work.
- b) Bamboowood panelled shutters of doors are ready to use as factory finished hence precautions should be carried out in new or under renovation area
- c) All wet trades such as plastering, conducting, and painting, walling, Ceiling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to installation of doors works
- d) No unauthorized work shall be carried out after panelled shutter of doors in place at that area.

#### **26.5.4 Measurements:**

For paneling of shutters of door, length & width of panels shall be measured correct to a centimetre and the area shall be calculated to the nearest 0.01sqm. The portion of panels insert or glazed panel inside the grooves or rebates shall be measured for payment.

**26.5.5 Rates:** The rate shall include cost of all the materials and labour involved in all the operation described above.

### **26.6 FACTORY MADE DOOR FRAME OF PHENOL BONDED BAMBOOWOOD**

#### **26.6.1 MATERIAL**

**26.6.1.1 Frame:** The door frame (chowkhat) opening shall be of strong, or as specified and leveled and smooth. The Bamboowood frame for doors shall have 10mm gap between concrete and frame. The frame shall have interlocking system of rails and gap filling foam as back lument, over prepared surface.

#### **26.6.1.2 Frame for doors:**

The Bamboowood frame for doors shall be 65mm thick with pre - molded planks having inter locking system of micro beveled edges, eco-friendly bamboowood high in density and hardness, made from bamboo grass, a renewable source of raw material.

The Frames shall be of 65mm thick bamboowood planks. The Bamboowood planks shall have minimum density of 1000 Kg/m<sup>3</sup> & minimum Hardness 1000Kgf. The bamboowood frames shall have approved





coating in approved colour, texture and factory finished. The bamboowood shall have Performance Appraisal Certificate (PAC) issued by Building Materials & Technology Promotion Council (BMTPC).

The Bamboowood planks pre - molded into frame for doors characterized with density, hardness, modulus of rupture, modulus of elasticity, thermal conductivity as per IS: 3346-1980 - 0.50 W/ m-K, termite resistant as per 6months termite mound test and borer resistant as per box test.

#### **26.6.1.3 Base Material:**

Strong, dry concrete or as specified and smooth and leveled.

#### **26.6.2 Fixing of Frames:**

The pre-molded planks of Bamboowood frames shall have interlocking provisions between vertical and horizontal rails. The frame shall be fixed to strong, dry concrete with jamb. The jamb shall fixed on both sides of frame with 2nos of 100mm GI screws per jamb and 3nos of jamb each side first and then insert other end of jamb into concrete hole and locked bamboowood frame in place by concrete.

There shall be a air gap of 10mm all around to bamboowood frame and this gap to be filled with PU foam and covered with architraves.

#### **26.6.3 Precautions:**

- a) Concrete must be strong, leveled and dried prior to installation of bamboowood frame of door.
- b) Bamboowood frame ready to use as factory finished hence precautions should be carried out in new or under renovation area.
- c) Jamb should be fixed to sides of frame at equal interval and jamb hole should be made in advance in concrete prior to installation work.
- d) All wet trades such as plastering, conducting, and painting, walling, Air Conditioning duct work, Electrical chasing or drawing lines & cables, etc should be completed prior to installation of frame works.
- e) No unauthorized work shall be carried out after installation of frame at place.

#### **26.6.4 Measurements:**

Length & breadth of the frame shall be measured correct to a centimeter as per approved drawings and prior to installation work. Rails of verticals and horizontal shall be measured with pre-molded profiles. Inserts of rails shall be measured as thickness of top rail as 65mm. These inserts shall be taken into account of measurements. The volume shall be calculated in cum correct to four decimal places. No deduction shall be made inserts. Installation of frame of doors and fitting of accessories shall be extra payment and be made for labour involved in making such openings.

#### **26.6.5 Rates:**

The rate shall include cost of all the materials and labour involved in all the operation described above:

### **26.7 BAMBOO MAT CORRUGATED SHEET (BMCS)**

#### **26.7.1 MATERIAL**

Material and testing criteria as per IS 15476:2004 ( upto amendment No.-4)

#### **26.7.2 Fixing Procedure:**

1. The roof slope should be minimum 20° OR maximum 45°.
2.
  - a) For 2440mm long BMCS, the purlin spacing should be @ 1145mm centre to centre.
  - b) For 2140mm long BMCS, the purlin spacing should be @ 995mm centre to centre.



- c) For 1830mm long BMCS, the purlin spacing should be @ 840mm centre to centre.
  - d) In the same Horizontal Plan, the purlin level (Elevation) at all points must be same to avoid concave / convex formation of BMCS's surface which will obstruct the proper flow of water on the BMCS, as shown in the figure no. 26.1
  - e) The rafter (1), (2), (3), (4) etc. as shown in figure 26.1, must be perfectly straight otherwise it will give concave / convex surface of BMCS which will obstruct the proper flow of water.
3. Minimum 6" (150mm) end lap to be provided while fitting the BMCS on Purlins. See figure no. 26.2
  4. The Standard width of BMCS is 1050mm. There are 9 nos. of Crown and 8 nos. of Valley in One BMCS of standard width of 1050mm. See figure no.26.3
  5. One Corrugation side lap of 110mm to be provided while fitting the BMCS on Purlins. See figure no. 26.4 below:
  6. BMCS & BMRC to be fitted with Self-Drilling Screws with Stainless Steel EPDM bonded washers complete (See figure no. 26.5) OR 8mm diameter J Hooks / L Hooks, Bolts, nuts, bitumen washer, galvanized washers complete. (See figure no. 26.6). NAIL should never be used for fitting the BMCS & BMRC
  7. For fitting the Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc., the correct size hole in the BMCS & BMRC must be made with Drill Machine only. The holes should never be made by PUNCH, as it will crack the BMCS & BMRC.
  8. The holes for fixing the Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc. to be made on the APEX (Crest) only and NOT in the Valley. See figure no. 26.5 & 26.6.
  9. At least one of the fixing Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc. to pass through the end lap of BMCS / BMRC. If it is not possible, extra Self-Drilling Screws OR J Hooks / L Hooks, Bolts, nuts etc. to be provided. The end lap of BMCS / BMRC to be jointed together. The edges of the BMCS & BMRC should be straight when fixed end to end and the surface to be plain and parallel to the general plan of the roof. See figure no. 26.7 below:
  10. Free overhanging of BMCS to be not more than 300mm.
  11. The BMRC Ridge purlin to be fitted at a distance of 200mm from the Apex of the Truss /Roof. See figure no. 26.7.
  12. Polyurethane (PU) Coating Green colour / any other colour coated side must face the SUN to resist severe Heat & Rain.
  13. Polyurethane (PU) Coating Green colour / any other colour of Exterior quality to be applied after every five years for longer life of the BMCS / BMRC.

### 26.7.3 Precautions:

BMCS/ BMRC cutting should be done with Fine Teeth Carpenter hand saw / electric hand cutting machine and after cutting, the edges to be sealed with any of the following sealants available in the markets:

- a) Exterior Grade quality Varnish
- b) Polyurethane Coating of Exterior Grade quality
- c) Bituminized Rubber sealant.
- d) Silicon Based sealant.

The products should be handled with care and the product should not fall on edges during handling, unloading and loading process.



The BMCS / BMRC procured from must be stored in a covered shed/ location at site with sufficient cross ventilation inside the covered shed/ location. The BMCS / BMRC must also be stacked on elevated wooden pallets which are not touching the ground level

#### **26.7.4 Finish:**

The complete roof shall present a neat and uniform appearance and be leak proof.

#### **26.7.5 Measurements: (for Roofing)**

Length and breadth shall be measured correct to a cm and its area shall be calculated in square metres correct to two place of decimal. The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge etc. shall be included in the measurements of the roof. No deduction in measurements shall be made for the opening upto 0.4 sqm and nothing extra shall be allowed for forming such opening. For any opening exceeding 0.40 sqm in area, deduction in measurements for the full opening shall be made and in such case the labour involved in making these openings shall be paid separately. Cutting across corrugation shall be measured on the flat and not grithed.

#### **26.7.6 Rates:**

The rate shall include cost of all the materials and labour involved in all the operation described except otherwise stated. This includes the cost of roof sheets, L hook, bolts and nuts, bituminous and galvanized iron washers.

#### **26.7.7 Measurements: (for Ridges and hips)**

The measurement for ridges and hips shall be taken for the finished work along the centre line of the ridge and hip lines in length, correct to a cm. the laps in adjacent ridges pieces shall not be measured. The underlay of ridges under expansion joint pieces where the latter are provided shall however be measured.

#### **26.7.8 Rates:**

The rates shall included the cost of all material and labour specified above but does not include

(a) the cost of required hook, bolt nuts and screws and their washers, (b) the cost of supplying and fixing expansion joint pieces, (c) the cost of closing the gaps between plain ridge and the sheet roofing corrugation. Item(a) above will be covered by the rate of BMCS roofing while item (b) & (c) will be paid for separately unless specifically included in the description of item of the BMRC.

### **26.8 PHENOL BONDED BAMBOO MAT BOARD FOR FALSE CEILING**

#### **26.8.1 Material**

Material and testing criteria as per IS:13958-1994 ( upto amendment No.-4)

##### **26.8.1.1 Frame**

The frame work shall consist of GI Tee sections for main runners of size 30×25×0.3 mm thick and for cross runners of size 25×25×0.3 mm thick and parameter wall angle of GI section of size 25×25×0.4 mm thick fixed to the wall with dash hold faster 12.5 mm dia and 50 mm long. The frame work shall be executed in a manner so as to form a grid of 600 mm x 600 mm as specified in the item. The frame work shall be suspended from ceiling by level adjusting hangers made of 4 mm dia. GI rods fixed to slab by means of GI ceiling cleats. The ceiling cleats shall be fixed to the slab by means of mechanical dash fasteners 12.5 mm dia and 50 mm long. MS hangers and ceiling cleats shall be painted with a coat of yellow zinc chromate primer and two coats of synthetic enamel paint.

##### **26.8.1.2 Ceiling Tiles**



Ceiling tiles shall be of 4 mm thick phenol bonded Bamboo mat board bound confirm to IS 13958-1994 of required size.

#### **26.8.2 FIXING OF CEILING TILES**

The ceiling tiles shall be placed over the GI frame.

#### **26.8.3 Measurements**

Length & breadth of the finished ceiling shall be measured correct to a centimetre. The area shall be calculated in square metre correct to two decimal places. No deduction shall be made for making openings for electrical, air conditioning, fire fighting fixtures nor shall extra payment be made either for extra materials or labour involved in making such openings.

#### **26.8.4 Rate**

The rate shall include the cost of all the materials and labour involved in all the operation described above including frame work, scaffolding etc.

### **26.9 BAMBOO MAT BOARD FOR PARTITION TO FRAME**

#### **26.9.1 MATERIAL**

Material and testing criteria as per IS:13958-1994 ( upto amendment No.-4)

##### **26.9.1.1 Frame**

The base frame work to be executed as per items specified and as per direction of Engineer-in-Charge

#### **26.9.2 Fixing Procedure:**

- a)Sawing of Bamboo mat board shall be truly straight and square. The Bamboo mat board shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patchings or plugging of, any kind shall not be permitted except as provided
- b)Bamboo mat board can be screwed or nailed as per the requirement on the existing frame work.
- c)The screws used for fixing the mat board shall be sunk into the wood work and their tops covered with putty.
- d)When the Bamboo mat board is cut, the edges has to be sealed by using any of the following sealants available in the market.
- e)Exterior Grade quality Varnish
- f) Polyurethane Coating of Exterior Grade quality (iii) Bituminized Rubber sealant.
- g)Silicon Based sealant.
- h)Bamboo mat board, if used for outside (exterior) a waterproofing coating to be provided on the board for each longer life against weathering effects.
- i) Cutting should be done with fine teeth carpenter hand saw/ electric hand cutting machine.
- j) The ornament work shall be made if required in true and accurate to the dimensions shown in the working drawings
- k)The fixing shall be done true to line and levels.

#### **26.9.3 Precautions:**

The Bamboo mat board must be stored in a covered shed/ location with sufficient cross ventilation inside the covered shed/ location. The Bamboo mat bard must also be stacked on the elevated wooden pallets



which are not touching the ground level. The product should be handled with care and the product should not fall on edges during handling, unloading and loading process.

#### **26.9.4 Measurements:**

Length and breadth shall be measured correct to a cm. Bamboo mat board used for partition work shall be measured in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.

For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening.

#### **26.9.5 Rates:**

The rate includes the cost of materials and labour required for all the operation described above but excluding the cost of backing or studding.

### **26.10 WALL PANELLING WITH PHENOL BONDED BAMBOO MAT BOARD**

#### **26.10.1 MATERIAL**

Material and testing criteria as per IS:13958-1994 (upto amendment No.-4)

#### **26.10.2 Grounds**

Grounds shall be provided where so specified. These shall consist of first class hard wood plugs or the class of wood used for fabricating the frames, of trapezoidal shape having base of 50 x 50 mm and top 35 x 35 mm with depth of 5.0 cm and embedded in the wall with cement mortar 1:3 (1 cement 3fine sand) and batten of first class hard wood or as specified of size 50 × 25 mm or as specified, fixed over the plugs with 50 mm long wood screws. The plugs shall be spaced at 45 to 60 centimeters centre to centre, depending upon the nature of work. The battens shall be painted with priming coat, of approved wood primer before fixing.

#### **26.10.3 Fixing Procedure:**

- a) Sawing of Bamboo mat board shall be truly straight and square. The Bamboo mat board shall be planed smooth and accurate to the full dimensions, rebates, roundings, and mouldings as shown in the drawings made, before assembly. Patchings or plugging of, any kind shall not be permitted except as provided
- b) Bamboo mat board can be screwed or nailed as per the requirement on the existing frame work.
- c) The screws used for fixing the mat board shall be sunk into the wood work and their tops covered with putty.
- d) When the Bamboo mat board is cut, the edges has to be sealed by using any of the following sealants available in the market.

Exterior Grade quality Varnish

(i) Polyurethane Coating of Exterior Grade quality fin Bituminized Rubber sealant.

(iv) Silicon Based sealant.

e) Bamboo mat board, if used for outside (exterior) a waterproofing coating to be provided on the board for each longer life against weathering effects.

f) Cutting should be done with fine teeth carpenter hand saw/ electric hand cutting machine.



- g) The ornament work shall be made if required in true and accurate to the dimensions shown in the working drawings.
- h) The fixing shall be done true to line and levels.

#### **26.10.4 Precautions:**

The Bamboo mat board must be stored in a covered shed/ location with sufficient cross ventilation inside the covered shed/ location. The Bamboo mat board must also be stacked on the elevated wooden pallets which are not touching the ground level. The product should be handled with care and the product should not fall on edges during handling, unloading and loading process.

#### **26.10.5 Measurements:**

Length and breadth shall be measured correct to a cm. Bamboo mat board used for paneling work shall be measured in square metre nearest to two places of decimal. The moulded work shall be measured in cm running metre i.e. in running metres stating the girth in cm. The sectional periphery (girth) of moulding excluding the portion in contact with wall shall be measured in cm correct to 5 mm and length in metre correct to a cm. No deduction will be made of openings of area upto 0.40 sqm nor shall extra payment be made either for any extra material or labour involved in forming such openings.

For opening exceeding 0.40sqm in area, deduction in measurements shall be made but extra will be payable for any extra material or labour involved in making such opening

Where only plugs are required to be fixed for the ornamental work, the cost for the same shall be deemed to be included in the rate of ornamental work and no separate payment shall be made for plugs.

#### **26.10.6 Rates:**

The rate includes the cost of materials and labour required for all the operation described above but excluding the cost of backing or studding. The testing of bamboowood products and the criteria as listed in Table No.26.1

### **26.11 EXTRUDED POLYSTYRENE RIGID INSULATION BOARD**

#### **26.11.1 MATERIALS**

50mm thick extruded polystyrene rigid insulation board of required size between cavity wall, complying with ISO 4898:2008 & ASTM C 578-08b-type VI, having thermal conductivity of 0.0289 W/ mk as per ASTM C 578 (Measured as per IS 3346), Compressive strength of > 350 KPA listed as per ASTM D 1621, density of 34-36 kg/Cum as per ASTM D 1622, Water absorption < 1% by Volume as per ASTM D 2842, Oxygen Index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN 4102 Part 1 of class B2 and as per ASTM E 84 Class A.

#### **26.11.2 Installation Process**

1. The Cavity Wall Insulation system has to be installed by the Trained and authorized Applicator Only.
2. The insulation board has to be installed from Inside of the wall and should be firmly struck with the help of water based adhesive applied on all the four sides of the Insulation Board.
3. The Struck insulation board should further be fixed with the help of PVC fasteners, which has be fastened on all the four corners in such a way that it should hold adjoining insulation sheets as well

Requirement for extruded polystyrene rigid insulation board (See Fig No.26.8)

Since this product of performance based product, the third Party testing is Mandatory and should be done from any NABL approved laboratory or from any NYLAP approved international laboratory. The requirements of tests as mentioned in table no.26.2



### **26.11.3 Requirement for extruded polystyrene rigid insulation board (See Fig No.26.8)**

Since this product of performance based product, the third Party testing is Mandatory and should be done from any NABL approved laboratory or from any NYLAP approved international laboratory. The requirements of tests as mentioned in table no.26.2

### **26.11.4 Measurements**

Length and breadth of the wall insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work.

### **26.11.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding if any required

## **26.12 UNDER DECK INSULATION SYSTEM**

### **26.12.1 MATERIALS**

50mm thick extruded polystyrene rigid insulation board of required size for Underdeck Insulation System, complying with ISO 4898:2008 & ASTM C 578-08b-type VI, having thermal conductivity of 0.0289 W/mk as per ASTM C 578 (Measured as per IS 3346), Compressive strength of > 350 KPA listed as per ASTM D 1621, density of 34-36 kg/Cum as per ASTM D 1622, Water absorption < 1% by Volume as per ASTM D 2842, Oxygen Index of 24.1 to 28.1 listed as per ASTM D 2863, cell size 0.4mm of dia (max) as per ASTM D 3576. Fire retardant property as per DIN, Part 1 of Class B2 and as per ASTM E 84 Class A.

### **26.12.2 Installation Process**

1. The specified Under Deck Insulation System shall be applied by an Authorized applicator only.
2. The level of the slab should be checked and kept within permissible limit of variation of 3 to 5mm.
3. The Substrate/Roof Underdeck on which the insulation system needs to be installed must be free from all waste products such as petroleum, grease, oil, solvents, vegetable or mineral oil, animal fat etc.
4. The Insulation board must be fixed to the concrete slab from inside with the help of water based adhesive and Fasteners with PVC Capping. This has-to be ensured that the PVC screws are embedded in the concrete with a minimum distance of 50mm from the edges and have a pull out strength of 0.3 kN.

### **26.12.3 Requirement for extruded polystyrene rigid insulation board (Fig.26.9)**

Since this product is a performance based product, the third Party testing is Mandatory and should be done from any NABL approved laboratory or any other accreditation body which operates in accordance with test ISO/IEC 17011 and accredits labs as per ISO/IEC-17025 for testing. The test requirements as listed in table 26.3

### **26.12.4 Measurements**

Length and breadth of the roofing insulation shall be measured correct to a cm and the surface area worked out in square metre of the finished work. No deduction shall be made for openings of areas upto 0.40 square metre. No extra payment will be made for any extra material or labour involved in forming such openings. For openings exceeding 0.40 square metre in area, deduction for the full opening will be made, but no extra will be paid for any extra material or labour involved in forming such openings.

### **26.12.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above including scaffolding if any required.





## **26.13 FACTORY MADE SOLID FOAM UPVC PROFILE FOR KITCHEN CABINET FRAME AND SHUTTER/PARTITION**

### **26.13.1 Material**

uPVC (un-plasticised polyvinyl chloride) is PVC resin blended with acrylic modifier, titanium dioxide and other chemicals. Then it is processed through machine and mould to produce required solid Foam uPVC multi-chambered profiles. The factory made solid Foam uPVC white colour doors and windows shall be comprising of approved solid Foam uPVC make multi-chambered frames, sash and mullion duly reinforced with appropriate thickness of galvanised iron section of required length, an appropriate dimension of solid Foam uPVC glazing beads, EPDM gasket according to frame/sash profile and specified hardware and fittings of approved make having dimensions as per nomenclature of items. There are two type of solid Foam uPVC extruded profile series which are used depending upon the size and design of kitchen cabinet frame. Depth and width of the profile mentioned in the nomenclature of the item is as following.

Depth of a profile (D) Dimension which is measured at right angles to the glazing plane, between the front and back face surfaces of a profile.

(1) Width of a profile (W)-Dimension, measured in the direction of the glazing plane, and perpendicular to the longitudinal axis of the profile.

Tolerance in profile dimension

For solid Foam uPVC frame, sash and mullion extruded profile minus 5% tolerance in dimension. ie in depth and width of profile shall be accepted. Variation in profile dimension in higher side shall be accepted but no extra payment on this account shall be made.

### **26.13.2 Terminology**

- a) Frame - Non movable or fixed portion of the kitchen cabinet frame and shutter/Partition attached to the wall and to which the sash is assembled.
- b) Sash - Movable part in a kitchen cabinet frame and shutter/Partition.
- c) Glazing Bead - Profile which holds the glass or any other partition materials.
- d) Transom (or Mullion) - Profile used within the frame, vertically or horizontally in a frame and/ or sash.

### **26.13.3 Marking**

Solid Foam uPVC profiles shall be legibly and visibly marked in an unobtrusive position not visible when the window is closed at least once every one meter along the length of the profile and it should be visible when the window is open as well as shall contain the following minimum information on the main profile such as frame, sash and mullion/transom.

(i) The name of the trade mark or brand name of the manufacturer

(1) Date of manufacturing and profile code

### **26.13.4 Testing (Criteria for conformity)**

The Solid Foam uPVC extruded hollow profiles use in kitchen cabinet frame and shutter/ Partition shall conform to the specification as per EN 12608 and other standards as mentioned in table 26.4 Minimum percentage of titanium dioxide content in Solid Foam uPVC profiles shall not be less than 7.00 percent and calcium carbonate content shall not be more than 10.00 percent.

The Solid Foam uPVC kitchen cabinet frame and shutter/Partition shall be factory fabricated by the approved manufacturer and installation work shall be carried out by them or their authorised vendor duly approved by the Engineer -in -charge.

### **26.13.5 Configuration**





Indicative size and configuration of kitchen cabinet frame and shutter/Partition to be provided, same shall be specified in the item and figure included in the tender document.

#### **26.13.6 Fabrication**

According to the drawing, the required dimension and length of Solid Foam uPVC frame, sash and mullion profiles shall be mitred cut and reinforced with galvanised iron section of required length and thickness.

All frame and sash profiles of kitchen cabinet frame and shutter/Partition shall be fusion welded at all corners. Mullion and Transom profiles shall also be fusion welded as per window / door design so as to prevent any ingress of water or air in the reinforcement chamber.

Each corner and joints shall be neatly cleaned by removing all excess material. The weld shall be finished by grooving, knifing etc. at exposed welded portion only.

The kitchen cabinet frame and shutter/Partition shall be designed and provided water drainage/ventilation slots in profile of frame, sash, transom or mullion in order to permit the escape of entrapped water, moisture from the system. A minimum of 2 nos slots shall be provided at least at every 500 mm. The drainage shall be so designed as not to puncture the reinforcement chamber and prevent water running through the reinforcement chamber.

The holes and slots shall offset between the inner and outer walls so as to prevent any back flow.

#### **26.13.7 Reinforcement**

The reinforcement material should be non-hygroscopic and should have no adverse effect of the performance of the kitchen cabinet frame and shutter/Partition and it shall conform to any grade of IS 1079 or IS 513.

Mild steel section reinforcement made from Roll forming process and shall be hot dip zinc galvanised in accordance with IS 277 with a minimum coating mass of 120 gm/sqm.

The thickness of reinforcement shall be as such that the Solid Foam uPVC kitchen cabinet frame and shutter/Partition meet the design wind pressure in accordance with IS 875 (Part-3) and design of the reinforcement should be as per Solid Foam uPVC profile manufacturer recommendation and fix to ensure adequate fastener retention.

Galvanised mild steel reinforcement section is to be inserted in Solid Foam uPVC frame, sash and mullion profile of required length with in 6 to 15 mm distance from the face of the weld and then shall be screwed at 150mm from the end at every 400 mm (maximum) pitch to Solid Foam uPVC profile so that it does not move or rattle.

#### **26.13.8 Kitchen cabinet frame and shutter/Partition Hardware and Fittings**

Materials for all hardware except for fixing shall have at least the equivalent corrosion resistance of EN 1670-1988 grade 4 (240 hrs) when subjected to natural salt spray testing in accordance with EN ISO 9227. Testing shall be carried out on complete hardware items and also duly approved by the Engineer - in - charge before use at the site of work.

Hardware like hinges, rollers and locking devices which have been life cycle tested in accordance with EN 199 (Windows and Doors - Resistance to repeated opening and closing - Test method) and have achieved at least 10,000 operating cycles (i.e. opening and closing) without deterioration, failure or excessive wear. These shall be provided as per nomenclature of item of approved make and duly approved by Engineer-in-Charge before fixing at site of work. Hardware / fittings such as handle, roller, touch lock, multipoint locking, 3D hinges, friction hinges etc. shall be directly screwed not pre-drilled or hammered.

#### **26.13.9 For kitchen cabinet frame and shutter/Partition**



Approved quality stainless steel friction hinges (SS 304 grade) with SS screws shall be provided as per nomenclature of item and length of friction hinges should cover more than 60 percent width of the shutter and two number friction hinges required for each shutter one at top and one at bottom.

#### **26.13.10 Tolerance**

The tolerance in dimensions of finished kitchen cabinet frame and shutter/Partition in size shall not be more than + 5mm from the approved drawing dimension.

#### **26.13.11 Installation**

There shall be a maximum gap of 3 to 5mm in between Solid Foam uPVC door / window frame and finished opening and the plastic packers shall be provided to maintain the level. To maintain the exact dimension of door or window, the opening shall be checked for dimension and orthogonally using a prefabricated template. Any defect shall be made good by the agency at his own cost before fixing of door or window.

The Solid Foam uPVC frames are to be fixed in prepared opening in the walls. kitchen cabinet frame and shutter/Partition shall be fixed into the aperture by drilling through the outer frame to the existing structure and shall use 100 x 8mm fasteners of approved make. (iv) The gap between Solid Foam uPVC kitchen cabinet frame and shutter/Partition and adjacent RCC/Brick/Stone cladding work shall be filled with weatherproof Silicon sealant of approved make to maximum 5mm depth and 5mm in width to allow expansion/contraction of Solid Foam uPVC profiles. Silicon sealant of matching colour of Solid Foam uPVC profile shall be applied over backer rod

#### **26.13.12 Precautions taken before installation of Solid Foam uPVC kitchen cabinet frame and shutter/Partition**

Jambs, sills and soffits of the opening shall be finished with plaster / stone / tiles according to agreement where Solid Foam uPVC kitchen cabinet frame and shutter/Partition to be fixed.

Aperture shall be smooth in line and level as well as in plumb.

Flooring (where kitchen cabinet frame and shutter/Partition is to be installed should be complete before installation of door).

Installation of Solid Foam uPVC kitchen cabinet frame and shutter/Partition should be done before the last coat of the paint on the wall where window jambs, sills and soffits to be finished by paint. Atleast one coat of paint should be done before installation begins

The colour of the profile shall be same and uniform on any surfaces or part of the surfaces which may be visible after installation of the kitchen cabinet frame and shutter/Partition fabricated from the profile, when viewed by the normal vision.

The Solid Foam uPVC profiles manufacturer shall provide warranty of 10 years for colour fastness and any manufacturing defects in respect of Solid Foam uPVC profiles as well as water and air tightness in case of casement Solid Foam uPVC kitchen cabinet frame and shutter/Partition unit.

Solid Foam uPVC kitchen cabinet frame and shutter/Partition hardware and fittings manufacturer shall provide warranty of 10 years for any manufacturing defects.

#### **26.13.13 Mode of Measurement**

The length and width of the kitchen cabinet frame and shutter/Partition shall be measured from outer to outer face of the Solid Foam uPVC frame correct to a centimetre. Area shall be calculated in square meter nearest to 0.01 square metres.

#### **26.13.14 Rate**



The rate includes the cost of all labour, material and T&P involved in all the operations described above at all heights of the building. The cost of glass panes, wire mesh and silicon sealant shall be paid separately.

## **26.14 REINFORCED SOIL RETAINING WALLS USING GEOGRIDS**

### **26.14.1 General**

The work shall include the design and construction of reinforced soil structures using geogrids.

Geogrids are defined as a geosynthetic reinforcement material consisting of connected parallel sets of polymeric tensile ribs with apertures of sufficient size to allow strike-through of surrounding soil, aggregate or other particulate matter. The ribs are called longitudinal and transverse respectively, depending on the direction of major stress. The connection points of the longitudinal and transverse ribs are called junctions / nodes. The openings in the geogrids, which are usually, square, rectangular or oval, are called apertures.

The primary function of geogrid is soil reinforcement. In those applications where the direction of major stresses are known, like reinforced walls & embankments, reinforced slopes, etc. unidirectional or uniaxial geogrids are used. In applications where the stresses come from random directions in the plane of the geogrid, bidirectional or biaxial grids are used. In addition, geogrids having three sets of ribs, at 120° to each other, where strength is balanced along the three rib directions, are also available. These are called triaxial geogrids, and may be used if the situation so demands.

In essence geogrids are of three types from the point of view of manufacturing process

Extruded Polyethylene (PE) or Polypropylene (PP) (uniaxial, biaxial or triaxial) (b) - Coated yarn of Polyester (polyethylene terephthalate-PET) or Polyvinyl Alcohol (PVA) coated with PVC or latex or Bitumen or any such similar coating for purpose of environmental protection. The entanglement of the yarn at the nodes is an important parameter which varies from product to product (unidirectional or bidirectional) for providing dimensional stability to the product.

High tenacity PET or PP straps or rods are overlapped longitudinally and transversely and the junctions are ultrasonically or laser bonded to form stable geogrids (unidirectional or bidirectional).

This specification does not cover the soil reinforcement works executed with metallic reinforcement, or with geotextiles as reinforcement or natural fibre (coir or jute or bamboo) reinforcement materials or with Geoweb / geocells.

It also does not cover 'Hybrid' systems, where multiple / more than one type of reinforcement product / system is used within the same structure.

- a) Geogrids are used in the following applications
- b) Sub-base / Foundation reinforcement
- c) Erosion control
- d) Reinforced Soil Walls and Slopes

Sub-base / Foundation reinforcement:

Geogrids for use as reinforcement of sub-base of pavements or foundations shall be biaxial grids and shall meet the requirements listed in Table 26.5

Note:

MD - Machine direction during manufacture

X-MD - Cross Machine direction during manufacture

All numerical values in the above Table represent MARV in the specified direction.



Minimum Average Roll Value (MARV):

At least 6 sample rolls are taken from each lot of supply. "Lot" is defined by each quantum of continuous supply or each quantum of continuous manufacture, whichever is less OR as agreed between Engineer-in-Charge and contractor. From each of the rolls of material, at least 8 specimen are taken and tested for the required property. The arithmetic average over all specimen are calculated for each roll (average roll value). The minimum of the averages denotes MARV.

Statistically, MARV is 2 standard deviations less than the mean of average roll values. If the lot comprises more than 216 rolls, the number of samples should be  $\sqrt[3]{\text{No. of rolls}}$ .

Erosion control:

Detailed specifications for erosion control systems with geogrids shall be worked out as per manufacturer's specifications for the system adopted.

Reinforced Soil Walls and Slopes

Structures with faces steeper than  $70^\circ$  are considered as reinforced soil walls (RSW) (or mechanically stabilized earth walls) and structures with face inclinations  $< 70^\circ$  are considered to be reinforced soil slopes (RSS). Some kind of fascia system will be required for walls and slopes steeper than  $45^\circ$ .

All reinforced soil walls or slopes shall be executed based on approved designs and drawings by the technical sanction authority. In case of EPC contracts, all generic specifications for reinforced soil walls or slopes, to the extent deemed fit by NIT approving authority, shall be made part of the tender document.

All reinforced soil walls and slopes having fascia elements require connections between reinforcing elements and fascia. The design of fascia including architectural / aesthetic considerations shall be made part of the tender documents. Similarly, different manufacturers / vendors / solution providers propose different forms of soil reinforcement to fascia connectors. The strength, elongation at load and durability of the connection shall be ascertained and generic requirements made part of the tender document. The performance guarantee of the system as a whole shall inter alia include the performance of fascia and connectors.

In case of geonet or geocomposite drainage system provided in reinforced soil retaining walls or slopes, the specifications for the same shall be provided separately as per the drainage requirement and system adopted, based on manufacturer's specifications. Guidance may be taken from ASTM D 1390 "Testing and Performance of Geosynthetics in Subsurface Drainage". The different patterns of Geogrids as shown in Fig 26.10, 26.11 and 26.12.

Reference may be made to IRC: SP: 102-2014 "Guidelines for Design and Construction of Reinforced Soil Walls" for guidance on design principles, construction issues, quality control and common causes of failure of reinforced soil walls.

## **26.14.2 Physical and Mechanical Properties of Geogrids**

### **26.14.2.1 General Requirements**

The physical dimensional properties of the reinforcing elements like type of structure, rib/strap dimensions, junction type, spacing between rib/strap, thickness of reinforcement elements, which vary from product to product, can be readily measured for compliance with manufacturer's specifications / data sheet. Some physical properties like mass per unit area, roll width and length, weight of roll, etc. impact the logistical issues like truckability, wastage, etc.

The manufacturers of geogrids shall have ISO - 9001 certification for manufacturing process and quality control.

The product proposed to be used in the work shall have certification for use as soil reinforcing material from an agency accredited for certifying geosynthetic reinforcement product. The polymers used in the



manufacture of soil reinforcing geogrids shall be virgin material. The manufacturer shall provide third party test reports from NABL (or Geosynthetic Accreditation Institute - Laboratory Accreditation Program [GAILAP]) accredited laboratories in India for quantity of geogrids beyond a limit to be specified in the Notice Inviting Tender. The said limit will depend on quantum of work, its location, urgency, availability of accredited laboratories, etc. For all quantities less than that, manufacturer's test certificate shall suffice. Test reports from ITs shall also be acceptable. In case of one laboratory not having the entire gamut of facilities, different tests may be got done from separate tests facilities.

#### 26.14.2.2 Physical Properties

Density of the PE, PP, PET or PVA material of extruded geogrids or bonded strap geogrids can be measured using ASTM D 792 or ASTM D 1505. Coated PET yarn geogrids shall have molecular weight (AST D 4603) not less than 25000 gm/mol (minimum) and Carboxyl End Group Content (ASTM D 7409) which should not exceed 30 mmol/kg (maximum).

#### 26.14.2.3 Engineering Properties of Geogrid

The following engineering properties are required to be provided for all types of geogrids intended to be used in the work:

Wide width tensile strength (ASTM D 6637 or ISO 10319) : This is the Short term strength or characteristic strength (I CHARAR) or ultimate tensile strength (Turr). It is taken as the MARV strength i.e. mean strength less two standard deviations. Test for the ultimate tensile strength shall be carried out for each grade of reinforcement. The test results shall be accompanied by stress - strain curves showing strength at 2% and 5% strain and strain elongation at failure.

Endurance properties denoted by the various reduction factors: The manufacturer shall provide third party test reports from above mentioned laboratories / IITs for all the tests needed to establish all the reduction factors listed below

RFoR - Reduction factor for creep

RF. - Reduction factor for installation damage

RFw - Reduction factor for weathering

RFoH - Reduction factor for chemical / environmental effects co6"- Factor for the extrapolation of data. It caters to the statistical variation in the reduction factors but does not consider the uncertainties of soil structure and calculation of loads.

All the above factors shall be determined in accordance with the provisions of ISO/TR

20432 - "Guide to the determination of long term strength of geosynthetics for soil reinforcement"

The Long Term design strength (LTDS) is determined as :

$T_o = T_{CHAR} / R$ ; where  $R = R_{Fc}$

$CR \times R_{FI} \times R_{Fw} \times R_{Fc}$

Junction efficiency is defined as a percentage of junction strength determined in accordance with ASTM D 7737 and single rib failure strength as per ASTM D 6637. It varies between 90 to 100% for extruded biaxial grids, 10 to 25% for woven or knit grids and 40 to 70% for bonded strap grids.

For extruded biaxial or triaxial geogrids, the junction efficiency shall be 95%  $\pm$  2% 26.14.2.4 Project Specific Tests

Annual average Daily Temperatures (AADT / design temperature of the project site shall be worked out and values of reduction factor for creep RF procedures given in ISO / TR -20432.

CR and for RE cH shall be provided as per



Also Tests shall be carried out to provide the following parameters for all grades of geogrids used in the project :

- (a) Pull-out coefficient as per ASTM D 6706 "Standard Test Method for measuring Geosynthetic pullout Resistance in Soil" and;
- (b) Coefficient of interaction between reinforced fill soil and geogrids as per ASTM D 5321 - " Standard Test Method for Determining the coefficient of soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method" or as per IS :13326

Part 1 - 1992 " Method of test for the evaluation of interface friction between Geosynthetic and soil: Part 1 Modified direct shear technique".

One set of project specific tests shall be conducted at field or third party accredited laboratory or at any reputed institute like IITs, which may be mentioned in the tender

### 26.14.3 Engineering Properties of Earth Fill

The fill material in the reinforced soil zone shall have drained or effective angle of friction not less than  $30^\circ$ , measured in accordance with IS :2720 (Part 13), by conducting a drained direct shear test.

In case the fill material has 25 percent or more particles of 4.75 mm or larger, drained shear test using large shear box may be conducted (IS :2720 : Part 39 : Section 1).

The Plasticity Index of the fill material shall be  $<6$ .

The gradation of fill soil shall be as per limits specified in Table 26.6

Materials with more than 15 percent passing 75 micron sieve, but less than 10 percent of particles smaller than 15 microns are acceptable provided Plasticity Index (PI) is less than 6 and angle of internal friction (Q) is not less than  $30^\circ$ .

Where Geosynthetic reinforcement material used is polyester yarn, the pH value of the fill material shall be between 3 and 9. For Geosynthetic reinforcement material manufactured from PVA, PP and HDPE, the pH value of the fill material shall be greater than 3. The pH value of the soil fill shall be determined as per IS : 2720 (Part 26) - 1987 (Reaffirmed 2016)

Fly ash may be used as fill materials in reinforced soil walls provided its angle of internal friction

(Q) is not less than  $30^\circ$  and PI is less than 6. Reference may be made to IRC Guide lines on Use of Fly ash in Road Embankments (IRC:SP-58).

Fly ash shall also satisfy requirements concerning pH values as above.

The fill materials used in the reinforced soil zone shall be free from organic or other deleterious materials and shall not react adversely (chemically, electrically or biologically) with the reinforcement material and / or facing material.

Properties of fill soil in the reinforced zone, unreinforced zone (or retained / back fill) soil and the foundation soil shall be determined accurately during the construction phase, as per quality assurance plans and directions of Engineer-in-Charge so as to ensure that these are the same as those considered in the design.

The fill soil in the unreinforced zone shall also conform to the requirements specified in the design.

### 26.14.4 Identification, Transportation, Storage and Handling

Geogrids shall be procured in roll form of width as per design requirement and with the prior approval of the Engineer-in-Charge. All rolls shall have a protective cover with a label or tag (at multiple locations and inside the core of the rolls in accordance with ASTM D 4873) specifying name of the product, name of the manufacturer, roll number, date of manufacture and roll dimensions.





Material shall be protected from sunlight, mud, dirt, debris, any other harmful substances or mechanical damage during transportation.

Rolls shall be stored in a secured area sufficiently elevated above the ground and adequately covered to protect them from the following: Construction site damage, precipitation, prolonged exposure to ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, high temperatures, and any other environmental conditions that may damage the physical property values of the Geogrid.

Any material, which is damaged during transportation, handling or storage and do not meet the minimum requirements of the specifications, rendering it unsuitable for use in the specific application, is liable for rejection by the Engineer-in-Charge.

**26.14.5 Failure Definition, System Responsibility and Performance Bond The design life, performance criteria and failure definitions shall be as per FHWA-NHI-10-024 and IRC:**

SP: 102-2014. The design of reinforced soil wall or slope shall spell out the design life, performance criteria and failure definitions. For example, the deformations of the wall/ slope or any component thereof exceeding the design values, any visible structural distress in any wall element, any subsidence of the top surface of reinforced soil leading to distress in the infrastructure which is structurally dependent on the reinforced soil wall or slope or foundation system, etc. are some conditions to be watched.

The decision of the Engineer-in-Charge as to the failure or otherwise of the reinforced soil wall or slope or foundation system shall be final and binding on the contractor.

In case of failure, approved retrofitting measures may be adopted, duly vetted by expert institutions like ITs, at the risk and cost of the contractor. The retrofitting measure shall be approved by the Engineer-in-Charge.

Alternatively, and as a last resort, the whole or part of the structure, which has failed, shall be dismantled and redone to the entire satisfaction of the Engineer-in-Charge.

If specified in the contract, the reinforced soil system performance shall be covered under performance guarantee of the entire work, and no separate defect liability period or bond need be specified for the reinforced soil structure. However, corporate guarantee for system performance for a period covering the Defect Liability Period or more may be sought from the contractor.

**26.14.6 Installation & Measurement for Payment**

**26.14.6.1 Site Preparation**

The site shall be prepared by clearing, grubbing, and excavation or filling the area to the design grade.

This includes removal of topsoil and vegetation.

**26.14.6.2 Foundation:**

The foundation shall be a leveling pad of minimum 100mm width over and above the width of the fascia element, and 150mm thick M10 grade plain concrete, provided at a depth not less than 1000mm to receive the fascia elements and / or bottom most layer of reinforcement. The designer may provide higher specifications if the situation at site so demands.

**26.14.6.3 Laying of Geogrid**

The geogrid shall be laid perpendicular to the face of the wall with greater cross sectional dimension in the horizontal plane. The geogrid shall be laid stretched and smooth without wrinkles or folds on the prepared subgrade (or within the granular subbase / base course if shown in the drawings) with the machine direction oriented in the direction of major stress or as shown in the drawings. It shall be held taut by suitable arrangement at site.



Geosynthetic uniaxial reinforcement shall be placed in continuous longitudinal rolls in the direction of the main stress. Joints parallel to the wall shall not be permitted, except as shown on the working drawings.

Reinforcement coverage shall be a given percent of embedment area to be mentioned in the design/working drawings, as per the type of reinforcement being used. Adjacent sections of geosynthetic reinforcement need not be overlapped or mechanically connected. In case of biaxial / triaxial reinforcement applications, overlap / connections shall be as per manufacturer's requirements.

On curves, the geogrid may be folded or overlapped to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, etc.

Prior to placing sub base / base course material the installed geogrid shall be inspected and approved by the Engineer-in-Charge. Any minor damages shall be repaired by covering the damaged location with a geogrid patch, which shall be mechanically connected to the parent reinforcement, as directed by the Engineer-in-Charge.

#### **26.14.6.4 Placing and Compacting Sub base/base course**

The sub base or base shall be placed by end dumping onto the geogrid from the edge of the geogrid or over previously placed sub base or base aggregate. The dumper shall move in reverse direction over the spilled material.

Movement of construction equipment directly over the geogrid shall not be permitted. The grid shall have a minimum compacted thickness of 150 mm over the grid before allowing movement of vehicles, the speed of which shall be limited to 10 km/hr.

Sudden breaking and sharp turning of construction equipment shall be avoided on the first lift of earth over the geogrid

#### **26.14.6.5 Specifications for Facia**

The facing system shall be one of the following:

(a) Precast reinforced concrete panels:

The minimum thickness of precast concrete panels shall be 180 mm including facing textures, logos and embellishments. The grade of concrete shall be minimum M35. The concrete shall conform to the requirements of IS 456-2000.

Facia panel systems shall have provision of both horizontal and vertical gaps to prevent concrete to concrete contact. The horizontal gap between the facing elements shall be maintained by provision of Ethylene Propylene Diene Monomer (EPDM) pad.

The joints between the panels shall be covered from inside (inner face side) with non - woven geotextile strips glued to the facing element ensuring full coverage of joints, to prevent loss of aggregate filter material. Synthetic glue shall be used for this purpose. The width of the geotextile strip shall not be less than 100 mm. This provision of covering of panel joints with geotextile strips need not be followed if Geocomposite filter is used in place of aggregate filter media.

All dimensions of the RCC panel facia elements shall be within  $\pm 5$ mm, except thickness for which tolerance shall be (+5mm & (-) 0mm. Additionally, the evenness of the front face shall be  $\pm 5$ mm over 1500 mm length. The difference between length of the two diagonals shall not be more than 5mm

(b) Precast concrete interlocking blocks or Precast concrete hollow blocks:

Precast concrete blocks are dry cast and shall be manufactured from fully automatic block making machines. The minimum grade of concrete shall be M 35 for all kinds of modular blocks. In case of hollow blocks, the hollow area shall not exceed 40 percent of the cross sectional area of the block. The outer side





of the block shall have minimum thickness of 100mm. The hollow area shall however be filled with filter media.

The dimensional tolerance for length and width shall be +2.5mm and for height \*1.5mm.

(c) Gabion facing:

Where gabion facia is used, it shall conform to the provisions of BS - 1:2010 and EN 14475 and made of mechanically fabricated double twisted hexagonal mesh. Wire used for the double twisted mesh and selvages shall be hot dip galvanized as per IS : 4826 - heavily coated and soft type, with wire and mesh properties in accordance with EN - 10223 with minimum Zn + alloy coating as per EN - 10244 and 0.5 mm thick PVC coating as per EN - 10245 and ISO - 527.

(d) Wrap around facia using geotextiles:

Where geosynthetics, including geogrids are used as wrap around facia, these shall form a part of the reinforcing element. The wrap around shall have adequate length to resist pull out and the wrap around length shall be calculated on the basis of safety in pull out. Wrap around facia shall be protected by suitable means, against adverse effects of UV and other elements of nature.

e) Other proprietary and proven systems at the discretion of NIT approving authority

The facing material as well as the connections between facia and reinforcement shall be sufficiently flexible to withstand any deformation of the fill and foundations.

The facia shall have an inward batter as shown in the drawings so that the tendency of the facia panels to bulge outwards is countered.

Facia type adopted shall be given in the design and shown with complete details in the drawings.

The system supplier shall provide any test data to satisfy the Engineer-in-Charge regarding the properties and suitability of the facia system adopted, if so required.

Where facia such as wrap around or gabion or welded wire and woven steel wire mesh facings have been used and where climate conditions are appropriate, a green finish may be provided where specified.

#### **26.14.6.6 Connection between the Facia And Reinforcement**

Connection between the facia panels and the reinforcing element shall be by using either nut or bolt, HDPE inserts with bodkin joint, hollow embedded devices, polymeric/galvanized steel strips, / rods, /pipes, / loop & toggle, fiber glass dowels or any other material shown in the drawings. The connection between the panel and the reinforcement shall provide for 100 percent of the long term design strength of the reinforcing element in continuity. Proprietary connections systems may be provided as per design, subject to the condition that they are compliant with the design requirements and durable.

In case of modular block facia and other type of facia such as gabion facia, where the reinforcement is held by friction between the facia block and the reinforcement, the connection strength shall be determined as per ASTM D 6638 :Standard Method of Test for Determining Connection Strength between Geosynthetic Reinforcement and Segmental Concrete Units".

The available connection strength shall satisfy the design requirements and shall not be less than the maximum possible tensile force that the reinforcement layer under consideration may be subjected to.

#### **26.14.7 Measurement for Payment & Rates**

(1) Reinforced Soil Wall:

The measurement for payment for reinforced soil wall shall be in square meters of finished work of each face and shall be measured in the plane of final inclination specified in the drawings. The measurement of length shall be the finished work along the length of the road. The measurement of height along the



slope shall be done from the top level of the footing on which the fascia element is placed to the top of the capping beam. Measurement for friction slab and crash barrier shall be made separately.

#### (ID-Reinforced Soil Slope)

The measurement for payment for reinforced soil slope shall be in square meters of finished work of each face and shall be measured in the plane of final inclination specified in the drawings. The measurement of height along the slope shall be done from the top of the leveling pad, where provided, to the top of the embankment. Where leveling pad is not provided, the height shall be measured, in the final plane of inclination specified in the drawings, from the bottom of the slope face to the top of topmost facing element provided.

Measurement and payment of friction slab and crash barrier if provided shall be made separately.

Rates: The rate shall include cost of material, labour, plant and machinery, royalties, handling, storage and transportation expenses, leveling pad, fascia elements, coping beam, connectors, reinforcing elements, scaffolding, all inclusive EXCEPT supply and installation of the specified filter media material, bed block, supply of soil fill for the reinforced as well as unreinforced zone of the quality specified in the contract, placing, spreading and compaction through mechanical means, which shall be measured separately.

No separate measurements for overlaps, wastages, or on any other account shall be admissible, unless specifically provided for in the tender.

The rate shall include full compensation for design, drawings and testing of materials, as per tender conditions.

The rate shall NOT include the cost of investigations, design and construction of ground improvement measures, if required. The same shall be provided and paid as per NIT.

The payment for friction slab and crash barrier shall be made separately.

#### **26.14.8 Design and Drawings:**

The design of reinforced soil structure, the same shall be carried out in accordance with the following standards as applicable:

(1) BS:8006-1-2010 "Code of Practice for Strengthened /Reinforced Soils and other Fills"

IRC:SP:102-2014 "Guidelines for Design and Construction of Reinforced Soil Walls"

FHWA - NHI-10-024 and FHWA - NHI-10-025 - "Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes"

The design shall include the design of drainage system for the reinforced soil wall or slope or foundation system.

#### **26.14.9 Quality Control and Testing**

The quality management system of the manufacturer shall conform to the requirements of ISO 9001:2015.

Manufacturer shall issue a test report stating minimum average roll values of material properties, at the time of shipment from factory.

CE-certification should be required for supply of polymer geogrid material.

Manufacturer shall submit proof of having supplied to - (1)

One project in India having at least 80% of the tender quantity, OR

Two projects in India having at least 60% of the tender quantity, OR



Three projects in India having at least 40% of the tender quantity

The manufacturer shall submit project references if required by the Engineer-in-Charge.

In addition, at least one of the above qualifying projects shall have performed satisfactorily for at least a 5-year period. Owner / Engineer's certificate to that effect shall be submitted.

The NIT approving authority may, for recorded reasons, alter the above specifications due to exigencies of work.

## **26.15 ALUMINUM PROFILE INDUSTRIAL TROUGHED SHEET ROOFING**

### **26.15.1 MATERIALS**

#### **26.15.1.1 Aluminum profile industrial troughed sheet**

These shall be made of alloy 31500/ 31000/40800 of thickness specified in the description of the item and Chemical Composition of Wrought Aluminium and Aluminium Alloy Sheet and Strip shall conform to IS 737. The weight of the sheet shall not be less than the value as per table 26.7.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The sheets shall not show signs of rust or white powdery deposits on the surface.

The corrugations shall be uniform in depth and pitch and parallel with the side.

#### **26.15.1.2 Purlins**

Purlins of the specified material or M.S. rolled sections of requisite size shall be fixed over the principal rafters. These shall not be spaced at more than the following distances. (Table 26.8)

The unsupported overhang sheets should not be more than 100mm and 150mm for the sheet thickness of 0.71mm and 0.91mm respectively. The top surfaces of the purlins shall be uniform and plane. They shall be painted before fixing on top. Embedded portions of wooden purlins shall be coal tarred with two coats.

### **26.15.2 Slope**

Roof shall not be pitched at a flatter slope than 1 vertical to horizontal. The normal pitch adopted shall usually be 1 vertical to 4 horizontal.

### **26.15.3 Laying and Fixing**

The sheets shall be laid and fixed in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

The sheets shall be laid with a minimum lap of 15 cm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 15 cm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 20 cm. The minimum lap of sheets with ridge, hip and valley shall be 20 cm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

Sheets shall not generally be fixed into gables and parapets. They shall be bent up along their side edges close to the wall and the junction shall be protected by suitable flashing or by a projecting drip course, the latter to cover the junction by at least 7.5 cm.

The laying operation shall include all scaffolding work involved.



Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with fixed using self drilling/ self tapping SS screw (See Fig 26.13A & 26.13B) of size 5.5x65mm with

EPDM seal complete upto required pitch in horizontal, vertical or curves surfaces.

When fastening with self-drilling fasteners, it is imperative that the screw point has cleared the substrate before the threads engage or the driller will actually pull the threads through the substrate faster than it can be drilled, thereby breaking the fastener.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. There shall be a minimum of three self drilling / self tapping placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 30 cm.

The self drilling/ self tapping SS screw shall be continuous and free from defects such as blisters, flux stains, drops, excessive projections or other imperfections which would impair service ability.

#### **26.15.4 Finish**

The roof when completed shall be true to lines, and slopes and shall be leak proof.

#### **26.15.5 Measurements**

The length and breadth shall be measured correct to a cm. Area shall be worked out in sqm correct to two places of decimal.

The superficial area of roof covering shall be measured on the flat without allowance for laps and corrugations. Portion of roof covering overlapping the ridge or hip etc. shall be included in the measurements of the roof.

Roof with curved sheets shall be measured and paid for separately. Measurements shall be taken on the flat and not girthed.

No deduction in measurement shall be made for opening upto 0.4 sqm and nothing extra shall be allowed for forming such openings. For any opening exceeding 0.4 sqm in area, deduction in measurements for the full opening shall be made and in such cases the labour involved in making these openings shall be paid for separately. Cutting across corrugation shall be measured on the flat and not girthed. No additions shall be made for laps cut through.

#### **26.15.6 Rate**

The rate shall include the cost of all the materials and labour involved in all the operations described above including all screws, seal, ridge, scaffolding, machinery for fixing and approved sealant where required etc. but excluding the cost of purlins, rafters and trusses.

### **26.16 ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE FALSE CEILING (TEGULAR EDGED)**

#### **26.16.1 Materials**

##### **26.16.1.1 Tiles**

Eco friendly light weight calcium silicate tiles shall be made from Non-cementitious hydrated wet moulded calcium silicate slurry/mixture, reinforced with fibers and natural fillers. Free from formaldehyde and other harmful materials. Does not contain any toxic ingredients. Shall have appropriate recycled material contents.

The Ceiling Tiles shall be of appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 X 595 mm in size and shall be 15 mm thick integral densified tegular edged type, light weight wet moulded calcium silicate.



Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. Eco Friendly Light Weight Calcium silicate tiles shall have the following properties:

- (a) Surface: All tiles are prime coated on both sides. Standard finish in two coats white dispersion type, solvent free paint.
- (b) Dimensions: 595mmx595mmx 15mm thick tegular edged. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.
- (c) Thickness: 10 mm thick in the center and 15mm thick all around on edge resting portion with integral densified edge.
- (d) Density of material: 350 kg per cum in the central 10 mm thick portion and 450 kg cum on the edges, (Average 370 kg per cum as per ECBC Code 2007).
- (e) Relative humidity: 100% RH resistant.
- (f) Fire resistance: Non-combustible as per BS:476 Part-4. Fire performance: as per BS:476 (Part-6) for fire propagation and BS 476 (Part 7) for Surface spread of flame.
- (g) Thermal conductivity: 0.048 W/m- K - 0.052 W/m- K as per ECBC Code 2007 and ASTM 518-1991
- (h) Recycled Content: Shall have 46-50% recycled content out of which 18-20% should be FLYASH
- (i) Acoustic control: Sound Attenuation 30-32dB  
Noise reduction coefficient (NRC)  
Plain & Designer tile: 0.10-0.15.  
For Pin Hole/Texture pattern tiles: 0.20-0.30.  
Pin hole/Texture fully perforated tile: 0.30-0.40.  
For 5mm fully perforated 0.40-0.50.  
For 5mm fully perforated with 50mm/48gsm glass wool 0.65-0.85.
- (j) Light reflectance: >85%.
- (k) Weight: 5 - 5.5Kg/m<sup>2</sup>
- (l) Suspension system: Suspension system shall be made of roll-formed hot-dipped galvanized steel.

#### 26.16.1.2 Frame

Frame is made up of interlocking metal T-grid of hot dipped galvanized steel sections of 0.33mm thick (Galvanized @ 120 gms/m<sup>2</sup> including all sides) comprising of main T runners of size 24 x 38mm of length 3000mm, cross T of size 24 x 32 mm of length 1200mm and secondary intermediate cross T of size 24 x 32mm of length 600mm to form grid modules of size 600 x 600mm. This grid shall be suspended from ceiling using galvanized mild steel members (Galvanized @ 80 gms/m<sup>2</sup> including all sides) i.e. 12x50mm long dash fasteners, 6mm dia fully threaded hanger rod upto 1000 mm length and L-shaped level adjuster of size 76 x 25 x 25x 1.6mm fixed with grid and Z cleat of size 25x37x25x1.6mm thick with precut hole on both 25mm flange to pierce into 12x50mm or even bigger dash fastener if require. Frame also consist of galvanized iron perimeter wall angle of size 24 x 24 x 0.40mm of length 3000mm to be fixed on periphery wall partition with the help of plastic rawl plugs at 450mm centre to centre and 40mm long dry wall SS screws.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.



### 26.16.2 Fixing

Outer wall angle shall be fixed accurately and truly at required height and level, parallel and close to the wall. Thereafter all the T members shall be placed and fixed carefully to form the grid.

The grid comprises of main T-runners at 1200mm centres securely fixed to the structural soffit by approved and adjustable hanger rods at 1200mm maximum centres and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners of 1200mm length shall be placed at 600mm centre to centre. 600x600mm modules to be formed by fitting 600mm long flush fitting cross Tees (secondary cross T) centrally between 1200mm cross T-runners. The tiles shall then be placed properly in the grids as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge. If required, level of the false ceiling grid shall be checked after placing of calcium silicate tiles and necessary adjustment shall be made wherever required through level adjuster.

### 26.16.3 Precaution:

- (a) All wet trades such as plastering, conduiting and painting etc, be completed prior to start of false ceiling works.
- (b) Air conditioning duct work is to be completed preferably even before the suspension of the grid section.
- (c) Electrical chasing or drawing lines & cables, etc are to be in place before start of false ceiling work.
- (d) No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge manufacturer guide line.
- (e) The area is dry prior to ceiling installation work.

### 26.16.4 Finishing

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

### 26.16.5 Measurements

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square meters. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. Nothing extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

### 26.16.6 Rate

The rate shall include the cost of all materials and labour involved in all the operations described above.

**26.16.7 MTC:** Manufacturers test certificate/ report of invoice to be submitted for every delivery challan by suppliers.

## 26.17 ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE FALSE CEILING (MICRO LOOK EDGE) (Fig . 16)

### 26.17.1 Materials

#### 26.17.1.1 Tiles

Eco friendly light weight calcium silicate tiles shall be made from Non-cementitious hydrated calcium silicate slurry/mixture, reinforced with recycled material and natural fillers. Free from formaldehyde and other harmful materials. does not contain any toxic ingredients.





Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and shall be 15mm thick integral densified micro-edged type light weight calcium silicate.

Where width of room/ corridor is in multiple of standard width of tiles, same pattern shall be maintained throughout the length. Where the width of rooms/ corridor is not in multiple of standard width of tiles, borders with appropriate width and material of boards shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length/ width of room/ corridor. Calcium silicate tiles shall have the following properties:

- (a) Surface: All tiles are prime coated on both sides. Standard finish in two coats white dispersion type, solvent free paint.
- (b) Dimensions: 595mm x 595mm x 15mm thick integral densified micro-edge. Size referred to are always module sizes. The nominal panel size may differ depending on the suspension system used.
- (c) Thickness: 10 mm thick in the center and 15mm thick all around on edge resting portion with micro look integral densified edge.
- (d) Density of material: 350 kg per cum in the central 10 mm thick portion and 450 kg cum on the edges, (Average 370 kg per cum as per ECBC Code 2007).
- (e) Relative humidity: 100% RH resistant.
- (f) Fire resistance: Non-combustible as per BS:476 Part-4. Fire performance: as per BS:476 (Part-6) for fire propagation and BS 476 (Part 7) for Surface spread of flame (g) Thermal conductivity: 0.048 W/m- K - 0.052 W/m- K as per ECBC Code 2007 and ASTM 518-1991.
- (g) Recycled Content: Shall have 46-50% recycled content out of which 18-20% should be FLYASH.
- (h) Acoustic control: Sound Attenuation 30-32dB
  - Noise reduction coefficient (NRC)
  - Plain & Designer tile: 0.10-0.15.
  - For Pin Hole/Texture pattern tiles: 0.20-0.30.
  - Pin hole/Texture fully perforated tile: 0.30-0.40.
  - For 5mm fully perforated 0.40-0.50.
  - For 5mm fully perforated with 50mm/48gsm glass wool 0.65-0.85.
- (i) Light reflectance: >85%.
- (j) Weight: 5 - 5.5Kg/m<sup>2</sup>

Suspension system: Suspension system shall be made of roll-formed hot-dipped galvanized steel.

#### **26.17.1.2 Frame**

Frame is made up of interlocking metal pre coated T-grid of hot dipped galvanized steel sections of 0.40mm thick on Silhouette profile comprising of main T runners of size 15 x 42mm of length 3000mm, cross T of size 15 x 42mm of length 1200mm and secondary intermediate cross T of size 15 x 42mm of length 600mm to form grid modules of size 600 x 600mm. This grid shall be suspended from ceiling using galvanized mild steel members (Galvanized @ 80 gms/m<sup>2</sup> including all sides) i.e. 12x50mm long dash fasteners, 6mm dia fully threaded hanger rod upto 1000 mmlength, L-shaped level adjuster of size 76 x 25 x 25x 1.6mm fixed with grid and Z cleat of size 25x37x25x1.6mm thick with precut hole on both 25mm



flange to pierce into 12×50mm or even bigger dash fastener if required. Frame also consist of galvanized iron perimeter wall angle of size 22 x 19x 0.40mm of length 3000mm to be fixed on periphery wall partition with the help of plastic rawl plugs at 450mm centre to centre and 40mm long dry wall SS screws.

The bottom surface of the frame shall be checked and corrected to true plans and slopes.

#### **26.17.2 Fixing**

Outer wall angle shall be fixed accurately and truly at required height and level, parallel and close to the wall. Thereafter all the T members shall be placed and fixed carefully to form the grid.

The grid comprises of main T-runners at 1200mm centres securely fixed to the structural soffit by approved and adjustable hanger rods at 1200mm maximum centres and not more than 150mm from spliced joints of main T-runners. The last hanger at the end of each runner should not be greater than 600mm from the adjacent wall. Similarly, cross T-runners of 1200mm length shall be placed at 600mm centre to centre. 600x600mm modules to be formed by fitting 600mm long flush fitting cross Tees (secondary cross T) centrally between 1200mm cross T-runners. The tiles shall then be placed properly in the grids as per required pattern, texture and design/ drawing and as per directions of the Engineer-in-Charge. If required, level of the false ceiling grid shall be checked after placing of calcium silicate tiles and necessary adjustment shall be made wherever required through level adjuster.

All wet trades such as plastering, conduting and painting etc, be completed prior to start of false ceiling works.

Air conditioning duct work is to be completed preferably even before the suspension of the grid section.

Electrical chasing or drawing lines & cables etc are to be in place before start of false ceiling work.

No unauthorized weight is put on false ceiling. Lighting fixtures, diffusers are to be suspended independently with proper chain/wire & dash fasteners as directed by Engineer In Charge/ Manufacturer guide line

The area is dry prior to ceiling installation work.

#### **26.17.3 Finishing**

Care should be taken while placing Light Weight calcium silicate tiles into the grid so that there will be no displacement to grid and stains/ dirty marks put by the workers. (worker should preferably wear clean soft cotton gloves while placing tile).

#### **26.17.4 Measurements**

Length and breadth shall be measured correct to a cm. Areas shall be worked out to nearest 0.01sqm. The superficial area of the finished work ceiling shall be measured in square meters. No deduction in measurements shall be made for openings of areas upto 0.36 Sqm. extra shall be payable either for any extra material or labour involved in forming such openings. For openings exceeding 0.36 sqm in area, deductions in measurements for the full opening in multiple of area of each tile (0.36 Sqm) will be made.

#### **26.17.5 Rate**

The rate shall include the cost of all materials and labour involved in all the operations described above.

**26.17.6 MTC:** Manufacturers test certificate/ report of invoice to be submitted for every delivery challan by suppliers.

### **26.18 ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE WALL PANELLING (FULLY PERFORATED SQUARE/ BUTT EDGED) (Fig . 17)**

#### **26.18.1 Materials**

##### **26.18.1.1 Tiles**





Eco Friendly Light Weight Calcium silicate tiles shall be made from Non-cementitious hydrated calcium silicate slurry/Mixture, reinforced recycled material with fibers and natural fillers. Free from formaldehyde and other harmful materials. Does not contain any toxic ingredients.

Tiles shall be appropriate class and of finished thickness as specified in the description of the item. Only selected tiles of uniform width shall be used. Unless otherwise specified in the description of the item or shown in the drawings, the width of tiles selected for use shall not be less than 595 x 595mm in size and of approved texture, design and patterns and shall be 15mm thick fully perforated square/ butt edged type.

Where width and height of room is in multiple of standard width of tiles/panels, same pattern shall be maintained throughout the length. Where the width and height of rooms is not in multiple of standard width of tiles, cut tile of same design shall be used, material of tile shall be provided in design approved by the Engineer-in-charge and maintained uniformly throughout of the length / height of room.

Calcium silicate tiles shall have the following properties:

- (a) Surface: All tiles are prime coated on both sides. Standard finish in two coats white dispersion type, solvent free paint.
- (b) Dimensions: 595mmx595mm Butt look Edged. The nominal panel size may differ where cut tile are used to make similar pattern
- (c) Density of material: 350 kg per cum in the central 10 mm thick portion and 450 kg cum on the butt edge, (Average 370 kg per cum as per ECBC Code 2007).
- (d) Relative humidity: 100% RH resistant.
- (e) Fire resistance: Non-combustible as per BS: 476 Part-4. Fire performance: as per BS:476 (Part-6) for fire propagation and BS 476 (Part 7) for Surface spread of flame.
- (f) Thermal conductivity: 0.048 W/m- K - 0.052 W/m- K as per ECBC Code 2007 and ASTM 518-1991.
- (g) Recycled Content: Shall have 46-50% recycled content out of which 18-20% should be FLYASH.
- (h) Acoustic control: Sound Attenuation 30-32dB  
Noise reduction coefficient (NRC)  
For 5mm fully perforated 0.45-0.65.  
For 5mm fully perforated with 50mm/48 kg° density glass wool 0.65-0.85.
- (i) Light reflectance:>85%.
- (j) Weight: 5 - 5.5Kg/m<sup>2</sup>
- (k) Glass Wool: (to be procured separately by installer 50mm thick of density 48 Kg/m° shall be inserted uniformly before laying the tiles/panels.
- (l) Framing system: Framing system shall be made from especially fabricated galvanized mild steel sheet of 0.50mm thick pressed sections.

#### 26.18.1.2 Frame

Framing system shall be made from especially fabricated galvanized mild steel sheet of 0.50mm thick pressed sections having hot dipped galvanizing @120gms/m<sup>2</sup> including all sides. Framing system comprising of vertical studs of size 48 x 34 x 36mm, ceiling channel section of size 50 x 32mm fixed to the floor and soffit at 600mm centres and the channel section of size 50 x 32mm is then to be fixed in horizontal direction at 600mm centre to centre so as to form a grid of 600 x 600mm.



The surface of the frame shall be checked and corrected to true verticality and slopes if any.

#### **26.18.2 Fixing**

Framing system shall be made from especially fabricated galvanized mild steel sheet of 0.50mm thick pressed sections having hot dipped galvanizing @1 20gms/m<sup>2</sup> including all sides. Framing system comprising of vertical studs of size 48 x 34 x 36mm placed at 600mm centre to centre in a floor and ceiling channel section of size 50 x 32mm fixed to the floor and soffit at 600mm centres using 12mm dia, 50mm long wedge type expanded zinc alloy dash fastener with 10mm bolt. This channel is then to be fixed in horizontal direction at 600mm centre to centre so as to form a grid of 600 x 600mm. Glass wool of 50mm thickness and of density 48 Kg/m<sup>3</sup> is then to be inserted in the slot. Finally, calcium silicate tile/ panels are to be screw fixed with self-tapping pan head nickel coated M S screws of size 13 x 3.2mm on the grid leaving an even groove of 1mm between the panels/ tiles as per required pattern, texture and design/ drawing, preferably start from 2.5/4.0ft/window sill height or as per directions of the Engineer-in-Charge. Joint between the tiles/ panels are then be jointed and finished using recommended jointing calcium silicate based compound and fibre joint tape roll of 50 mm wide and two coats of primer suitable for paneling.

## BAMBOO MAT CORRUGATED SHEET (BMCS)

Sub Head: 26 New Technologies and Materials

Clause: 26.7.2



Figure 26.1 : General Arrangement

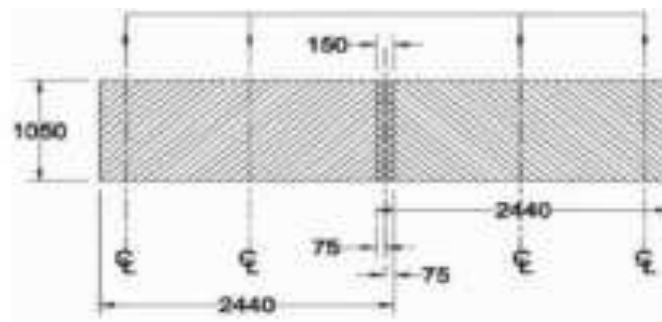


Figure 26.2 : End Lap of BMCS

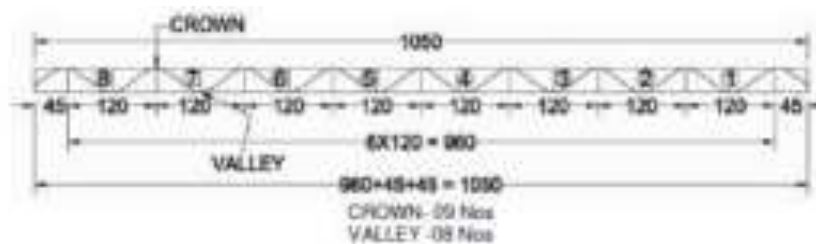


Figure 26.3 : Details of Corrugation

## BAMBOO MAT CORRUGATED SHEET (BMCS)

Sub Head: 26 New Technologies and Materials

Clause: 26.7.2

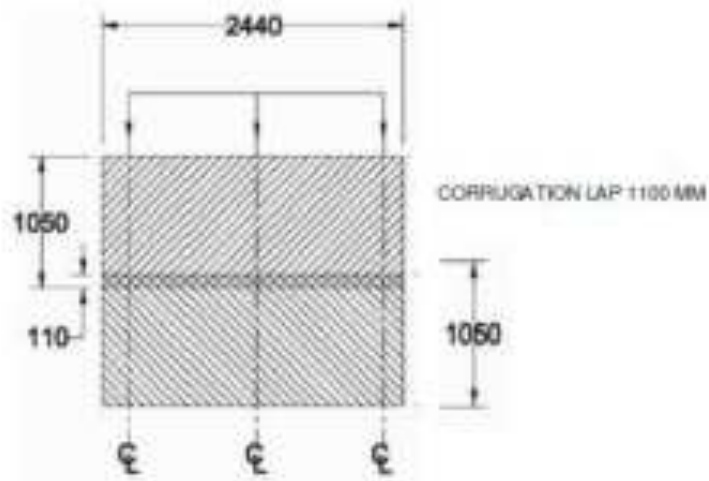


Figure 26.4 : Side Lap of BMCS



Figure 26.5 : Side Lap of BMCS



Figure 26.6 : Side Lap of BMCS

## BAMBOO MAT CORRUGATED SHEET (BMCS)

Sub Head: 26 New Technologies and Materials

Clause: 26.7.2



Figure 26.7 : BMCS Ridge Purlin

## CAVITY WALL THERMAL INSULATION SYSTEM WITH RIGID FOAM INSULATION

Sub Head: 26 New Technologies and Materials

Clause: 26.11.3

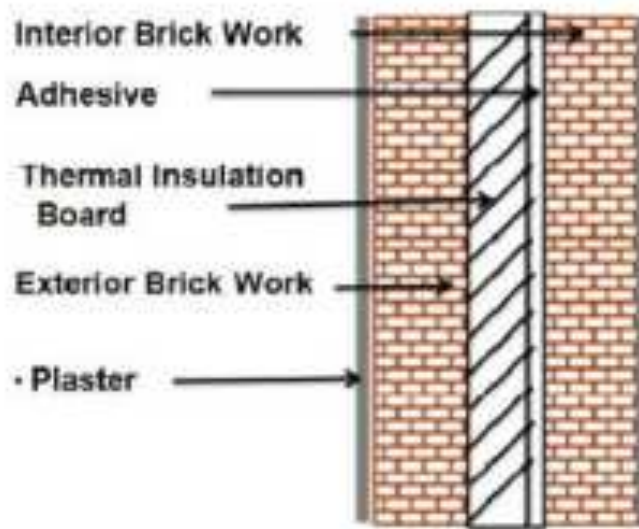


Figure 26.8 : Cavity Wall Thermal Insulation System with Rigid Foam Insulation

## UNDER DECK INSULATION SYSTEM

Sub Head: 26 New Technologies and Materials

Clause: 26.12.3

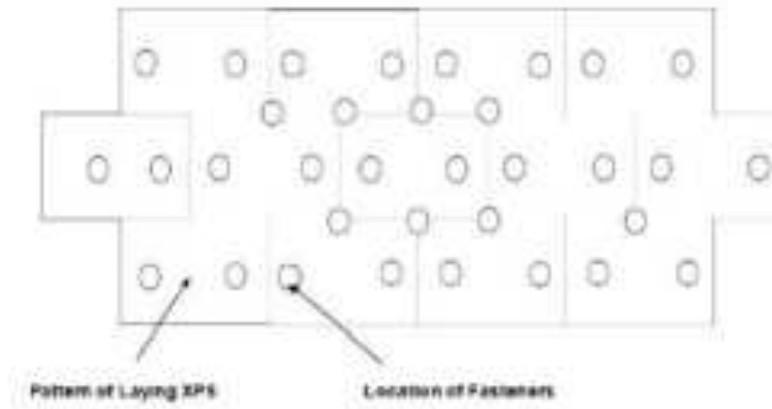


Figure 26.9 : Location OF Fasteners of Extruded Polystyrene Rigid Underdeck Insulation

## GEOGRIDS

Sub Head: 26 New Technologies and Materials

Clause: 26.14.1

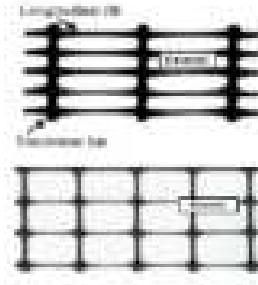


Figure 26.10 : Extruded Geogrids



Figure 26.11 : Coated Woven or Knit Yarn Geogrids

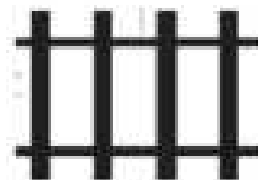


Figure 26.12 : Bonded Strap Geogrids

## ALUMINIUM PROFILE INDUSTRIAL TROUGHED SHEET -SELF DRILLING FASTENER

Sub Head: 26 New Technologies and Materials

Clause: 26.14.1

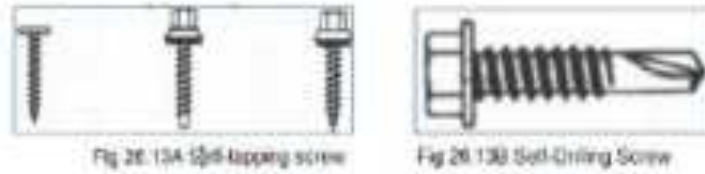


Figure 26.13 : Aluminium Profile Industrial Troughed Sheet – Self Drilling Fastener



## GALVANIZED STEEL DECK SHEET

Sub Head: 26 New Technologies and Materials

Clause: 26.42.1.1

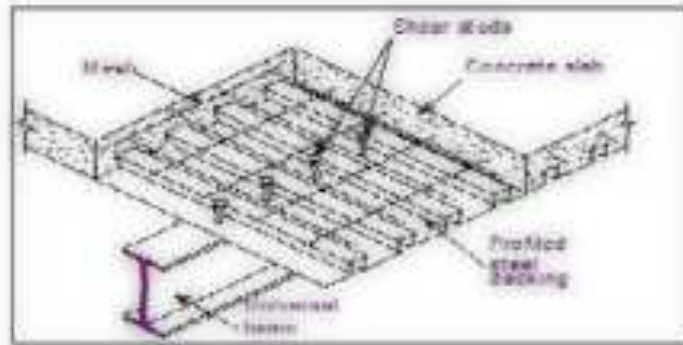


Figure 26.14 : Galvanized Steel Deck Sheet

## SHEAR CONNECTORS

Sub Head: 26 New Technologies and Materials

Clause: 26.42.1.2

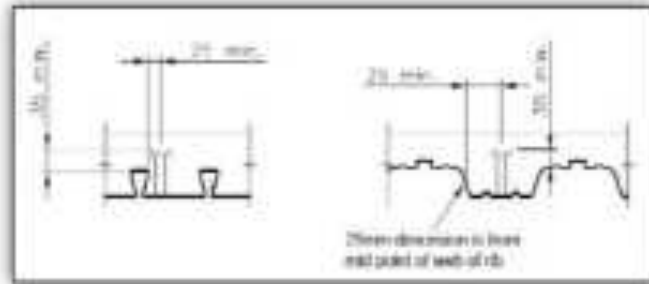


Fig 26.15 A

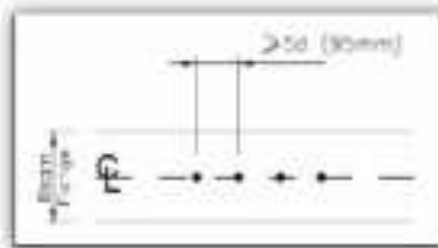


Fig 26.15 B

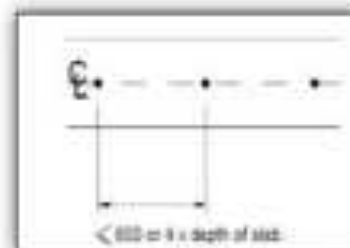


Fig 26.15 C

Figure 26.15 : Shear Connector

## ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE FALSE CEILING (MICRO LOOK DEGE)

Sub Head: 26 New Technologies and Materials

Clause: 26.17

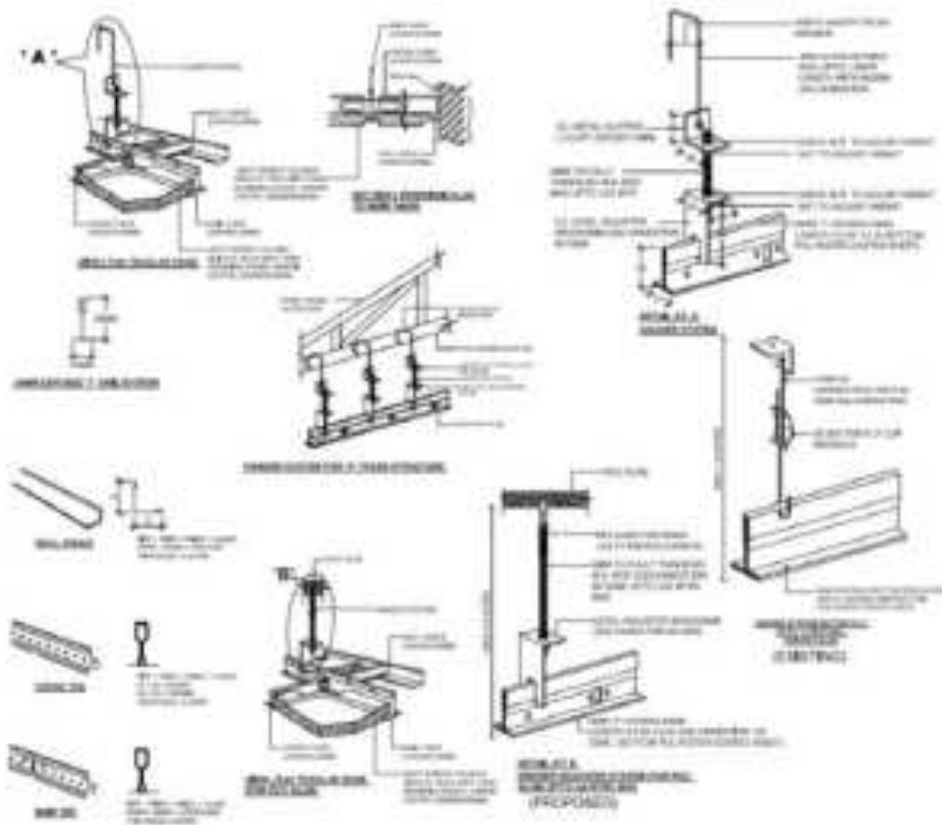


Figure 26.16 : Eco Friendly Light Weight Calcium Silicate False Ceiling (Micro Look Edge)

## ECO FRIENDLY LIGHT WEIGHT CALCIUM SILICATE WALL PANELING (FULLY PERFORATED SQUARE/ BUTT EDGED)

Sub Head: 26 New Technologies and Materials  
Clause: 26.18

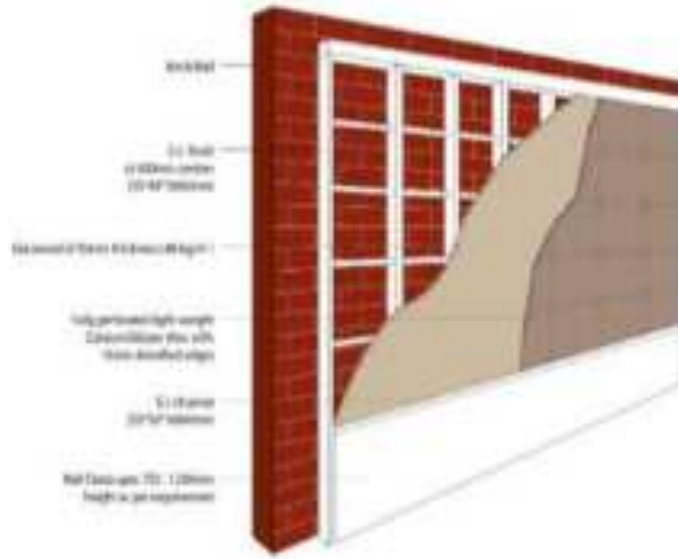


Figure 26.17 : Eco Friendly Light Weight Calcium Silicate Wall Paneling (Fully Perforated Square/ Butt Edged)



# HORTICULTURE AND LANDSCAPE

ENVIRONMENT



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## 27 HORTICULTURE AND LANDSCAPE

### 27.0 HORTICULTURE WORK

Horticultural operations shall be started on ground previously levelled and dressed to required formation levels and slopes. In case where unsuitable soil is met with, it shall be either removed or, replaced or it shall be covered over to a thickness decided by the Engineer-in-charge with good earth. In the course of excavation or trenching during horticultural operations, any walls, foundations, etc. met with shall not be dismantled without pre-measurement and prior to the written permission of the Engineer-in-charge.

### 27.1 TRENCHING IN ORDINARY SOIL

**27.1.1** Trenching is done in order to loosen the soil, turn over the top layer containing weeds etc. and to bring up the lower layer of good earth to form a proper medium for grassing, regrassing, hedging and shrubbery. Trenching shall be done to the depth ordered by the Engineer-in-charge. The depth is generally 30 cm for grassing and 60 cm for regrassing in good soil.

**27.1.2** The trenched ground shall, after rough dress, be flooded with water by making small kiaries to enable the soil to settle down. Any local depression unevenness etc. shall be made good by dressing and/or filling with good soil.

**27.1.3** Weeds or other vegetation which appear on the ground are then uprooted and removed and disposed off and paid.

#### 27.1.4 Trenching

Trenching shall consist of the following operations:

- a) The whole plot shall be divided into narrow rectangular strips of about 1.5 m width or as directed by the Engineer-in-Charge.
- b) These strips shall be sub-divided lengthwise into about 1 m long sections. Such sections shall be excavated serially and excavated soil deposited in the adjacent section preceding it.
- c) In excavating and depositing care shall be taken that the top soil with all previous plant growth including roots, get buried in the bottom layer of trenched area, the dead plants so buried incidentally being formed into humus.
- d) The excavated soil shall be straight away dumped into the adjoining sections so that double handling otherwise involved in dumping the excavated stuff outside and in back filling in the trenches with leads is practically eliminated.

#### 27.1.5 Measurements

Length and breadth of the plot shall be taken correct to 0.1 m and depths correct to cm. Cubical contents shall be calculated in cubic meters, correct to two places of decimal. No deduction shall be made nor extra paid for removing stones, brick bats and other foreign matter met with during excavation upto initial lead of 50 m and stacking the same.

#### 27.1.6 Rate

The rate shall include the cost of all labour and material involved in the operations described above, including cost of all precautionary measures to be taken for protections and supporting all services etc. met with during trenching. It does not include the cost of mixing of earth, sludge/manure.

### 27.2 GOOD EARTH

**27.2.1** The earth shall be stacked at site in stacks not less than 50 cm high and of volume not less than 3.0 cum.





**27.2.2 Measurements:** Length, breadth and height of stacks shall be measured correct to a cm. The volume of the stacks shall be reduced by 20% for voids before payment, unless otherwise described.

**27.2.3 Rate:** The rate shall include the cost of excavating the earth from areas lying at distance not exceeding one km. from the site, transporting the same at site breaking of clods and stacking at places indicated. The rate shall also include royalty if payable.

### **27.3 OIL CAKE**

**27.3.1 Neem/Castor:** The cake shall be free from grit and any other foreign matter. It should be undecorticated and pulverized. The material shall be packed in old serviceable gunny bags of 50 kgs capacity approximately. The weight of gunny bag shall be deducted @1 kg per bag and payment shall be made for net quantity. The quality of cake should be got approved by the Engineer-in-charge before supply.

#### **27.3.2 Measurements**

The arrangement for weighing shall be made at site of work by the department. The gunny bags shall be the property of the government.

**27.3.3 Rate:** The rate shall include the cost of labour and material involved in all operations described above, including carriage up to site of work with all lead and lifts, weighing etc.

### **27.4 SUPPLY AND STACKING OF SLUDGE**

It shall be transported to the site in lorries with efficient arrangement to prevent spilling enroute. It shall be stacked at site. Each stack shall not be less than 50 cm height and volume not less than 3 cum.

#### **27.4.1 Measurements**

Length, breadth and depth of stacks shall be measured correct to a cm. The volume of the stack shall be reduced by 8% for looseness in stacking and to arrive at the net quantity for payment.

#### **27.4.2 Rate**

The rate shall include the cost of labour and material involved in all operations described above, including carriage up to one km. The rate shall also include royalty if payable.

### **27.5 SUPPLY AND STACKING OF MANURE**

**27.5.1 Farmyard Manure:** Same as 27.4.1.

**27.5.2 Measurements:** Same as 27.4.2.

**27.5.3 Rate:** Same as 27.4.3.

### **27.6 ROUGH DRESSING OF THE TRENCHED GROUND**

**27.6.0** Rough dressing of the area shall include making kiaries for flooding.

**27.6.1** The trenched ground shall be levelled and rough dressed and if there are any hollows and depressions resulting from subsidence which cannot be so levelled, these shall be filled properly with earth brought from outside to bring the depressed surface to the level of the adjoining land and to remove discontinuity of slope and then rough dressed again. The supply and spreading of soil in such depressions is payable separately. In rough dressing, the soil at the surface and for 75 mm depth below shall be broken down to particle size not more than 10 mm in any direction.

#### **27.6.2 Measurements**

Length, breadth of superficial area shall be measured correct to 0.1 metre. The area shall be calculated in sqm. correct to two places of decimal.

#### **27.6.3 Rate**



The rate shall include the cost of all the labour and material involved in all the operations described above

## **27.7 UPROOTING WEEDS FROM TRENCHED AREAS**

**27.7.1** After 10 days and within 15 days of flooding the rough dressed trenched ground with water, the weeds appearing on the ground shall be rooted out carefully and the rubbish disposed off as directed by the Engineer-in-charge.

### **27.7.2 Measurements**

Length, breadth of superficial area shall be measured correct to 0.1 meters. Superficial area of the weeded ground shall be measured for purpose of payments.

### **27.7.3 Rate**

The rate shall include the cost of all the labour and material involved in all the operations described above.

## **27.8 FINE DRESSING THE GROUND**

Slight unevenness, ups, and downs and shallow depressions resulting from the settlement of the flooded ground, in drying and from the subsequent weeding operations, shall be removed by fine dressing the surface to the formation levels of the adjoining land as directed by the Engineer-in-charge, and by adding suitable quantities of good earth brought from outside, if necessary.

### **27.8.1 Measurements**

Length, breadth and depth of stacks shall be measured correct to a cm. The area shall be calculated in sqm. correct to two places of decimal.

### **27.8.2 Rate**

The rate shall include the cost of all the labour and material involved in all the operations described above.

## **27.9 SPREADING GOOD EARTH**

Good earth shall be removed from stacks by head load and spread evenly over the surface to the thickness ordered by the Engineer-in-charge. It shall be spread with a twisting motion to avoid segregation and to ensure that spreading is uniform over the entire area.

**27.9.1 Measurements:** The quantity of good earth spread shall be determined by the difference in the volume of good earth in stacks before and after spreading duly reduced for looseness in stacking by 20% of good earth.

**27.9.2 Rate:** The rate shall include of all the labour and material involved in all the operations described above but does not include the cost of the good earth which shall be paid for separately unless specifically described in the item.

## **24.9.A SPREADING SLUDGE/MANURE**

Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-Charge. The mixing shall be spread as described in 24.9.1 to the thickness ordered by the Engineer-in-Charge.

### **27.9.3 Measurements**

The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth and sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

### **27.9.4 Rate**



The rate shall include of all the labour and material involved in all the operations described above, but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

#### **27.10 MIXING OF GOOD EARTH AND SLUDGE/MANURE**

The stacked earth shall, before mixing be broken down top particle of sizes not exceeding 6 mm in any direction. Good earth shall be thoroughly mixed with sludge or manure in specified proportion as described in the item or as directed by the Engineer-in-charge.

##### **27.10.1 Measurements**

The quantity of good earth and sludge or manure mixed shall be determined by the difference in the volume of good earth, sludge or manure in stack, before and after spreading duly accounted for voids and looseness in stack.

##### **27.10.2 Rate**

The rate shall include the cost of all labour and materials involved in all the operations described above but does not include the cost of good earth sludge or manure which shall be paid for separately, unless otherwise described in the item.

#### **27.11 GRASSING WITH SELECT GRASS NO. 1 DOOB GLASS**

The area from where the grass roots are to be obtained shall be specified by the Engineer-in- Charge at the time of execution of the work and no royalty shall be charged on this account from the contractor. Grass is to be arranged by contractor (cost of grass to be paid separately).

The soil shall be suitably moistened and then the operation of planting grass shall be commenced. The grass shall be dibbled at 10 cm, 7.5 cm, 5 cm apart in any direction or other spacing as described in the item. Dead grass and weeded shall not be planted. The contractor shall be responsible for watering and maintenance of levels and the lawn for 30 days or till the grass forms a thick lawn free from weeded and fit for moving whichever is later. Generally planting in other direction at 15 cm, 10 cm, spacing is done in the case of large open spaces, at 7.5 cm spacing in residential lawn and at 5cm spacing for Tennis Court and sports ground lawn. Rates are including cost of labour and material (grass shall be paid separately.)

During the maintenance period, any irregularities arising in ground levels due to watering or due to trampling by labour, or due to cattle straying thereon, shall be constantly made up to the proper levels with earth as available or brought from outside as necessary, Constant watch shall be maintained to ensure that dead patches are replanted and weeds are removed.

##### **27.11.1 Measurements**

Length, breadth of the lawn grassed shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

##### **27.11.2 Rate**

The rate shall include of all the labour and material involved in all the operations described above, excluding supply of the requisite quantity of good earth and grass so needed for properly maintaining the levels of the lawns. (payment of grass to be paid separately).

#### **27.12 RENOVATION OF LAWNS**

The area shall be first weeded out of all undesirable growth. The entire grass shall be scrapped (cheeled) without damaging roots and level of the grounds. Slight irregularities in surface shall be levelled off and the area shall then be forked so as to aerate the roots of the grass without, however up- rooting them.



Specified quantity of sludge or manure shall than be spread uniformly with wooden straight edge (phatti) as directed by the Engineer-in-charge. The area shall then be slightly sprinkled with water so as to facilitate proper integration of the manure or sludge with the soil and later flooded. The contractor shall be responsible for watering, proper maintenance and tending of the lawn for 30 days or till the grass forms a lawn fit for mowing, whichever is later.

During the above operations, all undesirable growths shall be constantly weeded out and all rubbish removed and disposed off as directed by the Engineer-in-Charge.

#### **27.12.1 Measurements**

Length, breadth of the lawn renovated shall be measured correct to 0.1 meter and the area shall be calculated in sqm. correct to two places of decimal.

#### **27.12.2 Rate**

The rate shall include of all the labour and T & P (excluding RH pipe/grass) involved in all the operations described above, excluding the supply of the requisite quantity of good earth if so needed for proper maintenance of the levels of the lawns. The cost of the sludge or manure shall be measured and paid for separately, unless its supply is specifically included in the description of the item.

### **27.13 UPROOTING RANK VEGETATION AND WEEDS AND PREPARING THE GROUND FOR PLANTING SELECTION NO. 1 DOOB GRASS**

Initially the area shall be dug up to a depth of 30 cm. and weeds and rank vegetation with roots removed thereon by repeated forking. The whole area then shall be retrenched to a depth of 60 cm in the same manner as described in 24.1. Clods of excavated earth shall then be broken upto the size not more than 75 mm in any direction. The area shall then be flooded with water and after 10 days and within 15 days of flooding, weeds shall be uprooted carefully. The rubbish arising from the above operations shall be removed and disposed off in a manner directed by the Engineer-in-charge, away from the site. The earth shall then be rough dressed and fine dressed as described in 24.6 & 24.8.

#### **27.13.1 Measurements**

Length, breadth of uprooted area shall be measured correct to 0 .1 meter and the area shall be calculated in sqm. correct to two places of decimal.

#### **27.13.2 Rate**

The rate shall include the cost of all the labour and material involved in all the operations described above.

### **27.14 EXCAVATION AND TRENCHING FOR PREPARATION OF BEDS FOR HEDGE AND SHRUBBERY**

Beds for hedges and shrubbery are generally prepared to width of 60 cm. to 125 cm. and 2 to 4 meters respectively.

Beds for hedges and shrubbery shall be prepared in the following manner. The beds shall first be excavated to a depth of 60 cm. and the excavated soil shall be stacked on the sides of the beds. The surface of the excavated bed shall then be trenched to a further depth of 30 cm, in order to loosen the soil, in the manner described in 24.1. No flooding will be done at this stage but the top surface shall be rough dressed and levelled. The excavated soil from the top 60 cm depth of the bed stacked at the site shall then be thoroughly mixed with sludge over manner in the proportion 8: 1 by ratio or other proportion described in the item. The mixed earth and manure shall be refilled over the trenched bed, levelled neatly and profusely flooded so that the water reaches even the bottom most layers of the trenched depth of the bed. the surface after full subsidence shall again be refilled with the earth and manure mixture, watered and allowed to settle and finally fine dressed to the level of 50 mm to 75 mm below the adjoining



ground or as directed by the Engineer-in-Charge. Surplus earth if any, shall be disposed off as directed by the Engineer-in-charge. Any surplus earth if removed beyond initially lead shall be paid separately. Stones, bricks bats and other foreign matter if met with during excavation or trenching shall be removed and stacked within initially lead & lift, such material as is declared unserviceable by the Engineer-in-charge shall be disposed by spreading and levelling at places ordered by him. If disposed outside the initial lead & lift, then the transport for the extra leads will be paid for separately. If a large proportion of material unsuitable for the hedging and shrubbery operations is met with and earth from outside is required to be brought in for mixing with manure and filling, the supply and stacking of such earth will be paid for separately.

#### **27.14.1 Measurements**

Length, breadth and depth of the pit excavated and trenched shall be measured correct to a cm. the cubical contents shall be calculated in cubic meter correct to two places of decimal.

#### **27.14.2 Rate**

The rate shall include the cost of all the labour and material involved in all the operations described above. The rate shall not include the cost of supply & stacking of the manure unless the same is specifically included in the description of the item.

### **27.15 DIGGING HOLES FOR PLANTING TREES**

In ordinary soil, including refilling earth after mixing with oil cake, manure and watering.

Holes of circular shape in ordinary soil shall be excavated to the dimensions described in the items and excavate soil broken to clods of size not exceeding 75 mm in any direction, shall be stacked outside the hole, stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth met with during excavation shall be separated out and unserviceable material removed from the size as directed. Useful material, if any, shall be stacked properly and separately. Good earth in quantities as required to replace such discarded stuff shall be brought and stacked at site by the contractor which shall be paid for separately.

The tree holes shall be manured with powdered Neem/castor oil cake at the specified rate along with farm yard manure over sludge shall be uniformly mixed with the excavated soil after the manure has been broken down to powder, (size of particle not be exceeded 6 mm in any direction) in the specified proportion, the mixture shall be filled in to the hole up to the level of adjoining ground and then profusely watered and enable the soil to subside the refilled soil shall then be dressed evenly with its surface about 50 to 75 mm below the adjoining ground level or as directed by the Engineer-in-charge.

**27.15.1 Measurements:** Holes shall be enumerated.

**27.15.2 Rate:** The rate shall include the cost of all the labour and material involved in all the operations described above, excluding the cost of supply and stacking the requisite quantity of manure/sludge and oil cake.

### **27.16 IN SOIL OTHER THAN ORDINARY SOIL**

Where holes are dug in (a) Hard soil (b) Ordinary rock or (c) Hard rock, the above soils occurring independently over in conjunction with each other and /or ordinary soil in any hole, the different excavated soil shall be stacked separately. Excavation in hard rock shall be carried out by chiseling only.

The stack measurement of ordinary rock and hard rock shall be reduced by 50% and of soil by 20% to arrive at the excavated volume. This excavation shall be paid for as extra over the rate for holes dug in ordinary soil above, at rate appropriate to particular soil concerned.



Sufficient quantity of good soil to replace the solid volume of stones, brick bats, unsuitable earth and other rubbish, all roots and other undesirable growth, ordinary and hard stacks shall be brought and stacked at site but the supply and stacking of such shall be paid for separately.

The useless excavated stuff shall be disposed off by spreading at places as ordered by the Engineer-in-charge. If such places are outside initially leads, carriage for the extra lead shall be paid for separately.

The ordinary soil excavated from the hole and the earth brought from outside shall then be mixed with manure screened through sieve of IS designation 1 6 mm in the proportion specified in the description of the item and filled with the pit and the same watered and finally dressed.

**27.16.1 Measurements:** The pit shall be enumerated. The volume of excavation in soil and other than a ordinary soil shall be determined by reducing the stack volume of the relevant soil with respective percentage for voids specified in 27.14.2.2.

**27.16.2 Rate:** The rate shall include the cost of all the labour and material involved in all the operations described above, including mixing refilling, watering, dressing etc. but shall not include

(a) Cost of manure over sludge (b) cost of supplying and stacking of good earth for replacement and (c) the cost of carriage beyond initial lead for disposing off useless materials. The excavation other than that of ordinary soil shall be paid extra over and above the rate if excavation in ordinary soil.

## **27.17 M.S. FLAT IRON TREE GUARD**

### **27.17.1 M.S. Iron Riveted Tree Guard**

The tree guard shall be 600 mm in diameter and 2 meter high above ground level and 25 cm in below ground level.

The tree guard shall be framed of 4 nos. 25 x 6 mm M.S. flat 2 meter long excluding displayed outward at lower and upto an extent 10 cm and 8 nos. 25 x 3 mm vertical M.S. Flat Rivetted to 3 Nos. 25 x 6 mm Flat iron rings in two halves, bolted together 8 mm dia and 30 mm long M.S. bolts and nuts. The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade over a priming coat of ready mixed steel primer of approved brand and manufacturer. The design of tree guards shall be shown in the drawing.

**27.17.2 Measurement:** The tree guard shall be enumerated.

**27.17.3 Rate:** The rate shall include the cost of all the labour and material involved in all the operations described above.

### **27.17.4 M.S. Flat Iron Welded Tree Guard**

The tree guard shall be 600 mm in diameter and 2 meter high above ground level and 25 cm in below ground level.

The tree guard shall be framed of 4 nos. 25 x 6 mm MS. Flat 2 metres long excluding displayed outward at lower and upto an extent 10 cm and 8 Nos. 25 x 3 mm vertical M.S. Flat Riveted to

3 nos. 25 x 6 mm flat iron rings in two halves, bolted together 8 mm dia and 30 mm long M.S. Bolts & nuts. The entire tree guard shall be given two coats of synthetic enamel paint of approved brand and manufacturer of required shade brand and manufacturer of required shade over a priming coat of ready mixed steel primer of approved brand and manufacturer. The design of tree guards shall be shown in the drawing.

**27.17.5 Measurement:** The tree guard shall be enumerated.

**27.17.6 Rate:** The rate shall include the cost of all the labour and material involved in all the operations described above.





## **27.18 FILLING MIXTURE OF EARTH & SLUDGE OVER MANURE**

The separately specified earth and sludge shall be broken down to particles of size not exceeding 6 mm in any directions before mixing. Good earth shall be thoroughly mixed with sludge over manure in specified proportions as directed by Officer-in-Charge. During the process of preparing the mixture as above, trenches shall be flooded with water and levelled.

### **27.18.1 Measurements**

Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

### **27.18.2 Rate**

The rate shall include the cost of all the labour and material involved in all the operations described above, but do not include the good earth, sludge or manure which will be paid separately.

## **27.19 EXCAVATION OF DUMPED STONE OR MALBA**

Excavation operations shall include excavation and getting out water if required. During the excavation stone, brick bats and other foreign material if met shall be removed and stacked within 50m leads and lifts. Such material as is declared unserviceable by the Engineer-in-Charge be disposed within 50m. The excavated surface shall be neatly dressed and levelled.

### **27.19.1 Measurements**

Measurement shall be made in (Length, breadth and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

### **27.19.2 Rate**

The rate shall include the cost of all the labour and material involve in all the operations described above.

## **27.20 EXCAVATION IN BAJRI PATH**

All excavated operations shall include excavation and stacking of serviceable and unserviceable material. Excavated surface of Bajri path shall be removed and stacked upto 50 meter lead and disposed material neatly dressed.

### **27.20.1 Measurements**

Same as 24.18.2.

### **27.20.2 Rate**

Same as 24.18.3.

## **27.21 EXCAVATION OF WATER BOUND MACADAM/ WET MIX MACADAM**

All excavated operations shall include excavation, stacking of serviceable and unserviceable material. Excavation shall be straight and uniform in width. Soling stone and aggregate obtained from excavation of W.B.M. shall be stacked separately and unserviceable material disposed off with lead upto 50 meter and lift upto 1.50 meter and neatly dressed.

### **27.21.1 Measurements**

Measurement shall be made in (Length, breadth, and height of stacks) cubic meter. The cubical contents shall be worked out to the nearest two places of decimal in cubic meter.

### **27.21.2 Rate**

The rate shall include the cost of all the labour and material involved in all the operations described above.

## **27.22 FLOODING THE GROUND WITH WATER AND MAKING KIARIES**



The water for flooding shall be of soft water and free from chemical and good for growing the trees and shrubs etc. Before flooding the kiaries shall be made in required size and shape as per directions of Officer-in-charge. After uprooting weeds from the trenched area and uprooting vegetation, kiaries shall be dismantled.

#### **27.22.1 Measurements**

Measurement shall be made in sqm. of area.

#### **27.22.2 Rate**

The rate shall be for 100 sqm of area and include the cost of all the labour and material involved in all the operations described above.







