The Contractor shall carry out, at the work place, the requisite tests like pull out test, shear test, etc. for chemical anchors and pull out test for dowels. The chemical anchors shall withstand the load specified in the drawing/ documents and the Dowels shall be tested for full tensile capacity of the rebars. The decision of the Engineer-in-Charge regarding the adequacy of strength and load carrying capacity of the anchors/ dowels shall be final and binding to all. The cost of all such tests shall be borne by the Contractor.

12.4 Installation

The Contractor shall install the chemical anchors/ dowels at their correct location (to suit the requirement of fixtures as shown in drawings) as per the procedure laid down by the manufacturer. Location of all holes shall be pre-marked on the concrete surfaces and then holes drilled carefully with an electric drill to the correct recommended size and depth. Holes shall be exactly round and true perpendicular to the concrete surface. Edge distance and pitch of fasteners shall be as recommended by the manufacturer. The contractor shall suitably shift the hole with the approval of the Engineer-in-Charge in case any reinforcement bar is met with while drilling the hole in RCC structure. Necessary staging shall be provided for working and the Contractor shall take requisite safety precautions so as not to cause any damage to the existing structure/ equipment. Any damage done while executing the job shall be made good by the Contractor at his cost.

12.5 Payment

Payment for installing chemical anchors shall be made on number basis (each). The rate shall include supply of complete assembly i.e. chemical anchors along with chemical foils as per manufacturer specifications.

Payment for installing chemical dowels shall be made on number basis (each). The rate shall include fixing of dowels by drilling/ cleaning hole and injecting odourless chemical as per manufacturer specifications. Rebars used as dowels shall be paid separately under relevant SOR item.

For chemical anchors/ dowels, the rate shall be inclusive of handling, transporting, providing necessary temporary staging, installing (as per manufacturer's specifications) in PCC/ RCC structures to a required depth with a specified hole diameter, at all levels and locations, testing, drilling holes, cleaning, covering with jute cloth, relocating and re-drilling in case of any obstruction, making good any damage done to the structure, grouting the abandoned holes and any gap left between the contact surfaces of PCC/ RCC and fixtures to be added, etc. all complete.

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STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

ईंट की चिनाई

BRICK MASONRY

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	21.12.20	REVISED & REISSUED AS STANDARD SPECIFICATION	AS	RBS	AS	SM
4	10.03.16	REVISED & REISSUED AS STANDARD SPECIFICATION	MK	AJS	RS	S CHANDA
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2	06.04.00	REAFFIRMED & ISSUED	SBJ	SKP	SCJ	MI

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Abbreviations:

BIS	:	Bureau of Indian Standards
IS	:	Indian Standards

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Convener: Mr. Anurag Sinha

Members: Mr. C. Damodaran
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

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1.0 SCOPE

This specification establishes the materials, dressing, laying, joining, curing, workmanship etc. for brick masonry works. Brick masonry shall also comply with all the requirements of IS: 2212.

2.0 REFERENCES

2.1 BIS Codes

S. No.	IS No.	Title
1.	IS:2212	Brick works- code of practice
2.	IS: 2250	Code of practice for preparation and use of Masonry mortars
3.	IS: 2750	Specification for Steel Scaffoldings

2.2 EIL specifications

6-68-0002: Materials

3.0 MATERIALS

Refer EIL Specification No. 6-68-0002.

4.0 GENERAL REQUIREMENTS

4.1 Cement Mortar

Cement mortar shall meet the requirements of IS:2250 and shall be prepared by mixing cement and sand by volume. Proportion of cement and sand shall be 1:6 (1 part of cement and 6 parts of sand), or as directed by the Engineer-in-Charge/shown on the drawing, for brick masonry of one brick thickness or more, while 1:4 cement mortar (1 part of cement and 4 parts of sand) shall be used for brick masonry of half brick thickness. The sand being used for mortar shall be sieved. The mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within initial setting time of cement after water is added to the dry mixture. Mortar unused for more than initial setting time of cement, shall be rejected and removed from the site of work.

4.1.1 Proportioning

The unit of measurement for cement shall be a bag of cement weighing 50 Kg and this shall be taken as 0.035 cubic metre. Sand shall be measured in boxes of suitable size on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

4.1.2 Mixing

The mixing of mortar shall be done in a mechanical mixer operated manually or by power. The Engineer-in-Charge may, however, permit hand-mixing as a special case, taking into account the magnitude, nature and location of work. The Contractor shall take the prior permission of Engineer-in-Charge, in writing, for using hand-mixing before the commencement of work.

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4.1.2.1 Mixing in Mechanical Mixer

Cement and sand in specified proportions, by volume, shall be thoroughly mixed dry in a mixer. Water shall then be added gradually and wet mixing continued for atleast one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste. Wet mix from the mixer shall be unloaded on water-tight masonry platform, made adjacent to the mixer. Platform shall be atleast 150 mm above the levelled ground to avoid contact of surrounding earth with the mix. Size of the platform shall be such that it shall extend atleast 300mm alround the loaded wet mix area. Wet mix, so prepared, shall be utilised within initial setting time of cement after addition of water. Mixer shall be cleaned with water each time before suspending the work.

4.1.2.2 Hand Mixing

The measured quantity of sand shall be levelled on a clean water-tight masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backward and forward, several times till the mixture is of uniform colour. The quantity of dry mix which can be consumed within initial setting time of cement shall then be mixed with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

5.0 CONSTRUCTION PROCEDURE

5.1 Soaking of Bricks

Bricks shall be soaked in water before use for a period that is sufficient for the water to just penetrate the whole depth of bricks as well as to remove dirt, dust and sand. Proper soaking of bricks shall prevent the suction of water from the wet mortar as otherwise mortar will dry out soon and crumble before attaining any strength. The bricks shall not be too wet at the time of use as they are likely to slip on mortar bed and there will be difficulty in achieving the plumbness of wall as well as proper adhesion of bricks to mortar. The period of soaking shall be determined at site by a field test by immersing the bricks in water for different periods and then breaking the bricks to find the extent of water penetration. The least period that corresponds to complete soaking, will be the one, to be allowed for in the construction work.

The soaked bricks shall be stacked over a clean place, wooden planks or masonry platforms to avoid earth, dirt being smeared on them. It shall be ensured that at the time of laying of soaked bricks, they are skin dry.

5.2 Laying

5.2.1 Brick Work (one or more brick thickness)

Brick work (one or more brick thickness) shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except when needed to complete the bond. In no case the defective bricks shall be used.

A layer of average thickness of 10mm of cement mortar shall be spread on full width over a suitable length of lower course or the concrete surface. In order to check and achieve uniformity in masonry, the thickness of bed joints shall be such that four courses and three joints taken consecutively shall measure equal to four times the actual thickness of the brick plus 30mm. Each brick with frog upward, shall be properly bedded and set in position by gently tapping with handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next brick is laid and pressed against it. After completion of the course, all vertical joints shall be filled from top with mortar.

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All brick courses shall be taken up truly plumb; if battered, the batter is to be truly maintained. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. The level and verticality of work in walls shall be checked up at every one metre interval.

The masonry walls of structures shall be carried up progressively, leaving no part one metre lower than the other. If this cannot be adhered to, the brick work shall be raked back according to bond (and not left toothed) at an angle not more than 45 degrees but raking back shall not start within 60 cm of a corner. In all cases returns, buttresses, counter forts, pillars etc. shall be built up carefully course by course, and properly bonded with the main walls. The brick work shall not be raised more than fourteen (14) courses per day.

At the junction of any two walls, the bricks shall at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work.

The courses at the top of plinth and sills, at the top of the wall just below the soffit of the roof slab or roof beam and at the top of the parapet, shall be laid with bricks on edge. Brick on edge course shall be so arranged as to tightly fit under the soffit of the roof beam or roof slab, restricting the mortar layer thickness upto 12mm. However, any gap between the finished brick work and soffit of roof slab/beam shall be suitably sealed with the mortar.

5.2.2 Brick Work (half brick thickness)

For brick walls of half brick thickness, all courses shall be laid with stretchers. Wall shall be reinforced with 2 nos. - 6mm diameter mild steel bars, placed at every fourth course. The reinforcement bars, shall be straightened and thoroughly cleaned. Half the mortar thickness for the bedding joint shall be laid first and tor steel reinforcement, one on each face of the wall, shall be embedded, keeping a side cover of 12mm mortar. Subsequently, the other half of the mortar thickness shall be laid over the reinforcement covering it fully.

The reinforcement bars shall be carried at least 150mm into the adjoining walls or RCC columns. In case the adjoining wall being of half brick thickness, the length of bars shall be achieved by bending the bars in plan. During casting of reinforced concrete columns, 6mm dia. mild steel bars shall be placed at every fourth course of brick masonry. At the junction of two walls, the brick shall, at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. The brick masonry work shall not be raised more than 14 courses per day.

Brick course under the soffit of beam or slab, shall be laid by restricting the mortar thickness to 12mm. However, any gap between the finished brickwork and soffit of slab/beam, shall be suitably sealed with the mortar.

5.2.3 Cavity Walls

Brick work in cavity walls shall be similar to general brickwork. It shall consist of one wall of one or more brick thickness while the other wall shall be of half brick thickness at a clear gap of 50mm. The brick work on either side of cavity shall conform to the specifications already as stated in Cl. No. 5.2.1 and 5.2.2. At the base of the cavity wall, the walls shall be solidly constructed upto 300mm above the ground level. The cavity wall shall be terminated 300mm below the soffit of roof slab/beam and the courses over this shall be continued as solid brickwork.

Cavity should be continuous and free from obstructions. Mortar droppings shall be prevented from falling down the cavity by the use of laths or by hayhands which shall be drawn up the cavity as the work proceeds. Any mortar which may unavoidably fall on the

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wall-ties, shall be removed daily and temporary openings shall be provided to permit the daily removal of mortar droppings from the bottom of the cavity.

The outer and inner leaves shall be tied by means of wall ties. Ties shall be of tor steel bars of 8mm dia. 200 mm long with hooks at both the ends. These shall be placed not more than 750mm c/c horizontally and not more than 300mm vertically, and staggered. Additional ties shall be provided near the openings. There shall at least, be 5 ties per square metre of surface area of the wall. Ties shall be given a bituminous coat before placement, to protect them from corrosion.

In order to keep the cavity dry, air slots shall be provided in the cavity walls at bottom as well as top to the extent of 50 sq.cm area of vents to every 2.0 sq.metre area of the wall.

5.2.4 Circular Brick Work

The detailed specification for brick work covered under clauses 5.2.1 & 5.2.2 shall also apply for circular brickwork. Bricks forming skew backs, shall be dressed or cut so as to give proper radial bearing. Defects in dressing of bricks shall not be covered up by extravagant use of mortar, nor shall the use of chips etc. be permitted.

The circular brick work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flushed 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 be between 5mm and 15mm.

5.3 Jointing

Joints shall be restricted to a width of 10mm with brickwork of any classification. All bed joints shall be normal to the pressure upon them i.e. horizontal in vertical walls, radial in circular brick masonry and at right angles to the face in the battered retaining walls. The vertical joints in alternate courses shall come directly one over the other and shall be truly vertical. Care shall be taken that all the joints are full of mortar, well flushed up. In case no pointing is to be done, cement mortar shall be neatly struck as the work proceeds. The joints in faces which are to be plastered or pointed shall be squarely raked out to a depth of 12mm while the mortar is still green. The rake joints shall be brushed to remove loose particles. After the day's work, the faces of the brick work shall be cleaned on the same day with wire brush and all mortar droppings removed.

5.4 Curing

Green work shall be protected from rain or any other running water or accumulated water from any source, by suitable means. Masonry work, as it progresses, shall be kept thoroughly wet by sprinkling water at regular intervals, on all faces. Curing shall be done after 24 hours of completion of day's work as per IS:2212.

5.5 Staging/Scaffolding

5.5.1 Staging/scaffolding shall be properly planned and designed by the Contractor. Use of only steel tubes is permitted for staging/scaffolding. Design of staging/scaffolding shall be submitted for approval of the Engineer-in-Charge, before commencement of work.

Single scaffolding having one set of vertical support, shall be used and other end of the horizontal scaffolding member shall rest in a hole provided in the header course. The support shall be sound and strongly clamped with the horizontal pieces over which the scaffolding planks shall be fixed. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with plain cement concrete of grade 1:2:4 (M15)

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during plastering. Suitable access shall be provided to the working platform area. The scaffolding shall be strong enough to withstand all loads likely to come upon it and shall also meet the requirements specified in IS:2750.

Double scaffolding shall be provided for pillars less than one metre in width or for the first class masonry or for a building having more than two storeys.

Following measures shall also be considered during erection of the scaffolding/ staging:

a) Sufficient sills or underpinnings, in addition to base plates, shall be provided, particularly, where scaffoldings are erected on soft grounds.

b) Adjustable bases to compensate for uneven ground shall be used.

c) Proper anchoring of the scaffolding/staging at reasonable intervals shall be provided in each direction with the main structure wherever available.

d) Horizontal braces shall be provided to prevent the scaffolding from rocking.

e) Diagonal braces shall be provided continuously from bottom to top between two adjacent rows of uprights.

f) The scaffolding/staging shall be checked at every stage for plumb line.

g) Wherever the scaffolding/staging is found to be out of plumb line, it shall be dismantled and re-erected afresh. Efforts shall not be made to bring it in line with a physical force.

h) All nuts and bolts shall be properly tightened and care shall be taken that all the clamps/couplings are firmly tightened to avoid slippage.

i) Erection work of a scaffolding/staging, under no circumstance shall be left totally to semiskilled or skilled workmen and shall be carried out under the supervision of Contractor's technically qualified civil engineer.

5.5.2 For smaller works or works in remote areas wooden ballies may be permitted for scaffolding/staging by the Engineer-in-Charge at his sole discretion. The contractor must ensure the safety and suitability of such works as described under clause 5.5.1 above.

5.6 Embedment of Fixtures

All fixtures, pipes, conduits, holdfasts of doors and windows etc. required to be built in walls, shall be embedded in plain cement concrete block of grade 1:2:4 (M15), at the required positions, as the work proceeds.

6.0 PAYMENT

This clause shall apply to Item Rate tender only.

6.1 General

The payment of brick masonry shall be inclusive of all labour, material, scaffolding/staging sampling and testing, soaking of bricks, laying of bricks, raking of joints, cutting of bricks, providing recesses and making rectangular or round openings, sealing the gap between brick masonry and soffit of beam/slab with and including cement mortar, curing, making of masonry platform for unloading the wet mix, embedding the fittings/fixtures including

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providing PCC 1:2:4 (M15) etc, all as specified for all heights and depths. Deduction for rectangular or circular openings shall be done as per relevant BIS Codes.

6.1.1 Payment for brick masonry works of one or more brick thickness, including circular brickwork, shall be made on cubic metre basis of the work done.

6.1.2 Payment for half brick masonry work shall be made on square metre basis on the area of work done and shall also include the cost of supplying and fixing of reinforcement bars in position.

6.1.3 Payment for forming the cavity shall be in square metres and shall include the cost of laying of bitumen coated tor steel ties in position, labour required for keeping the cavity clear, providing air slots etc.

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STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

गिराने एवं तोडने सम्बंधी कार्य
DEMOLITION AND DISMANTLING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor		Standards Bureau Chairman
					Approved by		
5	13 05 19	REAFFIRMED & REISSUED	TK	AS	RS		RKT
4	18 11 13	REVISED & ISSUED AS STANDARD SPECIFICATION	AJS	RS	PKM	SC	SC
3	10 06 08	REAFFIRMED & REISSUED	PKB	PKM	VK		VC
2	25 04 01	REVISED & ISSUED AS STANDARD SPECIFICATION	SKP	RS	SCJ		MI
1	16 03 98	REVISED & ISSUED AS STANDARD SPECIFICATION	SARITA	SKP	SCJ		AS
0	AUG'89	ISSUED AS STANDARD SPECIFICATION		AKV	GPL		RCPC

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Abbreviations:

C&D	:	Construction & Demolition
GI	:	Galvanized Iron
RA	:	Recycled Aggregates
RCC	:	Reinforced Cement Concrete

Structural Standards Committee

Convenor : Mr. Rajanji Srivastava

Members : Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr, Amitabh Kishore
Mr. Gyasuddin
Mr. Ravindra Kumar (Const.)
Mr. Charanjit Singh (Proj.)

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1.0 SCOPE

This specification covers the procedure and safety requirements for demolition and dismantling of masonry (Brick & Stone), concrete (Plain /Reinforced), structural steel (sheeted/ unsheeted) works.

2.0 GENERAL

2.1 Apart from this specification, the demolition and dismantling of structures (part or whole) shall be in compliance with all statutory safety regulations and any other special requirement as shown/ noted on the drawings and General Conditions of Contract. Prior consent and approval of the Engineer-in-Charge shall be obtained in writing before starting any dismantling works. Any restrictions imposed regarding working hours shall also be strictly followed by the Contractor.

2.2 All materials obtained from dismantling/demolition operations shall be the property of the Owner unless otherwise specified and shall be segregated as serviceable or unserviceable materials and kept in safe custody until handed over to the Engineer-in-Charge.

2.3 Contractor shall follow the principle of selective demolition by sequencing the demolition activities in such a way that the non-structural materials like window/ door frames, pipes, tiles, bricks, asphalt, ceramics, etc. shall be removed first before starting the main demolition activities.

2.4 Where it becomes necessary to disconnect any existing service line(s) (such as electrical, piping etc.) during dismantling/demolishing operation and where so required by the Engineer-in-Charge, suitable alternate arrangement shall be made by the Contractor to maintain the continuity and proper functioning of the affected service line(s) with the approval of the Engineer-in-Charge at no extra cost to the Owner.

2.5 Specification No. 6-68-0003 (Earthwork) shall be referred to the extent applicable.

3.0 SAFETY PRECAUTIONS

3.1 The Contractor shall adhere to safe demolishing/ dismantling practice at all stages of work to guard against accidents, hazardous and unsafe working procedures.

3.2 Necessary propping, shoring, strutting and/or underpinning shall be done for the safety of all surrounding structures (whose safety is likely to be endangered) before taking up the demolishing and dismantling works.

3.3 Temporary enclosures/ barricading made out of GI sheets, fencings, danger lights, warning tapes, etc. shall be provided by the Contractor and got approved by the Engineer-in-Charge before start of work to prevent accidents.

3.4 Contractor must ensure the availability of adequate fire fighting equipments/ arrangements before starting actual demolishing/ dismantling works. These facilities shall be made available throughout the entire operation of demolition and dismantling of structures.

3.5 All equipments, pipes, fittings and instruments, underground utilities etc. located in the vicinity shall be protected by suitable means, as decided by the Engineer-in-Charge, during demolishing/ dismantling operations.

3.6 Roads and working spaces shall be kept free of any debris/dismantled materials at the end of day's work.

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3.7 Necessary measures shall be taken to keep the dust and noise nuisance to minimum levels.

3.8 Dismantled elements/components shall not be dropped from a height or thrown from a distance. Dismantling of elements fixed by screws/bolts/hooks etc. shall be done by taking out the fixtures with proper tools only. Such fixtures may be allowed to be cut by sawing or flame cutting, in the event of their being stuck up due to corrosion etc. However, the decision of Engineer-in-Charge in this regard shall be final and binding. Welds shall be removed by flame cutting. Tearing or ripping of elements shall not be resorted to under any condition.

3.9 Dismantling of equipments/ instruments and such other fixtures shall be done with utmost care with proper tools & tackles and shall be stacked separately. Their disposal or retainment shall be as per the directions of Engineer-in-Charge.

4.0 PROCEDURE

4.1 Entire work of demolishing & dismantling shall be meticulously planned. Prior to start of work, the Contractor shall thoroughly understand the scope and nature of the work, and then prepare and submit the proposed work execution plan of demolishing & dismantling to the Engineer-in-Charge for his review. Comments if any, shall be taken care by the contractor and execution of the work shall be done based on the revised execution plan.

4.2 Demolition and dismantling shall be restricted to the extent shown on drawings or as directed by the Engineer-in-Charge.

4.3 Necessary work permits (as applicable) shall be obtained prior to start of demolishing/ dismantling activities.

4.4 Demolition of any structure shall be carried out in the sequence reverse to that followed at the time of its construction.

4.5 Dismantling shall be done in a systematic manner. All elements including equipments/ instruments shall be carefully removed without causing any damage.

4.6 Blasting in any form shall not be permitted. However, techniques like pneumatic/ hydraulic breakers, diamond cutting, etc. shall be utilized to the maximum possible extent.

4.7 Chipping of concrete/grout shall be done with precision by chiseling. The finished surfaces shall be made true to the requisite size and shape.

4.8 Pockets/holes of specified size shall be made/ cut by drilling/ chiseling/ core cutting/ diamond cutting, etc.

4.9 Cut-outs in RCC Slab/ wall shall be made by vibration-less spark-free mechanical means like core-cutting, wet cutting by diamond wall saw system, etc.

5.0 CLEANING & STACKING

All demolished/dismantled serviceable materials such as bricks, stones, reinforcement bars, structural steel, sheeting etc. shall be separated out, cleaned and stacked in separate lots within the plant boundary as directed by the Engineer-in-Charge.

6.0 DISPOSAL

All unserviceable materials shall be disposed off in spoil heaps within or outside the plant boundary as per the directions of the Engineer-in-Charge. Areas required outside the plant

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boundary for dumping of disposed material shall be arranged by the contractor and got approved by the Engineer-in-Charge.

7.0 C&D WASTE MANAGEMENT

Contractor shall make all possible efforts to reduce, reuse and recycle Construction & Demolition (C&D) waste. A comprehensive Waste Management Plan shall be submitted to the Engineer-in-Charge for review. As a social responsibility, contractor shall promote and spread awareness about recycling of C&D waste that can act as a perfect substitute for depleting natural aggregate resources, shortage of dumping sites, increasing transportation & disposal cost, stringent regulations for extracting new materials and environmental pollution as a whole. Recycling equipments like jaw/ cone crushers, shaft impactors, magnetic separators, vibrating screens, washing equipments, etc. are now easily available in the market. Recycled Aggregates (RA) both coarse & fine can be used in PCC, pavements, drains, plastering, making bricks, kerb stones, pavement blocks and for soil stabilization. Residual concrete can be recycled in Ready Mixed Concrete Plants by installing Recycling Drum and rebars extracted from C&D waste can be used in drains, pavements, chairs, spacers, stirrups, etc.

8.0 PAYMENT

8.1 General

Measurement of all works shall be taken prior to start of demolishing/ chipping/ dismantling works.

8.2 Masonry/Concrete Works (Demolition)

8.2.1 Payment shall be made on the basis of actual volume in cubic metres (cu.m.) of masonry/ concrete works demolished. The thickness of plaster/ bitumen felt shall be included in measurements.

8.2.2 The rate for demolishing shall include supply of all labour, tools & tackles, necessary safety measures, propping, underpinning, scaffolding, handling, cutting, straightening, scraping & cleaning of reinforcement bars and other embedments (in case of reinforced concrete works), sorting out and stacking of all serviceable materials, disposal of all unserviceable material, clearing the site, etc. all complete as specified and directed by the Engineer-in-Charge.

8.3 Excavation & Backfilling

8.3.1 Excavation and backfilling shall be paid separately as per relevant clauses of Specification No. 6-68-0003 for Earth Work.

8.4 Chipping of Concrete Works

8.4.1 Payment shall be made on the basis of admissible area in square metres (sq.m.) of concrete surfaces chipped, pertaining to the different categories of thicknesses specified in the schedule of items.

8.4.2 The rate for chipping shall include supply of all labour, tools and tackles, necessary safety measures, scaffolding, chiseling, handling, exposing, cutting, straightening, scraping, clearing the reinforcement bars (in case of reinforced concrete works), wire brushing and washing the exposed surfaces, disposal of all unserviceable material etc. all complete as directed.

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8.5 Making Pockets/Holes in Concrete Works and Cut-outs in RCC Slab/ Wall

8.5.1 Payment for Pockets/ holes shall be made on the basis of number (Each) of pockets/ holes of sizes upto & inclusive of 200x200x500mm deep, made or cut in the concrete works at all depths & heights.

8.5.2 Payment for cut-outs in RCC slab/ wall shall be made in CuM on the basis of plan/ elevation area for a thickness upto & inclusive of 400mm at all depths & heights.

8.5.3 The rate for making pockets/holes and cut-outs shall include supply of all labour, tools & tackles, necessary safety measures, scaffolding, chiseling, drilling, core/ diamond cutting, diamond wall saw system, handling, cutting or relocating reinforcement bars, cleaning, disposal of all unserviceable material etc. all complete as directed.

8.6 Dismantling of Structural Steel Works

8.6.1 Payment shall be made on the basis of weight (MT) of the structure/components being dismantled. Assessment of weight shall be done as per the specifications or as per the direction of Engineer-in-Charge.

8.6.2 The rate for dismantling shall include supply of all labour, tools and tackles, equipment, consumables, necessary safety measures, scaffolding, propping, handling, unbolting, cutting (by sawing or flame cutting) of gussets/ plates/ bolts/ hooks/ welds, cleaning, sorting out and stacking of all serviceable materials, disposal of all unserviceable material, etc. all complete as specified and directed.

8.7 Dismantling of Roof & Wall Sheeting

8.7.1 Payment shall be made on the basis of dismantled sheeted area in square metres (sq.m.) of plan area in case of roof sheeting and area in elevation in case of side and louver sheeting.

8.7.2 The rate for dismantling shall include supply of all labour, tools and tackles, equipments, consumables, necessary safety measures, handling, scaffolding, unbolting, cutting (by saw or flame cutting) of hook bolts, removal of ridges, gutters, flashings, transporting, stacking of all serviceable materials, disposal of all unserviceable material, etc. all complete as directed.

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STANDARD SPECIFICATIONS
CIVIL AND STRUCTURAL WORKS
MISCELLANEOUS ITEMS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
6	13.03.25	REVISED & REISSUED	TARUN KAPOOR	AMARJEET	ANURAG SINHA	MAINAK NANDI
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0	AUG 89	ISSUED AS STANDARD SPECIFICATION	-	AKV	GPL2	RCPC

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Abbreviations:

BIS	:	Bureau of Indian Standards
DPC	:	Damp Proof Course
FGL	:	Finished Ground Level
IS	:	Indian Standard
RCC	:	Reinforced Cement Concrete

Structural Standards Committee

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1.0 SCOPE

The scope shall be as specified separately for different items below.

2.0 REFERENCES

2.1 BIS Codes

IS:73 : Paving bitumen - specification

IS:383 : Specification for coarse and fine aggregates from natural sources for Concrete

IS:6313 : Code of practice for Anti-termite measures in buildings

2.2 EIL specifications

6-68-0002: Materials
6-68-0004: Plain and Reinforced Cement Concrete

3.0 MATERIALS

The materials shall be as specified separately for different items below.

4.0 GENERAL REQUIREMENTS

The Contractor shall test the materials, wherever applicable, in approved laboratory as required by the Engineer-in-Charge and furnish test certificates for materials and obtain the approval of the Engineer-in-Charge prior to the use of such materials in the works. All tests shall be in accordance with relevant Indian Standards.

5.0 PRE-CONSTRUCTIONAL ANTI-TERMITE TREATMENT

5.1 Scope

This specification establishes the materials and method of accomplishing pre-constructional anti-termite treatment of soil for protection of buildings against attack by subterranean termites with the usage of chemical emulsions in accordance with the procedure laid down.

5.2 Materials

Refer EIL Specification No. 6-68-0002.

5.3 Procedure for Treatment

5.3.1 Anti-termite chemicals have an adverse effect upon health when absorbed through the skin, inhaled as vapours or spray mist or swallowed. Applicators shall wear appropriate Personal Protective Equipments (PPEs) and exercise due precautions in handling these chemicals while preparing solution and carrying out soil treatment.

The storage and application of anti-termite compounds shall be carried out by a trained professional agency possesses a valid license issued by the respective State/ Central government department of Agriculture as required under the Insecticides Act and the Rules framed thereunder. Necessary documents shall be submitted by the Contractor to the Engineer-in-Charge for review and approval.

Apart from this specification, the work shall be carried out in compliance with IS:6313. In case of any contradiction, this specification shall govern.

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5.3.2 **Site Preparation**

Prior to start of Anti Termite treatment, area(s) shall be made free from logs, stumps, timber offcuts, leveling pegs, roots of plants/ trees etc. Soil treatment shall start when foundation trenches/ pits are ready to take concrete/ masonry in foundations and plinth area ready for laying the subgrade. Treatment shall not be carried out when it is raining or the subsoil water level is at the same or higher than the level of treatment. In the event of water-logging of foundations, the water shall be pumped out and the chemical emulsion applied when the soil is absorbent.

5.3.3 **Treatment of the excavated pits/ trenches and backfill for Foundations**

a) The bottom surface and the lower 300 mm side surfaces of the excavated pits/ trenches for foundations of masonry works and RCC plinth beams supporting such masonry works, shall be treated with specified chemical emulsion @ 5 litres/m^2 of the surface area. However, no such treatment shall be required in case of pits/ trenches made for RCC foundations supporting RCC walls and/ or columns.

b) On completion of construction of masonry foundations, the backfill in immediate contact with the substructure shall be treated in layers, of 300 mm, with emulsion @ 7.5 litres/m^2 of the vertical surface of the substructure (i.e. 7.5 x 0.3 = 2.25 litres/meter of perimeter) for each side. The treatment shall be given after ramming of each layer of soil, by rodding the earth at 150 mm centres close to the wall surface and working the rod backward and forward (parallel to the wall surface) and then spraying the specified dosage of emulsion. The emulsion shall be directed towards the masonry surfaces so that the soil in contact with these surfaces is well treated with the chemical. After the treatment, the soil shall be tamped back into place. This shall be done for full depth of the fill.

c) For RCC walls and columns, the treatment as specified in (b) shall start from a depth 500 mm below the finished ground level, and shall be done upto the FGL.

5.3.4 **Treatment of Plinth/ Basement and Apron**

a) The top surface of the consolidated earth below the non-suspended floor slabs and the peripheral aprons of widths upto 750 mm, the bottom surface and side surfaces of the excavated pits for the basements shall be treated with chemical emulsion @ 5 litres/m^2 of the surface area. Holes 50 mm to 75 mm deep at 150 mm centre, both ways, shall be made on the surface with 12 mm diameter mild steel rod and then emulsion shall be sprayed uniformly over the area. At expansion joint locations, anti-termite treatment shall be supplemented by treating through the expansion joint @ 2.0 litres per linear metre of joint after the sub-grade has been laid.

b) Treatment of Junctions of plinth filling and wall/column faces shall be done after making a small channel 30 mm x 30 mm, by making rod holes 150 mm apart (upto the ground level) in the channel and then by moving the rod backward and forward to break up the earth. The chemical emulsion shall be poured along the channel @ 7.5 litres/m^2 of the vertical wall/column surface so as to soak the soil right to the bottom. The soil shall be tamped back into place after the treatment.

5.3.5 **Treatment of Soil along External Perimeter of Building**

After the building is complete, the earth along the external perimeter shall be rodded at intervals of 150 mm and to depth of 300 mm. The rod shall be moved backward and forward parallel to the wall to break up the earth and chemical emulsion poured along the

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wall @ 7.5 litres/m^2 of vertical surface (i.e. 7.5 x 0.3 = 2.25 litres/metre of perimeter). After the treatment, the earth shall be tamped back into place.

5.4 Guarantee

A Guarantee of minimum 10 years shall be provided by the contractor against the performance of the Anti-termite treatment.

5.5 Payment

This clause shall apply to Item Rate tender only.

Payment for pre-constructional anti-termite treatment shall be made on square metre (sq.m.) basis of plinth area of the building at ground floor only.

The rate shall include supplying all materials, spray pumps, tools, tackles & other accessories, labour, site preparation, rodding, tamping, mixing, spraying the specified chemical emulsion at prescribed dosage, storage facilities, handling, transporting etc. all complete as directed & specified.

6.0 ANTI-CORROSIVE LAYER

6.1 Scope

This specification covers the requirement of materials, method of preparation and procedure for laying an anticorrosive layer over top surface of tank foundations for protection of bottom plates of steel tanks against corrosion attack.

6.2 Materials

6.2.1 Sand shall be clean, dry, coarse, hard, angular, free from coatings of clay, dust and mix of vegetable and organic matter and shall conform to IS:383 - Grade III.

6.2.2 Bitumen shall be of grade VG10 conforming to IS:73.

6.3 Mixing and Laying

The bitumen shall be heated till it melts. 3% kerosene may be added if required. Sand shall be thoroughly mixed with bitumen (8% to 10% by volume) in a mixing drum to give a uniform mixture and shall be laid over clean and dry surface of tank foundation to line, grade and levels as shown on the drawings and directed by the Engineer-in-Charge. Bitumen shall not be heated beyond the specified temperature limits. The layer shall be tamped to form hard mass of specified compacted thickness.

6.4 Payment

This clause shall apply to Item Rate tender only.

The payment shall be made on square metre (sq.m.) basis of the area covered with the anticorrosive layer.

The rate shall include supplying all materials, tools, plants, labour, transportation, handling, heating, mixing, laying, tamping etc. all complete as specified.

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7.0 DRESSING & TRIMMING

7.1 Scope

This specification covers the procedure for dressing, trimming and paving with earth the peripheral area around the completed building/ structure.

7.2 Procedure

The ground all around the completed building/structure for 3 metres width or as specified by the Engineer-in-Charge, shall be cleaned and dressed to suitable slope. Over the prepared ground a layer of approved earth shall be spread, watered and well consolidated so as to achieve an average thickness of 75 mm.

7.3 Payment

This clause shall apply to Item Rate tender only.

Payment shall be made on square metre (sq.m.) basis of the actual area dressed and paved with earth.

The rate shall include supplying all materials, labour including cleaning, dressing the ground to required slope, spreading of earth, watering, ramming, consolidating etc. all complete as directed.

8.0 BREAKING PILE HEADS

8.1 Scope

This specification covers procedure for breaking pile heads of RCC piles.

8.2 Procedure

8.2.1 Head of already cast/ driven RCC piles shall be broken after 28 days of casting up to a length and elevation as shown on the drawing by chiseling or by approved mechanical means taking all necessary safety precautions. Care shall be taken that pile reinforcement is not cut or damaged during chiseling operation. All debris and loose or cracked concrete in the pile shall be removed and disposed off within the plant boundary as per the directions of the Engineer-in-Charge and site shall be left clean for casting of pile caps. The surface of reinforcement bars shall be cleaned, if required by wire brushing, so that no old concrete sticks to them.

8.3 Payment

This clause shall apply to Item Rate tender only.

Payment shall be made per pile basis for the actual number of pile heads broken.

The rate shall include supplying all tools and tackles, labour including disposal of debris, bending the pile reinforcements for proper anchorage within the pile cap etc. all complete as directed.

9.0 BUILDING-UP PILE HEADS

9.1 Scope

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This specification covers requirements of materials and procedure for building-up of RCC Pile Heads.

9.2 Materials

9.2.1 Concrete shall be of the same grade & EIL specification shall be same as that for the pile.

9.2.2 Reinforcement shall be of the same grade as that for the pile.

9.2.3 Type of cement shall be same as that used for the pile.

9.3 Procedure

Concrete in existing piles shall be chiseled off minimum upto the lap-length of the reinforcements in the pile. In cases where reinforcements are longer than the concreted piles, the top concrete of the existing piles shall be chiseled or by approved mechanical means upto a length of 800 mm.

Concrete surface and reinforcement of pile shall be cleaned of any dirt, grease, debris etc. and concrete surface shall be made rough by hacking. Reinforcement shall be lapped/ welded as per the direction of the Engineer-in-Charge. Neat cement slurry shall be applied on top surface of concrete and using approved formwork, concreting shall be done upto the level shown on the drawing and as directed by the Engineer-in-Charge.

9.4 Payment

This clause shall apply to Item Rate tender only.

Payment shall be made on cubic metre basis for the total quantity of concrete actually poured for achieving the level as shown on drawings.

The rate shall include supply of all materials (except reinforcement which shall be paid separately as per respective item) labour, cleaning, welding, shuttering, vibrating, finishing, curing etc. all complete. Cutting of pile heads and excavation including backfilling shall be paid separately as per respective item.

10.0 HARD CORE

10.1 Scope

This specification covers the requirements of materials and procedure for laying of hard core.

10.2 Materials

Hard core shall consist of broken/ crushed stones of 150 mm and down size. Stones shall be sound, angular, hard and free from flakes, dust and other impurities.

10.3 Procedure

Hard core shall be laid to the grade, level and thickness as shown on the drawing. Broken stones of required height shall be vertically placed and blinded with approved murrum/ sand and consolidated with roller including watering, dressing etc. However, areas inaccessible by roller may be compacted by hand rammer.

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10.4 Payment

This clause shall apply to Item Rate tender only.

The hard core shall be measured on the basis of volume in cubic metres (cu.m.) of the compacted hard core laid. The rate shall include all labour, materials, consolidation by rammer/ roller, watering, dressing etc. all complete.

11.0 SAND FILLING IN PLINTH/FOUNDATIONS

11.1 For specification of sand to be used for filling, reference shall be made to EIL Specification No. 6-68-0002.

11.2 Filling shall be carried out in layers not exceeding 150 mm and shall be compacted mechanically or by saturation to specified grade and level and to obtain 90% laboratory maximum dry density or as specified in schedule of rates.

11.3 Compaction by flooding may be accepted at the discretion of the Engineer-in-Charge, provided the required compaction is achieved.

11.4 The Contractor shall not commence filling in and around any work until it has been permitted by the Engineer-in-Charge.

11.5 Payment

This clause shall apply to Item Rate tender only.

Payment shall be made on cubic metre (cu.m.) basis of the finished compact volume. The rate shall include cost of sand for any compacted thickness, wastage if any, all handling, transport for all leads, tamping, watering, flooding, dressing etc. Any brick work required for ponding shall be paid separately under relevant item.

12.0 DAMP PROOF COURSE - (DPC)

12.1 All materials used for Damp Proof Course shall comply with EIL Specification No. 6-68-0002.

12.2 The 40 mm thick Damp Proof Course shall consist of plain cement concrete of minimum grade M20 (Nominal mix) with 10mm down aggregates.

12.3 Integral water proofing compound of approved make, conforming to IS:2645, shall be mixed with concrete as per manufacturer's specification.

12.4 The Damp Proof Course shall be laid at plinth level of masonry walls, flush with the floor surface and shall not be carried across doorways.

12.5 Before laying, the top surface of wall shall be thoroughly cleaned and watered. The DPC layer of 40mm thick shall be laid, retaining the edges vertical by necessary formwork and shall be well tamped and troweled to smooth finish. The layer shall be cured by keeping the surface wet for 40 hours and after it has dried, two coats of hot bitumen of grade VG10 conforming to IS:73 shall be applied over it at the rate of 1.7 kg/sqm for each coat. Over the layer of hot bitumen, dry sharp sand shall be sprinkled evenly before hardening of top coat of bitumen paint.

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12.6 Payment

This clause shall apply to Item Rate tender only.

Payment shall be made on square metre (sq.m.) basis of the area laid with plain cement concrete. The rate shall be inclusive of formwork, providing and mixing Integral water proofing compound, curing, providing and laying bitumen, supplying and spreading sand over bitumen etc. all complete.

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STANDARD SPECIFICATION
CIVIL AND STRUCTURAL WORKS

प्रीकास्ट कंक्रीट
PRECAST CONCRETE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	17.05.2024	REVISED & REISSUED AS STANDARD SPECIFICATION	DB	RM	AS	MN
1	10.03.2019	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	AVM	AJS	RS	RKT
0	26.07.2013	ISSUED AS STANDARD SPECIFICATION	AK	VG/RS	PKM	DM

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Abbreviations:

IS: Indian Standard

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1.0 GENERAL

This Specification defines the requirements for the manufacture of precast concrete units. Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete units either RCC or PCC similar to that indicated in the project specifications or drawings for at least 7 years. The units to be precast shall take care of any special requirements specified in the "**Contract Specific Requirements**" or on the Drawings.

The precast units shall be manufactured in accordance with Specification No. 6-68-0004.

1.1 Reference Codes and Specifications

Apart from this specification, the construction of Precast concrete works shall be in accordance with the Indian Standard Code of Practice for "Building Design & Erection using Prefabricated Concrete" IS 15916 along with all amendments till date and other relevant codes mentioned therein.

2.0 QUALITY REQUIREMENTS

At a minimum, the Contractor's Quality Plan shall include the following documents, procedures and/or instructions:

(a) Lifting methods (where not shown on the Drawings).

(b) Erection methods including the erection sequence (where not shown on the Drawings).

(c) Minimum concrete strength requirements prior to lifting (where not shown on the Drawings).

(d) Where it is proposed to stack units, evidence to demonstrate the strength and stability of the stack.

(e) Procedure/format of records keeping for precast works. (Refer Annexure -I).

This documentation shall be submitted at least 28 days prior to the commencement of site work, if not submitted beforehand.

3.0 MANUFACTURE

Formwork shall be of rigid construction and concrete vibration shall be such that intense concrete compaction will be achieved. This may require the use of form vibrators or vibrating tables on some large and/or complex-shaped units.

Formwork and embedded items shall not restrain movements nor damage precast units within the formwork due to the effects of shrinkage or steam curing.

The casting of the precast units shall be carried out on specially prepared casting beds which will prevent any distortion or misalignment of the forms during and after concreting. Each precast unit shall be cast in one continuous operation with no construction joints.

If the batch volume is less than 2 cubic metres, the sampling rate shall be reduced as follows:

(a) Less than 2 cubic metres per batch : 50% rounded up

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(b) Less than 0.5 cubic metres per batch : 30% rounded up.

In any case a minimum of 1 test representing each member shall be undertaken. Test specimens, for the purpose of determination of adequate unit strength for lifting and handling, shall be subjected to the same curing regime as the unit they represent. The Contractor shall ensure that sufficient cubes are provided to enable the required testing to be undertaken.

4.0 CURING

Concrete shall be:

(a) moist cured in accordance with Specification No. 6-68-0004 or

(b) membrane cured in accordance with Specification No. 6-68-0004

5.0 MARKING

For the purposes of unit curing, testing, location and orientation within the final structure, each batch of units, or if continuous production methods are used, each day's production, shall be clearly identified and indelibly marked to show:

(a) Unit identification

(b) Date of manufacture.

(c) Marking of top and bottom surface to ensure correctness of the reinforcement.

Each unit shall be marked on a surface which is not visible in the final structure.

6.0 LIFTING, HANDLING, STORAGE AND ERECTION

Precast units shall not be lifted or handled before the concrete has attained a compressive strength of 10 MPa or strength required during lifting as per design requirement or as specified on the Drawings, whichever is greater.

The Contractor shall detail in the Quality Plan the measures to be taken to minimise handling stresses, in particular those due to de-moulding.

The Contractor shall carefully handle precast units by methods that will not damage them or their connections. Units shall be handled from the approved lifting points shown on the Drawings. Beams and slabs shall be lifted and supported with the top surfaces uppermost at all times, unless shown otherwise on the Drawings.

Units shall be stored clear of the ground and supported on non-staining timber bearers only at approved bearing points. The thickness and width of the bearers shall be compatible with the strength group of the timber used, the type of precast unit and the site. The bearers shall support the units over their full width at the specified lifting points. The ground or space between the bearers supporting the units shall be carefully cleared and leveled to prevent the unit from being supported at positions other than on the bearers. The bearers shall rest on a firm foundation and adequate precautions shall be taken to prevent subsidence.

If units are stacked in tiers, the bearers shall be placed directly over each other. The lowest unit shall not be overstressed.

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Temporary props, if required, shall be used to hold the precast elements joints till it attain the required strength. After attaining the required strength, props shall be removed.

7.0 TRANSPORTATION

Unless stated otherwise on the Drawings, units shall not be transported until the concrete has reached its 28 day characteristic compressive strength and is at least 7 days old.

No unit shall be removed from the casting yard until a lot conformance package has been completed.

Submission of the lot conformance package prior to removal from the yard shall be required.

Units shall be securely fixed to the transporter by ties fitted with suitable tensioners. Provision shall be made to protect the units from damage caused by these ties.

Precast concrete units shall be delivered to the site in accordance with the delivery schedule to avoid excessive build-up of units in storage at the site. Upon delivery to the jobsite all precast concrete units shall be inspected by the Engineer-in-charge for quality and final acceptance.

8.0 PAYMENT

8.1 Payment for precast concrete members shall be made on cubic meter basis of the volume of the finished member. The rate quoted shall include cost of formwork, preparation of casting yard, finishing as specified, curing, marking, lifting, handling, storage, transportation to site of work, fixing in position etc. Reinforcement and pipe sleeves shall be paid separately under relevant items. Lifting hooks shall be paid on the same basis as reinforcement. Metal inserts shall be paid as per relevant clauses of Specification No. 6-68-0008 (Miscellaneous Steel Works).

8.2 The quoted rate shall be inclusive of providing pockets, openings, recesses of all sizes, chamfers, fillets grooves, holes, curing (hot, cold or by using curing compounds). The rate shall be deemed to include complete cost of taking and testing concrete cubes and carrying out other tests including tests of various ingredients as per specification and as directed by the Engineer-in-Charge.

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ANNEXURE-I

Procedure/format of record keeping for precast works shall at least include the following:

I. PRE-POURING INSPECTION REPORT:

This shall include mould cleaning & oiling, inspection of shutter joins, reinforcement & cover check, prestressed strands check, inspection of lifting hooks, inserts, embedments, etc.

II. CONCRETE TESTING REPORT:

This shall include the strength attained by concrete at various stages i.e. de-shuttering, lifting transportation, erection, loading, with other structural components, grouting, etc.

III. POST POURING INSPECTION REPORT (PREDELIVERY / DISPATCH)

This shall include inspection of the size of precast element, honeycomb, cracks, exposed reinforcement, finishing works, etc.

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STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

कंक्रीट ब्लाक चिनाई

CONCRETE BLOCK MASONRY

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	13.03.2025	REVISED & ISSUED AS SPECIFICATION	TK	AJS	AS	MN
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ABBREVIATIONS:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
EIL	:	Engineers India Limited
IS	:	Indian Standard
PCC	:	Plain Cement Concrete
RCC	:	Reinforced Cement Concrete

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Members:
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1.0 SCOPE

This specification covers the technical requirements for materials, batching, mixing, dressing, laying, joining, curing, sampling, workmanship etc. for Hollow & Solid concrete blocks and Autoclaved Cellular (Aerated) Concrete blocks (AAC blocks) used in masonry works of following thicknesses:

a) 100 mm thick : Solid concrete block & AAC Blocks
b) 200 mm thick : Hollow concrete block (closed cavity) & AAC Blocks
c) 400 mm thick (fire walls) : Hollow concrete block (closed cavity) & AAC Blocks

2.0 REFERENCES

2.1 BIS Codes

IS 383, IS 455, IS 456, IS 1489, IS 2185 (Part 1), IS 2185 (Part 3), IS 2250, IS 2645, IS 3812, IS 3952, IS 6909, IS 8041, IS 8042, IS 8043, IS 8112, IS 9103 and IS 12269.

2.2 International Standards

ASTM C 1660-09

2.3 EIL Specifications

6-68-0002 : Materials
6-68-0004 : Plain & Reinforced Cement Concrete

3.0 MATERIALS

Grade of concrete block masonry units shall be as follows:

a) Solid concrete blocks : Grade C (5.0)
b) Hollow concrete blocks : Grade A (5.5) closed cavity
c) Autoclaved Cellular (Aerated) Concrete blocks : Grade I (5.0)

The nominal dimensions (length, height & width) and density of solid & hollow concrete block masonry units shall be in conformance to IS 2185 (Part 1) while that of Autoclaved Cellular (Aerated) Concrete blocks shall be in conformance to IS 2185 (Part 3) corresponding to the aforementioned grades.

4.0 GENERAL REQUIREMENTS

4.1 Cement Mortar

Cement mortar shall meet the requirements of IS 2250 and shall be prepared by mixing cement and Coarse sand by volume. Proportion of cement and sand shall be 1:6 (1 part of cement and 6 parts of Coarse sand), or as directed by the Engineer-in-Charge/ shown on the drawing, for concrete block masonry of 200 mm thickness or more, while 1:4 cement mortar (1 part of cement and 4 parts of Coarse sand) shall be used for concrete block masonry of 100 mm thickness. The sand being used for mortar shall be sieved. The mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within initial setting time of cement after water is added to the dry mixture. Mortar unused for more than initial setting time of cement, shall be rejected and removed from the site of work.

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4.1.1 Proportioning

The unit of measurement for cement shall be a bag of cement weighing 50 kg and this shall be taken as 0.034 cubic metre. Sand shall be measured in boxes of suitable size on the basis of its dry volume. In case of damp sand, its quantity shall be increased suitably to allow for bulkage.

4.1.2 Mixing

The mixing of mortar shall be done in a mechanical mixer operated manually or by power. The Engineer-in-Charge may, however, permit hand-mixing as a special case, taking into account the magnitude, nature and location of work. The Contractor shall take the prior permission of Engineer-in-Charge, in writing, for using hand-mixing before the commencement of work.

4.1.2.1 Mixing in Mechanical Mixer

Cement and sand in specified proportions, by volume, shall be thoroughly mixed dry in a mixer. Water shall then be added gradually and wet mixing continued for atleast one minute. Care shall be taken not to add more water than that which shall bring the mortar to the consistency of stiff paste. Wet mix from the mixer shall be unloaded on water-tight masonry platform, made adjacent to the mixer. Platform shall be atleast 150 mm above the levelled ground to avoid contact of surrounding earth with the mix. Size of the platform shall be such that it shall extend at least 300 mm all-round the loaded wet mix area. Wet mix, so prepared, shall be utilised within initial setting time of cement after addition of water. Mixer shall be cleaned with water each time before suspending the work.

4.1.2.2 Hand Mixing

The measured quantity of sand shall be levelled on a clean water-tight masonry platform and cement bags emptied on top. The cement and sand shall be thoroughly mixed dry by being turned over and over, backward and forward, several times till the mixture is of uniform colour. The quantity of dry mix which can be consumed within initial setting time of cement shall then be mixed with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

4.2 Ready mix Adhesive/ Mortar

Packaged ready to use adhesive/ mortar conforming to ASTM C 1660-09 shall also be used for joining the concrete blocks with prior approval of Engineer-in-Charge.

4.2.1 Ingredients

Ready mix package shall consist of cement, graded sand, flyash, additive polymers or a combination thereof as per manufacturer's specification.

4.2.2 Mixing & Curing

The dry ready mix shall be added to appropriate amount of potable water (not vice-versa) as per manufacturer's specification. Mixing shall be done slowly by using manual/ electrical stirrer to form a uniform paste free from lumps. The paste shall be kept undisturbed for few minutes as specified allowing ingredients to react properly. Thin bed paste as per manufacturer's recommendation (usually 2 to 4mm thickness) shall then be applied within the specified time limit.

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Curing is generally not required as the mix contains self curing polymers. However, manufacturer's specification shall be followed.

5.0 CONSTRUCTION PROCEDURE

5.1 Soaking of Concrete Blocks

Concrete blocks shall be soaked in water before use for a period that is sufficient for the water to just penetrate the whole depth of concrete blocks as well as to remove dirt, dust and sand. Proper soaking of concrete blocks shall prevent the suction of water from the wet mortar as otherwise mortar will dry out soon and crumble before attaining any strength. The concrete blocks shall not be too wet at the time of use as they are likely to slip on mortar bed and there will be difficulty in achieving the plumbness of wall as well as proper adhesion of concrete blocks to mortar. The period of soaking shall be determined at site by a field test by immersing the concrete blocks in water for different periods and then breaking the concrete blocks to find the extent of water penetration. The least period that corresponds to complete soaking, will be the one, to be allowed for in the construction work.

The soaked concrete blocks shall be stacked over a clean place, wooden planks or masonry platforms to avoid earth, dirt being smeared into them. It shall be ensured that at the time of laying of soaked concrete blocks, they are skin dry.

5.2 Laying

Concrete block masonry units (one or more block thickness) shall be laid in English bond while half block thickness masonry units shall be laid in Stretcher bond.

5.2.1 Concrete Block Masonry Work (200 mm & 400 mm thickness)

A layer of average thickness of 10 mm of cement mortar shall be spread on full width over a suitable length of lower course or the concrete surface. All such mortar shall contain the recommended amount of integral water-repellent admixture to assure proper bond strength. In order to check and achieve uniformity in masonry, the thickness of bed joints shall be such that four courses and three joints taken consecutively shall measure equal to four times the actual thickness of the concrete block plus 30 mm. Each concrete block, shall be properly bedded and set in position by gently tapping with handle of trowel or wooden mallet. Its inside faces shall be buttered with mortar before the next concrete block is laid and pressed against it. All required cutting of masonry units shall be done with power equipment which will produce true edges free of chipping and undamaged surfaces. Where fresh masonry joins the masonry that is partially or totally set, the exposed surface of the set masonry shall be cleaned and wet lightly so as to obtain the best possible bond with the new work. All loose masonry and mortar shall be removed. If it is necessary to "stop off" a run of masonry, this shall be done by raking back one-half unit length of each course. No toothing will be permitted. After completion of the course, all vertical joints shall be filled from top with mortar.

All iron fixtures, pipes, conduits, drains, sleeves, bolts, hold fasts of doors and windows etc. which are required to be built in walls shall be embedded in cement concrete as specified, in their correct position as the work proceeds. Other disciplines shall be consulted and provisions shall be made to permit installation of their work at a later stage.

All concrete block courses shall be truly plumb; if battered, the batter is to be truly maintained. All courses shall be laid truly horizontal and vertical joints shall be truly vertical. The level and verticality of work in walls shall be checked up at every one metre interval.

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The masonry walls of structures shall be carried up progressively, leaving no part one metre lower than the other. If this cannot be adhered to, the concrete block work shall be raked back according to bond (and not left toothed) at an angle not more than 45 degrees, but raking back shall not start within 60 cm of a corner. In all cases returns, buttresses, counter forts, pillars etc. shall be built up carefully, course by course, and properly bonded with the main walls. The concrete block work shall not be raised more than fourteen (14) courses per day.

At the junction of any two walls, the concrete blocks shall at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. Masonry wall intersections shall be bonded with joint reinforcing.

The courses at the top of plinth and sills, at the top of the wall just below the soffit of the roof slab or roof beam and at the top of the parapet, shall be laid with concrete blocks on edge. Concrete block on edge course shall be so arranged as to tightly fit under the soffit of the roof beam or roof slab, restricting the mortar layer thickness up to 12 mm. However, any gap between the finished concrete block work and soffit of roof slab/ beam shall be suitably sealed with the mortar.

Mortar for bonding shall have an adequate composition as to develop crushing strength not exceeding that of the elements which must be joined. All fair faces of the elements in the works, either normal or special, such as elements for shoulders, lintels, corners and crossing etc. must have a solid appearance.

Hollow concrete block cells shall be filled and packed solid with mortar for a minimum width of 400 mm (i.e. full concrete block length) or as specified on drawings at the following locations:

a) At free ends of the walls
b) Each side of openings
c) At tee junctions for bedding of wall ties.
d) At all places where wall ties are specified and/ or indicated on drawings.
e) At all other areas of walls specified on drawing for fixing the wall mounted equipment and/ or fittings.

Intersecting concrete block walls shall be tied, at every fourth course, with 8 mm dia. Tor steel ties having minimum 300 mm lap well embedded in mortar.

5.2.2 Concrete Block Masonry Work (100 mm thickness)

For concrete block walls of 100 mm thickness, all courses shall be laid with stretchers. Wall shall be reinforced with 2 nos. 6 mm diameter mild steel reinforcement bars, placed at every fourth course. The reinforcement bars, shall be straightened and thoroughly cleaned. Half the mortar thickness for the bedding joint shall be laid first and then steel reinforcement, one on each face of the wall, shall be embedded, keeping a side cover of 12 mm mortar. Subsequently, the other half of the mortar thickness shall be laid over the reinforcement covering it fully.

The reinforcement bars shall be carried at least 150 mm into the adjoining walls or RCC columns. In case the adjoining wall being of 100 mm thickness, the length of bars shall be achieved by bending the bars in plan. During casting of reinforced concrete columns, 6 mm diameter mild steel reinforcement bar shall be placed at every fourth course of concrete block masonry. At the junction of two walls, the concrete block shall, at each alternate course, be carried into each of the respective walls so as to thoroughly unite the work. The concrete block masonry work shall not be raised more than 14 courses per day.

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Concrete block course under the soffit of beam or slab, shall be laid by restricting the mortar thickness to 12 mm. However, any gap between the finished concrete block work and soffit of slab/ beam, shall be suitably sealed with the mortar.

5.2.3 Cavity Walls for Exterior Closures

Concrete block work in cavity walls shall be similar to general concrete block work. It shall consist of inner wall of 200 mm thickness while the outer wall shall be of 100 mm thickness at a clear gap of 50 mm. The concrete block work on either side of cavity shall conform to the specifications already mentioned in Clause 5.2.1. At the base of the cavity wall, the walls shall be solidly constructed upto 300 mm above the ground level. The cavity wall shall be terminated 300 mm below the soffit of roof slab/ beam and the courses over this shall be continued as normal (non-cavity) concrete block work.

Cavity should be continuous and free from obstructions. Mortar droppings shall be prevented from falling down the cavity by the use of laths or by hayhands which shall be drawn up the cavity as the work proceeds. Any mortar which may unavoidably fall on the wall-ties, shall be removed daily and temporary openings shall be provided to permit the daily removal of mortar droppings from the bottom of the cavity.

The outer and inner leaves shall be tied by means of wall ties. Ties shall be of tor steel bars of 8 mm dia. 200 mm long with hooks at both the ends. These shall be placed not more than 750 mm centres horizontally and not more than 300 mm vertically, and staggered. Additional ties shall be provided near the openings. There shall at be least 5 ties per square metre of surface area of the wall. Ties shall be given a bituminous coat before placement, to protect them from corrosion.

5.2.4 Circular Concrete Block Work

The detailed specification for concrete block work covered under Clause 5.2.1 shall also apply to circular concrete block work. Concrete blocks forming skew backs, shall be dressed or cut so as to give proper radial bearing. Defects in dressing of concrete blocks shall neither be covered up by extravagant use of mortar nor shall the use of chips etc. be permitted.

The circular concrete block work shall be carried up from both ends simultaneously and keyed in the centre. The concrete blocks shall be flushed 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 be 5 mm to 15 mm.

5.3 Jointing

Joints shall be restricted to a width of 10 mm with concrete block work of any classification. All bed joints shall be normal to the pressure acting upon them i.e. horizontal in vertical walls, radial in circular concrete block masonry and at right angles to the face in the battered retaining walls. The vertical joints in alternate courses shall come directly one over the other and shall be truly vertical. Care shall be taken that all the joints are full of mortar, well flushed up. In case no pointing is to be done, cement mortar shall be neatly struck as the work proceeds. The joints in faces which are to be plastered or pointed shall be squarely raked out to a depth of 12 mm while the mortar is still green. The rake joints shall be brushed to remove loose particles. After the day's work, the faces of the concrete block work shall be cleaned on the same day with wire brush and all mortar droppings removed.

5.4 Curing

Green work shall be protected from rain or running water or accumulated water from any source. Masonry work, as it progresses, shall be kept thoroughly wet by sprinkling water at

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regular intervals, on all the faces. Curing shall be done after 24 hours of completion of day's work as per IS 2212.

5.5 Surface Finishes

Surfaces finishing shall be carried out as specified in the Archirectural drawings and specifications for Architectural finishes.

5.6 Staging/ Scaffolding

5.6.1 Staging/ scaffolding shall be properly planned and designed by the Contractor. Use of only steel tubes is permitted for staging/ scaffolding. Design of staging/ scaffolding shall be submitted for approval of the Engineer-in-Charge, before commencement of work.

Single scaffolding having one set of vertical support, shall be used and other end of the horizontal scaffolding member shall rest in a hole provided in the header course. The support shall be sound and strongly clamped with the horizontal pieces over which the scaffolding planks shall be fixed. Suitable access shall be provided to the working platform. The scaffolding shall be strong enough to withstand all loads likely to come upon it and shall also meet the requirements specified in IS 2750. The holes left in the masonry work for supporting the scaffolding shall be filled and made good with plain cement concrete of grade M15 before plastering.

Double scaffolding shall be provided for pillars less than one metre in width or for the first class masonry or for a building having more than two storeys.

The following measures shall also be considered during erection of the scaffolding/ staging:

a) Sufficient sills or underpinnings, in addition to base plates, shall be provided, particularly, where scaffoldings are erected on soft grounds.
b) Adjustable bases to compensate for uneven ground shall be used.
c) Proper anchoring of the scaffolding/ staging at reasonable intervals shall be provided in each direction with the main structure wherever available.
d) Horizontal braces shall be provided to prevent the scaffolding from swaying.
e) Diagonal braces shall be provided continuously from bottom to top between two adjacent rows of uprights.
f) The scaffolding/ staging shall be checked at every stage for plumb line.
g) Wherever the scaffolding/ staging is found to be out of plumb line, it shall be dismantled and re-erected afresh. Physical force shall not be applied to bring it in plumb.
h) All nuts and bolts shall be properly tightened and it shall be ensured that all the clamps/ couplings are firmly tightened to avoid slippage.
i) Erection work of a scaffolding/ staging, under no circumstance shall be left totally to semiskilled or skilled workmen and shall be carried out under the supervision of Contractor's technically qualified civil engineer.

5.6.2 For smaller works or works in remote areas wooden ballies may be permitted for scaffolding/ staging by the Engineer-in-Charge at his sole discretion. The contractor must ensure the safety and suitability of such works as described under Clause 5.6.1 above.

5.7 Embedment of Fixtures

All fixtures, pipes, conduits, holdfasts of doors and windows etc. required to be built in walls, shall be embedded in plain cement concrete block of grade M15, as work proceeds.

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6.0 PAYMENT

This clause is applicable for Item Rate Tenders only.

6.1 General

The payment of concrete block masonry shall be inclusive of all labour, material (including cement mortar/ ready mix adhesive), scaffolding/ staging sampling and testing, soaking of concrete blocks, laying of concrete blocks, raking of joints, cutting of concrete blocks, providing recesses and making rectangular or round openings, sealing the gap between concrete block masonry and soffit of beam/ slab with cement mortar, curing, making of masonry platform for unloading the wet mix, embedding the fittings/ fixtures including providing PCC of Grade M15 etc, all as specified for all heights and depths as directed by the Engineer-in-Charge. Deduction for rectangular or circular openings shall be done as per relevant BIS Codes.

6.1.1 Payment for concrete block masonry works of 200 mm or more thickness, including circular concrete block work, shall be made on cubic metre basis of the work done.

6.1.2 Payment for 100 mm thick masonry work shall be made on square metre basis on the area of work done and shall also include the cost of supplying and fixing of reinforcement bars in position.

6.1.3 Payment for forming the cavity shall be in square metres and shall include the cost of laying of bitumen coated tor steel ties in position, labour required for keeping the cavity clear, providing air slots etc.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

बाईपोलर कंक्रीट अंतर्वेशित
क्षारण अंतर्अधिमिश्रण

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

BIPOLAR CONCRETE PENETRATING CORROSION INHIBITING ADMIXTURE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
1	18 06 2019	UPDATED AND REISSUED	TK	AJS	RS	RKT
0	26 04 2012	ISSUED AS STANDARD SPECIFICATION	AJS	PKM	SC	DM

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ABBREVIATIONS:

AASHTO	:	American Association of State Highway and Transportation Officials
ASTM	:	American Society for Testing & Materials
CPCIA	:	Concrete Penetrating Corrosion Inhibiting Admixture
IS	:	Indian Standard
JIS	:	Japanese Industrial Standard
OPC	:	Ordinary Portland Cement
PPC	:	Portland Pozzolana Cement
PSC	:	Portland Slag Cement
SRC	:	Sulphate Resistant Cement

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Convenor : Mr. Rajanji Srivastava

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1.0 SCOPE

This specification prescribes the requirements and test methods including performance test for evaluating the efficiency of Bipolar Concrete Penetrating Corrosion Inhibiting Admixture (CPCIA) for protecting steel reinforcement embedded in concrete from corrosion. Non-concrete penetrating, Nitrite & Nitrate corrosion inhibitors are excluded from the scope.

2.0 REFERENCES

2.1 Codes

ASTM-G1, ASTM-G3, ASTM-G109, ASTM-C1202, JIS-Z-1535, AASHTO T259, IS:2, IS:101(Part1/Sec.5), IS:456, IS:1202, IS:1448, IS:1786, IS:9103, etc.

2.2 EIL Specifications

6-68-0001 : General Scope
6-68-0002 : Materials

3.0 SAMPLING

3.1 The representative samples of the material shall be drawn as per the table given below:

No. of containers (Lot)	No. of containers to be selected for sampling (N)
Up to 50	1
51-100	2
101-300	3
301-500	4
501& Above	5 Plus 1 for every lot of 300 containers

4.0 TESTING REQUIREMENTS

4.1 The product shall comply with the requirements specified in Annexure-A (Short Term Tests) and Annexure-B (Long Term Tests). Both the tests shall be conducted in an approved laboratory.

4.2 Unless specified otherwise, all the tests under Indian tropical conditions shall be conducted at room temperature 27 ± 2°C and relative humidity at 65 ± 5 % in a well ventilated chamber free from dust.

4.3 The contractor shall select the product from EIL approved vendor list and submit the Manufacturer Test Certificate to the Engineer-in-Charge. Approval for usage of product shall be given after satisfactory Short Term test results. Long Term tests are not mandatory for the products listed in EIL approved vendor list.

If the product is not from an EIL approved vendor, both Short term as well as Long term tests are mandatory. The contractor shall submit the Manufacturer Test Certificate to the Engineer-in-Charge and approval for usage of product shall be given after satisfactory Short Term test results. However, payment shall be released after the product complies with the requirements of Long Term test results.

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5.0 HEALTH, SAFETY & ENVIRONMENT CONSIDERATIONS

5.1 The CPCIA shall not cause harm to applicators by mean of inhalation or skin contact. All precautionary measures shall be prescribed by the manufacturers along with instructions of usage. Application methodology shall be approved by the Engineer-in-Charge.

5.2 The waste shall be discharged in accordance with applicable Environmental laws of land.

5.3 CPCIA shall not degrade or damage the construction materials like concrete, aggregates, steel reinforcement, formwork/shuttering.

6.0 PACKAGING

The product shall be supplied in air tight containers and following information shall be labeled on each container:

a) Name of the material
b) Name of the manufacturer
c) Volume/ weight of material
d) Specification number
e) Batch No. or Lot No. in bar code or otherwise
f) Month and year of manufacture
g) Ingredients & method of usage
h) Instructions for safe usage

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ANNEXURE-A

SHORT TERM TESTS

S. No.	Characteristics	Requirements	Methods of Tests
1.	Appearance	Brownish Liquid free from any visible residual deposits	Visually
2.	Odour	Mild Ammonical Odour	By smell
3.	Skin irritation	No irritation	By applying on reverse of the palm for 5 minutes.
4.	Ph i) As in supplied condition ii) 1% dilution ,w/w	i) 9.0-11.0 ii) 9.0-11.0	pH meter / Standard pH paper
5.	Specific Gravity at 27 ± 2°C	1.04 - 1.06	IS 1448
6.	Viscosity of the material as in supplied condition, by Ford cup No 4, at 27 ± 2°C	10 - 20 sec.	IS: 101(Pt.1/Sec.5)
7.	Accelerated Corrosion Test, for 21 hrs. i) Raw water without CPCIA ii) Raw water with CPCIA	i) Excessive corrosion spots. ii) There shall not be more than 1-2 corrosion spots.	Modified accelerated corrosion test based on Japanese standard JIS Z 1535 (Refer Appendix-I)

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ANNEXURE-B

LONG TERM TESTS
(Shall be performed in triplicate)

S. No.	Characteristics	Requirements		Methods of Tests
		Without CPCIA	With 1% CPCIA	
1.	Immersion test for 720 hrs. (Rebar weight loss method)	40.00 mpy, max.	2.00 mpy, max.	Immersion Test (Rebar weight loss test) as per ASTM G1 (Refer Appendix-II)
2.	Effect of Concrete admixture on compressive strength	Concrete strength in sample with CPCIA* should be ≥concrete strength in sample without CPCIA*		Test for effect on compressive strength by addition of CPCIA as per IS 9103 (Refer Appendix-III)
3.	Polarization test by Tafel polarization with 3.5% Sodium Chloride, for 20 days: Rate of corrosion shall be	45 mpy, max.	9 mpy, max.	Electrochemical polarization test conducted on steel rebars embedded in concrete as per ASTM-G 3 & IS 9103 (Refer Appendix-IV)
4.	Effect of CPCIA* on corrosion of embedded steel rebars exposed to chloride environments after 09 cycles (14 days wetting and 14 days drying): Rate of corrosion shall be	25 Coulombs, max.	0.50 Coulombs, max.	Long term corrosion test as per ASTM G109 (Refer Appendix-V)
5.	Chloride Migration profile properties of concrete (for all types of cements viz. OPC, PPC, PSC, SRC)			AASHTO T-259 (Refer Appendix-VI)
	i) Chloride % in concrete at 30mm depth after 90 days.	0.025%, max.	Nil	Chloride ion penetration (Salt ponding test) as per IS:456
	ii) Ability to resist chloride ion penetration			
	a) Concrete grade M-30, Water cement ratio: 0.45	1650 Coulombs, max.	1000 Coulombs, max.	Electrical indication of concrete ability to resist Chloride Ion Penetration (Rapid Chloride Permeability test) as per ASTM C1202
	b) Concrete grade M-40, Water cement ratio: 0.40	1550 Coulombs, max.	1000 Coulombs, max.	

Notes:

a) CPCIA* : The CPCIA shall be used as 1% w/w of cement or as recommended by the manufacturer for conducting the tests mentioned in Annexure-B except Immersion test for 720 hrs. mentioned at S.No.1 where it shall be used as 1% w/w of water or as recommended by the manufacturer.

b) Rebars conforming to IS: 1786 shall be used for testing purposes

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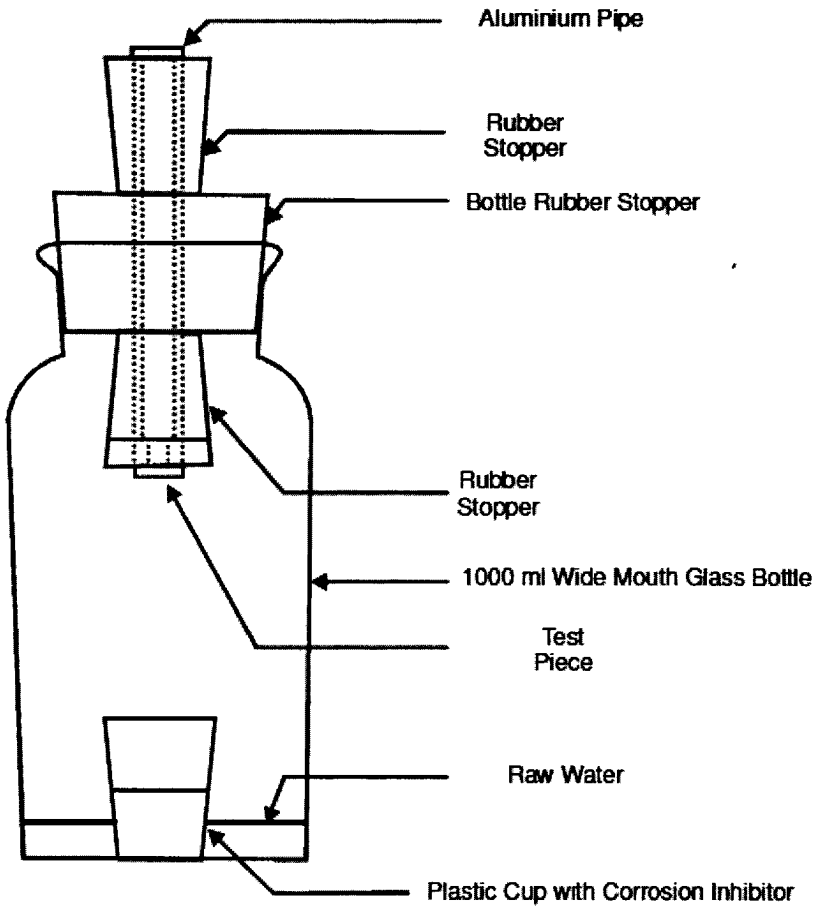
APPENDIX-I

MODIFIED ACCELERATED CORROSION TEST (BASED ON JAPANESE STANDARD JIS Z 1535)

TEST PROCEDURE

Attach steel test pieces conforming to IS: 1786 (of size approx. 15mm dia and 12mm thickness drilled from one side c/c to a dia of 10mm and a depth of 10 mm to hold the Aluminium pipe) after thorough cleaning to white metal by using 1000 grade grit paper and subsequently polishing with 3/0 grade and finally with 4/0 grade grit paper to the Aluminium pipe with the help of cello tape so that it is firmly attached. The Aluminium pipe is then slid upwards till the test piece rests in the slot provided in the rubber cork, as shown in the figure.



Assembly with Corrosion Inhibitor

Pour 100 ml of tap water in both the bottles. Fill the plastic cup with 25 ml CPCIA solution as in supplied condition. In one of the bottles place the plastic cup with the CPCIA solution so that the cup is placed in the tap water. Allow to remain for 18 hours at ambient temperature. After 18 hrs. add chilled water having temperature below 1.0 °C into the Aluminium pipes and allow to remain for 3 hrs. The temperature of the chilled water in the Aluminium pipes shall be maintained at 2.0 ± 0.5 °C by frequently changing the chilled water with the help of the pipette. Observe the steel test pieces after the experiments i.e. 18+3=21 hrs., for any corrosion spots.

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APPENDIX-II

IMMERSION TEST (REBAR WEIGHT LOSS TEST) (AS PER ASTM G 1)

TEST PROCEDURE

Take six pieces of Tor steel rebar conforming to IS: 1786 of size approx. 40 mm length and 10 mm dia. Clean the rebar of any rust, mill scale etc., with the help of steel wire brush, till it has overall a shining surface. Now clean all the six pieces with solvent such as Benzene/Acetone to remove any loose rust /dust from the surface. Dry at 100 ± 2 °C for 15 minutes in an oven. Cool and take the weights of all the six pieces and record it.

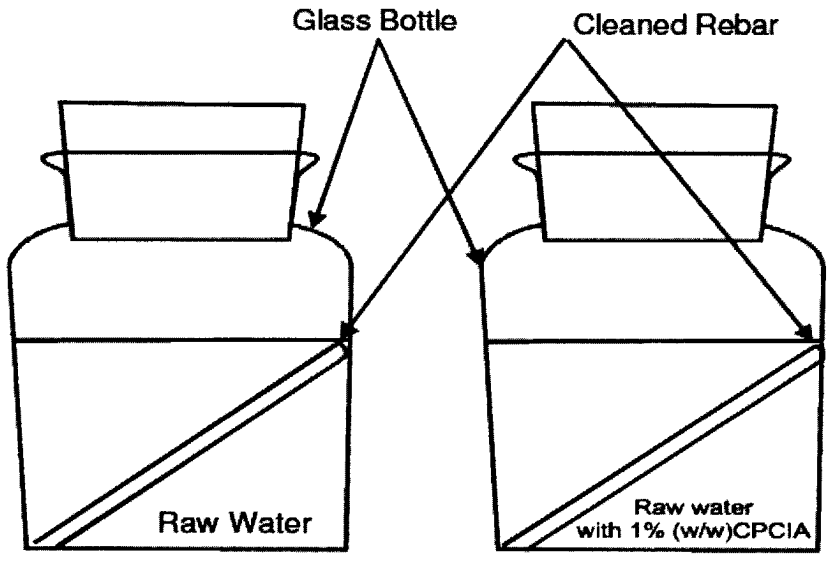
Take six transparent glass/plastic bottles of approx. 150±10 ml with air tight caps. Clean all the bottles with tap water and then fill them with 100 ml of tap water so that the bottles are approx. three fourth filled. In three of the six bottles, add CPCIA 1%, w/w or as recommended by the manufacturer of the water in the bottle. Now put one cleaned and weighed rebar test piece completely immersed in water/water + CPCIA, in all the six bottles and close the cap.

After 30 days (720 hrs.), take out all the six test pieces and put them in Clark solution (prepared by dissolving 20 gms. of Antimony Trioxide and 50 gms of Stannous Chloride in 1000 ml of Conc. Hydrochloric acid, S.G. 1.18) so that corrosion products are dissolved. After complete removal of corrosion products (in 5 minutes approximate), take out the test pieces and wash in running water and finally with distilled water. Then wash the test pieces, with solvent such as Benzene/Acetone. Dry at 100 ± 2 °C for 30 minutes in an oven. Cool and take the weights of all the six pieces and record it.

Calculate the corrosion rate in mpy, by using the formula

Corrosion rate (mpy) = 534 (W1-W2) / DAT

Where W1-W2 is the weight loss in mg., D is the density of steel , A is the area in sq.inch and T is the time of exposure in hrs



Assembly without Corrosion Inhibitor Assembly with Corrosion Inhibitor

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APPENDIX-III

TEST FOR EFFECT ON COMPRESSIVE STRENGTH BY ADDITION OF CPCIA

TEST PROCEDURE

Cast three concrete blocks of size 100mm x 100mm x 100mm each without and with CPCIA 1% (w/w) of cement or as recommended by the manufacturer, by casting the concrete of M20 grade as per Clause 6.2.3 of IS 9103.

The above casted blocks shall be demoulded after 24 hrs. These blocks shall be moist cured for 28 days. After completion of the curing period, the blocks of each type shall be tested for compressive strength in compression testing machine (Universal Tensile Machine) and data recorded.

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APPENDIX-IV

BRIEF OUTLINES OF ELECTROCHEMICAL POLARIZATION TEST CONDUCTED ON STEEL REBARS EMBEDDED IN CONCRETE (AS PER ASTM G 3)

TEST PROCEDURE

Cast three concrete cylinders, of size 75mm dia and 150mm length each without and with CPCIA 1% (w/w) of cement or as recommended by the manufacturer, by casting the concrete of M 20 grade as per Clause 6.2.3 of IS 9103, and placement of one cleaned rebar conforming to IS:1786 of size 375mm length and 12mm dia (preferably cleaned by pickling in Hydrochloric acid 20% (v/v) approximately, till surface shines and washed in running water) in each block .

The above casted blocks shall be demoulded after 24 hrs. These blocks shall be moist cured for 28 days.

After completion of the curing period, the blocks shall be subjected for Polarization test for 20 days as per ASTM G-3 and observations recorded.

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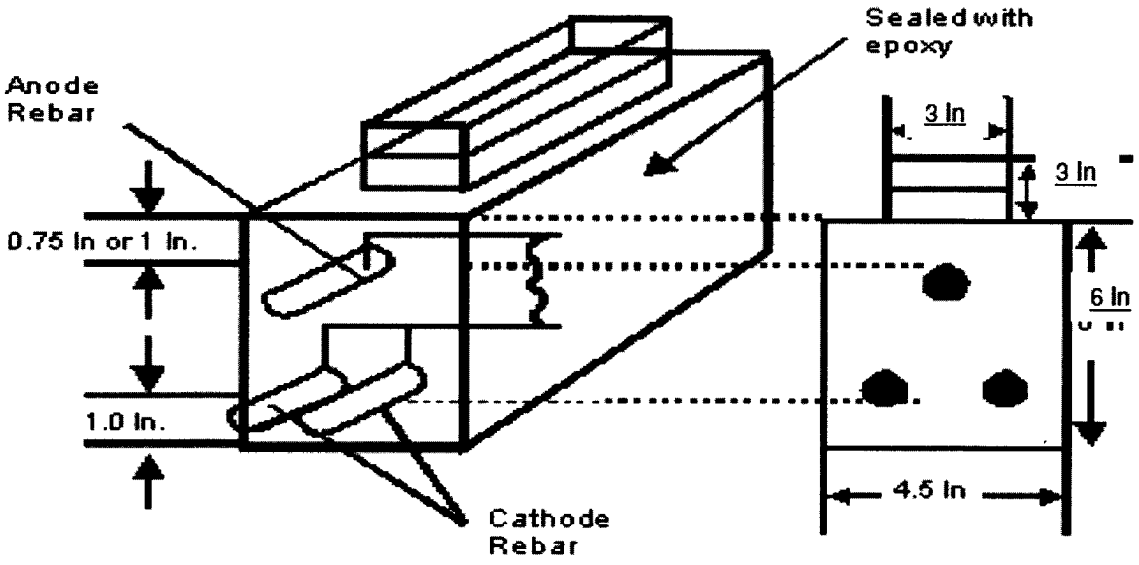
APPENDIX-V

BRIEF OUTLINES OF LONG TERM CORROSION TEST (AS PER ASTM G 109)

TEST PROCEDURE

Three specimens each of control concrete and that of CPCIA admixed concrete (1% w/w of cement or as recommended by the manufacturer) should be cast as per the size 280mmx150mmx115mm and with placement of three cleaned reinforcement bars conforming to IS:1786 (preferably cleaned by picking in Hydrochloric acid 20% (v/v) approx, till surface shines and washed in running water) of size 12mm and length 375mm as per the details shown in the figure. Admixture shall be added as per manufacturers recommended dosage. All the casted concrete samples shall be moist cured for 28 days.

Ponding of samples with 3% NaCl solution as shown in the figure to be continued and measuring of voltage across 100 ohm resistor to be continued beginning of the second week of ponding. Calculate the current IJ from the measured voltage and record. Also measure the corrosion potential of the bars against reference electrode. The experiment should be continued till the macrocell current reaches a value of 10 μA. After the experiment break the specimens and examine the rebars for extent of corrosion, measure the corroded area and record.



Note - All Measurements in In. (25.4 mm = 1 In.)

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APPENDIX-VI
(Sheet 1 of 2)

BRIEF OUTLINES OF RESISTANCE OF CONCRETE TO MIGRATION OF CHLORIDE ION TEST (AS PER AASHTO T259)

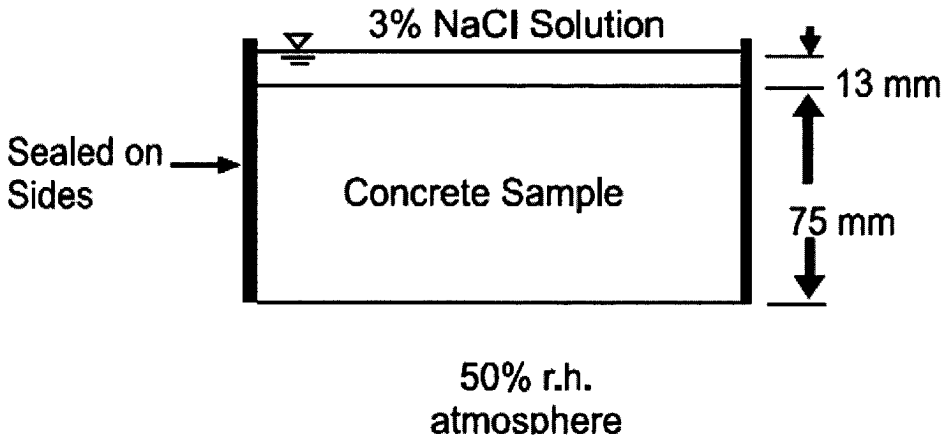
Part-A : Chloride Ion Penetration (Salt Ponding Test As per IS:456)

TEST PROCEDURE

Cast three concrete blocks of size 300mmx300mmx75mm each without and with CPCIA 1% (w/w) or as recommended by the manufacturer, by using the concrete mix as under:

S.No.	Material	M30 (Kg)	M40 (Kg)
i)	53 Grade Cement	50	50
ii)	Coarse Sand	104	87
iii)	Aggregate, passes through 20 mm and retained on 10 mesh	160	134
iv)	Water (subject to 55±5 slump)	24	20
v)	CPCIA	0.5*	0.5*
	* as recommended by the manufacturer with each type of cement viz. Ordinary Portland Cement, Portland Pozzolana Cement, Portland Slag cement, Sulphate resisting Cement		

AASHTO T259 test (commonly referred to as the salt ponding test) is a long-term test for measuring the penetration of Chloride ions into concrete. Three slabs of 75 mm thick and having a surface area of 300 mm square shall be casted. These slabs are moist cured for 14 days and then stored in drying room at 50 percent relative humidity for 28 days. The sides of the slabs are sealed except for bottom and top face. After the conditioning period, a 3% NaCl solution is ponded on the top surface for 90 days, while the bottom face is left exposed to the drying environment (see figure below).



At the end of this time (90 days) the slabs are removed from the drying environment and the Chloride concentration of 10 mm thick slices is then determined (AASHTO T259).Two or three slices are taken at progressive depth. The salt ponding test does provide a crude one-dimensional chloride ion ingress profile. Test results should meet the requirements as stipulated in IS: 456.

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APPENDIX-VI
(Sheet 2 of 2)

BRIEF OUTLINES OF RESISTANCE OF CONCRETE TO MIGRATION OF CHLORIDE ION TEST (AS PER AASHTO T259).....Contd.

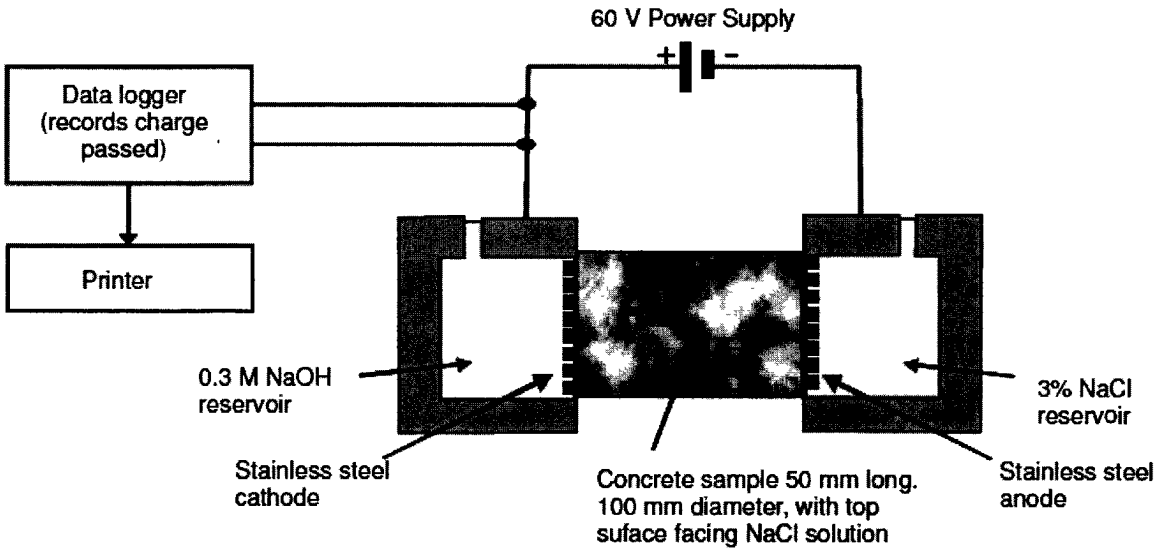
Part-B : Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (Rapid Chloride Permeability test As per ASTM C-1202)

TEST PROCEDURE

Cast three concrete cylinders of size 50 mm thick, 100 mm diameter without and with CPCIA 1% (w/w) or as recommended by the manufacturer, by using the concrete mix as under:

S.No.	Material	M 30 (Kg)	M 40 (Kg)
i)	53 Grade Cement	50	50
ii)	Coarse Sand	104	87
iii)	Aggregate, passes through 20 mm and retained on 10 mesh	160	134
iv)	Water (subject to 55±5 slump)	24	20
v)	CPCIA	0.5*	0.5*
	* as recommended by the manufacturer with each type of cement viz. Ordinary Portland Cement, Portland Pozzolana Cement, Portland Slag cement, Sulphate resisting Cement		

As per ASTM C-1202, water-saturated concrete specimen is subjected to a 60 V applied DC voltage for 6 hrs. using the apparatus shown in Figure below. In one reservoir is a 3.0% NaCl solution and in the other reservoir is a 0.3 M NaOH solution. The total charge passed is determined and this is used to rate the concrete's resistance to chloride ion penetration.



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मानक विनिर्देश

सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION CIVIL & STRUCTURAL WORKS

कंक्रीट की भूमिगत संरचनाओं का जल-रोधन

WATER-PROOFING OF UNDERGROUND CONCRETE STRUCTURES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
1	26.02.21	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	TK	AJS	AS	SM
0	15.01.15	ISSUED AS STANDARD SPECIFICATION	SP	AS	PKM	SC

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Abbreviations:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
DIN	:	Deutsches Institut für Normung (German Institute for Standardization)
EIL	:	Engineers India Limited
EN	:	European Standard
FGL	:	Finished Ground Level
FPO	:	Fully-bonded Poly Olefin
HDPE	:	High Density Poly Ethylene
IS	:	Indian Standard
ISO	:	International Organisation for Standardisation
PCC	:	Plain Cement Concrete
PVC	:	Polyvinyl Chloride
RCC	:	Reinforced Cement Concrete
SBR	:	Styrene Butadiene Rubber
UEAtc	:	Union Européenne pour l'Agrément technique dans la construction (European Union for technical approval)

Structural Standards Committee

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1.0 SCOPE

This specification covers the requirements of water-proofing of under-ground concrete structures such as basements, tunnels, ducts, trenches, pits etc., designed as per IS:456 for effectively preventing the infiltration of water from the surrounding soil into the structure and flow of water from inside the structure to outside, by using the following types of water-proofing systems:

a) Waterproofing barrier system/ materials applied to the structure,
b) Structurally integral watertight system; and
c) Drained cavity system/ internal water management system.

This specification shall also be applicable for under-ground structures designed as per IS:3370, in case shown on drawings.

Structures are generally characterized as "deep" if they have more than one storey below ground level, or "shallow" if they have only a single storey below ground. This specification is applicable to both.

This specification does not cover design philosophies, site evaluations of groundwater conditions, risk assessment and options for drainage outside the structure.

2.0 GENERAL REQUIREMENTS

2.1 The materials, constructional and performance requirements for water proofing treatment on concrete structures and any special requirements as shown or noted on the drawing(s) shall govern over the provisions of this specification.

2.2 The work shall be done in accordance with this specification. In case of conflict between the clauses mentioned in this specification and those in the Indian Standards, this specification shall govern.

3.0 REFERENCES

3.1 BIS Codes

IS:456, IS:800, IS:1322, IS:1343, IS:2314, IS:2645, IS:3370, IS:3384, IS:4911, IS:5871, IS:6461 (Part 7), IS:6494, IS:12027.

3.1 Other Codes & Standards

Various international ISO, EN, ASTM, DIN standards as mentioned.

4.0 TERMINOLOGY

For the purpose of this specification, the following definitions shall apply in addition to those given in IS:4911 and IS:6461 (Part 7), listed in alphabetical order:

4.1 **Cavity drain membrane** – Dimpled, flexible, high-density polymer sheet, which can be placed against the internal face of a structure after construction and is designed to intercept water penetrating the structure and direct it to a drainage system.

4.2 **Cut-off wall** – Embedded retaining wall designed to surround and seal-off an area, to inhibit water inflow from the surrounding area.

4.3 **Damp area** – Area which, when touched, might leave a light film of moisture on the hand but no droplets of water (that is beading).

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4.4 **Embedded retaining wall** – Wall used to support the sides of an excavation, installed in advance and penetrating below the lowest level of the below ground construction. Within this specification the principal forms considered constitute the primary permanent wall for the below ground construction, and are taken as diaphragm walls, contiguous or secant piles (which may be installed in different configurations) or steel sheet piles.

4.5 **Ground barrier** – Impermeable barrier between the structure and the ground intended to prevent or impede the ingress of water, dampness, radon, methane and other ground gases and contaminants.

4.6 **Loading coat** – Layer of material designed to hold a Type A waterproofing material in place when resisting water pressure.

4.7 **Perched water table** – Reservoir of water in the ground maintained permanently or temporarily above the standing water level in the ground below it, and is caused by the presence of an impervious soil or a stratum of low permeability.

4.8 **Seepage** – Slow transmission of water through discrete pathways of a structure.

4.9 **Tanking** – Application of an appropriate waterproofing barrier to the walls, the base slab and, where relevant, the roof of a below ground structure, such that the entire envelope of the structure below ground is protected against water ingress. A cavity drain membrane is not considered to constitute tanking.

4.10 **Type A (barrier) protection** – Protection against water ingress which is dependent on a separate barrier system applied to the structure.

4.11 **Type B (structurally integral) protection** – Protection against water ingress which is provided by the structure.

4.12 **Type C (drained) protection** – Protection against water ingress into usable spaces which is provided by the incorporation of an appropriate internal water management system.

4.13 **Vapour check** – Membrane or other element that restricts the transmission of water vapour.

4.14 **Water-proof** – Impervious to water, also known as water-tight.

4.15 **Water-proofing** – Application of water-proof/ water-resisting materials.

4.16 **Waterproofing barrier** – Material that does not permit the transmission of free water, but might allow some water vapour permeability.

4.17 **Water-proofing system** – Materials and methods used to protect a structure from water ingress and might also provide resistance to the diffusion of water vapour.

4.18 **Water resistance** – Ability of a material to resist water penetration.

4.19 **Water Bar/ Waterstop** – Material designed to inhibit the transmission of water through joints in the structure.

4.20 **Water vapour** – Water in its gaseous state.

4.21 **Water vapour resistance** – Ability of a material to resist water vapour penetration.

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5.0 WATER-PROOFING PROTECTION SYSTEMS

5.1 Types of Water-Proofing Protection Systems

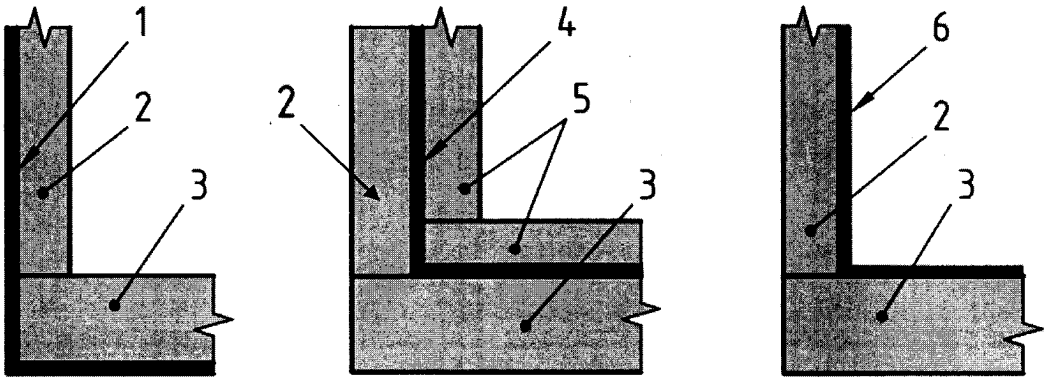
One, or a combination, of the following types of water-proofing protection systems should be selected:

a) Type A (barrier) protection;
b) Type B (structurally integral) protection;
c) Type C (drained) protection.

When making this selection, consideration should be given to:

1) the need for combined protection (see clause 5.4);
2) the water table classification and required performance level (see Table 1 & Table 2);
3) the need for continuity in the protection (see clause 5.6).

Examples of the three types of water-proofing protection systems are given in Figures 1a, 1b & 1c below:



Key to numbers:
1. External waterproofing
2. Concrete wall
3. Concrete floor slab
4. Sandwiched waterproofing
5. Loading coat
6. Internal waterproofing

Figure 1a : Type A (barrier) protection

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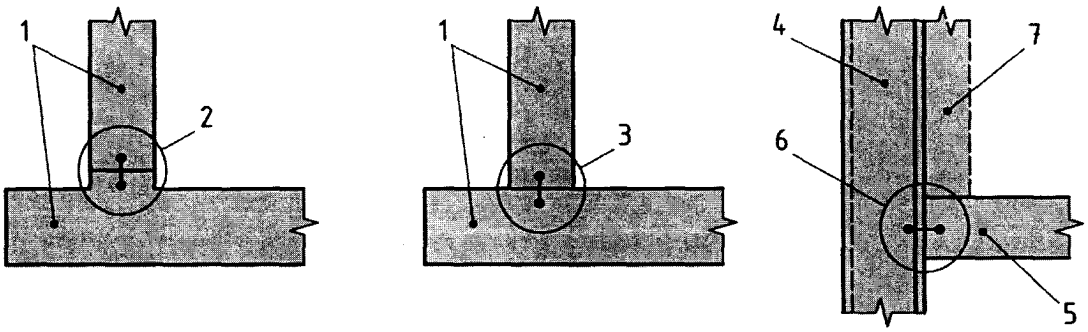
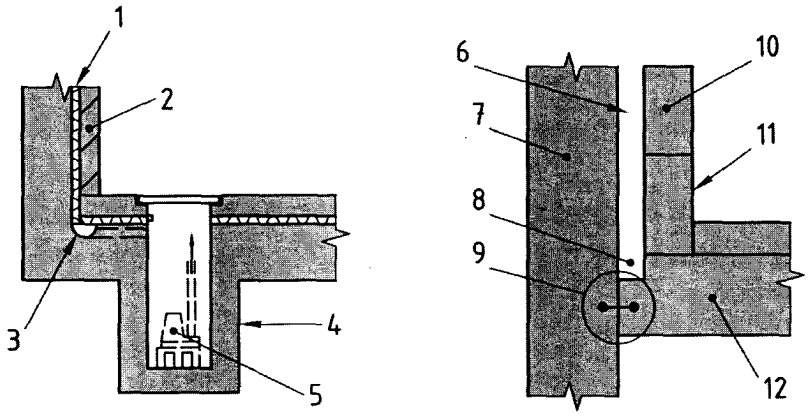


Key to numbers:
1. Water resistant reinforced concrete wall and slab
2. External or internal (within wall) waterstop, as required
3. Waterstop required at junction between wall and slab and at all construction joints
4. Concrete/steel piled wall
5. Water-resistant reinforced concrete floor slab or slab with added barrier
6. Waterstop at junction to follow profile of wall
7. Piled wall might need to be faced to achieve desired water resistance (see Table 1)

Figure 1b : Type B (structurally integral) protection



Key to numbers:
1. Cavity drain membrane
2. Inner skin (render, drylining or walling, depending on system)
3. Maintainable drainage channel with pipe connection to suitable discharge point
4. Sump formed in-situ or preformed
5. Pump
6. Wall cavity
7. Reinforced concrete/steel pile or diaphragm wall
8. Drainage channel
9. Waterstop at junction to follow wall profile
10. Internal block wall
11. Access point(s) to drainage
12. Floor slab with integral protection and/or added membrane (internal or external)

Figure 1c : Type C (drained) protection

5.2 Range of Water-Proofing Systems

There is a range of waterproofing systems that can be incorporated in each type of waterproofing protection system and these should be assessed in accordance with clause 7, 8 and 9, as appropriate, and relevant manufacturers' data sheets to confirm that the system selected is suitable for the structure to which it is to be applied. It is noted that the

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manufacturer's recommendations for installation, including provision of protection, should always be followed. Similarly, recommendations for fixings where proprietary products are used should be followed.

5.3 Water-proofing Systems for Existing Structures

For existing structures, the following types of waterproofing systems should be considered, subject to their suitability for application and their ability to be repaired:

a) an internal Type A waterproofing barrier on a structure of suitable strength and stiffness, built of concrete or masonry (subject to the condition of the surface) (see Figure 1a);
b) a drained cavity to the walls and floor, using a Type C cavity drain system (see Figure 1c).

5.4 Combined Protection

Consideration should be given to the use of combined protection (i.e. Type A & Type B, Type A & Type C or Type B & Type C) where in a single system:

a) the assessed risks are deemed to be high;
b) the consequences of failure to achieve the required internal environment are too high; or
c) additional vapour checks are necessary for a system where unacceptable water vapour transmission can occur.

Although structures with Type B protection are designed to be water-resistant, additional Water-proofing systems may be applied internally or externally to control water vapour movement, where appropriate. An in-situ "liner" wall designed to provide Type B protection can be cast inside an embedded retaining wall to provide combined protection. In some cases, a fully bonded barrier might also be provided between the two elements.

Although structures with Type C protection are designed to control and manage seepage into a structure, where this is unacceptably high the water resistance of the structure should be improved prior to the installation of the Type C protection, by the application of either Type A or Type B protection.

When combining types of protection, the compatibility of the different protection types should be assessed in order to minimize the risks and negate the need for remedial measures.

5.5 Water Table Classification and Grades of Water-proofing Protection

Where assessment of the water table is undertaken, this should be classed into the following three categories, which can then be used to determine the suitability of different types of waterproofing protection (see clause 5.1).

a) High – where the water table or perched water table is assessed to be permanently above the underside of the base slab.
b) Low – where the water table or perched water table is assessed to be permanently below the underside of the base slab. This only applies to free-draining strata.
c) Variable – where the water table fluctuates.

In certain ground conditions, external drainage systems can be used to convert the "high" and "variable" water tables to the "low" condition (see also clause 5.7)

When selecting a type of waterproofing protection system, Table 1 and Table 2 should be taken into account, in conjunction with the following:

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a) During the life of the structure, some degree of groundwater pressure is likely to build up against the chosen waterproofing system.
b) Cracking or defective construction joints can provide a potential path for water ingress.
c) Water ingress can occur where there is groundwater pressure. If this is not consistent with the required performance level (see Table 2):
   1) consideration should be given to the form and feasibility of remedial work;
   2) if remedial work is not possible, the design should be altered.
d) There are a number of risks associated with not carrying out planned maintenance for structures with Type C protection, e.g. pump failure (see clause 9.3).

The following should also be taken into account while selecting the type of waterproofing protection system:

1) initial capital costs compared with costs for future maintenance and any necessary upgrades;
2) the scope for testing during installation;
3) the risks associated with aggressive groundwater and other ground contaminants, which might require the use of a specific protection barrier;
4) the need or ability to provide heating and/or ventilation and the consequences arising in terms of water vapour.
5) the type of structure, i.e. building, basement, sump, etc.

Table 1 : Selection of type of Water-proofing based on Water Table Classification

<table>
<tr><td rowspan="3">Risk associated with water table</td><td rowspan="3">Water table classification (see note)</td><td colspan="4">Water-proofing protection type</td></tr>
<tr><td rowspan="2">Type A (barrier)</td><td colspan="2">Type B (structurally integral)</td><td rowspan="2">Type C (drained)</td></tr>
<tr><td>Piled Wall</td><td>Reinforced Concrete Wall</td></tr>
<tr><td>Low</td><td>Low</td><td>Acceptable</td><td>Acceptable</td><td>Acceptable</td><td>Acceptable</td></tr>
<tr><td rowspan="3">↕</td><td>Variable</td><td>Acceptable if the variable classification is due to surface water.</td><td rowspan="2">Acceptable where:
a) The piled wall is directly accessible for repair and maintenance from inside the structure; or
b) The piled wall is combined with a fully bonded waterproofing barrier; or
c) The piled wall is faced internally with a concrete wall.</td><td>Acceptable</td><td>Acceptable</td></tr>
<tr><td>High</td><td>Acceptable</td><td>Acceptable</td><td>Acceptable</td></tr>
<tr><td>High</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Measure to reduce risk</td><td colspan="5">Use combined protection</td></tr>
<tr><td colspan="5">Incorporate appropriately designed sub-surface drainage and ensure that it is maintained</td></tr>
<tr><td colspan="5">Use a fully bonded waterproofing barrier</td></tr>
<tr><td colspan="5">Lower the permeability of the main structure wall</td></tr>
<tr><td colspan="5">Use concrete with a waterproofing admixture</td></tr>
<tr><td colspan="5">Ensure that discharge systems, e.g. pumps are maintained so that the system remains effective</td></tr>
</table>

NOTE – The water table classifications are defined as follows (see also clause 5.5)
1) Low – where the water table or perched water table is assessed to be permanently below the underside of the base slab. This only applies to free drainage strata.
2) Variable – where water table fluctuates.

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3) High – where the water table or perched water table is assessed to be permanently above the underside of the base slab.
4) Ground permeability might affect risk under a low or variable water table (see clause 5.5)

Table 2 : Grades of Waterproofing Protection

Grade	Example of use of structure	Performance level
1	Car parking, plant rooms (excluding electrical equipments).	Some seepage and damp areas tolerable, depending on the intended use *.
2	Car parking, plant rooms (utilities) and workshops requiring a drier environment (than Grade 1), storage areas.	No water penetration acceptable. Damp areas tolerable, ventilation might be required.
3	Ventilated residential and commercial areas, including offices, restaurants, retails shops, leisure centres, Car parking etc.	No water penetration acceptable. Ventilation, dehumidification or air conditioning necessary, appropriate to the intended use.
4	Industrial plant areas like cable cellar, sumps in pump houses, sumps having equipments, panel rooms, etc.	No water penetration acceptable.
* Seepage and damp areas for some forms of construction can be quantified by reference to available Industry Standards.		

5.6 Continuity of Water-proofing Protection

The need for continuity in the waterproofing protection should also be considered when selecting a type of protection. In most circumstances, the protection should be continuous. In certain situations, for example, where a drained cavity is combined with an underslab membrane, discontinuity with respect to waterproofing can be acceptable subject to careful detailing and an appropriate assessment of risk. Any build up of water should be permanently controlled by a water management system.

The proposed type of foundation and its suitability for providing continuity of waterproofing (where so required) should be assessed.

Continuity can be provided in situations where the surface or structure of the wall and foundation provides uninterrupted positioning of the waterproofing measures.

In existing structures, assessment of any direct or potential discontinuity should be undertaken in order to determine the need for special waterproofing details, for example to overcome the effects of future movement.

Discontinuity of waterproofing protection might not be acceptable if there is a need to manage radon, methane and other ground gases and contaminants (see clause 5.9).

5.7 Exclusion of Surface Water

Where practicable, provision should be made to prevent or reduce percolation of rainwater into the ground. Burst water mains and leaky sewers can provide additional sources of surface water. These can affect perched water tables. The drainage behind the wall needs to be able to cope with the highest inflow rates, e.g. the burst water main, which might not be practicable in coarse-grained soils.

5.8 Sub-surface drainage

Where sub-surface drainage is deemed necessary to lower the potential for hydrostatic pressure on the waterproofing system and lessen the risk of water ingress through defects, it should be provided by one of the following methods:

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a) permeable granular fill;
b) no-fines or hollow block work;
c) geosynthetic drainage composite;
d) underslab drainage.

Figure 3 gives examples of the positioning of land drains, drainage channels and sub-surface drainage.

Such provisions should be made maintainable where they are used to control the level of water in a structure that does not in itself provide adequate water resistance.

Where practicable, water should be kept from prolonged contact with perimeter structure walls or base slabs by porous or open jointed land drains, combined with a geosynthetic drainage composite installed to the full height of the earth-retaining wall and laid to proper falls around the perimeter of the structure, adjacent to the wall footing and, where appropriate, beneath the slab itself.

The sub-surface system should be graded to an open outlet below the level of the lowest slab, such as to a stormwater drain protected by a pumped surcharge device or to a pumped sump, and can also provide a suitable outfall for any sub-floor drainage.

Perimeter drainage at floor level is likely to lower the groundwater table to a degree that varies with the permeability of the subsoil and the possible consequences of this (such as permanent lowering of the water table in the surrounding area) should be taken into account. Any existing system of land drains should be tested, checked and only retained if both appropriate and maintainable. Any local diversions necessary should retain the existing geometry so far as practicable with new and easily maintainable pipework.

Care should be taken so that no damage is caused in nearby structures. Where deep structures are contemplated in built-up areas, groundwater lowering should not be undertaken without careful investigation in conjunction with a groundwater specialist. Perimeter walls providing a cut-off into an impervious layer or stabilization of granular subsoils by grout injection or similar alternative treatments may be considered instead.

For structures in coarse-grained soil, with variable and high water tables (see clause 5.5), the flow rates are likely to make it impracticable to pump for the design life of the structure. In these cases, a hydraulic cut-off wall into fine-grained soils is required to isolate the ground below the base slab. This enables an underslab drainage system to relieve the water pressure below the base slab.

For structures in fine-grained soil, with variable and high water tables (see clause 5.5), the flow rates are more likely to make it practical to pump for the design life of the structure. A drainage system may be provided outside the retaining wall to control the water pressures. An underslab drainage system may also be provided below the base slab to control the water pressures.

Cut-off walls are formed from diaphragm walls, secant piles or steel piles. Over the excavated wall depth remedial works can be carried out on leaky walls. This is not feasible for the length of wall below formation. Therefore, specified tolerances should be such that there is adequate intersection between piles or provision of continuous water bars at diaphragm wall panel joints and particular attention should be given to workmanship. In inter-bedded soils, relief wells may be used below formation level. The cut-off wall may also be used to reduce the flow rate and control the drawdown outside the site.

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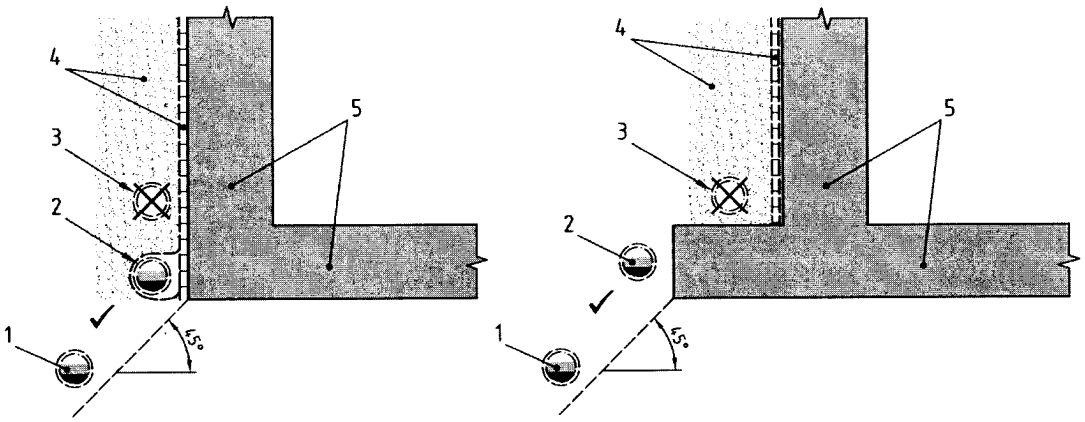

a) Construction without a toe

b) Construction with a toe

Key to numbers:

1. Maintainable land drain (see clause 5.8) not to be positioned closer than a line of 45° from the underside of the slab/ blinding or with an invert above the upper surface of the floor slab
2. Measures to control water vapour might be necessary where the invert of the land drain is above the underside of the floor slab
3. Incorrect position of land drain, which can cause hydrostatic pressure on barrier leading to water ingress, if defects are present.
4. Subsoil drainage layer, where appropriate (see clause 5.8)
5. Structural wall slab and foundation slab

Figure 2 : Sub-surface drainage positioning

5.9 Ground Gases

The insertion of a ground barrier for the prevention of radon, methane and other ground gases and contaminants from entering a structure should be considered in the design, choice of the materials and installation of any waterproofing system.

6.0 GENERAL CONSTRUCTION ISSUES

6.1 Site De-watering

Where appropriate, the site should be de-watered at least until such time as the below ground structure and waterproofing is completed. On open sites, where any adjacent structures are sufficiently remote to be unaffected by groundwater lowering, de-watering or pumping from carefully arranged sumps with appropriate drainage channels should be continuous while the laying of any waterproofing barrier materials is in progress and until all loading coats have hardened and the structure has developed sufficient strength to resist the full water pressure.

6.2 Structural Elements

Forms of construction to receive below ground waterproofing protection may include the following:

a) Walls – constructed from:

i) masonry (plain or reinforced brick or block);
ii) precast concrete;
iii) in-situ concrete, either cast in form (plain, reinforced or prestressed) or embedded walls; or
iv) steel or concrete piles in embedded walls.

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b) Base slab – constructed from concrete cast in situ, plain or reinforced, raft or other form.
c) Roof, where applicable – constructed from reinforced in-situ concrete, precast concrete with an in-situ topping, or a steel composite slab, as appropriate.

7.0 TYPE A (BARRIER) PROTECTION

7.1 Structural Aspects

Schematic illustrations of Type A protection are given in Figure 1a.

7.2 General

Barrier protection design should be based on an evaluation of:

a) the nature of the substrate(s);
b) the likely overall and local movements that might cause distress in the waterproofing barrier;
c) the ability of the barrier system to accommodate these movements;
d) the essential characteristics of the waterproofing system, e.g. bonded/ unbonded, pre-applied/ post-applied, liquid-applied or pre-formed;
e) the need for external or internal application; and
f) the effects of environmental contaminants.

7.3 Differential Movement and Cracking

Barrier-specific properties should also be evaluated, allowing for any predicted cracking from the structure. The waterproofing barrier should be capable of providing the appropriate protection against water and water vapour without disruption or decay.

Although some barrier materials accept local strains and can accommodate a crack opening in the supporting structure, it should be noted that others might be damaged by differential movement or cracking (see Figure 3).

Care should be taken so that a load-bearing substrate is capable of supporting the barrier material, even under sustained water pressure, particularly around openings or service penetrations. A levelling or smoothing layer should be applied to masonry structures, as required.

Note – There are two issues in regard to the possible influence of cracks on barrier performance. One relates to cracks pre-existing at the time of application and the ability of the selected system to initially bridge the crack. Decisions based on the specific properties of the barrier material would be needed before deciding whether any such cracks require pre-treatment. The second issue is the ability of the selected system to accommodate cracks that might form after application.

Remedial measures to fill significant voids or openings should be undertaken as the effect of sustained water pressure forcing the barrier material into them might create a risk of failure.

7.4 Continuity of Water-proofing Barrier

The water-proofing barrier should, in most instances, be continuous around the structure. In order to maintain the continuity of the barrier, penetrations through walls or floors that are to be protected (e.g. openings for services, pipes, cables) should be avoided, wherever possible. Where it is essential to provide such openings, special treatment around the penetration should be provided and reference should be made to the manufacturer's instructions and specialist

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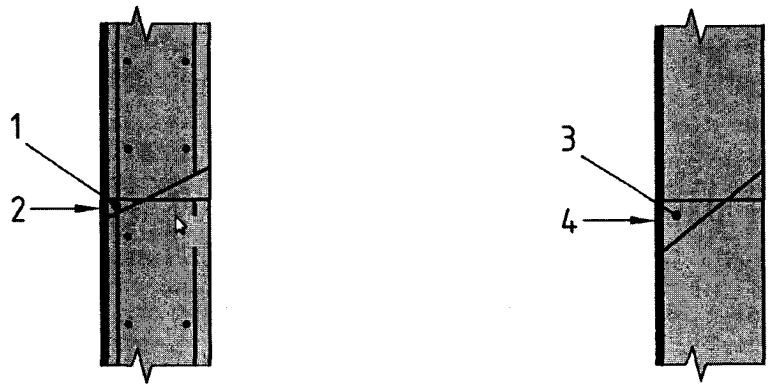
advice. Similarly, where fixings through the barrier are necessary, the manufacturer's instructions should be followed. Movement joints below ground should not be used unless unavoidable; in such cases these should be waterproofed in accordance with the manufacturer's instructions.

Where a water-proofing barrier is required for a structure supported on piled foundations, special consideration should be given to the detailing so that structural continuity is not compromised (*see* Figure 4) and reference should be made to the manufacturer's instructions.

7.5 Materials Water-proofing Barrier

The water-proofing barrier used to provide Type A protection should be installed in one of the following locations, depending on the material(s) from which it is formed:

a) On the exterior face of walls or slabs (external waterproofing);
b) On some external source of support (reverse waterproofing);
c) Within the structure (sandwiched waterproofing);
d) On the interior face of perimeter walls (internal waterproofing).



a) Reinforced (in-situ) concrete wall

b) Un-reinforced or nominally reinforced (in-situ) concrete wall

Key to numbers:
1. Stress and crack width reduced by reinforcement
2. Likely to be compatible with most waterproofing barriers
3. Stress and crack width increased by lack of reinforcement
4. Might exceed strain capacity of some water proofing barriers if wall cracks

Figure 3 : Effect of structure on applied waterproofing barrier

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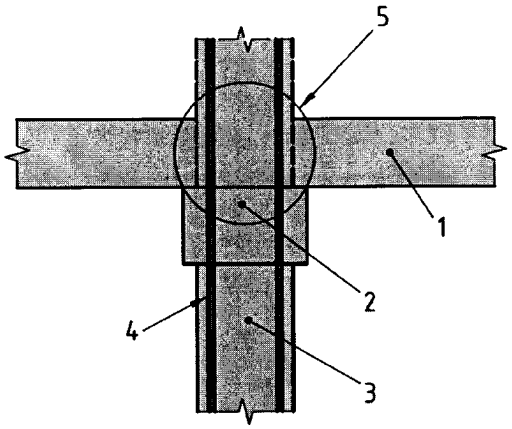

Key to numbers:
1. Floor slab
2. Pile cap, as appropriate
3. Pile
4. Pile reinforcement
5. Slab/ pile/ pile cap to have integral protection and/or added internal or external membrane

Figure 4 : Pile to floor slab junction

Table 3 should be considered when selecting the appropriate waterproofing barrier for use. All barriers should be installed strictly in accordance with the manufacturer's instructions, including any recommendations regarding:

1) protection from damage, following application and curing, where the barrier is applied externally;
2) penetrations through the barrier;
3) fixings, where these are necessary;
4) application over joints in the substrate.

Table 3 : Categories of barrier materials

Sl.	Type of Barrier	Description	Application
1.	Bonded sheet membranes (see clause 7.5.1)	Pre-applied composite sheet membranes comprising HDPE/ FPO based carrier film, synthetic adhesives and protective layer that bond to concrete poured against them.	Applied before concreting of structural slabs and confined walls. Can be applied externally or sandwiched.
		Synthetic or Bitumen based sheet membrane can be either: a) Flexible, cold applied (self adhesive); or b) Hot applied (torch-on, or bonded using a hot melt bitumen adhesive) generally applied in multiple layers	Can be applied externally or sandwiched. Does not provide bonded membrane protection below slabs.
2.	Unbonded sheet membranes (see clause 7.5.2)	Flexible, synthetic sheet co-extruded membranes generally made of plasticized PVC with a signal layer in case of damage	Can be applied externally or sandwiched. Requires separation layers and protection screed below slab.
3.	Liquid applied membranes (see clause 7.5.3)	There are many types of liquid applied membranes, which included one or two part systems.	Can be applied externally or sandwiched
4.	Geosynthetic clay liners (see clause 7.5.4)	These comprise Bentonite with a single or dual carrier material, typically of Geotextile or HDPE. There are two principal forms; dry Bentonite and pre hydrated Bentonite.	Can be applied externally or sandwiched. Vulnerable to wet/dry cycling and must remain confined to be watertight.

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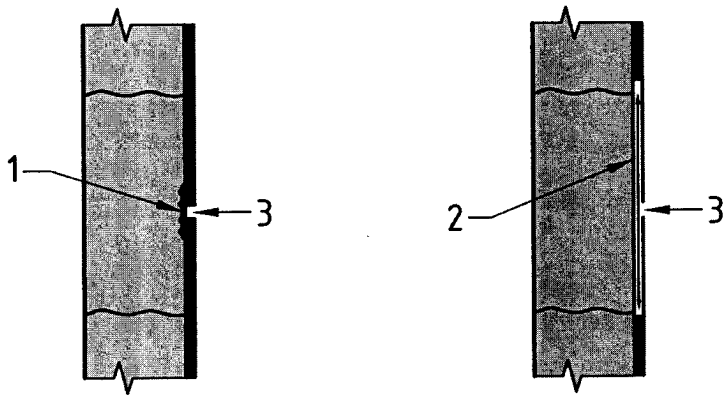
Sl.	Type of Barrier	Description	Application
5.	Cementitious crystallization slurries and powders (see clause 7.5.5)	These are applied as coating to surface of concrete walls and slabs or a solution or powder added to concrete.	Can be applied internally or externally
6.	Cementitious multi-coat renders, topping and coatings (see clause 7.5.6)	These are generally applied in multicoats or slurries and are resistant to liquid water but allow some water vapour penetration.	Can be applied internally or externally



Key to numbers:

1. Bonded barrier preventing water from tracking from a defect in the membrane to a crack/ joint in the supporting concrete wall (if the defect is coincident with a crack, the crack can be repaired with crack injection)
2. Partially bonded or un-bonded barrier allowing water to track from a defect
3. Defect in barrier

Figure 5 : Effect of bonded and un-bonded barriers

7.5.1 Bonded Sheet Membranes

Bonded sheet membranes may be pre-applied or post-applied to the structure.

Pre-applied membranes are initially attached to enabling works in a reverse waterproofing application; they subsequently become bonded to poured concrete walls and slabs using synthetic adhesive layers.

Pre-applied bonded sheet membranes shall confirm to EN 13967 "*Flexible sheets for waterproofing. Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet. Definitions and characteristics*" and shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Water-tightness to liquid water	EN 1928	Pass
2.	Durability of water-tightness against ageing	EN 1286/ EN 1928	Pass
3.	Water vapour transmission	EN 1931	0.50 to 0.75 g/sqm
4.	Tensile strength	EN 12311	$\geq$ 8 N/sqmm
5.	Joint strength	EN 12317-2	$\geq$ 220 N
6.	Mass (per unit area)	EN 1848/ EN 1849	1.5 g/sqm
7.	Straightness	EN 1848-2	$\leq$ 75 mm per 10 m
8.	Visible defects	EN 1848-2	Pass

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Sl.	Property	Code/ Standard	Result
9.	Resistance to static load	EN 10730 B	≥ 15 kg
10.	Resistance to impact	EN 12691	≥ 350 mm
11.	Resistance to tear (nail shank)	EN 12310-1	≥ 600 N
12.	Resistance to fire	EN ISO 11925-2	Pass

Post-applied membranes are either cold-applied (flexible self adhesive type) or hot-applied (torch-on or bonded type).

Cold-applied (flexible self adhesive type) bonded sheet membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Tensile strength	ASTM D638	≥ 39 N/sqmm
2.	Elongation of membrane	ASTM D638	≥ 200%
3.	Elongation of compound	ASTM D412	≥ 2000%
4.	Tear resistance	ASTM D146	250 N/mm
5.	Adhesion to concrete	ASTM D1000	2.2 N/sqmm
6.	Adhesion to self	ASTM D1000	3.5 N/sqmm
7.	Puncture resistance	ASTM E154	< 300 N
8.	Water absorption @ 24 hours	ASTM D540	< 0.02%
9.	Water permeability	ASTM D638	Nil
10.	Resistance to hydrostatic head	ASTM D5385	60 m
11.	Crack bridging	ASTM C836	1.5 mm
12.	Tape strength	ASTM D638	4.3 N/sqmm

Hot-applied (torch-on or bonded type) bonded sheet membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Tensile strength	UEAtc	730 N/ 5 cm
2.	Elongation of membrane	UEAtc	65%
3.	Tear resistance	ASTM D4073	180 N
4.	Puncture Resistance	UEAtc	1.4
5.	Water absorption	ASTM D5147	< 0.15%
6.	Water vapour transmission	ASTM E96	< 0.50 g/sqmm/24h

7.5.1.1 General

A bonded sheet membrane should be firmly supported by a load-bearing structure so that external ground and water pressures are adequately resisted.

It is important that the substructure provides a satisfactory base on which to apply the membrane, and therefore concrete should be free from ridges and indentions and finished to a true and even surface, preferably with a wood float finish. Brickwork and block work should have flush joints. In all cases the manufacturer's instructions shall be closely followed regarding, substrate preparation, detailing and lap sealing.

For hot applied materials, care needs to be taken to ensure the adhesive is melted for the whole area to avoid only partial bonding of the membrane and associated risks of water tracking (see Figure 5). Cold applied materials are increasingly preferred due to ease of installation and to avoid the high risk of fire and injury.

7.5.1.2 Horizontal applications

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Membrane applications below foundations slabs are all effectively reverse waterproofing applications and should therefore use only a pre-applied bonded membrane slab (see Figure 5). Protective screeds, fabrics or boards should be avoided as they act as a de-bonding layer between the membrane and structural concrete and provide a path for water migration.

7.5.1.3 Vertical applications (pre-applied)

For protection of walls on confined sites against temporary works or piled walls, a pre-applied membrane that subsequently becomes bonded to the poured concrete should be mechanically fixed to the vertical substrate to provide a fully bonded application.

7.5.1.4 Vertical applications (post-applied)

For walls with external working space that allows the waterproofing to be applied after the concrete wall is poured, post-applied self adhesive membranes shall be used. Walls shall be prepared in accordance with membrane manufacturer's instructions. Careful attention needs to be paid to the compatibility and sealing of the junction between the exposed external face of the pre-applied slab membrane and the post-applied membrane.

7.5.1.5 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.2 **Un-bonded Sheet Membranes**

Un-bonded sheet membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Thickness	EN 1849-2	2 mm
2.	Tensile strength	ASTM D412	$\geq$ 15 N/sqmm
3.	Tear resistance	ASTM D624	$\geq$ 600 N
4.	Elongation	ASTM D412	$\geq$ 300%
5.	Puncture resistance	ASTM E154	$\geq$ 2.5 kN
6.	Water impermeability	BS EN 12393	Nil (@ 5 bar)

7.5.2.1 General

Generally made from plasticised PVC to a minimum of 2 mm thick, sheets are co-extruded in two colours to provide a signal layer to show damage for visual inspection. As the membrane is unbonded utmost care should be taken to avoid any damage. All substrates should be as smooth as possible, free from debris, and other irregularities that may puncture the waterproofing layers.

7.5.2.2 Horizontal applications

The membrane is loose laid sandwiched between layers of geotextile; the first layer is an adjustment layer to compensate for surface irregularities, the second is a separation layer from subsequent minimum 50 mm screed protection. The engineer should note that on piled foundations, the unbonded membrane is separated from the structure and will fall away in case of ground settlement leaving the membrane unsupported against water pressure.

7.5.2.3 Vertical applications

For walls the same sandwich layers are required. The membrane must be attached to the walls using mechanical fixings recommended by the manufacture to which the membrane can be spot welded. Protection to be provided by boards or masonry walls.

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7.5.2.4 Lap seam welding

For all applications, watertightness of unbonded membranes relies totally on lap seam welding. Adjacent membranes are joined together using specialist equipment to provide a double seam weld that allows pressure testing of joints. The pressure testing is to check the integrity of the welds for watertightness and strength and must be completed before subsequent layers are applied.

7.5.2.5 Compartmenting

To prevent water tracking as described in Figure 5, un-bonded membranes require a compartmenting system to enable the membrane to be divided into sectors and limit the free movement of water ingress around the structure. This is achieved using waterstops profiles of the same material double welded to the waterproof layer. These welds should also be pressure tested for integrity. Future repair operations can be carried out by injection of water reactive resins. For these repairs to be effective and the source of leaks readily identified, compartment sizes should be limited to no more than 150 sqm.

7.5.2.6 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.3 **Liquid Applied Membranes**

Liquid Applied membranes shall possess the following properties:

Sl.	Property	Code/ Standard	Result
1.	Tensile strength	ASTM D412	$\geq$ 0.3 N/sqmm
2.	Elongation	ASTM D412	$\geq$ 600%
3.	Tack free time	-	15 hours
4.	Time to full cure	-	7 days
5.	Water permeability	ASTM E96	Negligible
6.	Water vapour (moisture) permeability	ASTM E96	< 25 g/sqmm/24h

7.5.3.1 General

Details on the preparation of the substrate, application rate, method and curing requirements should be sought from the manufacturer. Liquid membrane (such as for silicone based water repellents in IS:12027) performance is dependent on the applied thickness and correct mixing of components. Particular attention should therefore be paid to site quality control of mixing and application, both wet and dry film thicknesses to avoid thin patches and unmixed material.

7.5.3.2 Sandwich applications

When applied to the internal face of the structure, the membrane might need to be restrained against the effects of water pressure; in such cases, the restraining element should be firm against the applied liquid membrane. Suitable protection to the membrane should be provided.

7.5.3.3 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.4 **Geosynthetic Clay Liners**

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Bentonite is a natural clay mineral, which has the capacity to expand when in contact with water forming a barrier to the transmission of water and other liquids. Sodium bentonite is held between two geosynthetic (geotextile) layers. The bentonite forms an impervious seal providing it remains hydrated and fully confined. The geosynthetic layers attach to the poured concrete.

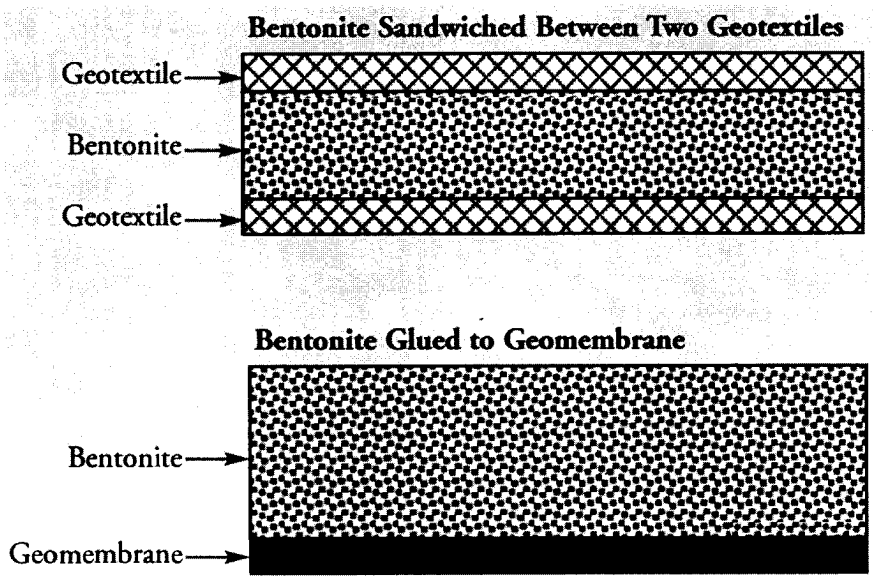

Figure 6 : Geosynthetic Clay Liners

Geosynthetic clay liners are available in two forms. Dry bentonite liners rely on activation taking place on site from the absorption of the groundwater once installed. Pre-hydrated bentonite liners are manufactured by vacuum extrusion and do not need to be hydrated on site.

Geosynthetic clay liners are generally used in environmental containment applications, e.g. solid waste landfills, mining, liquid effluent ponds, etc.

7.5.4.1 General

Bentonite-based waterproofing should only be used where the liner remains confined between two surfaces. For this reason, bentonite membranes are generally not suitable for use below slabs where ground settlement is likely, e.g. on piled foundations. The materials are suitable for new-build and refurbishment applications.

7.5.4.2 Horizontal applications

Geosynthetic clay liners can be laid onto compacted sub-base or blinding concrete. The surface can be damp, but the liner should not be laid into standing water and should be protected from wet weather to avoid premature hydration. Prematurely hydrated material should be replaced prior to concreting. The manufacturer's advice should be sought on surface preparation requirements.

The manufacturer should also be consulted regarding the continuity of the horizontal liner with the vertical liner as different options exist depending on the type of vertical application, i.e. pre-applied or post-applied.

7.5.4.3 Vertical applications (pre-applied)

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When pre-applied, the liner should be fixed to formwork or to secant, contiguous or steel piles or diaphragm walls and the concrete should be poured directly, confining the liner.

7.5.4.4 Vertical applications (post-applied)

When post-applied, the liner should be nailed to the reinforced concrete structure. Minimal substrate preparation is required. As the waterproofing performance relies on full confinement for the life of the structure, as soon as possible after the vertical bentonite sheeting has been applied to the walls, backfilling should take place in accordance with the manufacturer's instructions and to avoid the risk of premature hydration.

7.5.4.5 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

7.5.5 **Cementitious Crystallization Slurries and Powders**

Cementitious crystallization barriers (such as IS:2645) are blends of Portland cement, treated quartz sands and active chemicals. They are supplied in powder form and can be applied:

a) mixed with water to form slurry, which is then applied directly to the prepared concrete surface using brush, roller or spray (@ ~ 1.2 kg/sqm per coat), or
b) added to concrete mixer (@ ~1% w/w cement), or
c) dry shake over freshly laid PCC (@ ~ 2 kg/sqm)

The active chemicals combine with free lime and moisture present in the capillary tracts to form insoluble crystalline complexes which prevent water ingress.

7.5.5.1 General

Cementitious crystallization barriers should be applied to either internal or external surfaces of the concrete structure by brush, roller or spray. They are suitable for use on both new and existing structures, and do not require a loading coat.

Surfaces should be prepared (in accordance with the manufacturer's instructions) so as to have a capillary open structure prior to the application of the barrier. A capillary open structure refers to the intrinsic fine capillary tracts (pore structure) of a concrete matrix.

7.5.5.2 Horizontal applications

Cementitious crystallization barriers can be applied as single coat slurry to hardened concrete or dry sprinkle and trowel-applied to fresh concrete. They can also be applied to concrete blinding immediately prior to the placing of overlaying concrete.

7.5.5.3 Vertical applications

The barrier should be applied in a two-coat application to all vertical surfaces. Vertical surfaces should be prepared in accordance with the manufacturer's instructions. The rate and final depth of the crystals growing into the capillary channels depends on the concentration of active elements in the product, the concrete quality, the presence of free lime, temperature and humidity. All these are variable factors and change over the life of the concrete particularly as free lime is no longer available.

7.5.5.4 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

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7.5.6 **Cementitious Multi-coat Renders, Mortars and Coatings**

The installation of cementitious or acrylic polymer modified or elastomeric multi-coat renders, mortars and coatings should, unless otherwise advised by the manufacturer, be left until as much as practicable of the structure's dead load has been applied. The substrate should be prepared in accordance with the manufacturer's instructions prior to the application of the system.

Details on the application method and rate, mixing, number of layers/ coats and curing requirements should be sought from the manufacturer.

Existing substrates and structural elements should be assessed for suitability to withstand any increase in applied loads from water pressure.

7.5.6.1 Manufacturer's technical datasheet and method statement/ recommendations shall be referred for detailed information about the product and its handling, storage, surface preparation, application & precautions.

8.0 TYPE B (STRUCTURALLY INTEGRAL) PROTECTION

8.1 General

For water and water vapour resistance, Type B protection relies upon the design and the materials incorporated into the external shell of the structure itself. Schematic illustrations of Type B protection are given in Figure 1b.

Concrete structures containing a waterproof admixture should be considered as having a lower degree of water/vapour transmission when the design of the concrete mix and casting of the structure is adequately supervised and the admixture is assessed and certified (see clause 8.2.1.3). Service entries are particularly vulnerable to water penetration; where they cannot be avoided, they should be carefully detailed, incorporating sealing, to minimize the risk of water ingress.

8.2 Materials for Structurally Integral Protection

8.2.1 Concrete

8.2.1.1 General

Reinforced concrete structures may be designed and detailed specifically to minimize water ingress with no additional protective measures. Concretes meeting minimum design requirements for structural use and durability in the ground, and properly placed and compacted, are likely to have good resistance to the transmission of water in liquid form. A degree of resistance to water vapour transmission is also achieved dependent on section thickness. The pattern of any seepage encountered is often associated with poor joints, cracks or other discontinuities such as service penetrations.

The following factors are considered as being of particular importance in achieving a water-resistant concrete structure and thus should be taken into account:

a) the design of the structure (general and detailed), and the specification of materials;
b) the quality of workmanship in preparing and placing concrete;
c) curing;
d) site organization;
e) the condition of the formation, i.e. the formation should be clean with no running water; material storage;

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f) the close-fitting of formwork, the fixing of reinforcement(s) and the preparation of joints.

Crack widths in concrete should be controlled by using the appropriate design, mix specification, detailing, construction supervision and curing (especially in relation to temperature).

The effects of residual moisture ingress (water or water vapour) may be minimized by the provision of appropriate internal environmental design and control mechanisms.

When selecting applied internal finishes, advice should be sought from the manufacturer. Moisture content and relative humidity should also be considered.

8.2.1.2 Reinforced and prestressed concrete (in-situ or precast)

Structures in reinforced or prestressed concrete should be designed and constructed in accordance with IS:456 and IS:1343.

8.2.1.3 Concrete containing waterproofing admixtures

Water-proofing admixture shall confirm to IS:2645. Manufacturers should be consulted as to the performance of a specific waterproofing admixture in reducing the risk of water penetration through a crack, possibly under considerable hydrostatic pressure. Potential seepage locations, such as penetrations and joints, would typically be addressed by design (for example waterstops; see clause 8.2.1.4).

Waterproofing admixtures should preferably be used in conjunction with other waterproofing components supplied by the same manufacturer, e.g. waterstops, sealants.

8.2.1.4 Water bars/ Waterstops

The principal types of waterstops can be classified as the following:

a) Passive sections:

   1) Rubber or flexible polyvinyl chloride (PVC) extruded profiles cast into the concrete on both sides of the joint, either at the concrete surface or mid-depth of the concrete section, to form a physical obstruction to water transmission;
   2) Steel water bar strips placed mid-depth of the concrete section to form a physical obstruction to water transmission.

b) Active or hydrophilic strips or crystallization slurries:

   1) Preformed profiles of materials or sealant composition applied to the concrete joint at depth in the section. The materials swell or give rise to crystal growth on contact with water providing an enhanced obstruction. They can used as a sole material or in a composite product with passive waterstop sections;
   2) Post-injected systems.

c) Permeable hose or other sections that are fixed to the construction joint surface before casting the second pour, to facilitate the injection of a specialist sealing resin into the joint, when required.

Waterstops should be used to provide enhanced resistance to water transmission at joints in the concrete structure, e.g. at construction or day-work joints, services or other penetrations (see Figure 1). The positioning of the waterstop(s) (external and/ or internal) should be appropriate

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for the method of construction and the level of risk. Particular attention should be given to the use of waterstops at movement joints (see clause 7.4).

The specifier should be satisfied that waterstops have been tested and certified for the application, service conditions and groundwater chemistry proposed.

Where centre-bulb waterstops are used, robust methods of fixing should be used to keep the components in place during concreting operations. Correct orientation should be provided to facilitate adequate compaction of the concrete around any internal components and to avoid creating paths for subsequent water ingress.

8.2.2 Steel

Steel piles in either sheet (IS:2314) or tubular form may be used as the permanent structural wall in cases where the pile clutch interlock system between individual sections can be adequately sealed. Soldier piles formed from H or I sections may also be used with suitable lagging. Steel structures should be designed and constructed in accordance with IS:800.

8.3 Embedded Retaining Walls

8.3.1 General

Construction for deep structures may be either top-down or bottom-up, or a combination thereof. The construction method should, as dictated by the ground conditions and site constraints (including the proximity of buildings on adjacent sites), determine the use and type of embedded piled walls, which may be of concrete or steel pile, or diaphragm walls.

For all types of embedded retaining wall, the requirements for water resistance should be clearly specified. In particular, the acceptability of running or dripping water (seepage) and the extent to which any damp areas are tolerable should be considered and specified, as appropriate for the required grade of waterproofing protection.

For all embedded retaining walls, whether concrete or steel, the joint between the base slab and the wall should be precisely detailed to achieve structural continuity consistent with the design. This junction should be viewed as a three-dimensional arrangement, such that all potential water paths can be identified and detailed. The joint should be carefully detailed and waterstops should be attached to, and follow, the profile of the wall in accordance with the manufacturer's instructions.

Grouting tubes may also be installed within a clean flush joint so that remedial grouting can be undertaken, if necessary. Attempts to install grout tubes that maintain intimate contact with convoluted joints might be unsuccessful; in this situation, a hydrophilic strip bonded to the joint with adhesive might be more suitable (see also clause 5.5)

8.3.2 Concrete Retaining Walls

Piled and diaphragm retaining walls should conform to the general requirements. The water penetration through well-formed walls using these techniques is normally limited to, and controlled by, the vertical joints rather than the flow through the concrete elements and there is thus little benefit in designing concrete piled and diaphragm walls in accordance with the higher tightness classes specified.

Where secant pile retaining walls are used, specialist advice should be obtained as to the appropriate system and construction method for the project. The joints between diaphragm wall panels can be enhanced by the incorporation of water bars, where the performance requirements justify it. Such water bars can be effective at restricting water ingress via

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transverse flow through the wall section but further attention might be necessary to deal with water flowing up the wall joints inboard of the water bar location.

8.3.3 Steel Retaining Walls

The performance level of water tightness should be specified. This may be achieved by the application of an appropriate sealing system(s) to the clutch interlocks, using one of the following systems:

a) active (hydrophilic) systems, pre-applied or, if essential, applied under shelter and tightly controlled conditions on site; or
b) passive (hot-installed bituminous product) systems; or
c) welded clutches.

The system selected should be able to provide the specified performance and be consistent with the method of installing the piles. The manufacturer's instructions should be followed to achieve the necessary resistance to seepage.
In some instances, welded clutches might be used in addition to the systems specified in a) and b).

For integral protection, sheet pile interlocks should be welded or sealed with a hydrophilic material.

Sealing welds along the interlock should be capable of accommodating any movement that might take place. The welding process should be selected to suit the environment to which the welds are exposed and the site conditions in which welding occurs.

Steel sheet pile interlocks can be seal-welded after installation to provide watertight structural walls.

The connection to the base slab should cater for any uplift forces in addition to providing a robust barrier to water ingress. Horizontal sealants should be provided at the junction between the base slab and the perimeter wall using active or passive methods.

Where possible, sheet piles should be shop-welded and subsequently driven in sets of two or three, thus reducing the extent of site welding required. If welding is undertaken on site, only the exposed length of the sheet piles is treated. Appropriate working conditions need to be provided and the piles should be driven within acceptable deviations to form the joint.

Failure to prepare the surfaces appropriately increases the risk of porosity in the welds, with reduction in the degree of water resistance over time.

9.0 TYPE C (DRAINED) PROTECTION

Type C waterproofing protection manages water that penetrates the external shell of a structure, by collecting it in a cavity formed between the external wall and an internal lining/ wall. There is permanent reliance on this cavity to collect groundwater seepage and direct it to a suitable discharge point, for example, drains or a sump for removal by gravity drainage or mechanical pumping.

New construction generally incorporates a cavity drain membrane. However, the use of other products and techniques, such as drained voids constructed in masonry, can also be considered. Traditionally, the cavity in floor construction has been formed by the use of either no-fines concrete or ceramic tile systems. These are rarely used in new construction, but might be encountered when refurbishing existing structures. Schematic illustrations of Type C protection are given in Figure 1c.

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9.1 Structural Aspects

The outer leaf of the exterior wall should be capable of controlling the quantity of water that can pass through it, in order not to exceed the drainage capacity of the system. Water entering a drained cavity system is regulated by the structure, so defects that might result in unacceptable leaks should be remedied before the system is installed.

9.2 Cavity Drain Systems

Cavity drain systems do not change the loadings due to water on an existing structure, other than where remedial measures are taken to control water ingress.

9.2.1 Cavity Drain Systems with Membranes

9.2.1.1 Cavity drain membranes

Where cavity drain membranes are used, the membrane forms a permanent cavity between the external elements of the structure and the internal wall/ floor finishes. Such cavities vary in width, depending on the stud height or profile of the membrane, but are usually up to 20 mm.

Cavity drain membranes should be used in accordance with the manufacturer's instructions. In particular, the stud height or profile of the membrane should be selected in conjunction with the manufacturer's data and after considering the external hydrostatic pressure, the porosity of the structure and the predicted rates of water ingress though the structure's external fabric. Cavity drain membranes can be used on surfaces that have been contaminated with impurities. However, in these situations, consultation should be undertaken with the local environmental agency regarding discharge from the system.

Before a cavity drain membrane is laid or fitted on walls and floors constructed of new concrete, the concrete surface should be treated to reduce the risk of leaching of free lime or mineral salts and to avoid the obstruction of the drainage system.

9.2.1.2 Floor cavities

Where the floor cavity incorporates perimeter channels that discharge into a sump(s), both the channels and the sump(s) should be cleaned before, during and after installation of the membrane to allow uninterrupted drainage (see also clause 9.3). Before the cavity drain membrane is laid:

a) the floor should be flood tested to confirm that all water runs freely to the points of collection; and
b) the base slab should be cleaned to remove all debris that might cause blockages.

Sections of the membrane(s) laid across the floor should be jointed and sealed. Once laid, the membrane should be protected against damage caused by following trades. The membrane should be inspected for damage and any defects should be remedied before floor finishes are applied.

The cavity drain membrane may be covered with a variety of floor finishes dependent on the design requirements of the structure.

9.2.1.3 Wall cavities

The wall cavity should be constructed so that it remains free draining at all times.

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Where the wall cavity incorporates perimeter channels that work in conjunction with a drained floor cavity, the drainage, which is common to walls and floors, should conform to 9.2.1.2.

Before the cavity drain membrane is fitted, in situations where the cavity is to be constructed or installed over existing walls, all wall coverings that might decay, or become loose or friable, should be removed.

If they are not removed, such wall coverings can cause the blockage of the cavity or drainage channels and impede free drainage. Sections of the membrane(s) fitted to the walls should be jointed and sealed ensuring adequate laps.

The cavity drain membrane may be covered with a variety of wall finishes dependent on the design requirements of the structure.

9.2.2 Cavity Drain Systems without Membranes

Where a drained cavity is formed by a masonry cavity wall, the inner leaf should be either built off a concrete upstand, constructed integrally with the slab, or built of engineering bricks to a minimum of 150 mm above channel level. Materials should be selected which are appropriate to the environment on both faces. Where the cavity is constructed against an embedded retaining wall, allowance should be made for the permitted construction tolerances, in order to maintain the necessary channel width. Care should be taken during construction to keep the cavity clear of debris and mortar droppings.

In order to allow free drainage from the channel and access for maintenance, it is recommended that this channel is laid nominally level but with adequate access points for maintenance through the inner leaf of the cavity wall. Where possible, the drainage channel should be formed within the depth of the slab. Where this cannot be achieved, the detailing should be such that water cannot migrate from the cavity across the slab.

A drained cavity to the roof should be considered either as part of the base construction or, where necessary, as part of the remedial measures.

9.2.3 Cavity Ventilation

It is not usually advisable to ventilate the cavity; however, it might be necessary in certain circumstances, such as where there is a potential for radon, methane or other ground gases and contaminants to be present. In these circumstances, specialist advice should be sought during the design phase.

9.3 Maintenance and Commissioning

9.3.1 Design

In order to maximize the long-term integrity and effectiveness of a waterproofing system incorporating Type C protection, the waterproofing system should be designed to be maintainable. Access points that allow routine maintenance of channels and outlets should be incorporated into the design of the waterproofing system.

9.3.2 Installation and Inspection

Immediately after the installation of a cavity drain system, drainage channels and sumps should be cleared out and tested. Pumping devices should be checked, tested and fully commissioned in accordance with the manufacturer's instructions.

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In circumstances where pumps are running for long periods of time, or where the system is subject to silting or the deposition of free lime, more frequent servicing might be necessary.

The servicing requirements for the waterproofing system should be clearly set out in the documentation supplied by the designer to the client, including the need for regular planned maintenance of the drainage and/or pumping systems not less than once a year. The client should be informed that any failure to adhere to the maintenance schedule could result in a failure of the waterproofing system.

10.0 REMEDIAL MEASURES

10.1 General

There are many causes of seepage in new and existing structures, principally poor design and/or specification, defective materials, defective workmanship, deterioration of the structure, or a change in the external environment (for example, rising groundwater or locally leaking sewers or water mains). Adjacent construction works can also affect the pattern of groundwater flow and surface water run-off. A number of these factors can also combine to cause problems.

Before any remedial action is taken, defects should be diagnosed to determine the cause and extent of failure. The correct diagnosis of the fault is of vital importance, to establish whether faults exist with the system as a whole, or whether faults are localized (*see* also clause 4.2). Where remedial work is required, the following measures should be considered:

a) the installation of a tanking system or a drained cavity;
b) the installation of external drainage; or
c) localized works to the fabric of the structure, such as:
   1) pressure or vacuum grouting (see clause 10.2);
   2) crack sealing with resin or cementitious mortar (see clause 10.3);
   3) crack filling by pressure or vacuum injection (see clause 10.4);
   4) the replacement of locally defective material (see clause 10.5).

These should be considered irrespective of whether planned remedial treatment has been included as a contingency measure in new construction or for maintaining or improving the internal environment of an existing structure.

If the location of a defect in an existing external membrane can be established, it is possible in some instances, where access is not a problem, to expose the membrane and carry out repairs by excavating locally, adjacent to the walls of the structure.

Where the internal membrane is fully bonded to the substrate, the defect is generally located at the position where dampness or seepage occurs. Once the internal finish has been removed to reveal the defect, the membrane can be locally repaired using compatible materials.

Where the internal membrane is only partially bonded to the substrate, the defect might be more difficult to locate. Even if the defect can be found, further migration to other defects can follow. In such cases, consideration needs to be given to removing and replacing the entire membrane with a new bonded system.

Locating defects in a sandwich system can be particularly problematic and localized repair is seldom viable. Where access is not feasible, grouting in accordance with 10.2 and 10.4 ought to be considered.

10.2 Pressure or Vacuum Grouting

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Grouting to cut off seepage might repair isolated defects. However, it should be noted that, where a large number of defects occur, it is more effective to prevent water ingress by other methods. There are a number of grouting materials available for use based on:

a) cement;
b) bentonite;
c) chemical (example, acrylic);
d) resin (example, epoxide, polyester and non-expansive polyurethane);
e) expansive polyurethane;
f) modified rubber latex.

Holes should be drilled through the walls and floor of the structure adjacent to the defect (sometimes inclined to intersect seepage paths) and the pressure or vacuum grout should be driven into the material behind to gel and seal the leak. As grout selection and application are specialized techniques, advice should be sought from manufacturers and experienced applicators prior to use.

Often more than one phase of grouting is needed as the seepage might be moved to defects elsewhere in the structure or higher up in the walls.

Care should be taken when grouting larger areas to avoid blocking any external drainage systems.

10.3 Crack Sealing with Resin or Cementitious Mortar

Where structural continuity is not required and there is no hydrostatic pressure against the adhesion of the repair, cement grout, neat cement grout or low viscosity latex emulsion should be brushed into cracks and porous areas to seal them against water ingress. Suitable materials include:

a) cementitious slurry;
b) cement/silica-fume slurry;
c) polymer-modified cementitious slurry;
d) polymer resin;
e) cementitious crystallization systems;
f) epoxide putty.

10.4 Crack Filling by Pressure or Vacuum Injection

Pressure or vacuum injection can be used to fill and seal cracks and joints, particularly at kickers where a waterstop has become displaced and cutting out and replacement is not practical.

Porous areas of concrete can sometimes be injected successfully, but severe honeycombing might require the defect to be cut out and replaced.

Injection techniques have been used to seal very fine cracks.

The selection of grout systems should take into account:

a) the likelihood of structural movement;
b) the nature and size of the defect;
c) the moisture content of the substrate;
d) the temperature of the structure;
e) the injection method to be used.

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Where the wall or floor is expected to remain damp, a water-tolerant grout should be used. Suitable materials include:

1) epoxy resin;
2) polyurethane resin;
3) acrylic resin;
4) polyester resin;
5) styrene-butadiene rubber (SBR) and acrylic emulsions;
6) polymer-modified cementitious grouts.

10.5 Replacement of Locally Defective Material

Where a relatively small number of well-separated defects in the walls or floors result in seepage (e.g. poorly compacted concrete), adequate repairs can be achieved by cutting out and replacing the defective area. Achieving a water-resistant joint between the substrate concrete and the repair material is the most critical feature of this method. The installation of temporary drainage points, in the area to be repaired, might be necessary in some situations to control the seepage. However, some repair materials are formulated for application where running water is present.

Surface preparation and the compatibility of the physical and chemical properties of the repair material are important. Many types of repair materials are available, including:

a) concrete compatible with that used in the original construction;
b) polymer-modified cementitious mortars and concrete;
c) polymer-based mortars;
d) sprayed concrete.

The properties of the repair material should be selected to match the substrate as closely as possible, particularly the shrinkage and thermal behaviour. Specialist advice should be obtained to select the most suitable concrete repair system and to specify the required performance of the material to suit the size, depth and location of the area to be repaired.

Where proprietary mortars or concretes are used, they should be applied in accordance with the manufacturer's instructions, and any repair should be undertaken by experienced contractors.

11.0 TESTING

11.1 Liquid retaining structures shall be tested strictly in accordance with IS:3370 for water tightmess in addition to the structural tests as mentioned in EIL Standard Specification No. 6-68-0004. The total maximum drop in water surface level shall not exceed 6 mm in 24 hours in case of covered reservoirs and 12 mm in 24 hours in case of open reservoirs.

11.2 If the test proves that the structure is defective, the contractor shall rectify/ repair the same at his own cost as per the approved scheme as agreed to by Engineer-in-charge. The required structure shall again be tested as per clause 10.1 above. If the structure is still not found to satisfy the acceptance criteria, the same shall be dismantled and rebuilt.

11.3 All testing after construction and remedial treatments shall confirm to the provision of IS:6494.

11.4 Backfilling around underground structures shall be allowed only after the test results are found satisfactory by the engineer-in-charge.

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12.0 GUARANTEE

The Contractor shall guarantee the water tightness of the structure for a period of 10 (ten) years after the certified completion and handing over of the same. The water-proofing application work shall be executed by a firm of specialists in the trade, approved by the Engineer-in-charge.

13.0 PAYMENT

This clause shall apply to item rate tender only.

13.1 Payment for water-proofing treatment shall be based on actual surface area in square metres to be water-proofed. The contractor shall include in his rate all allied works viz. cleaning, preparing the surfaces, cutting groves and filling with cement mortar, rendering, scaffolding, drying etc. with all labour and materials complete.

13.2 No separate payment shall be made for testing and report making which is deemed to be included in the quoted concrete rate including cost of tests, all appliances and rectifications, if any.

13.3 If the test proves that the structure is defective, the contractor shall develop and execute with the approval of Engineer-in-charge, suitable methods for making the structure, water-tight/ leak-proof at his own cost. Even after this if the test fails, the contractor shall have to dismantle and rebuild the structure within the specified time schedule at his own cost.

13.4 Cost of initial and subsequent testing, inclusive of cost of water, shall be borne by the Contractor. The Contractor shall make his own arrangement for filling as well as emptying the reservoir after the completion of test and no payment shall be made on this account.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

इपोक्सी रेजिन प्रणाली द्वारा नई कंक्रीट को पुरानी कंक्रीट से जोडना

BONDING FRESH CONCRETE TO OLD CONCRETE BY EPOXY RESIN BONDING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	28.02.25	REVISED & REISSUED	RIVA	VIKRAM	AS	MN
4	28.01.20	REAFFIRMED & REISSUED	IQBAL	ALPANA	RS	RKT
3	21.08.14	REAFFIRMED & REISSUED	AJS	AS	PKM	SC
2	30.06.09	REAFFIRMED & REISSUED	AS	SCH	VINAY KUMAR	N.DUARI
1	16.06.99	REISSUED AS STANDARD SPECIFICATION	RPM	RS	SCJ	A. SONI

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Abbreviations:

ASTM : American Society for Testing & Materials

Structural Standards Committee

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Mr. Vikram Kumar Gupta

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1.0 SCOPE

1.1 This specification defines the material, constructional and other performance requirements for proper bonding of fresh concrete to old, hardened concrete by epoxy resin bonding system which is able to cure under humid conditions and bond to damp surfaces. Any special requirement as shown or noted on the drawings and directed by the Engineer-in-Charge shall govern over the provisions of this specification.

1.2 Actual working shall be carried out in accordance with this specification and recommendation of the manufacturer of the resin system to suit specific requirements for the particular site and other climatic conditions existing there. In case of any conflict, this specification shall govern.

2.0 MATERIALS

2.1 Epoxy resin system used for bonding fresh concrete to old hardened concrete shall consist of two components, viz. epoxy resin and hardener for combining immediately prior to use as per manufacturer's recommendations. Filler material shall be added, if required, as per manufacturer's specification. However, this shall be incorporated in any of the two components. The system shall cure under humid conditions and bond to damp surfaces.

2.2 The bonding material shall be compatible with the concrete to which it is to be applied and shall have the following minimum properties:

Compressive Yield Strength	55 N/mm^2 (7 days)
Tensile Strength	40 N/mm^2 (7 days)
Bond Strength	10 N/mm^2 (14 days)
Flexure Strength	35 N/mm^2 (7 days)
Shear Strength	10 N/mm^2 (7 days)
Pot Life	45 minutes
Full Cure	7 days at 20°C to 35°C
Overlaying Time (open time)	1 hour at 20°C to 35°C

2.3 The resin and hardener shall be mixed in the proportion as specified by the manufacturer. The preparation, mixing and application of the resin system shall strictly be in accordance with the manufacturer's recommendations.

2.4 Certificate of test results of all the materials from BIS/NABL recognised laboratories duly authenticated by the approved manufacturer(s) shall be submitted to Engineer-in-Charge and got approved by him in writing prior to commencement of work. In the event of failure to submit such test results from the manufacturer for any material, the contractor shall carry the tests from an approved laboratory and submit the test results including the name(s) of manufacturer(s) to the Engineer-in-Charge and get approved by him in writing prior to commencement of work. All tests shall be in accordance with ASTM C881M (Type V) in case of non-availability of any specific Indian Standard.

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2.5 Pot life and open time

Pot life is the period during which the resin system after mixing retains sufficient workability for proper use and the resin system must be applied to the prepared concrete surface within this period.

The 'open time' is the maximum period of time allowable between application of resin system and pouring of fresh concrete. Exceeding the 'open time' shall result in considerably reduced adhesion. The adhesive shall be applied to the prepared substrata as soon as the components have been mixed and fresh concrete shall be poured immediately before adhesive begins to gel. The bonding of fresh concrete to old concrete shall not to be done if the temperature is below 10°C.

3.0 SPECIAL REQUIREMENT

3.1 All works covered by this specification shall be carried out by experienced and approved agency having sufficient knowledge in epoxy resin treatment works. Only skilled and experienced operators shall be employed for the purpose.

4.0 APPLICATION

4.1 Preparation of Concrete Surface

4.1.1 Grease, oil, algae and other foreign substances likely to impair good bonding shall be thoroughly removed from the surface by scrubbing or using detergent and washing with clean water. All loose and spalling concrete pieces shall be removed. The surface to be bonded shall be made thoroughly rough by chiselling, taking off the skin of concrete and sharp edges of aggregate shall be exposed. The surface shall be washed, wetted cleaned and dried with dry compressed air. Exposed reinforcement shall be thoroughly cleaned with sand paper and wire brushes to remove all dust and sticking mortar.

4.2 Mixing

4.2.1 The resin and hardener shall be thoroughly mixed in a mixer. The approved resin system shall be prepared strictly as per manufacturer's recommendations. It shall not contain lumps and shall have uniform colour. Filler material shall be added if so specified by the manufacturer. Hand mixing shall be allowed for small quantity with prior permission of the Engineer-in-Charge.

4.3 Method of Application

4.3.1 The resin system shall be applied by spraying to the prepared surface. Manual application by using stiff nylon bristle brush may also be allowed with prior permission of the Engineer-in-Charge. The manufacturer shall specify the method of application suitable for the specified work.

4.4 Coverage

4.4.1 A minimum of half kilogram per square metre (½ kg/m^2) or resin system shall be applied to prepared concrete surface. However, the covering capacity depends on the nature of surface over which the system is being applied and the contractor shall use additional quantity of the resin system as per the recommendation of the manufacturer.

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4.5 Handling Precaution

4.5.1 Only skilled and experienced workers shall be entrusted with the application of epoxy system. The resin and hardener shall not be allowed to come into direct contact with the skin. Rubber or polythene gloves with cotton gloves underneath must be worn by the workers handling resin products. Parts of skin which have accidently come into contact with resin or hardener shall immediately be washed with lukewarm water and a mild soap. Special cleaning creams or chemical shall be kept readily available and used as recommended by the manufacturer.

4.6 Cleaning and Maintenance of Equipment

4.6.1 Tools and mixing equipment shall be cleaned immediately after use by using scrapers and other solvents (e.g. toluene, xylene or acetone) as recommended by the manufacturer.

5.0 APPROACH, WORKING PLATFORM & SCAFFOLDING

5.1 The contractor shall arrange all approaches, stairways, ladders, working platform etc. for carrying out the entire operation safely. The working area shall be neatly maintained and all facilities required by the Engineer-in-Charge for proper supervision of the work shall be provided by the contractor.

5.2 All precautionary measures required for the safety of the structure during the progress of operation and till the successful completion and handing over shall be the responsibility of contractor. He shall carry out all such measures as directed by Engineer-in-Charge.

6.0 PAYMENT (applicable to item rate tenders only)

6.1 Payment shall be made by weight of resin system actually used in the work.

6.2 The rate quoted shall be inclusive of all labour and materials required for the successful completion of the work including all cleaning operation before and after the work, preparation of the old, hardened concrete surface as specified, mixing, application of epoxy resin and other safety measures including their removal after completion, all plants and tools etc. complete. Rate shall also be inclusive of all tests required to check the specific properties of materials.

6.3 Any test specified and directed to establish the soundness and monolithicity of bonding of fresh concrete to old concrete actually executed shall be paid separately unless such tests fail to meet the requirements of this specification. In case of failure, no such payment shall be made and the contractor shall repair/ rectify or re-do the work as directed by Engineer-in-Charge at no extra cost to the owner.

6.4 Underground work like excavation, backfilling, removal of surplus earth, keeping the pit dry by pumping/ bailing out subsoil water shall be paid separately as per relevant item in the contract.

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भूमिगत पाइपिंग हेतु भूमि कार्य के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR EARTHWORK FOR UNDERGROUND PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	14 03 19	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	AVM	AJS	RS	RKT
3	23 05 11	REVISED AND ISSUED AS STD SPEC	ALOK	RKS	RBB	DM

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Abbreviations:

IS	:	India Standard
RCC	:	Reinforced Cement Concrete
U/G	:	Underground

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1.0 SCOPE

This specification deals with earthwork in trenches and pits (for valves, manholes, catch pits etc.) for underground piping.

2.0 CODES & STANDARDS

IS: 783	Code of practice for laying of RCC pipes.
IS: 1200 (Part-I)	Method of measurement of building and civil engineering works.
IS: 3764	Excavation work – code of safety.
NOTE:-	Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIAL

All workmanship and materials shall conform to the provisions of IS: 1200 (Part-1) and IS: 3764.

4.0 EARTHWORK IN EXCAVATION FOR TRENCHES / PITS FOR PIPELINES

4.1 Excavation

Plant, machinery and equipments for excavation shall be selected and deployed to provide optimum mechanization in excavation of trenches and pits. The selection for excavation and earth movement machinery etc. shall take into account type of materials to be excavated, method of excavation, prevailing weather conditions and type of transport to be used.

The excavation of area of cut shall be so timed that the bottom level is not exposed to the deteriorating influence of the weather for longer duration.

Excavation and earth moving equipment shall be deployed such that minimum damage is caused to the natural sub-soil structure of exposed formations.

The monitoring of soil deformations, ground water levels during and possibly after construction work shall be taken into consideration.

In the event, when excavation works are carried out in the vicinity of structures of any importance, the above monitoring shall be carried out within a distance, from the edge of the excavation of 5 to 15 times the excavation depth, depending upon the subsoil conditions and the stability of the neighboring structures.

4.2 Trenching work shall be carried out in all classes of soil including soft rock and excluding hard rock and shall be for all depths.

4.3 The trench shall be cut true to the line and level as per drawings.

4.4 If the trench is excavated below the required level than that indicated in the drawing, the extra depth shall be filled with concrete 1:5:10 or approved equivalent materials, as directed by the Engineer-in-Charge, at no extra cost to the owner.

4.5 In case of pressure piping, the trench shall be excavated generally as to provide a cover of 1000 mm or dia of pipe whichever is more. In case of gravity sewers/ pipes, the trench shall be excavated to conform to invert levels as per drawings. However in certain cases, the pipes may run at shallower levels or at deeper levels depending upon drawing, site condition etc.

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No rebate for lesser excavations, nor extra payment due to deeper excavations, shall be admissible in those cases where pipeline laying rates are inclusive of earthwork items. The rates quoted shall be deemed to cover all works connected with trenching, whether trenches are with single pipeline or have multiple pipelines in common trenches including road cutting and making good the same.

4.6 The width of the trench shall be sufficient to give free working space of personnel, equipment, supports and ancillaries on each side of the pipe. The free working space shall conform to IS: 783. Generally it shall not be less than 150 mm on either side or 1/3 dia of outer diameter of the pipe, whichever is greater.

4.7 When pipelines are running parallel, whether the trenching shall be individual or common, shall be decided by the Engineer-in-Charge and such decision shall be final and binding on the contractor. No extra shall be payable for common excavations.

4.8 All earthwork involved in excavations of all types of manholes, catch pits, valve chambers, inspection chambers, chambers for instrumentation tapping etc., which are coming on the alignment of U/G piping or as defined by drawing as a part of U/G piping work, shall be paid extra under Earth work in excavation, back filling and removal of surplus earth etc. under relevant clauses of the SOR.

4.9 Aspects such as variations in the soil conditions and the geological structure, depth of excavation, the existence of ground water and surface water, the type and extent of excavation, the topography of site, the proximity of items such as roads, buildings and buried services, construction traffic and activities near the excavation eg. Stock piling shall be taken into account when determining whether the sides of excavation should be free standing, sloping or temporary supported.

Suitable drainage and / or dewatering system like Well Point method / Bore well method etc. shall be provided to prevent or limit ingress of surface or sub surface water into excavation.

Serviceable materials intended for reuse should be used as soon as possible after excavation otherwise they should be stock piled at a location beyond 1.5m from the top edge of the excavation or beyond a distance equal to the depth of the excavation whichever is higher at a location approved by the Engineer-in-charge. If excavated serviceable material is not possible to be stacked within the limits specified above, due to some constraint, it shall be stacked away at a location approved by Engineer-in-Charge and paid separately under relevant item.

Areas used for temporary stockpiling of excavated material shall be kept clean and orderly, with excavated material kept by the side of road to avoid traffic movement. Excavated areas shall be restored to their original condition before completion of works.

All types of shoring and strutting, wherever necessary, shall be adopted to with hold the face of earth or cutting in slope, as per site requirements and direction of Engineer-in-Charge. Supports shall be maintained such that the integrity of the sides of the excavation is not impaired.

4.10 Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed.

4.11 The contractor shall maintain all excavated trenches and pits, in a dry and trim condition.

4.12 Necessary barricading and protection of slopes against slips due to traffic movement shall be provided to the satisfaction of Engineer-in-Charge. Necessary warning flags and lights shall be provided to caution traffic in the areas where trenches and/ or pits are provided.

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4.13 In case of road cutting, all road material i.e. metal etc., shall be taken out carefully and kept separately for reuse and road work shall be redone up to the original level, as it was prior to cutting the road, with the excavated road materials after laying and testing of the pipeline, within 10 days from the date of starting this work, at the cost of the contractor. The contractor shall provide suitable warning signs and barricades to prevent accidents.

Contractor shall also provide reasonable bye pass at his own cost when a road is cut for laying pipeline. Tankage dykes cut due to laying of the pipes, shall be redone conforming to the original specifications, by the Contractor at his own cost. Secondary dykes, to take care of any eventuality during construction, shall be provided by the Contractor at his own cost.

4.14 Dewatering shall be done in advance of the installation of the pipe to allow adequate inspection of padding of the bottom, if required. Dewatering shall be continued throughout during installation and backfilling.

The trench shall follow the gradient of pipeline as specified in the drawing. The contractor shall keep the trench in good condition, until the pipe is laid and tested. No extra claim shall be entertained due to its caving or setting down, either before or after the pipe is laid.

In case, pipe is lowered in caved trench and backfilled before being inspected by the Engineer-in-Charge, the Contractor shall re-excavate the trench for inspection and backfill it at his own cost.

5.0 BACKFILLING AND COMPACTION

Backfilling

Trenches shall be back filled with suitable materials which should be compacted to the same degree or better as the surrounding soils.

5.1 The soil used should be selected and approved by Engineer-in-Charge. Suitable material can be extracted from available excavated material. The soil should be free from rubbish, grass, organic matter, stones, building waste and Black Cotton Soil etc. It should be free from clods and hard lumps. In case good soil is not available from excavated material for back filling, trench shall be filled back with locally available coarse sand upto 30 cm. thick above the pipe and rest of trench shall be filled back with excavated soil upto required level.'

5.2 The filling should commence only after approval of Engineer-in-Charge is obtained and after the structures or pipes to be buried are tested and approved. Otherwise, if required, contractor shall uncover buried portion and refill at his own cost.

Temporary excavation supports should be removed as back filling and compaction proceeds, such that unacceptable movement of the supported ground does not occur.

Voids caused by extracted supports should be filled and compacted.

5.3 Filling should be done in layers. Each layer should be not more than 15 cm thick when loose and should be well rammed, with necessary watering, to obtain at least 90% of maximum laboratory dry density.

Compaction trials should be carried out on each soil type to be placed in backfill, in order to confirm the type of machine and number of passes required to obtain optimum compaction for given soil moisture contents. These trials should also be used to determine the variability of the proposed fill material for different weather conditions.

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5.4 Care must be exercised to protect cables, pipes, joints, and other features from damage due to backfilling and consolidation.

5.5 Filling should extend up to the level of original ground surface or as per drawing or as directed by Engineer-in-Charge. The finished surface should be properly trimmed and dressed. The adjoining area should be cleaned and no heaps of surplus earth should be left out.

6.0 TRANSPORTATION OF SURPLUS EARTH

Unserviceable materials and serviceable materials not intended for re-use shall be removed from the work site and disposed off at a location as approved by Engineer-in-charge.

The surplus earth is generated due to pipe laying, valve chambers, and manhole construction etc. Surplus earth is also generated due to voids in the back filled volume of earth. The removal of surplus earth shall include excavation, loading, transportation, dumping, stacking or spreading, as per the directions of Engineer-in-charge.

7.0 PAYMENT

7.1 Unless specifically stated in the schedule of rates, no separate payment for earthwork in excavation, backfilling, transportation, dewatering etc. shall be admissible and the payment for the same is deemed to have been included in the relevant items of the contract.

7.2 In case payment for earthwork is specified separately in the Schedule of Rates, the payment shall be based on the actual quantity of excavation, backfilling and transportation done, taking into consideration the slopes authorised by the Engineer-in-Charge for excavation, volume of backfilling calculated on the basis of excavation reduced by the volume of pipes.

7.3 In cases where hard rock excavation is involved, the matter shall be referred to Engineer-in-Charge, before proceeding with the work.

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STANDARD SPECIFICATION FOR ROADS AND FLEXIBLE PAVEMENTS (UPTO WMM LAYER)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
2	16 03 20	REVISED & ISSUED AS STANDARD SPECIFICATION	NS	GS/AK	RS	RKT
1	25 06 14	REAFFIRMED & ISSUED AS STANDARD SPECIFICATION	GYAS	RKS	RBB	SC
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Abbreviations:

IS	:	Indian Standard
IRC	:	Indian Road Congress
LSTK	:	Lump Sum Turn Key
P.I.	:	Plasticity Index
POL	:	Petroleum Oil and Lubricant
WMM	:	Wet Mix Macadam

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1.0 SCOPE

This specification covers the material and construction details for earthwork in filling for road embankments, filling with sand/murrum, Granular Sub-Base (GSB) as sub-base, WMM as base course for roads and flexible pavements.

2.0 REFERENCES

2.1 Codes & Standards

IS: 460	Specifications for Test Sieves
IS: 2720	Methods of Test of Soil
IRC: 109	Guidelines for Wet Mix Macadam
IRC: 36	Recommended Practices for the Construction of Earth Embankments for Road Works

2.2 Specifications

Specifications for Road and Bridge Works – Ministry of Road Transport & Highway (Orange Book)

NOTE: -Latest Edition of all Codes, Standards and Specifications shall be followed.

3.0 CONSTRUCTION OF EMBANKMENTS, SUBGRADE AND SHOULDERS

3.1 Materials

Only those materials, considered suitable by the Engineer-in-Charge shall be employed for the construction and that considered unsuitable shall be disposed off as directed by Engineer-in-Charge at contractor's cost and no claim for compensation will be entertained. The Contractor shall give the samples of earth, he proposes to use for filling along with the following characteristics of the sample to Engineer-in-Charge prior to collection and use, for approval.

i) Mechanical analysis or gain size analysis as per IS: 2720 Part IV.

ii) Liquid limit as per IS: 2720 Part V.

iii) Plastic limit as per IS: 2720 Part V.

iv) Moisture density relationship as per IS: 2720 Part VIII.

The material (soil) used for filling shall be free from boulders, lumps, tree roots, rubbish or any organic deleterious matter.

Material (soil) having plasticity index less than 20 shall be used for filling purposes. Soil having laboratory maximum dry density of less than 1.5gm/cc shall not be used. Care shall be taken to see that unsuitable waste material is disposed off in such a manner that there is no likelihood of its getting mixed with the materials proposed to be used for filling.

The material (soil) shall have a minimum CBR of 8% for filling in subgrade.

The work shall be so planned and executed such that the best available material (soil) is reserved for the top portion of embankment.

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3.2 Filling and Compaction

3.2.1 The area where filling is to be placed must be cleared of all loose material and virgin soil must be exposed. Such exposed surface must be consolidated properly to obtain 97% of maximum laboratory dry density of the soil as per IS: 2720 Part VIII. All soft patches must be worked out to remove the soft soil and selected approved earth must be filled back and compacted. The minimum CBR of the natural soil shall be 3%. In case, the CBR of the natural soil is less than 3%, Geotechnical recommendation for the same shall be obtained and accordingly the treatment shall be carried out.

3.2.2 Payment for the removal of loose top soil as described in clause 3.2.1 above shall be included in the item for earthwork in filling. No separate payment for consolidation of exposed ground surface will be made. The rate quoted for the earth fill shall be inclusive of the cost of clearing and stripping, consolidation, including watering, testing etc. of the exposed ground.

3.2.3 Approved fill material shall be spread in uniform layers not exceeding 20 cm in loose depth for embankment filling. Shoulder construction shall be so organised as to keep pace with the construction of different layers of the pavement, which may require earth fill thickness less than 20 cm. All clods, lumps etc. shall be broken before compaction.

3.2.4 In general the soil shall be spread uniformly over the entire width of embankment or shoulder as the case may be. For large embankments, the spreading of soil shall he as directed by Engineer-in-Charge.

3.2.5 Successive layers of filling shall not be placed until the layer under construction has been thoroughly compacted to satisfy the requirements laid down in this specification.

3.2.6 Prior to rolling, the moisture content of material shall be brought to within $\pm 2\%$ of the optimum moisture content as described in IS: 2720 - Part-VIII. The moisture content shall preferably be on the wet side for potentially expansive soils.

3.2.7 After adjusting the moisture content as described in Clause 3.2.6, the layers shall be thoroughly compacted by means of 8-10T rollers or equivalent vibratory rollers till 97% of maximum laboratory dry density for both road embankment and sub-grade as per IS:2720 Part VIII is obtained.

3.2.8 Each layer shall be tested in field for density and accepted by Engineer-in-Charge subjected to achieving the required density before laying the next layer. A minimum of one test per $500m^2$ area for each layer shall be conducted.

3.2.9 All type of rollers that should be employed for compaction shall be as per direction of Engineer-in-Charge.

3.2.10 If the layer fails to meet the required density, it shall be reworked or the material shall be replaced and method of construction altered as directed by Engineer-in-Charge to obtain the required density.

3.2.11 The filling shall be finished in conformity with alignment, levels, cross-sections and dimensions as shown in the drawings.

3.2.12 Extra material shall be removed and disposed off as directed by Engineer-in-Charge.

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3.3 TOLERANCE

Embankment and shoulders for roads, units etc. shall be carried to within a tolerance of plus minus 2.5 cm. from final lines but shall be to required grades and slopes.

4.0 FILLING WITH SAND/MURRUM

4.1 Sand for filling shall preferably be locally available sand, clean and free from any chemical or other impurities. Murrum for filling shall be clean and well graded. Sand/Murrum shall not contain any vegetation, organic, clayey or other material and shall be obtained from a source approved by Engineer-in-Charge.

4.2 Murrum/Sand shall be spread in layers not exceeding 15 cm in loose thickness over the areas. Each layer shall be uniform in density, quality of material and ' moisture content before compaction. The moisture content shall be within two percent of the optimum moisture content as per IS: 2720 Part VIII.

4.2.1 In case of pure sand, flooding with water is permissible.

4.3 Compaction of each layer shall be by mechanical means as per directions of Engineer-in-Charge. Only in accessible reaches shall be worked manually. Each layer shall be uniformly compacted to obtain 85% relative density in case of sand and 95% of maximum laboratory dry density in case of murram. If the material fails to achieve the required density, the layer shall be reworked with necessary alteration in compaction, so that the required compaction is obtained. A minimum of one test per 500 m^2 area for each layer shall be conducted.

4.4 Subsequent layers shall be placed only after the layer already laid has been compacted to the required density-and approved by Engineer-in-Charge.

4.5 The finished surface must be dressed to required grade and slope. Excess material must be removed from compaction site, as directed by Engineer-in-Charge.

5.0 GRANULAR SUB BASE (GSB) COURSE

The Granular sub-base course shall consist of one or more layers, each of minimum 100 mm compacted thickness and maximum 200mm compacted thickness provided suitable type of compacting equipment shall be used.
The sub-base course shall be provided as per Section 401 of the Orange Book.

5.1 MATERIALS

5.1.1 The material shall be natural sand, crushed gravel, crushed stone, crushed slag, or combination thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents and shall conform to the Grading II as given in Table 400-1 of the Orange Book and the physical requirements given in Table 400-2 of the Orange Book. If the water absorption of the aggregates determined as per IS:2386 (Part 3) is greater than 2 percent, the aggregates 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).

5.2 LAYING OF GSB

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5.2.1 Preparation of Sub-Grade

The sub-grade shall be prepared as explained above free from all vegetation and other extraneous matter, lightly sprinkled with water, if necessary and rolled with two passes of 80- 100 kN smooth wheeled roller.

5.2.1 Spreading & Compacting

The clauses as given in Clause 401.3.2 of the Orange Book shall be followed.

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 VIII). 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.

5.2.2 TESTING

The surface finish of the completed construction shall conform to the requirements of Clause 902 of the Orange Book. All materials and workmanship shall comply with the provisions set out in Section 900 of the Orange Book.

6.0 WET MIX MACADAM BASE COURSE

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 upto 125 mm with the approval of the Engineer-in-Charge.

The base course shall be provided as per Section 406 of the Orange Book.

6.1 MATERIALS

6.1.1 AGGREGATES

6.1.1.1 Coarse aggregates shall be crushed stone. The aggregates shall conform to the physical requirements as per Table 400-12 of the Orange Book. The grading requirements shall conform to the Table 400-13 of the Orange Book. Material finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.
The final gradation approved within these limits shall be 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.

6.2 CONSTRUCTION OF WMM

The construction shall be carried out as per Clause 406.3 of the Orange Book.

6.2.1 Preparation of Base and Provision of Lateral Confinement of Wet Mix

6.2.1.1 The sub grade or sub-base to receive WMM course shall be prepared to the required grade and camber and made free of dust and other extraneous matter. Before starting with WMM construction, side shoulders shall be constructed in advance to a thickness corresponding to the compacted layer of the WMM course for lateral confinement of aggregate. After shoulders are ready, their inside edge shall be trimmed vertical to receive WMM. The practice of

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constructing WMM in a trench section excavated on the embankment/formation must be avoided.

6.2.2 Preparation of Mix

6.2.2.1 WMM shall be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement, like, pug mill or pan type mixer. The mixing plant features shall be as per Clause 406.3.3 of the Orange Book.

6.2.2.2 Optimum moisture for mixing shall be determined in accordance with IS:2720 (Part VIII), 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.

6.2.3 SPREADING OF MIX

6.2.3.1 Immediately after mixing, the mixed material shall be transported to site and spread uniformly and evenly upon the prepared sub-base/ base in required quantities. Hauling of the mix over a freshly completed stretch is not permitted.

6.2.3.2 The mix may be spread either by a paver finisher or motor grader or a combination of both as directed by Engineer-in-Charge. However, the use of paver finisher should be preferred to motor grader for spreading. For portions where mechanical means cannot be used, manual method of spreading can be adopted with approval of Engineer-in-Charge. The equipment used for spreading shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic controls suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

6.2.3.3 The paver finisher shall be self-propelled, conforming to the features as given in Clause 406.3.4 of the Orange Book.

6.2.3.4 The surface of the layer as spread shall be carefully checked with templates and all high or low spots remedied by removing or adding wet mix materials as may be required. The layer thickness may be checked by depth blocks during construction. No segregation of coarse or fine particles shall be allowed. The layer as spread shall be of uniform gradation and shall not have pockets of fine materials.

6.2.4 Compaction

6.2.4.1 After the mix has been laid to the required thickness, grade and cross-fall/camber, the same shall be uniformly compacted to the full depth with a suitable roller. If the thickness of the single compacted layer does not exceed 100mm, a smooth wheel roller of 80 to 100 KN static weights may be used. For compacting single layer of higher thickness upto 200mm, the compaction shall be done with the help of vibratory roller of minimum static weight 80-100 KN with an arrangement for adjusting the frequency and amplitude. An appropriate frequency and amplitude may be selected. The speed of roller shall not exceed 5km/hr.

6.2.4.2 In portions having uni-directional cross-fall/super elevation, 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 upto the centre line. Alternate trips of the roller shall be terminated in stops at least 1m away from the preceding stop. The process of compaction is then to be repeated from the other edge of the pavement upto the centre line,

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until the entire pavement is compacted. Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected.

6.2.4.3 Along forms, kerbs, walls or other places not accessible to the roller, the mix shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin patching of an area without sacrificing the surface to permit proper bonding of the added material shall not be permitted.

6.2.4.4 Rolling should not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or sub-grade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 m 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 cross-fall. In no case should the use of unmixed material be permitted to make up the depressions.

6.2.4.5 Rolling shall be continued till the density achieved is at least 98% of the maximum dry density for the material as determined by the method outlined in IS: 2720 (Part VIII).

6.2.4.6 After completing, the finished surface shall present a well-closed appearance, 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 layers and re-compacted.

6.2.4.7 Longitudinal joints and edges shall be constructed true to the delineating line parallel to the centre line of the road. All longitudinal and traverse joints shall be cut vertical to the full thickness of the previously laid mix before laying the fresh mix.

6.2.5 Setting and Drying

After final compaction of the wet mix macadam course, the road shall be allowed to dry for 24 hours before overlaying with any bituminous layer.

6.2.6 Surface Finish and Quality Control of Work

The surface finish of construction shall conform to the requirements of Clause 902 of the Orange Book. Control on the quality of materials and works shall be as per Section 900 of the Orange Book.

6.2.7 Where the surface irregularity of the WMM course exceeds the permissible tolerances, or where the course is otherwise defective, the rectification of that area shall be carried out as per Clause 406.6 of the Orange Book.

7.0 PAYMENT

7.1 FILLING IN EMBANKMENT, SUB GRADE AND SHOULDERS

7.1.1 Payment for filling shall be made on cubic meter of volume calculated on the basis of cross section plotted from the level of the ground surface prepared as described in clause 3.2 above and from where filling is to be carried out and the levels reached after filling and due consolidation.

7.1.2 Rates for embankment, shoulder or fill formation shall include cost of material for filling, royalties, transportation, breaking clods, watering, consolidation, providing testing apparatus and testing the degree of consolidation, providing and operating, including POL and operator

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charges of necessary road rollers and other equipment, dressing and levelling of sides and top surfaces and any work incidental to this etc.

7.2 FILLING WITH SAND / MURRUM

Payment for sand/murrum filling shall be made on the basis of volume of fill, after placement and compaction. The rate quoted shall include cost of sand/murrum, royalties, transportation, handling, compacting, watering, testing at various stages, dressing, removal of surplus material and any other work incidental to this etc.

7.3 GRANULAR SUB BASE COURSE

Payment for granular sub-base shall be made on cubic meter basis, measured after consolidation and finishing. Rate shall include supply of all materials, royalty, taxes, handling, transportation, spreading in layers, including compacting, cost of carrying the material to work for all leads and lifts, providing all equipment, testing etc. complete as per specifications and satisfaction of Engineer-in-Charge.

7.4 WET MIX MACADAM BASE COURSE

Payment for laying WMM shall be made on cubic meter basis of each layer of WMM laid, measured after compaction and finishing. Rate shall include supply of all materials, royalty, taxes, handling, transportation, spreading in layers, including compaction by vibration roller, cost of carrying the material to work for all leads and lifts, providing all equipments etc. complete as per specifications and satisfaction of Engineer-in-Charge.

7.4 The payment clause(s) as described in the above clauses shall not be referred / applicable for LSTK Jobs

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STANDARD SPECIFICATION FOR CONCRETE PAVEMENT

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
4	04 07 19	REVISED AND ISSUED AS STD SPEC	SD	GS/AK	RS	RKT
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1	15 7 98	REVISED AND ISSUED AS STD SPEC	PCS	RJAIN	MMK	ASONI
0	31 3 82	ISSUED AS STANDARD SPECIFICATION	RP	RPB	HVR	RCPC

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Abbreviations:

BS	:	British Standard
IRC	:	Indian Road Congress
IS	:	Indian Standard
MS	:	Mild Steel
PCC	:	Plain Cement Concrete
RCC	:	Reinforced Cement Concrete
DLC	:	Dry Lean Concrete

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Convenor: Mr. Rajanji Srivastava

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Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
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1.0 SCOPE

This specification establishes the requirements of material, laying and finishing of concrete pavements and roads.

2.0 REFERENCE CODES AND SPECIFICATIONS

IS: 456	Plain and Reinforced Concrete-Code of Practice.
IS: 1834	Specification for Hot Applied Sealing Compounds for Joints in Concrete.
IS: 1838, Part-1	Specification for Preformed Fillers for Expansion Joints in Pavements and Structures (Non Extruding and Resilient Type): Part 1 Bitumen Impregnated Fibre.
IS: 2720, Part-8	Method of Test for Soils-Part 8: Determination of Water Content-Dry Density Relation Using Heavy Compaction.
IS: 9214	Method of Determination of Modulus of Sub-grade Reaction (k value) of Soils in the Field.
IRC: 57	Recommended practice for sealing of joints in concrete pavement
IRC-15	Standard Specifications and code of Practice for construction of concrete roads
MoRTH	Specification for Road and Bridge Works of Ministry of Road Transport and Highways
6-68-0002	Technical Specification - Civil & Structural Works - Materials.
6-68-0004	Technical Specification - Civil & Structural Works – Plain and Reinforced Cement Concrete.
7-65-0404	RCC Pavement Details
	MoRTH Specification for Road and Bridge

In case of conflict between the Clauses mentioned in this Specification and those in above Codes and Specifications, this Specification shall govern.

3.0 MATERIALS

3.1 Material for Cement Concrete viz. Cement, Sand, Coarse and Fine aggregate and water, Reinforcements Bars, Embedment, Inserts and Admixture etc. shall be as described in EIL Specification no. 6-68-0002.

3.2 Material for DLC shall be as described Specification for Road and Bridge Works of Ministry of Road Transport and Highways (MoRTH).

4.0 GRADES, TYPE OF CONCRETE MIX, PROPORTIONING AND BATCHING

4.1 The grades of concrete shall be as per standard / Job drawing.

4.2 Specification for Concrete mix, Mix Proportioning and Batching shall be as described in EIL Specification no. 6-68-0004 and IS: 456.

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5.0 EQUIPMENTS

All equipments like sub grade templates, hand tempers, vibrating screens, internal vibrators, longitudinal floats, bridges, push brooms, straight edges, edging tools etc. shall be on the worksite in first class working condition and shall have been inspected by the Engineer-in-Charge before paving operations are permitted to start. Throughout the construction period, the contractor shall maintain adequate equipment in first class working conditions to ensure the proper execution of the work.

6.0 PREPARATION OF SUB GRADE

6.1 The area where concrete is to be placed must be cleared of all loose material and virgin soil must be exposed. Such exposed surface must be consolidated properly to obtain 95% of Maximum Laboratory Dry Density of the soil. All soft patches must be worked out to remove the soft soil and selected approved earth must be filled back and compacted.

6.2 For areas, where pavement is to be laid on cutting / natural grade level, Sub grade shall be thoroughly compacted to 95% of laboratory dry density as per IS: 2720 Part VIII. For filled up areas, top 450 mm of the soil shall be compacted to 95% of laboratory dry density below pavement in layers of 150 mm.

6.3 The difference between the sub grade levels of Type-I, Type-II, Type-III and any other type (as per job drawing) Concrete pavements (due to difference in thickness of Type-I, Type-II, Type-III and any other type pavements) shall be achieved by stripping the grade level and not by filling. Hence, site-grading level below pavement shall be kept up to sub grade level of Type-II or Type-III as the case may be, to avoid filling of smaller thickness at later stage.

6.4 The sub grade or sub base for laying of the concrete pavement shall comply with the following requirements:

6.4.1 No soft spots shall be present in the sub grade.

6.4.2 The uniformly compacted sub grade or base course shall extend at least 300mm on either side of the area to be concreted.

6.4.3 The sub grade shall be properly drained.

6.4.4 The minimum modules of sub grade in wet condition, reaction obtained with a Plate Bearing Test as per IS: 9214, shall be 6.0 $Kg/cm^2/cm$.

6.4.5 Sub grade shall be prepared to the lines and grades to match with the slope of pavement as shown on the drawings.

7.0 PREPARATION OF SUB BASE

7.1 The construction of the Dry Lean concrete sub base for cement concrete pavement shall conform to the requirements of section 601.0 of specification for Road and Bridge Works of Ministry of Road Transport and Highways (MoRTH) and EIL standard Drg. No. 7-65-0404/ Job drawing.

7.2 Sub Base layer shall be prepared to the lines and grades to match with the slope of pavement as shown on the drawings.

7.3 No concrete shall be placed around manholes or other structures until they have been brought to required grade and alignment. All sides of manholes / pits etc. shall have same elevation.

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7.4 A separation membrane shall be used between the concrete slab and the sub base (DLC) which shall conform to EIL standard Drg. No. 7-65-0404/ Job drawing. The separation membrane shall be laid flat without creases. Before placing the separation membrane, the sub-base shall be swept clean of all the extraneous materials using air compressor. Wherever overlap of plastic sheets is necessary, the same shall be at least 300 mm and any damaged sheeting shall be replaced at the Contractor's expense. The separation membrane may be nailed to the lower layer with concrete nails.

8.0 FORMS

8.1 All side Forms shall be of mild steel unless use of wooden sections is specially permitted. The steel forms shall be of MS channel sections and their depth shall be equal to thickness of the pavement. The sections shall have a length of at least 3.0m except on curves, where shorter sections may be used. These forms should be provided with ample bracing and supports to prevent the springing of the forms under the concrete pressure or thrust of machinery operating nearby.

8.2 The forms should be in a sufficient number and they should not be removed until concrete has hardened sufficiently.

8.3 In case wooden forms are permitted, these shall have minimum base width of 100 mm for 150mm or lesser thick slabs and 150mm for 200mm thick slabs.

9.0 REINFORCEMENT, MIXING & PLACING OF CONCRETE

9.1 Laying of Reinforcement

All reinforcement work shall confirm to IS: 456 and as described in EIL Specification no. 6-68-0004.

9.2 Mixing

Mixing shall be as described in EIL Specification no. 6-68-0004.

9.3 Placing

9.3.1 The place where concrete is to be poured should be clean and free from all loose dirt, wooden pieces, dust, standing water etc.

9.3.2 Walking on reinforcement layers is not permissible. Walkways of wooden planks or similar material can be placed with removable supports and should be independent of the reinforcement. The reinforcement position should not be disturbed nor should it sag during carriage and placement of concrete.

9.3.3 Placing and vibration should not take totally more than 20 minutes from time of mixing. Method of placing should be got approved by Engineer-in-Charge. Segregation during carriage and placement should be avoided. If during carriage concrete segregates, it should be remixed before placement.

9.3.4 Concrete should not be dropped from a height of over 1.5m.

9.3.5 To ensure bond and water tightness between old concrete surface and fresh concrete to be placed, the surface should be cleaned and roughened by "initial green cut" by wire brushing or chipping. The initial green may be done by wire brush after 6 hours of placing concrete in order to facilitate the work. Chipping can be done only after 48 hours. A layer of cement

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slurry with 1:1 mix (1 cement: 1 sand) should be poured to obtain a uniform coating on old concrete. Immediately thereafter, the fresh concrete should be poured.

9.3.6 Concrete shall be mixed in quantities required for immediate use and shall be deposited on the sub-grade in a single operation to the required depth and width of the pavement. Spreading shall be as uniform as possible to avoid re-handling of concrete. Where however, a certain amount of redistribution is necessary, it shall be done with shovels and not with rakes. Concrete shall be vibrated with internal vibrators. Concrete shall be placed continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge continuously until completion of the part of the work between construction joints or as directed by Engineer-in-Charge.

9.3.7 **Placing in inclement weather**

All precautions shall be taken for concreting in extreme weather in accordance with the relevant clauses of IS: 456. Due protection shall be provided to prevent cement being blown away while proportioning and mixing during windy weather. No concreting shall be carried out in continuous heavy rains. Necessary arrangements to cover the freshly poured concrete shall be provided, to protect it from the direct rays of the sun and from drying winds.

9.3.8 All concreting placement should be co-coordinated with placement of conduits, inserts, embedded parts etc. executed either by same agency or separately.

9.3.9 Concrete shall be laid in panels as shown in the standard drawing or as directed by Engineer-in-Charge.

9.4 Compaction & Finishing

9.4.1 **Compaction**

The surface of the pavement shall be compacted either by means of power driven finish machine or a vibrating hand screed. For areas where width of the pavement is very small, hand consolidation and finishing shall be done as follows:

9.4.1.1 Concrete as soon as placed, shall be struck off uniformly and screeted to the crown and cross-section shown on the plans and to such level above the base that when compacted and finished, the pavement shall conform to the grade and cross-section indicated by the plans. The entire surface shall then be tamped until a close-knit dense surface is obtained.

9.4.1.2 The Tamper shall rest on the side forms and shall be drawn ahead with a swing motion in combination with a series of lifts and drops alternating with lateral shifts. The aim of this operation is compaction and screeding to the approximate level required. Subsequent tamping should advance 75 mm at a time in the direction in which the work is proceeding and in final stages, the tamping should be closer, about 12 mm at a time, until a level and dense surface is obtained.

9.4.1.3 If so directed by Engineer-in-charge, hand operated vibrating tamper consisting of normal type of hand tamper attached to a pneumatic or electric vibrating unit shall be used for compaction.

9.4.1.4 Segregated particles of coarse aggregate, which collect in front of the tamper, shall be thrown outside the forms or thoroughly mixed by hand with a mass of concrete already on the base.

9.4.1.5 Compaction by tamping shall be carried on till the mortar in the mix just works up to the surface. The surface shall be examined after compaction correction. If needed correction shall be made by adding or removing concrete, followed by further compaction and finishing.

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9.4.2 **Floating**

As soon as practicable, after concrete has been struck off and compacted, it shall be further smoothened and compacted by means of a longitudinal float, 1200 mm long and 75 mm wide, operated from a foot bridge.

9.4.3 **Straight Edging**

After floating is completed and excess water removed but while concrete is still plastic, the slab surface shall be tested for trueness with a straight edge and rectified, if necessary.

9.4.4 **Brooming**

After belting and as soon as surplus water has risen to the surface, the pavement shall be given a broom finish to produce corrugations of uniform appearance of not more than 1/16 inch in depth.

9.4.5 **Edging**

Before the concrete has its initial set, the edges shall be carefully finished with an edger of the radius required and pavement edge shall be left smooth and true to line.

9.5 Curing

Curing of concrete shall be as described in EIL Specification no. 6-68-0004.

10.0 JOINTS

10.1 Wherever called for on the drawings, expansion joints, construction joints and sealing joints shall be provided as per details indicated in the drawing and as directed by Engineer-in-Charge.

10.2 Sealing of Joints

10.2.1 After the curing, the temporary seal or other intruded materials of all expansion and contraction joints shall be removed completely and the slots filled with approved silicone sealant. It shall be self leveling low modulus type confirming to ASTM 5893. The sealant shall conform to IRC 57. The filler material for Expansion and Sealing joints shall be preformed fillers of Bitumen Impregnated Fiber, conforming to IS: 1838, Part-I.

10.2.2 The edges of the joints shall be thoroughly cleaned and a suitable primer as recommended by sealant manufacturer shall be applied in accordance with IRC:57.

10.2.3 The application of the sealing compound shall conform to the process as specified in IRC 57.

11.0 OPENING TO TRAFFIC

11.1 Traffic shall not be allowed for a period of 28 days after laying of concrete in pavement.

11.2 Before opening the pavement to traffic, all joints shall be filled and trimmed or topped out as required.

11.3 Sampling, testing and acceptance of concrete work for pavement / road shall be according to IS: 456 / IRC -15 as applicable.

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12.0 METHOD AND BASIS FOR PAYMENT

12.1 Plain and Reinforced Concrete

12.1.1 Payment for plane and reinforced concrete in pavements shall be made on cubic metre basis of the volume of the actual finished work done and shall be inclusive of cost of providing Forms, Pockets, Chamfers, Fillets, Grooves, Cement wash, Curing by normal moist curing or using curing compound etc. as directed by Engineer-in-Charge. The rates shall be deemed to include complete cost of getting the respective mix designs approved, making and testing concrete cubes and carrying out other tests including tests of various ingredients, as per specifications and as directed by Engineer-in-Charge.

12.1.2 No separate payment shall be made for any admixture used by the contractor for accelerating or retarding the strength of concrete or for achieving specified workability / water tightness. The rate quoted shall be deemed to be inclusive of all costs related to any such additive / admixture.

12.1.3 The rate shall however be exclusive of reinforcement, metal inserts, pipe sleeves and any filler material in expansion / sealing joints.

12.1.4 Where the strength of concrete mix (nominal or design mix) as indicated by tests, lies in between the strengths of two grades given in Table-1 of EIL Specification No. 6-68-0004 and it is accepted by owner/Engineer-in-charge, such concrete shall be classified as a grade belonging to the lower of the two grades between which it lies. In case the cube strength shows higher results than those specified for the particular grade of the concrete, it shall not be placed in the higher grade nor shall the Contractor be entitled for any extra payment on such account. The concrete giving lower strength than specified may be accepted at reduced rates after satisfying the safety of the structure by checking it with tests as specified or rejected entirely at the discretion of the Engineer-in Charge. The rejected concrete shall be dismantled at no extra cost to the owner and no payment or extension of time shall be granted for the concrete so rejected and the formwork and reinforcement used for the same. Cost of any material supplied by the Owner free of cost shall be recovered from the contractor at double the prevailing market rate. In case the concrete of lower strength can be improved by carrying out some strengthening measures entirely at the discretion of the Engineer-in-Charge, then Contractor shall carry out the said measures including all related tests at his own cost. If the Contractor is able to make up the strength to the required grade by such improvement measures to the entire satisfaction of Engineer-in-Charge, payment shall be made for the grade achieved. However, if the strength of concrete is not made up to the strength of required grade, payment shall be made only for the lower strength if such concrete is accepted by the Engineer-in-Charge.

12.1.5 Deductions for openings, pockets etc. shall be as specified in relevant Indian Standard Codes.

12.2 Reinforcement

12.2.1 Payment for plain round mild steel reinforcement bars and high strength deformed steel bars shall be on the basis of weight of bare steel, irrespective of any coating applied, in metric tons. The weight of the bar shall be derived from the sizes and corresponding unit weights given in hand book of Bureau of Indian Standards. Standard hook length, chairs, spacer bars and authorised laps only shall be included in the weight calculated. Binding wire shall not be weighed nor otherwise measured. Measurement for weight shall not include cutting allowance etc.

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12.2.2 Rate quoted for reinforcement shall include cost of supplying, decoiling, straightening, cleaning, cutting, bending, placing, binding, welding if required, and providing necessary cover blocks of concrete.

12.3 Joints

Payment for expansion joints, construction joints and sealing joints shall be made on running metre basis. The rate shall include cleaning of joints, filler material and sealing with approved compound, all material, labour etc. complete, as per drawing.

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STANDARD SPECIFICATION FOR PIPE CULVERTS & ERC/ IRC CROSSING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	14 03 19	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	AVM	AJS	RS	RKT
3	23.05 11	REVISED & ISSUED AS STD SPEC	AS	RKS	RBB	DM

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Abbreviations:

ERC	:	Electrical Road Crossings
IRC	:	Instrumentation Road Crossings
IS	:	Indian Standard
PVC	:	Poly Vinyl Chloride
RCC	:	Reinforced Cement Concrete

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1.0 SCOPE

The scope of this specification covers RCC pipe culverts and ERC/ IRC crossings with RCC or PVC pipes.

2.0 CODES & STANDARDS

IS: 458	Precast Concrete Pipes (with and without reinforcement)
IS: 783	Code of practice for laying of RCC pipes
IS: 4985	Unplasticised PVC pipes for potable water supplies
NOTE: -	Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

3.1 All pipes must be new and perfectly sound, free from cracks, cylindrically straight and of standard nominal diameter and length, with even texture. PVC Pipes shall be Class-I as per IS: 4985.

For pipe culverts, class of RCC pipe shall be NP3 / NP4 or as mentioned in the drawings.

3.2 The Contractor shall submit manufacturer's test certificate for acceptance of RCC/PVC pipes.

3.3 Spun yarn for pipe joints shall be of best quality. It shall be free from dust etc.

4.0 TRANSPORTATION AND STACKING

4.1 The transportation of materials to the worksite and stacking shall be done in a manner to cause minimum inconvenience to the traffic and other construction work.

4.2 The pipe shall be protected during handling against impact, shocks and free fall to avoid cracks and damage.

4.3 The Contractor shall be fully responsible for the safety and security of materials transported and stacked in the field.

4.4 Earthwork

Refer standard specification No.6-68-0003 for earthwork.

5.0 LOWERING AND LAYING OF RCC PIPES

5.1 General

The laying and jointing of RCC pipes shall confirm to IS: 783.

The trench shall be checked for proper level, grade and alignment before lowering the pipes.

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5.2 Lowering

The RCC pipe shall be lowered cautiously to prevent disturbance to the bed and sides of the trench. The heavy RCC pipes shall be lowered by means of proper tripods, chain pulley blocks or as directed by Engineer-in-charge. Great care should be taken to prevent sand etc. from entering the pipes.

5.3 Laying

5.3.1 Laying of RCC pipes shall proceed up grade of slopes.

5.3.2 The error of grade shall not be rectified by packing up earth underneath the pipe. If required, concrete shall be used for packing.

5.3.3 The end of RCC pipes shall be kept closed to keep dirt, mud and foreign materials out. Adequate provision shall be made to prevent floating of pipes in the event of flooding of trenches.

The body of RCC pipe, for its entire length, shall rest on an even bed in the trench.

5.4 Jointing of RCC pipes.

5.4.1 Cement mortar 1:2 (1 cement: 2 sand) shall be slightly moistened and must on no account be soft or sloppy and shall be carefully inserted by hand into the joint. The mortar shall than be punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar.

5.4.2 Any surplus mortar projecting inside the joint is to be removed and guarded against any damage. Sack or gunny bags shall be drawn past each joint after completion.

5.5 Curing.

The Cement mortar joints in RCC pipes shall be cured at least for seven days.

5.6 Testing.

All joints in culvert pipelines shall be tested to a head of 1.5 m of water above the top of the highest pipe, if required, by Engineer-in-Charge.

5.7 Payment

Payment shall be made on running meter basis, which includes supplying, transporting, lowering, laying, jointing and curing, concreting around RCC pipes etc., all complete.

6.0 LOWERING AND LAYING OF PVC PIPES

6.1 Lowering and laying of PVC pipes shall be done as per IS: 4985. The jointing of the pipes shall be done by expanding one end after heating and using solvent cement.

6.2 Payment

Payment shall be made on running meter basis of PVC pipes, which includes supplying, transporting, lowering, laying and jointing, concreting around PVC pipes etc., all complete.

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STANDARD SPECIFICATION FOR GRAVEL FILLING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by
4	28.06.18	REAFFIRMED AND ISSUED AS STANDARD	BP	DCB	RAJANJI SRIVASTAVA	RK TRIVEDI
3	03.08.12	REVISED & ISSUED AS STD. SPEC.	JAY KUMAR	RC	RBB	DM
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1	1.07.99	REVISED & ISSUED AS STD. SPEC.	PKT	PCS	MMK	A SONI
0	30.8.91	ISSUED AS STD. SPEC.	RLT	SKC	RPB	RNS

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Abbreviations:

HDPE	:	High Density Poly Ethylene
IS	:	Indian Standard
LSTK	:	Lump Sum Turnkey
PE	:	Poly Ethylene
SOR	:	Schedule of Rates

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1.0 SCOPE

This specification covers gravel filling with HDPE Film underneath in open areas, transformer areas or at any other location.

2.0 CODES & STANDARDS

IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 2720 Part VII	Methods of tests for soils, Part 7, Determination of water content – dry density relation using light compaction
IS: 10889	Specification for HDPE films.
NOTE:-	Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIAL

3.1 Gravel

3.1.1 The material to be used for gravel filling shall be either gravel or hard durable crushed stone from source/ quarries approved by Engineer-in-charge. It shall be free from flat, elongated, soft and disintegrated particles without any fissures. It shall also be free from clay and weathering action. The size of gravel/ crushed stone shall range from 27 mm to 50 mm.

3.1.2 The gravel/ crushed stone shall be stacked by the side of gravel fill area on firm, well drained ground in regular stacks, as directed by Engineer-in-charge and contamination by earth and other extraneous matter shall be prevented effectively.

3.2 Film Specification

Film specification shall be as per IS: 10889. The various requirements shall be as follows:

1.	Material	:	HDPE Grade-I
2.	Appearance	:	Uniform in colour, texture and finish. No visible defects, free from un-dispersed raw material, streaks and foreign matter particles.
3.	Film form	:	In flat sheets or rolls
4.	Odour	:	Free from objectionable odour.
5.	Density (mass)	:	940 – 952.4 Kg/m^3 @ $27^0 \pm 2^0$C
6.	Film thickness	:	150 Micron (0.15mm) minimum or more to achieve above density.
7.	Tensile strength at break		
	Machine direction	:	Minimum 300 kgf/cm^2
	Transverse direction	:	Minimum 250 kgf/cm^2
8.	Elongation at break		
	Machine direction	:	Minimum 300 %

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	Transverse direction	:	Minimum 300 %
9.	Water penetration	:	Nil
10.	Carbon black content	:	2.5±0.5% by mass
11.	Nominal width	:	5 to 10 m
12.	Joint breaking strength	:	10KN/m

4.0 CONSTRUCTION DETAILS

4.1 Preparation of Sub Grade

The area to be filled with gravel shall be cleared of all loose material and virgin soil shall be exposed. Such exposed surface shall be consolidated properly to obtain 90% of maximum laboratory dry density of the soil as per IS: 2720 Part VII. All soft patches shall be worked out to remove the soft soil and selected approved earth shall be filled back and compacted. The sub grade shall be free from sharp objects such as stone, weed roots etc. and shall be smooth without any depressions and humps etc. The surfaces so prepared shall be leveled and sloped as per drawings, for effective drainage.

4.2 Film Laying

The film shall be laid / spread / unrolled over the prepared sub grade and laid loose so as to provide for the thermal contraction etc. The film shall be spread loosely over the Sub grade so that it shall attain the contours of sub grade and compensate for thermal variations during the day. An extra length in both the directions on this account shall be provided. The loose ends of the film shall be firmly anchored at the ends with the adjacent area. The adjacent layer of film should be joined firmly with a minimum of 200 mm overlap and jointing by thermal sealing. Thermal sealing shall be done as per manufacturer's recommendations. The joints of the film shall be kept to the minimum.

4.3 Gravel Filling

4.3.1 75 mm thickness of clear, hard and durable Sand shall be spread over a firmly spread film. The gravel / crushed stone aggregate shall be spread uniformly and evenly, on the prepared base covered with film and sand, in required quantities from the stacks. The aggregate shall be spread to proper profiles and slopes / gradients, in such a way that it will not damage or pierce the film.

4.3.2 The surface of the aggregate spread shall be carefully dressed up and all high and low spots remedied by removing or adding aggregates, as may be required. The thickness of layer of aggregate so spread shall be 100mm.

5.0 PAYMENT

5.1 Payment of gravel filling shall be made on the basis of area covered with 100mm thick (or as specified in Item description in SOR) layer of gravel / crushed stone. The rate quoted shall include cost of HDPE Film, sand, gravel / crushed stone, transportation, handling, laying & dressing etc. over consolidated and exposed ground including the cost of clearing and stripping, leveling, consolidation, watering, testing of exposed ground, removal of waste / surplus earth within plant battery limit and covering of prepared sub base with film etc., as directed by Engineer-in-charge, all complete.

5.2 The payment clause 5.1 is not applicable in case of LSTK Jobs.

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FLEXIBLE PAVEMENTS WITH DENSE BITUMINOUS MACADAM & BITUMINOUS CONCRETE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convener	Standards Bureau Chairman
					Approved by	
0	07.09.20	ISSUED AS STD. SPEC.	NS	GYAS/ AK	AS	SM

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Abbreviations:

DBM	Dense Bituminous Macadam
IRC	Indian Road Congress
IS	Indian Standard
Kg	Kilogram
Kg/m^2	Kilogram per Square Meter
m	Meter
mm	Millimeter
m^2	Square Meter
MORTH	Ministry of Road Transport & Highway

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1.0 SCOPE

This specification establishes the material, construction requirements and procedures for the flexible pavement with Bituminous Concrete & Bituminous Macadam, interlocking paver blocks on road shoulders and pitching on embankment.

2.0 REFERENCES

2.1 Codes & Standards

IS: 73	Paving bitumen
IS: 2386 Part 1	Methods of Test for Aggregates for Concrete, Part I: Particle Size and Shape
IS 15658	Precast concrete blocks for paving
IRC:SP:63	Guidelines for the use of Interlocking Concrete Block Pavement
IS 2720 Part VIII	Method for Test for Soils- Part 8: Determination of Water Content-Dry Density relation using heavy compaction

2.2 Specifications

Specifications for Road and Bridge Works – Ministry of Road Transport & Highway (Orange Book)

NOTE: -Latest Edition of all Codes, Standards and Specifications shall be followed.

3.0 DENSE BITUMINOUS MACADAM (DBM)

Dense Bituminous Macadam of specified thickness in a single course shall be constructed as per Section 505 of the Orange Book.

3.1 MATERIAL

3.1.1 Bitumen

The bitumen shall be viscosity graded paving bitumen complying with Indian Standard Specification for paving bitumen, IS: 73 or as 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 500-1 of the Orange Book.

3.1.2 Coarse Aggregate

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. It shall be clean, hard, durable and cubical shape, free from dust and soft organic and other deleterious substances. The aggregate shall satisfy the physical requirements specified in Table 500-8 of the Orange Book of MORTH. Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on 4.75 mm sieve shall have at least two fractured faces resulting from crushing operation. Before approval of the source, the aggregates shall be tested for stripping. Where the contractor's selected source of aggregates have poor affinity for bitumen, as a condition for the approval of that source, the bitumen shall be treated with approved anti-stripping agents, as per the manufacturer's recommendations, without additional payment.

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3.1.3 Fine Aggregates

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of two, passing 2.36 mm sieve and retained on 75 micron sieve. It shall be clean, hard, durable, free from dust and soft organic and other deleterious substances. Natural sand shall not be used in the binder course.

3.1.4 Filler

Filler shall consist of finely divided material such as rock dust, hydrated lime or cement approved by Engineer-in-Charge. The filler shall be graded within the limits indicated in Table 500-9 of the Orange Book of MORTH.

The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime. Where the aggregates fail to meet the requirements of the water sensitivity test in Table 500-8, then 2 percent by total weight of aggregate, of hydrated lime shall be used and percentage of fine aggregate reduced accordingly.

3.1.5 Aggregate Grading & Binder Content

When tested in accordance with IS:2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and filler for the particular mixture shall fall within the limits given in Table 500-10 of the Orange Book of MORTH. for grading 1 or 2 as specified in the Contract. To avoid gap grading, the combined aggregate gradation shall not vary from the lower limit on one sieve to higher limit on the adjacent.

3.1.6 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 ratio (F/B) by weight of total mix shall range from 0.6 to 1.2.
All the steps shall be carried out as per Clause 505.3 of the Orange Book of MORTH.

3.1.6.1 The quality requirements of the individual ingredients, the mixture shall meet out the requirements set in Table 500-11 of the Orange book of MORTH.

3.1.6.2 The binder content shall be selected to obtain 4% air voids in the mix design.

3.1.6.3 The Job mix formula shall be got approved by Engineer-in-Charge as per the requirements given in clause 505.3.3 of the Orange book of MORTH.

3.1.6.4 After approval of the job mix formula, the plant trials & laying trials shall be carried out in line with clause 505.3.4 and clause 505.3.5 respectively of the Orange book of MORTH.

3.2 LAYING/ CONSTRUCTION

3.2.1 Weather and Seasonal Limitations

The provision of the Clauses 501.1.5 of the Orange Book of MORTH shall apply.

3.2.2 Preparation of the Base

The base on which Dense Bituminous Macadam is to be laid shall be prepared, shaped and compacted to the required profile in accordance with Clauses 501 and Clause 902 of the Orange Book of MORTH or as directed by the Engineer. The surface shall be thoroughly

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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.

3.2.3 Geosynthetics

Where Geosynthetics are specified in the contract, this shall be in accordance with Clause 703 of the Orange Book of MORTH.

3.2.4 Stress Absorbing Layer

Where stress absorbing layers are specified in the contract, this shall be in accordance with Clause 517 of the Orange Book of MORTH.

3.2.5 Prime Coat

Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified, in accordance with the provisions of Clause 502 of the Orange Book.

3.2.5 Tack Coat

Where the material on which the dense bituminous macadam is to be laid is either a bitumen bound layer or primed granular layer, tack coat shall be applied, as specified, in accordance with the provisions of Clause 503 of the Orange Book.

3.2.6 Preparation & Transportation of the mix

The provisions of Clauses 501.3 and 501.4 of the Orange Book shall be followed.

Table 500-2 of the Orange Book of MORTH 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.

3.2.7 Spreading

The provisions of Clause 501.5.3 and Clause 501.5.4 of the Orange Book of MORTH.

3.2.8 Rolling

Compaction shall be carried out in accordance with the provisions of Clauses 501.6 and 501.7 of the Orange Book of MORTH as approved by Engineer-in-Charge during plant trials.

3.3 TESTING

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. The surface finish of the completed construction shall conform to the requirements of the Clause 902 of the Orange Book of MORTH. All materials and workmanship shall comply with the provisions of Section 900 of the Orange Book of MORTH.

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4.0 BITUMINOUS CONCRETE

The layer of Bituminous Macadam shall be covered with one layer of Bituminous Concrete within 48 hours of the construction. If there is any delay, the dense bituminous macadam shall be covered with one layer of Seal Coat as per Clause 512 of the Orange Book before opening to any traffic.
The layer of Bituminous Concrete, for use in wearing course, of specified thickness, shall be constructed as per Section 507 of the Orange Book.

4.1 MATERIAL

4.1.1 Bitumen

The bitumen shall conform to Clause 504.2.1 of the Orange Book.

4.1.2 Coarse Aggregate

The coarse aggregates shall be generally as specified in Clause 504.2.2 of the Orange Book, except that the aggregates shall satisfy the physical requirements of Table 500-16 of the Orange Book and 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.

4.1.3 Fine Aggregates and Filler

The aggregates shall be as specified in Clause 505.2.3 of the Orange Book. Filler shall be as specified in clause 505.2.4 of the Orange Book.

4.1.4 Aggregate Grading & Binder Content

When tested in accordance with 1S:2386 Part 1 (Wet grading method), the combined grading of the coarse and fine aggregates and filler shall fall within the limits shown in Table 500-17 of the Orange Book.

4.2 MIX DESIGN

The design mix shall be carried out as per Clause 507.3 of the Orange Book.

4.3 LAYING/ CONSTRUCTION

4.3.1 Preparation of Base

The surface on which the bituminous concrete is to be laid shall be prepared in accordance with Clauses 501 and 902 of the Orange Book as appropriate. The surface shall be thoroughly swept clean by mechanical broom and dust removed, by compressed air. In locations where a mechanical broom cannot get access, other approved methods shall be used as directed by the Engineer.

4.3.2 Tack Coat

The tack coat shall be applied in accordance with Clause 504.4.6 of the Orange Book.

4.3.3 Preparation & Transportation of the mix

The provisions of Clauses 501.3, 501.4 and 504.4.7 of the Orange Book shall be followed.

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4.3.4 Spreading

The provisions of Clause 507.4.7 of the Orange Book shall be followed.

4.3.5 Rolling

The provisions of Clause 507.4.8 of the Orange Book shall be followed.

4.4 TESTING

The surface finish of the completed construction shall conform to the requirements of Clause 902 of the Orange Book. All materials and workmanship shall comply with the provisions set out in Section 900 of the Orange Book.

5.0 INTERLOCKING PAVER BLOCKS FOR ROAD SHOULDERS

5.1 MATERIALS

5.1.1 Material for Cement Concrete viz. Cement, Sand, Coarse and Fine aggregate and water and Admixture etc. shall be as described in EIL Specification no. 6-68-0002.

5.1.2 Material for bedding sand & Joint filling sand shall be as per IRC:SP:63

5.1.3 Paver Block

5.1.3.1 Interlocking paver blocks of Category A as per IRC:SP:63 shall be provided as per standard.

5.1.3.2 The minimum compressive strength of a single paver block shall be 35 MPa.

5.1.3.3 The color of the paver blocks shall be Black or Red or Brown as per IS 44. The quantity of pigment shall conform to IS 15658.

5.1.3.4 All the Physical requirements like recommended dimensions, tolerances & compressive strength etc. shall conform to IS 15658.

5.2 LAYING/ CONSTRUCTION

5.2.1 Preparation of Base

The area where paver blocks are to be placed must be cleared of all loose material. The exposed surface must be consolidated properly to obtain 95% of Maximum Laboratory Dry Density of the soil. All soft patches must be worked out to remove the soft soil and selected approved earth must be filled back and compacted. For filled up areas, top 450 mm of the soil shall be compacted to 95% of laboratory dry density as per IS: 2720 Part VIII in layers of 150 mm.

5.2.2 Sand Bed Layer

The method of placing & screeding of Bedding Sand shall be as per IRC:SP:63.

5.2.3 Laying of Paver Blocks

5.2.3.1 The Blocks shall be laid in Herringbone bond pattern. The maximum joint width is limited to 4 mm. At least 2 passes of vibratory plate compactor shall be made on the paver block for the proper compaction of bedding sand. Laying of blocks shall be done, precisely at the indicated level and profile and in a way that good surface drainage is assured.

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5.2.3.2 Laying of broken blocks is not allowed except along connections. The minimum length of a broken block proposed to be used shall be 100 mm. Breaking of the blocks shall be done with a "block splitter".

5.2.3.3 Fine angular sand max. 1.25 mm shall be brushed into the joints; thereafter compaction shall be done with a vibrating plate compactor on a clean surface. After compaction again fine angular sand shall be brushed into the joints.

5.2.3.4 Precast Kerb Stone of Concrete M30 shall be provided at the edges as per the standard drawing.

6.0 BRICK PITCHING ON EMBANKMENT SLOPES

6.1 Excavation

Embankment shall be dressed true to line, section and grade as per drawings prior to starting the pitching work.

6.2 Material

6.2.1 Bricks shall be locally available best bricks.

6.2.2 Cement, sand and water used shall be as per IS: 269 and 2116.

6.3 The concrete mix used for bedding shall be as per drawings and schedule of rates.

6.4 The work of pitching shall be done after the bottom concrete has been laid and sides properly trimmed to the required grade and thoroughly compacted.

6.5 Brick pitching shall be done in 1:4 cement mortar using best quality locally available bricks.

6.6 Bricks shall be laid in herring bone pattern with their length at 45^0 to the length of the ditch as shown in drawings.

6.7 Mortar joints shall never exceed 6mm in thickness and all bricks shall be laid with vertical joints quite full of mortar.

6.8 Bricks shall be soaked for a period of at least 12 hours immediately before use and no broken and damaged bricks shall be used in any part of the work except as required to close any line of bricks.

6.9 The face of pitching shall be made even and smooth.

6.10 The brickwork shall be raked and flush pointed with cement mortar 1:3 as specified.

7.0 REMOVAL OF SURPLUS EARTH

7.1 Surplus earth and soil from excavation shall be removed from construction area to the area demarcated by the Engineer-in-charge.

7.2 Payment shall be made only for lead beyond initial 50M from construction areas. Rate shall include loading, transportation, dumping, stacking the surplus earth and soil in the area demarcated. Payment shall be made on cubic meter basis of the difference of measurements of the volumes of the excavated pits and the measurements of the backfilling.

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8.0 PAYMENT

8.1 Dense Bituminous Macadam

Payment shall be made on sq. m. basis of finished surface including all labour & materials as per above specifications.

8.2 Bituminous Concrete

Payment shall be made on sq. m. basis of finished surface including all labour & materials as per above specifications.

8.3 Interlocking paver blocks for Shoulder

Payment shall be made on sq. m. basis of finished surface including all labour & materials as per above specifications.

8.4 Brick Pitching

Payment for brick pitching shall be made on the basis of area paved. It shall include all operations described above.

8.5 The payment clause 8.1, 8.2, 8.3 and 8.4 are not applicable in case of LSTK Jobs

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STANDARD SPECIFICATION FOR UNDERGROUND & ABOVE GROUND G.I. PIPELINE SYSTEM (WATER SERVICES)

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convenor	Approved by: Standards Bureau Chairman
5	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI
4	10.07.12	REVISED & ISSUED AS STD. SPEC.	JAI KUMAR	RC	RBB	DM

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Abbreviations:

GI	Galvanised Iron
IS	Indian Standard
Kg/cm^2g	Kilogram per Square Centimeter Guage

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1.0 SCOPE

This specification covers the fabrication and erection of GI pipeline system, both underground and above ground, including excavation, backfilling for the pipeline and testing of completed system.

2.0 CODES AND STANDARDS

IS: 554	Dimensions for pipe threads where pressure tight joints are made on threads.
IS: 778	Copper alloy gate, globe and check valves for water works purposes.
IS: 1239 Part I	Mild steel Tubes, Tubular and other wrought steel fittings.
IS: 1239 Part II	Mild steel Tubes, Tubular and other Wrought Steel fittings. Mild steel Sockets, Tubular and other Wrought steel pipe fittings.

NOTE: -Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

a) All G.I. piping shall conform to IS: 1239 part I.
b) All gun metal valves shall conform to IS: 778 Class II.
c) All G.I. fittings shall conform to IS: 1239 Part II.

The schedule of pipes & fittings shall be as per schedule of items under respective works.

4.0 EARTHWORK IN EXCAVATION AND BACKFILLING ETC.

All earthwork for GI lines shall be governed by the provisions of EIL specification 6-65-0006,"Earthwork for underground piping", to the extent applicable. All earthwork in excavation, backfilling and transportation are included in the quoted rates.

5.0 JOINTING AND ERECTION OF GI PIPING SYSTEM

5.1 Screw socket Joints.

The screwed end of all GI pipes shall be thoroughly cleaned and painted with a mixture of Red and White Lead or Teflon before jointing. The joint shall be made by winding a few threads of hemp round the ends of tubes and then screwing them into sockets to the full depth of threads. Exposed threads shall be coated with approved anticorrosive paint. No pipe shall be bent / offset to save fittings. The offset in GI pipes shall be made only after the permission of the Engineer-in-Charge. If threaded end of pipe is damaged, the contractor shall cut the end with hacksaw and shall prepare new threads conforming to IS: 554, to required length.

All fittings shall be malleable Galvanised Iron approved by the Engineer-in-charge. Fitting in GI line shall include all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts and rubber insertion and all other fittings to make a complete job.

5.2 Flanged Joints

Flanged joints shall be made by painting the faces of the flanges with red lead and bolting up evenly on all sides with compressed asbestos gasket as per piping material specification.

5.3 Valves

Flanged or screwed valves shall be installed in locations shown on the drawings as per specification for screwed or flanged joints.

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6.0 TESTING

All completed GI piping shall be hydrostatically tested to a test pressure equal to one and a half times the working pressure, as per job requirement (Minimum test pressure shall be $6Kg/Cm^2$ g) and the test pressure shall be maintained without loss for at least 30 minutes. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

7.0 PAYMENT

7.1 Payment shall be made on running meter basis of finished pipeline with fitting after testing etc. complete. No separate payment shall be made for earthwork in trenching and backfill, road cutting etc. Payment for valves and flanges etc. shall be made as per schedule of items on unit rate basis. The unions shall be provided at every 50 meter, unless otherwise stated in schedule of items / construction drawing. Rates shall include all incidental work such as transportation of all materials from Owners stores, custody, and fabrication and laying of GI piping system.

7.2 The payment clause 7.1 is not applicable in case of LSTK Jobs

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STANDARD SPECIFICATION FOR FABRICATION AND LAYING OF UNDERGROUND PIPING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	25.11.24	REVISED & ISSUED AS STD. SPEC.	GS	GYAS	S K NASKAR	M NANDI
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4	20.05.13	REAFFIRMED & ISSUED AS STD. SPEC.	RBT	RKS	RBB	DM

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Abbreviations:

ASME	AMERICAN SOCIETY FOR MECHANICAL ENGINEERS
dia.	DIAMETER
IS	INDIAN STANDARD
Kg/cm^2/minute	KILOGRAME/SQUARE CENTIMETRE/MINUTE
m	METRE
mm	MILLIMETRE
CS	CARBON STEEL

General Civil Standards Committee

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1.0 SCOPE

This specification covers the technical requirements for the execution of Piping Fabrication, Assembly, Laying and testing of the underground pipe work defined here under, for water and waste pipe lines.

i. Fabrication and erection of underground piping systems from piping materials in accordance with this specification and applicable drawings and standards.

ii. Fabrication and welding of reinforcement pads at branch pipe locations wherever required.

iii. Corrosion protection coating of underground piping.

iv. Repair of damaged corrosion protection coating and coating of field joints.

v. Fabrication and erection of drain assemblies, valves, strainers, instrument connection, flushing connection etc.

vi. Testing and flushing.

Underground piping systems shall be fabricated, installed, flushed, and tested in accordance with this specification and applicable codes, drawings and standards.

2.0 CODES & STANDARDS

ASME B31.3	Chemical Plant and Petroleum Refinery Piping.
6-65-0006	Standard specification for earth work for U/G piping.
6-44-0012	Standard specification for fabrication and erection of piping.
6-44-0013	Standard specification for inspection, flushing and testing of piping systems.
6-44-0016	Standard specification for Nondestructive examination requirement of piping
6-77-0001	Welding specification for the fabrication of piping
6-77-0005	Welding specification charts for piping classes
6-79-0011	Standard specification for corrosion protection tape coating for underground steel piping
6-79-0020	Standard specification for surface preparation and protective coating
6-71-0044	Standard specification for field joint coating (onshore pipeline)
6-71-0048	Standard specification for repair of polyethylene coating
----------	Job specification for 3LPE pre-coated pipes

NOTE 1: Latest Edition of all Codes and Standards shall be followed.
NOTE 2: In case job specification is available, same shall be followed.

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3.0 FABRICATION

3.1 The contractor shall fabricate all the pipe work in conformity with the Job/ Standard Specification for fabrication & Erection of Piping, and requirements of relevant general arrangement drawings/ isometrics. Where specific details of fabrication are not indicated on the drawings or not specified in the specification, fabrication and erection shall be done in accordance with ASME B 31.3.

3.2 The contractor shall be responsible for working to the exact dimensions as shown on the drawings, irrespective of individual tolerances permissible. Where errors and / or omissions occur on the drawings, it shall be the contractor's responsibility to notify the Engineer-in-Charge, prior to fabrication or erection. Dimensional tolerance for fabrication shall be as per EIL standard.

4.0 COATING & LAYING OF UNDERGROUND PIPING

4.1 Coating (for uncoated pipe)/ repair of coating (for pre-coated pipes & fittings)

Corrosion protection tape coating/ Painting of the underground lines shall be in accordance with Job/ Standard specification.

Repair of 3LPE coating of pre-coated pipes if required shall be as per Job/ Standard specification.

4.2 Laying

4.2.1 The Contractor shall lay the underground piping in accordance with the following clauses and as per the piping arrangement drawings and/ or isometrics issued during the course of construction.

4.2.2 The Contractor shall be responsible for alignment as per the drawing. Errors, if any, shall be rectified by the Contractor at his own cost.

4.3 Trenching

4.2.1 The trench shall be cut according to the drawing, true to the line, levelled with the help of sight rails provided at every 30 m, at change of direction / gradient and at any suitable distance, as directed by Engineer-in-Charge. The bottom elevation of pipe shall be maintained as shown in drawing

4.2.2 The width of the trench shall be sufficient to give free working space on each side of the pipe. The free working space shall conform to specifications. Generally, it shall not be less than 150 mm on either side or 1/3 of dia of pipe, whichever is greater.

4.2.3 If the trench is excavated below the required level as indicated in the drawing, the extra depth shall be filled with PCC 1:5:10 or approved equivalent material, as directed by the Engineer-in-Charge, at no extra cost to owner.

4.2.4 No excavated material shall be deposited within 1.5 meters from the excavated trench.

4.2.5 In case of road cutting, all materials i.e. metal, bricks etc., shall be taken out carefully and kept separately for reuse. Road work shall be redone up to the original level and profile with the excavated road materials /fresh material if required, after laying and testing of the pipe line, within 10 days from the date of starting the work, at the cost of the contractor. The contractor shall provide suitable slings and barricades to prevent accidents. He shall also provide reasonable by-pass at his own cost when a road is cut for laying pipeline.

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4.2.6 During excavation, if some obstacle is met with, the same shall be reported to the Engineer-in-Charge and dealt with as instructed by him.

4.2.7 The contractor shall do dewatering, shoring, strutting / timbering if required or do whatever might be required to excavate the trench, install the pipe in it and backfill the trench, in accordance with the specifications, at no extra cost to the Owner. Dewatering shall be done in advance of the laying of the pipe, to allow adequate inspection of padding of the bottom, if required. Dewatering shall be continued throughout during laying of the pipe and backfilling of the trench.

4.2.8 In muddy / slushy ground, the bed shall be provided with a layer of sand or lean concrete as directed by the Engineer-in-Charge.

4.2.9 The trench shall follow the gradient of pipeline as specified in the drawing. The contractor shall keep the trench in good condition, until the pipe is laid and tested. No extra claim shall be entertained due to its caving or settling down, either before or after the pipe is laid. All materials to shore the trench, in order to prevent caving, shall be furnished and removed by the Contractor, at no extra cost to the Owner.

4.2.10 In case pipe is lowered in caved trench and back filled before inspection by the Engineer-in-Charge, the Contractor shall re-excavate the trench for inspection and backfill it at his own cost.

4.3 Lowering & Laying

4.3.1 The pipe shall be lowered by mechanical method when the trench is ready and bottom of the trench is graded as per required pipe laying conditions and specifications.

4.3.2 By Machine

The shop coated pipe already transported to the pipe laying site in convenient length of pipe assembly, near the trench after hydrostatic testing, shall be placed on clean square cut skids suitably spaced, so as to keep the pipe away from touching the ground. The pipe may be lowered down in the trench by the launcher cranes with sufficient care, to protect the coating of the pipeline.

At tie in welds and other site fabrications, the contractor shall clean, prime, coat and wrap manually.

Also, short sections of pipelines, which are impracticable to shop-treat, may be hand treated, but only after obtaining prior written approval of the Engineer-in-Charge.

4.3.3 By Hand

Only in unavoidable circumstances and after obtaining approval of Engineer-in-Charge, the pipe may be lowered with the help of tripods and chain pulley blocks into the trench. However, if in the opinion of the Engineer-in-Charge, the temperature condition does not allow direct lowering, then the pipes shall be set down on clean square cut skids. The skids shall be so spaced as to keep the pipe away from touching the ground.

4.4 Method & Time of Lowering Pipe

4.4.1 Under favorable temperature conditions and using methods, which will not damage the coating, the pipe may be lowered into the trench.

4.4.2 Pipes previously set on skids, because of unfavorable temperature conditions, shall be lowered into the trench normally in the cool of the morning and only when the temperature of the pipes is below the softening point of the coating materials.

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4.4.3 All skid marks and other places of damage shall be thoroughly examined to ensure proper patching where necessary, before the pipe is finally lowered into the trench.

4.5 Handling Coated Pipe

4.5.1 Coated pipe shall not be placed in trench, until cave-in plugs, hard clods, stones, skids and welding rods etc. have been removed from there. Where the trench has a hard or jagged bottom, sufficient fine dirt or sand shall be placed therein, before the pipe is lowered.

4.5.2 Coated pipe shall not be handled or moved by means of cable or chains or by prying with skids or bars. It shall be tied and lowered by using lowering-in belts of a standard width and design, for the size of pipe being handled.

4.5.3 Coated pipe shall not be dragged along the ground or otherwise handled in a manner that will be detrimental to the coating.

4.5.4 Despite all precautions taken during handling of coated pipes, if the coating gets damaged, same shall be recoated by Contractor at site, at his own cost, as per directions of Engineer-in-Charge.

4.6 Lining up & Welding

4.6.1 The ends of the pipeline shall be kept securely closed, to prevent entry of any foreign material/ moisture, after lowering into the trench.

4.6.2 Before making joints, the pipe shall be laid carefully, so as to be perfectly aligned, in both plan and profile and the end closures provided shall be removed.

4.6.3 Tie-in shall be made in the coolness of the morning or when the ambient temperature is not exceeding 29^0C or softening temperature of the coating material, whichever is less. All bevelling, aligning and welding shall be in accordance with the welding specification given in the tender.

4.6.4 Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side, so that good welded joint is obtained.

4.7 Coating of field welded joints

Field welded joints shall be coated as per Job/ Standard specification. Field joints of externally 3LPE pre-coated pipes shall be coated as per Job/ Standard specification.

4.8 Back Filling

4.8.1 After testing and inspection of the pipeline to the entire satisfaction of the Engineer-in-Charge, the trench shall be back filled with the serviceable soil excavated earlier. No trench shall be back filled without the approval of the Engineer-in-Charge.

4.8.2 Backfilling with the serviceable soil excavated earlier shall be done in layers of 200 mm, well watered and rammed to avoid any settling afterwards.

4.8.3 The earth cover up to 300 mm above the top of the pipe shall be compacted by manual methods, to protect the pipe from any damage by mechanical compactor.

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4.8.4 If due to exigencies of the work, some portion of the pipeline is backfilled without approval of the Engineer-in-Charge, the Engineer-in-Charge shall have the right to order uncovering of the pipe for examination and the cost of such uncovering shall be borne by the Contractor.

4.8.5 The backfill material shall be free from stone pieces/sharp objects/debris.

4.8.6 When the trench has been dug through roads, all backfill shall be thoroughly compacted. In certain cases, special compaction methods may be required by the Engineer-in-Charge. This shall be done by the contractor at no extra cost to the Owner.

4.8.7 When the trench has been dug across unlined ditches, the backfill shall be thoroughly compacted in 150 mm layers for a distance of 1.5m beyond the outside banks of the ditch on either side. The banks of the ditch shall also be compacted in 150mm layers, at no extra cost to the Owner.

4.8.8 After the roads have been already graded, and if they are trenched or otherwise disturbed by the Contractor during laying of the pipe lines, the contractor shall restore the road to its original level and condition. In the event the Contractor is required to place extra fill, gravel, or other special materials, it shall be done by the contractor without any extra cost to the Owner.

4.8 Clean up of Surroundings

4.9.1 As soon as the backfill is completed, the contractor shall immediately clean up the adjoining area by removing all surplus and defective material and dispose off all refuge such as spurs, sheet-iron and broken skids and surplus excavated earth etc., at his own cost, to the entire satisfaction of the Engineer-in-Charge.

4.9.2 The earth on both sides of the pipeline trench, which has been disturbed during the construction of the pipe line, shall be smoothened and left in a condition to the entire satisfaction of Engineer-in-Charge.

5.0 INSPECTION & FLUSHING

Inspection and flushing of the piping shall be done as per Job/ Standard specification (Specification for inspection, flushing and testing of piping system).
Non-Destructive examination of shop/ field fabricated piping shall be as per Job/ Standard specification (Specification for non-destructive examination requirement of piping).

6.0 TESTING

6.1 Pressure Piping

Pressure testing of pressure piping shall be done as per Job/ Standard specification (Specification for inspection flushing and testing of piping system). Test pressure shall be as per line list/ AFC document.

6.2 Gravity/ Non-pressure Piping

6.2.1 Fabrication yard/ facility

All piping sections fabricated at yard, shall be tested in conformance to Job/ Standard specification (Specification for non-destructive examination requirements of piping). In addition to the above, each fabricated section shall be leak tested at atmospheric pressure for water tightness of the fabricated section. Any repair of coating (internal/ external) at joint location shall be carried out only on

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completion of inspection of leak test and subsequent repair of joint, if any. Care shall be taken during transportation of tested pipes for integrity of tested joints.

6.2.2 In-situ fabrication and erection

All piping including sub headers and headers fabricated/ joined and laid in-situ, shall be tested in conformance to Job/ Standard specification (Specification for non-destructive examination requirements of piping). In addition to the above, each fabricated section: piping upstream of a manhole/ between any two manholes/ sump inlet and upstream manhole shall be considered as a single system and each such system (defined in concurrence with Engineer-In-Charge) shall be leak tested at atmospheric pressure for water tightness of the fabricated section. Any repair of coating (internal/ external) at joint location shall be carried out only on completion of inspection of leak test and subsequent repair of joint, if any.

6.3 Leak Test

6.3.1 Fabrication yard/ facility

The pipe section as fabricated, from the funnel to end of transportable length shall be temporarily blanked and filled with water so that water level is up to the top of the funnel. The entire section shall be kept filled for 4 hours.

The drop in water level of all water and sewage (sanitary, chemical and industrial drainage and other gravity sewers) piping being leak tested shall be recorded at end of 4 hour at the funnel. The value so recorded shall represent a total leak test of the section (Pipe/ group of pipes). The total leak observed shall be limited to the evaporation loss for the open funnel. During test, all funnels but for the observation manhole shall be kept sealed and the observation funnel shall be provided with a temporary cover. During leak test, all exposed pipe, joints, fittings, valves, shall be carefully examined for leakage. Leaking pipes, joints, and fittings shall be replaced/repaired.

The hydrostatic test shall be repeated after the repair of any defects until the system is proved satisfactory. The piping shall be satisfactory if there is no evidence of leakage after the 4 hours.

The contractor shall undertake repairing and testing of the joint without any extra cost to the owner. After completion of the test, all temporary covers shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

6.3.2 In-situ fabrication and erection

The pipe system as defined, upstream of a manhole/ between any two manholes/ sump inlet and upstream manhole shall be filled with water so that water level is up to the top of the manholes. The entire system shall be kept filled for 24 hours.

All water and sewage (sanitary, chemical and industrial drainage and other gravity sewers) piping and retaining structures under atmospheric pressure such as manholes, sumps, catch basins etc. being leak tested shall be topped up with Water to the brim after initial 8 hours and then the drop in water level shall be recorded every 4 hours at the observation manhole. The value so recorded shall represent a total leak test of the system (Pipes and Manhole). The total leak observed shall be limited to the evaporation loss for the open system of Pipes funnels and manholes. During test, all manholes and funnels but for the observation manhole shall be kept sealed and the observation manhole shall be provided with a temporary cover. Site testing shall take place prior to backfill. During hydrotest, all exposed pipe, joints, fittings, valves, shall be carefully examined for leakage. Leaking pipes, joints, and fittings shall be replaced/repaired.

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The hydrostatic test shall be repeated after the repair of any defects until the system is proved satisfactory. The piping shall be satisfactory if there is no evidence of leakage after the 24 hours.

The contractor shall undertake repairing and testing of the joint without any extra cost to the owner. After completion of the test, all temporary covers shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

Before commissioning, the cleanliness of the pipeline shall be checked by following test.

Ring Test (Manhole to Manhole)

In this method of testing, two steel / wooden rings of suitable thickness and design shall be fixed facing each other, at a distance of 2 feet or more. The block of rings shall be inserted from one end of the pipeline, inside manhole and pulled by a rope fixed to the block from the other end of the pipeline, inside the next manhole. The rings shall be of dia. 2" less than the inside dia of pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by the contractor either during construction or afterwards by suitable means. Any obstruction/ debris/ major misalignment will prevent the ring to pass through the pipeline in which case the pipeline shall again be cleaned / rectified and the test redone. The ring test shall be performed for the complete network of the sewer system, before the same is put in service.

8.0 PAYMENT

8.1 Payment for Piping fabrication and erection shall be made based on respective rates. Payment of piping fabrication shall be based on inch dia. measurement whereas payment for erection of piping shall be based on inch meter measurements, calculated on the basis of the execution drawings. The length shall be measured along the center lines of pipes, center lines of bends and elbows, tees, reducers and flanged joints. All types of valves shall be excluded from this measurement. Branch connections shall be measured from the outer surface of the header.

The payment shall be made on per inch metre basis of piping work laid, measured to the nearest centimeter. The unit rates for the underground piping shall be inclusive of earthwork in excavation, backfilling, compaction, disposal of surplus earth and corrosion protection coating/ coating of field joints of 3L PE pre-coated pipes including supply of materials.

All piping attachments, such as couplings, nipples, thermowells etc., shall be installed by the Contractor as part of piping work and no separate payment shall be made for such work. However, extension on such attachments such as vents and drains will be measured and paid as applicable for the respective size and category of piping / valves.

Fabrication of mitre bends, concentric and eccentric reducers fabricated from pipes supplied by owner & fabrication of flanges from plates supplied by owner, will be paid at respective unit rates. However, erection of these items will be along with piping of the respective size and no separate payment will be made for erection.

The reducers will be measured and paid along with the piping of large diameter.

Payment of Reinforcement pads for branch connections shall be made as per respective SOR rates.

Fabrication, installation and removal of temporary spool pieces etc. to aid contractor's work such as fabrication, erection, flushing and testing etc. will neither be measured nor paid separately. The same is deemed to be included in the unit rates for piping. Payment for carrying out radiographic examination shall be based on inch dia. of joint radiographed. Repeat radiography / additional

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radiography required due to contractor's faults / poor performance of his welders and defective films etc., shall be done at contractor's own cost.

8.2 The payment clause(s) as described in the clause no. 8.1 shall not be referred / applicable for LSTK Jobs

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STANDARD SPECIFICATION FOR UNDERGROUND C. I. PIPING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	28.05.24	REVISED & ISSUED AS STD. SPEC.	PREETI	RKS	SKN	MAINAK NANDI
4	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI

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Abbreviations:

C.I.	: Cast Iron
cm	: Centimeters
cm^3	: Cubic Centimeters
IS	: Indian Standard
Kgs	: Kilograms
Kg/cm^2	: Kilogram / Square Centimeters
mm	: Millimeter
C.S.	: Carbon Steel
LSTK	: Lump sum turnkey

General Civil Standards Committee:

Convenor: Mr. Samir Kumar Naskar

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Mr. Amitabh Kishore
Mr. Dinesh Deb Barma
Mr. Gyasuddin
Mr. Raj kumar Singh
Mr. U.C. Pathak (Piping)
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1.0 SCOPE

This Specification covers all works involved in providing underground C.I. piping system as per drawings and specifications. Rates quoted shall include transportation of materials from Owner's stores to the site, in cases where the owner issues materials. All other items of work, such as cutting, laying, jointing and testing etc., are included in the quoted rates. The work shall also include erection of all valves and in line instruments etc., which forms part of the system.

2.0 CODES & STANDARDS

IS: 638	: Specification for Sheet rubber jointing and rubber insertion jointing
IS: 782	: Specification for Caulking lead.
IS: 1367	: Technical supply conditions for threaded steel fasteners.
IS: 1536	: Centrifugally cast (spun) iron pressure pipes for water, gas and sewage- Specification.
IS: 1537	: Specification for Vertically cast iron pressure pipes for water, gas and sewage.
IS: 1538	: Cast iron fittings for pressure pipes for water, gas and sewage- Specification.
IS: 3114	: Code of practice for laying of cast iron pipes.
IS:14846	: Sluice Valve for Water Works Purposes (50 to 1200 mm Size)- Specification
6-65-0006	: Standard Specification for Earth Work for Under Ground Piping System.
NOTE:-	Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

3.1 Cast Iron Socket and Spigot Pipes

All centrifugally cast (spun) iron pipes shall conform to IS: 1536 class A. The pipes shall have standard weight as specified in Indian Standard. No payment shall be made for extra weight of the pipes, if any. The socket of pipe shall be of modified design, such that socket & spigot shall be jointed with tyton or other similar coupling.

3.2 Cast Iron Double Flanged Pipes

All cast iron flanged pipes shall conform to IS: 1537 Class A. The pipes shall have standard weight as specified in Indian standard. No payment shall be made for extra weight of the pipes, if any.

All C.I. fittings shall conform to IS: 1538.

Rubber gasket for flanged joints shall be 3mm thick, conforming to IS: 638, Type-B, Grade 2.

C.S. hexagonal bolts and nuts shall conform to IS: 1367.
All flanges shall conform to IS: 1537.

3.3 Cast Iron Sluice Valves

Cast Iron Sluice Valves are double flanged, non-rising Stem type, conforming to IS: 14846 for 50 to 1200mm diameter.

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Rubber gasket for flanged joints shall be 3mm thick, conforming to IS: 638. C.S. hexagonal bolts and nuts shall conform to IS: 1363.

4.0 EARTHWORK IN EXCAVATION, BACKFILLING AND TRANSPORTATION

4.1 All earthwork involved in laying of cast iron pipes shall be deemed to have been included in the quoted rates for laying of C.I. pipes.

4.2 All earth work shall be carried out as per EIL Standard specification No. 6-65-0006 "Earthwork for underground piping".

4.3 The bed of 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.

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 (fine murrum, if fine sand or soil is not available) and compacted, so as to provide a smooth bedding for the pipe.

Where excavation requires blasting operations, it shall be ensured that no pipes are stacked in the vicinity and complete piping in the vicinity have already been covered before starting of blasting operation.

4.5 The trench shall be kept free from water. Shoring and strutting / timbering shall be done, wherever required. Excavation below water table shall be kept dry by dewatering the trenches, if required.

4.6 After 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 hollows shall be refilled with sand after jointing the pipe.

5.0 LOWERING, LAYING AND JOINTING

5.1 General

The trench shall be checked for proper level, gradient and alignment before lowering the pipes. The contractor shall get the trench approved from Engineer-in Charge, before lowering the pipes.

In case of flanged pipes, it shall be checked that holes of two joining flanges are concentric.

Before laying, each pipe shall be inspected carefully. Broken or cracked pipes shall be rejected. The inside of the pipes shall be cleaned of all foreign materials.

5.2 Lowering

The C.I. pipes shall be lowered cautiously to prevent disturbance to the bed and sides of the trench. The heavy pipes shall be lowered by means of proper shear legs, chain pulley blocks or as directed by Engineer-in-Charge.

5.3 Laying

Laying of pipes shall proceed up grade of slope. In case of socket and spigot pipes, the pipes shall be laid with socket ends facing up stream. The spigot shall be pushed well home to the full depth of the socket. The collars shall be slipped on before the next pipe is laid. Pipes shall

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be carefully laid over the alignment, levels and gradient as shown in the drawings. The levels shall be checked with the help of sight rails and bonding rods and with the help of levelling instruments, as directed by Engineer-in-Charge.

No sand, earth or other matter shall enter the pipes during laying. The error of grade shall not be rectified by packing up earth underneath the pipe. If required, concrete M-10 shall be used for packing, at contractor's own cost.

The ends of the pipe shall be kept closed to keep dirt, mud and foreign materials out. Adequate provision shall be made to prevent floating of pipe in the event of flooding of trenches.

Contractor shall provide thrust blocks of concrete M-15 at all changes in direction or as shown in drawings.

5.4 Jointing

5.4.1 **C.I. Socket and Spigot Pipes (Socket & Spigot Joints)**
The socket and spigot shall be jointed with tyton or other similar make instantaneous jointing couplings. These couplings shall be used only on the manufacturer recommended brand of pipes.

5.4.2 **Double Flanged C.I. Pipes (Flanged Joints)**
Flanged joints shall be made by painting the facing of the flanges with red lead and bolting up evenly on all sides with packing of rubber insertion in between the two flanges. The packing shall be of full diameter with proper holes to suit the flange's bolt holes.

5.4.3 **Jointing Using Lead**
Pig lead, conforming to IS: 782 shall be used for joints.

The spigot shall be carefully centered in the socket and sufficient spun yarn shall be thoroughly caulked to leave a specified depth for lead caulking. The minimum depth of joint lead caulking shall be as per IS: 3114.

The depth left for joint shall be checked before running the lead, by passing a notched wooden gauge around the pipe, the notch being held close up against the face of the socket. After checking the alignment and levels of pipe, the space left for caulking in the socket shall be filled in by pouring molten lead as per directions of Engineer-in-Charge. The lead shall be rendered thoroughly fluid and each joint shall be caulked in three stages, with proper caulking tools of increasing thickness and a hammer of 2 kgs. weight, in such a manner as to make the joint sound and water tight.

The junctions of the piping with the manhole / valve pit / catch basin walls shall be grouted with 1:2 cement mortar, to the entire satisfaction of Engineer-in-Charge.

6.0 TESTING OF CAST IRON PIPING

6.1 General

6.1.1 Contractor shall carry out testing of all cast iron piping laid by him as a part of the quoted rates.

6.1.2 Test manifolds, connection piping and all other necessary appurtenances for testing shall be provided and installed by the contractor, at his own cost, at the time of test. Pumps, if required, for filling the pipe line with water for the test shall also be provided and installed by the contractor, at his own cost.

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6.2 Testing

6.2.1 **Pressure Piping**

C.I. double flanged and socket & spigot pressure piping shall be tested in suitable sections before back filling. After all lines are tested in sections, a final test shall be performed before commissioning the system. Test pressure shall be as indicated in drawings or specifications.

6.2.2 **Gravity Piping**

Gravity Cast Iron pipes shall be tested in sections, to a pressure of 1 kg/cm^2.

6.2.2.1 **Procedure**

End of the pipes shall be suitably blanked and the line pressurised to 1 kg/cm^2. After 1 hr. repressurizing upto .1 kg/cm^2 shall be done using measured quantity of water, which shall be less than or equal to ND/3.3 cm^3, where N is the number of joints in the piping and D is the diameter of the pipe in mm.

6.2.3 **Failure of Test**

In case of failure of test, contractor shall identify the reason for leakage and take action for redoing of joints, at his own cost.

The contractor shall remove the water from the piping and clean it after testing, at his own cost, without flooding the adjoining areas.

7.0 RESTORATION OF DAMAGED SURFACE AND CLEANING THE SITE

7.1 All pavements, structures, piping, cables, etc. removed, damaged or disturbed during the pipe laying work shall be restored to original condition.

7.2 Surplus excavated soil or rubbish material shall be removed to a place, as directed by the Engineer-in-Charge.

8.0 PAYMENT

8.1 Measurement of piping work for the purpose of payment shall be taken in running meters of the laid pipe measured along the centerline, inclusive of spigot and socket etc. No extra payment shall be made for providing and laying of fittings like bends, tees, etc. (except valves) that may be necessary for completion of work. The rate quoted shall be inclusive of excavation, lowering, laying, jointing, connecting the pipe to Inspection Chambers etc. and grouting to chamber walls, testing, cleaning of piping, backfilling and any other operation involved in the piping work.

8.2 The above payment clause 8.1 is not applicable in case of LSTK Jobs.

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STANDARD SPECIFICATION FOR UNDERGROUND SEWER SYSTEM (PRE CAST RCC PIPES)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	12.03.24	REVISED & ISSUED AS STD. SPEC.	PREETI	RKS	SKN	MAINAK NANDI
4	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI

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Abbreviations:

IS	:	Indian Standard
Litres/km/hr/cm	:	Liters/ Kilometer/ Hours/ Centimeter
RCC	:	Reinforced Cement Concrete
mm	:	millimeter
cm	:	centimeter

General Civil Standards Committee:

Convenor: Mr. Samir Kumar Naskar

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Mr. C. Damodaran
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Mr. Dinesh Deb Barma
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1.0 SCOPE

This specification covers the supply, laying, cutting, jointing and testing of Precast RCC pipes and related works.

2.0 CODES & STANDARDS

IS: 458 Pre Cast Concrete Pipes (with and without reinforcement- specification)

IS: 783 Code of practice for laying of Concrete Pipes

6-65-0006 Standard Specification for Earth Work for Under Ground Piping

NOTE:- Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

3.1 The pipes shall be centrifugal cast concrete pipes, socket and spigot type, with reinforcement conforming to IS: 458. The class of pipes shall be as specified on drawings. The pipes shall be accepted on the basis of Test Certificates from Manufacturers. Additional testing shall be done, if directed by Engineer-in Charge.

3.2 The surfaces and edges of the pipes shall be well defined and their ends shall be perpendicular to longitudinal axis

4.0 EARTHWORK

4.1 All earthwork involved in laying of RCC pipes and related works is deemed to have been included in the quoted rates for the laying of RCC pipes.

4.2 All earthwork shall be carried out as per specification No.6-65-0006 "Earthwork for underground piping ".

4.3 The bed of 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.

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 (fine murrum, if fine sand or soil is not available) and compacted, so as to provide smooth bedding for the pipe.

Where excavation requires blasting operations, it shall be ensured that no pipes are stacked in the vicinity and complete pipelines in the vicinity have already been covered before starting of blasting operation.

4.5 The trench shall be kept free from water. Shoring and strutting / timbering shall be done, wherever required. Excavation below water table shall be kept dry by dewatering the trenches, if required.

4.6 After 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 hollows shall be refilled with sand after jointing the pipe.

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5.0 LOWERING & LAYING

5.1 The pipes shall be lowered when the trench is ready and the bottom has been properly graded as per drawings.

5.2 Before lowering, the pipes shall be inspected carefully. Broken or cracked pipe shall be rejected. The inside of the pipe shall be cleaned off from sand, earth or any other matter.

5.3 The pipe shall be lowered carefully so as not to disturb the bed and sides of the trench. Heavy pipes shall be lowered with chain pulley blocks or crane.

5.4 Pipes shall be set according to line and grade. Prior to making joints, all surfaces shall be thoroughly cleaned and prepared as required, for the type of joint to be made. Pipe shall be carefully centered so that the complete sewer will have a smooth uniform invert.

5.5 In socket & spigot pipes, the socket end shall face the upstream direction.

5.6 Railway authorities or other appropriate authorities shall be consulted wherever the pipeline crosses a railway line, canal, etc.

5.7 Connection to existing sewer shall be done through a manhole.

5.8 The ends of the pipeline shall be kept sealed to prevent entry of any foreign materials. The seals shall be broken before / after the testing is done.

5.9 Wherever the joining material is cement, six or more lengths of pipe shall be laid in advance of each joint before it is finished.

5.10 In cases, where the natural foundation is inadequate, the pipes shall be laid either in concrete cradle supported on proper foundations or any other suitably designed structure. If concrete cradle bedding is used, the depth of concrete below the bottom of pipe shall be at least 1/4th of the internal diameter of the pipe subject to the min. of 100 mm and a maximum of 300 mm, the concrete shall extend by 150 mm on each side beyond the outside diameter of pipes. The pipes 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 as possible, up the haunches of the pipes, so 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 and around the curve of the pipe from an even bed. Necessary provision shall be made for joints, wherever required.

6.0 JOINTING

6.1 Joint in the pipeline shall be of socket and spigot type and conforming to relevant Indian standards.

6.2 As per IS: 458, only flexible rubber ring joints shall be used for the joints in (a) all pressure pipes and (b) all non- pressure pipes except when used for road culverts/ cross drains. The pipe joints shall be capable of withstanding the same pressure as the pipe. Contractor shall provide pipes of socket and spigot type, meeting the above requirements.

6.3 As per IS: 458, joints in pipes of diameter up to 700 mm, shall be external flush type joint and shall be internal flush type for pipes of diameter more than 700 mm.

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6.4 The groove in between the pipe ends is to be filled with jute, impregnated with bitumen and rolled in the form of gasket ring centrally around the pipe, to ensure uniform annular space between the collar and the pipe.

6.5 Cement mortar of proportion 1:2 shall be used for caulking the annular space. Care shall be taken to see that the bottom of the collar joint is also caulked properly.

6.6 The joint shall be finished at an angle of 45° and shall be kept wet for 10 days for curing.

7.0 TESTING

7.1 The pipeline shall be tested for water tightness of joints. The test shall be carried out from manhole. Pipe ends shall be closed and filled with water so that water level is up to the top of the manholes.

7.2 The line shall be kept full for 24 hours. Observations shall be taken at one hour interval and if leakage is within 2.5 liters/km/hr/cm of diameter of pipeline, it shall be deemed to have passed the test.

7.3 Engineer-in-Charge may at his own discretion, ask the contractor to test the laid pipe line in sections, in which case the contractor will do the same, as per the procedure to be decided by the Engineer-in-Charge, without any extra cost to Owner. The procedure adopted in such cases, however, will be to test the pipeline according to the criteria mentioned above.

7.4 In case joints are found to leak, they shall be repaired or redone and test shall be repeated until the joints are approved by Engineer-in-Charge.

The work shall have deemed to be rejected, in case any visual leakage observed from any of the joint. The contractor shall undertake repairing and testing of the joint without any extra cost to the owner.

7.5 After completion of the test, all temporary seals shall be removed, the test water shall be drained / pumped out and the line cleaned properly.

7.6 Before commissioning, the cleanliness of the pipeline shall be checked by following tests.

7.6.1 Torch & Mirror Test

In this method of testing, a torch will be held at one end of the pipeline inside a manhole and its image through the pipeline will be reflected and seen on a mirror held at the opposite end of the pipeline, inside the next manhole. Any obstruction / debris / major misalignment will not give a clear image, in which case the pipeline shall again be cleaned, rectified and the test redone.

7.6.2 Ring Test

In this method of testing, two steel / wooden rings of suitable thickness and design shall be fixed facing each other, at a distance of 2 feet or more. The block of rings shall be inserted from one end of the pipeline, inside manhole and pulled by a rope fixed to the block from the other end of the pipeline, inside the next manhole. The rings shall be of diameter 2"(inch) less than the inside diameter of pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by the contractor either during construction or afterwards by suitable means. Any obstruction/ debris/ major mis-alignment will prevent the ring to pass through the pipeline in which case the pipeline shall again be cleaned / rectified and the test redone.

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The ring test shall be performed for the complete network of the sewer system, before the same is put in commission.

8.0 RESTORATION OF DAMAGED SURFACES AND CLEARING THE SITE

8.1 All pavements, structures, pipelines, cables, etc. removed, damaged or disturbed during the pipe laying work shall be restored to original conditions.

8.2 Surplus excavated soil or rubbish material shall be removed to a place, as directed by Engineer-in-Charge.

9.0 PAYMENT

9.1 Measurement of pipeline work for the purpose of payment shall be taken in running metre of the laid pipe measured along centre line, inclusive of joints. The rate quoted shall be inclusive of excavation, lowering, laying, jointing, connecting the pipe to manholes and grouting the pipe to manhole wall, testing, cleaning of pipelines, backfilling, commissioning and any other operation involved in the pipeline work.

9.2 The payment clause(s) as described in this standard specification shall not be referred/ applicable for LSTK Jobs.

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भूमिगत सीवर प्रणाली के लिए

मानक विनिर्देश (एच.डी.पी.ई. पाइप)

STANDARD SPECIFICATION FOR UNDERGROUND SEWER SYSTEM (H.D.P.E. PIPES)

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
						Approved by
5	22.01.24	REVISED & ISSUED AS STD. SPEC	PREETI	RKS	SKN	MAINAK NANDI
4	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI
3	24.08.12	REVISED & ISSUED AS STD. SPEC.	JAY KUMAR	RC	RBB	DM

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Abbreviations:

ANSI	:	American National Standard Institute
BIS	:	Bureau of Indian Standards
cm^2	:	Square Centimeter
HDPE	:	High Density Polyethylene
IS	:	Indian Standards
mm	:	Millimeter
m	:	meter
Litres/km/hr/cm	:	Liters/ Kilometer/ Hours/ Centimeter
PTFE	:	Poly tetra flouro ethylene

General Civil Standards Committee:

Convenor: Mr. Samir Kumar Naskar

Members:
Mr. C. Damodaran
Mr. Amitabh Kishore
Mr. Dinesh Deb Barma
Mr. Gyasuddin
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1.0 SCOPE

This specification covers supplying, laying, cutting, jointing and testing of underground HDPE gravity pipelines and related works.

2.0 REFERENCES

2.1 Codes & Standards

IS 14333 : Polyethylene pipes for sewerage and industrial chemicals and effluent- Specification

IS: 7634 (Part 2) : Plastic pipes selection, handling, storage and installation for potable water supplies (Laying and jointing of polyethylene (PE) pipes)

2.2 Specifications

6-65-0006 : Standard Specification for earthwork for underground piping

NOTE: -Latest Edition of all Codes and Standards shall be followed.

3.0 MATERIALS

3.1 Pipes

All pipes shall strictly conform to the requirements of IS: 14333. The pipes shall be of minimum PN 2.5 pressure rating and of material grade PE 80. The pipes shall be supplied in suitable lengths convenient for handling, transportation and laying. Whenever possible it should be supplied in coils. The minimum internal diameter of the coil shall not be less than $18d_n$ (d_n= nominal outside diameter) of the pipe ensuring that buckling, kinking of the pipe is prevented. Manufacturer's name, trademark, pipe designation, lot number/ batch number containing date of manufacture and BIS certification marking shall be clearly stamped, on each pipe at intervals not more than 1.0m.

4.0 EARTHWORK IN EXCAVATION, BACKFILLING AND TRANSPORTATION

All earthwork involved in laying of H.D.P.E. pipes and related works is deemed to have been included in the quoted rates for the laying of H.D.P.E. Pipes.

All earthwork shall be carried out as per specification No. 6-65-0006 (Standard specification for earthwork for underground piping.)

5.0 LAYING AND JOINTING

5.1 Laying of HDPE Pipes Below Ground

The underground HDPE piping shall be laid, welded, aligned, flushed and tested as per the specifications given below, to the satisfaction of Engineer-in-Charge and also as per relevant clauses mentioned elsewhere:

(a) The contractor shall dig the pipeline trenches as per drawings, true to the line and gradient and as directed by Engineer-in-Charge.

(b) The contractor shall be responsible for correct layout and gradient of the pipe lines. Errors, if any, shall be rectified by the contractor at his own cost.

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5.2 The underground HDPE pipelines shall be buried in excavated trenches over a cushion of 200mm sand padding. No extra payment is admissible to the Contractor for excavation in trenches of required dimensions, sand padding under the pipe, compacting, backfilling after testing to the satisfaction of the Engineer-in-Charge and removal of surplus earth to a place designated by the Engineer-in-Charge within a limit of 0.5 km. All the above activities are deemed to have been included in the cost of pipe laying per meter length.

5.3 Contractor shall provide casing pipe of suitable sizes under the road as sleeves. The casing pipe will take care of vehicular traffic load. The contractor shall include the cost for taking in the pipe through the sleeve, cost of extra field joints and cost of providing jute or outer face hemp packing throughout the circumference of the outer face of HDPE pipe and inner face of the sleeve pipe in per meter cost of pipe laying. The specification of the packing material, shall be got approved from the Engineer-in-Charge in advance before the execution of the job.

5.4 Jointing

The pipes shall be butt jointed by heating the pipe using non- stick PTFE coated electrical heating plate (temperature range 200° C- 230° C) . Electrical power will be given to the contractor at the available locations on the site and power charges shall be as per General Conditions of the contract. The pipe end shall be butted accurately on hydraulic jack platform leaving the gap for insertion of hot plate and heated till a uniform rim of melted material is formed. Immediately the hydraulic jack shall be released and the pipe ends butted together such that a good butt joint shall be formed in between the pipes. Manufacturer's recommendations shall be strictly followed for jointing of pipes. Jointing shall be carried out by skilled fitters with past experience in doing such type of jobs. Care shall be taken that there is no displacement of the centre line of the pipe.

5.5 Maximum number of jointing shall be done on ground to minimise number of field joints to be made inside the trench. Jointed pipe on the ground in suitable lengths shall be lowered inside the trench, supporting it very carefully, without inducing any secondary stresses on the pipe and laid true to alignment and elevations as shown in the working drawings and as directed by Engineer-in-Charge.

6.0 BEDDING AND SIDE FILLING

6.1 After laying of the pipe on 200mm sand bed and testing to the satisfaction of Engineer-in-Charge, additional material free from all Kankars, clods, or any other foreign material which may damage the HDPE pipe should be placed around the pipe and compacted in 75mm layers up to a level of at least 100mm above the top of pipe.

7.0 TESTING

7.1 The pipeline shall be tested for water tightness of joints. The test shall be carried out from manhole to manhole. Pipe ends shall be closed and filled with water so that water level is upto the top of the manholes.

7.2 The line shall be kept full for 24 hours. Observations shall be taken after one hour interval and if leakage is within 2.5 litres/km/hr/cm of dia. of pipelines, it shall be deemed to have passed the test.

7.3 Engineer-in-Charge may at his own discretion ask the contractor to test the laid pipe line in section, in which case the contractor will do the same as per the procedure to be decided by the Engineer-in-Charge without any extra cost to owner. The procedure adopted in such cases, however, will be to test the pipeline according to the criteria mentioned in 7.2 above.

7.4 In case joints are found to leak, they shall be repaired or redone and test shall be repeated until the joints are approved by Engineer-in-Charge.

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7.5 After completion of the test all temporary seals will be removed the test water shall be drained out/pumped out and the line cleaned properly.

7.6 Before commissioning the cleanliness of the pipeline will be checked by:

7.6.1 **Torch & Mirror Test**

In this method of testing, a torch will be held at one end of the pipeline inside the manhole and its image through the pipeline will be reflected and seen on a mirror held at the opposite end of the pipeline, inside the next manhole. Any obstruction/debris/major misalignment will not give a clear image in which case the pipeline will again be cleaned/ rectified and the test re-done.

7.6.2 **Ring Test**

In this method of testing two steel/wooden rings of suitable thickness and design shall be fixed facing each other at a distance of 600mm or more. The block of rings shall be inserted from one end of the pipeline inside manhole and pulled by a rope fixed to the block from the other end of the pipeline inside the next manhole. The rings shall be of dia 2"(inches) less than the inside dia of pipe under testing. The rope used for pulling the ring block may be inserted in the pipeline by the contractor either during construction or afterwards by suitable means. Any obstruction debris major misalignment will prevent the ring to pass through the pipeline in which case the pipeline will again be cleaned/ rectified and the test redone. The ring test shall be performed for the complete net work of the pipe system before the same is put in commission.

8.0 RESTORATION OF DAMAGED SURFACES AND CLEARING THE SITE

8.1 All pavements, structures, pipelines, cables, etc. removed, damaged or disturbed during the pipe laying work shall be restored to original conditions.

8.2 Surplus excavated soil or rubbish material shall be removed to a place as directed by the Engineer-in-Charge.

9.0 PAYMENT

9.1 Laying of Pipes

The payment shall be made on running meter basis of the actual job executed. Pipeline shall be measured along the centreline. The rate quoted shall be inclusive of excavation, sand bedding, lowering, laying, jointing, testing, cleaning of pipelines, back filling, removal of surplus earth to a place designated by the Engineer- in- Charge within a limit of 0.5 Km and any other work(s) involved in the pipeline work.

9.2 The payment clause 9.1 is not applicable in case of LSTK Jobs.

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मानक विनिर्देश

STANDARD SPECIFICATION

FOR

RANDOM RUBBLE PITCHING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
5	01.10.24	REAFFIRMED & ISSUED AS STD. SPEC.	SAH	DOB	SKN	MN
4	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RS	R K TRIVEDI
3	27.09.13	REVISED AND ISSUED AS STD. SPEC.	RB	RKS	RBB	DM

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Abbreviations:

IS	Indian Standard
mm	Millimeter

General Civil Standards Committee:

Convenor: Mr. Samir Kumar Naskar

Members:
Mr. Amitabh Kishore
Mr. Dinesh Debbarma
Mr. Gyasuddin
Mr. Raj Kumar Singh
Mr. U.C. Pathak (Piping)
Mr. Charanjit Singh (Projects)
Mr. Indrajit Neog (Construction)
Mr. Vikram Kumar Gupta (Structural)

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1.0 SCOPE

This specification covers the general requirements for random rubble pitching for road side slopes, storm water ditches, embankment slopes, reservoirs, holding pool etc.

2.0 CODES & STANDARDS

IS: 1542	Specification for Sand for Plaster
IS: 2116	Specification for Sand for Masonry Mortars
IS: 8112	Specification for 43 Grade Ordinary Portland Cement
NOTE: -	Latest edition of all Codes and Standards shall be followed.

3.0 REFERENCE OF EIL SPECIFICATIONS / STANDARDS

Following standard specification shall be enclosed as part of the job specifications.

Technical Specifications – Civil and Structural Works - Materials	6-68-0002
Technical Specifications - Civil & Structural Works - Stone Masonry	6-68-0010

4.0 MATERIALS

Refer specification No. 6-68-0002

5.0 CONSTRUCTION DETAIL

4.1 Dressing

Stone shall be hammer-dressed on the face and sides. The 'Bushing' (Projections) on the face shall not project more than 40 mm on an exposed face and 15 mm on the face to be plastered.

4.2 Thickness of Random Rubble Stone Pitching

The thickness of Random Rubble Stone pitching shall be 225 mm (minimum) or as specified in job drawing.

4.3 Mortar

Cement Mortar 1:6 shall be used for jointing and 1:4 for pointing.

4.4 Preparation of Sub Grade

The sub grade shall be prepared, dressed and rolled true to level and according to required levels and cross sections to form a firm compacted bed for the pitching.

If at any point, material of prepared sub grade has been excavated beyond the required levels of pitching, the excess excavation shall be filled with material compatible with sub grade material and thoroughly compacted.

The sub grade shall then be uniformly soaked with water without making it slushy to ensure that water penetrates to a depth to about 300 mm in sandy soil and about 150 mm in other soils.

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4.5 Laying

The stones used shall be available from the excavated rock or quarry. The surface to be stone pitched shall be properly dressed and rammed prior to commencement of the work and the approval of the Engineer-in-Charge shall be obtained. Stone used shall be wetted before use. The surface shall be properly watered before placing the stone. The stone shall be carefully laid and hammered down with a wooden mallet in position. The bond shall be obtained by fitting in closely the adjacent stones and properly applying the cement mortar to the joint. The slopes for pitching as shown in the drawing shall be maintained. The required uniform thickness perpendicular to the sloped surface shall be maintained and this can be controlled by stretching thread between pre-measured markers installed over sub-grade at regular intervals.

4.6 Joints

Stones shall be so laid that all joints are full of mortar. Face joints shall not be more than 25 mm wide; joints shall be struck flush and finished at the time of laying. Joints shall be raked to a depth of 20 mm during construction, in case of plastering or pointing.

4.7 Flush Pointing

Joints in the stone pitching shall be raked out at least 20 mm deep during construction. The joints shall be brushed clean of dust with a wire brush and wetted thoroughly for 6 hours before pointing is commenced. The raked joints shall be filled with cement mortar of specified grade and shall be well pressed in the face of pitching or wall and rubbed smooth. After pressing the mortar to the joints, a neat cement wash shall be given to the mortar area only and finished smooth. The finished work shall give a clean, well worked look without blotches or runs or mortar on stone surface.

4.8 Curing

Green work shall be protected from rain by suitable covering. Stone Pitching work shall be kept constantly moist for a minimum period of 10 days.

5.0 PAYMENT

5.1 Rubble pitching shall be measured in square meter basis of the finished surface. The rate shall include cost of stone, royalties, breaking and dressing the stones to required size, transportation to place of site or place of work, dressing the surface to required slope and shape, tamping, laying in cement mortar, flush pointing etc. and all the operations mentioned above.

5.2 The payment clause 5.1 is not applicable in case of LSTK Jobs.

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STANDARD SPECIFICATION FOR PLUMBING AND BUILDING DRAINAGE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
4	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI
3	23.08.12	REVISED & ISSUED AS STD. SPEC	JAY KUMAR	RC	RBB	DM

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Abbreviations:

CI	Cast Iron
CM	Cement Mortar
CP	Chrome Plated
G.I.	Galvanised Iron
HCI	Heavy Cast Iron
IS	Indian Standard
Kg/sq.cm	Kilogram / Square Centimeter
LSTK	Lump Sum Trunkey
M.S.	Mild Steel
mm	Millimeter
P.C.C.	Plain Cement Concrete
Psi	Pound Per Square Inch
R.C.C.	Reinforced Cement Concrete

Structural Standards Committee:

Convenor: Mr. Rajanji Srivastava

Members:
Mr. Anurag Sinha
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

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1.0 SCOPE

1.1 This specification is intended to establish and define the materials and constructional requirements for plumbing & building drainage work.

1.2 All materials, fixtures and workmanship shall be in accordance with the relevant Indian Standard, Specifications and Codes of practices.

2.0 CODES & STANDARDS

IS: 269	Ordinary Portland cement, 33 grade
IS: 554	Dimensions for pipe threads where pressure-tight joints are made on threads
IS: 651	Salt-glazed stoneware pipes and fittings
IS: 778	Copper alloy gate, globe and check valves for water works purposes
IS: 782	Caulking lead
IS: 1239	Mild steel tubes, tubulars and other wrought steel fittings
IS: 1726	Cast iron manholes covers and frames
IS: 1729	Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
IS: 1742	Code of practice for Building drainage
IS: 2065	Code of practice for water supply in Buildings
IS: 2470	Code of practice for installation of septic tanks
IS: 3486	Cast iron spigot and socket drain pipes
IS: 3950	Surface boxes for sluice valves
IS: 3989	Centrifugally cast (spun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories
IS: 5455	Cast iron steps for manholes

NOTE: - Latest Edition of all Codes and Standards shall be followed.

3.0 H.C.I. NAHNI TRAP (FLOOR TRAP)

Nahni trap shall be of heavy cast iron as per IS: 3989 with 100mm inlet and 80/ 100mm outlet with CP pressed steel grating. It shall be of self-cleaning design. Grating shall be of either hinged or screwed down type.

It shall be fixed in cement mortar 1:2, as directed by Engineer-in-Charge.

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4.0 STONEWARE GULLY TRAP CHAMBER

The square mouth gully trap shall be of 100mm dia, conforming to IS: 651, of specified and/ or approved quality stoneware, complete with cast iron grating, and shall be got approved from Engineer-in-Charge. The size of CI frame and cover shall be of 300 x 300mm. It shall be properly fixed, as directed by the Engineer-in-Charge.

The size of the chamber shall be 300 x 300 x 675mm (internal). It shall be constructed of brick masonry walls, 125mm thick, in 1:4 cement mortar and M-20 concrete foundations. Inside & outside faces of the masonry walls shall be plastered with 1:3 cement mortar. The top of the chamber shall be provided with CI cover and frame.

5.0 VALVE CHAMBER, INSPECTION CHAMBER & MANHOLES

The size and type of construction of valve chamber, inspection chamber and manholes shall be as specified in the drawings or items.

6.0 C.I. SOIL / WASTE PIPES

CI pipes shall be socket and spigot of standard quality conforming to IS: 1729. The supply shall include all necessary accessories e.g. bends, Y- Junction, T- Junction, including plugs, shoes, cowls etc. complete.

CI soil / waste pipe below ground or floor shall be encased with 50mm thick PCC M20 Grade concrete.

The spigot of the pipe shall be placed fully resting inside the socket and hemp caulked home to leave space for lead depth as specified. Lead conforming to IS: 782 in molten state shall then be poured into the joint filling the same in one pouring. The lead shall be caulked by proper tools to make it even all round. Depths of lead in the joints from the top of the socket shall be 37mm for 150mm dia pipes, 25mm for 100 mm and 50mm dia pipes. All pipes shall be fixed 25mm clear of the wall with MS bat clamps or as approved by the Engineer – in Charge. All holes in walls and floors shall be made good by cement concrete M-15 grade and should be leak proof. All soil and waste pipes shall be tested for leakage by hydraulic test.

All CI pipes shall be painted with two coats of paint of approve make and shade over a coat of primer. Earthwork in excavation, backfilling and removal of surplus earth/ debris shall be considered as a part of the work. No separate payment shall be made for the same..

7.0 C.I. SOIL / WASTE VENT PIPES

CI pipes shall be standard quality conforming to IS: 1729. The supply shall include all necessary accessories e.g. bends, Y- Junction, T- Junction, including plugs, shoes, cowls etc. complete.

Jute yarn gasket of suitable diameter shall be used as required to support the spigot of the pipe at the proper grade and make truly concentric joints. Single piece of sufficient length shall be used to pass around the pipe and lap at the top and shall be thoroughly saturated in bitumen. This gasket shall be laid in the socket for lower third of the circumference of the joint and covered with cement mortar. The spigot of the pipe thoroughly cleaned with wet brush, inserted and carefully driven home after which a small amount of cement mortar (1:2) shall be inserted in the annular space around the entire circumference of pipe and solidly rammed into the joint with caulking tool. The joint shall then be completely filled with mortar and beveled off at angle of 45^0 with outside of the pipe. Cement used to join shall conform to IS: 269.

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All holes in walls and floors shall be made good by cement concrete M-15 grade. All soil and waste pipes shall be tested for leakage by hydraulic test.

All CI pipes shall be painted with two coats of anticorrosive bituminous paint externally.

8.0 GI PIPES AND FITTINGS

All G.I. pipes and fittings shall conform to IS: 1239 and shall be of heavy grade for water supply system.

All screwed tubes and sockets shall have pipe threads in accordance with the requirements specified in IS: 554. Unless specified otherwise, pipes shall be supplied screwed with taper threads and sockets with parallel thread.

All fittings shall be malleable galvanised iron, approved by the Engineer-in-Charge. Fittings in G.I. line shall include all couplings, elbows, tees, bends, unions, nipples, reducers, flanges with nuts, bolts and rubber insertions, bushes and all other fittings to make a complete job.

Screwed G.I. pipes shall be jointed with screwed socket joints using screwed fittings. Care shall be taken to remove any burr from the end of the pipes after threading. White lead with a few strands of fine hemp shall be applied while tightening. Compounds containing red lead shall not be used.

All pipes above ground shall be fixed with G.I. holder bat clamps, clear off the wall, at 1.2 m centre to center. If the pipes are encased or embedded in wall, they shall be secured in position by iron hooks at 1.2 m centre to center. All visible pipes and clamps within and outside building shall be painted with two coats of white paint or aluminium paint as directed by the Engineer-in-Charge. No extra payment shall be made for clamps, hooks, cutting holes in walls, chasing and making good the same.

All underground pipes shall have a minimum earth cover of 600mm or as directed by the Engineer-in-Charge. No extra payment shall be made for excavation in trenches, backfilling the same and removal of surplus earth. Before any pipes are painted or covered up, they shall be tested to a test pressure equal to one and a half times the working pressure, as per job requirement (Minimum test pressure shall be $6Kg/Cm^2$ g) and the test pressure shall be maintained without loss for at least 30 minutes. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment.

9.0 GUN METAL VALVE

All full way and globe valves shall be of heavy gunmetal and tested at 300 psi and shall be approved by the Engineer-in-Charge. Valves shall conform to IS: 778. Size of valve chamber shall be as per item description. Construction of valve chamber shall be carried out as per clause 5.0 above. Valve chamber shall be provided & fixed with heavy duty C.I. surface box conforming to IS: 3950. The surface box shall be hinged pin open type & shall be fixed in the chamber slab. It shall have a hole for opening.

10.0 M.S. RUNGS/ C.I. STEPS

The rungs for pits, manholes and septic tanks etc. shall be made out of M.S. bars conforming to Indian Standard and to the shape and size as shown in drawings.

CI steps for manholes, if needed shall be as per IS: 5455

M.S. rungs shall be coated with 2 coats of approved bituminous paint.

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11.0 SOAK PITS

All earthwork in excavation, brick work etc. shall conform to relevant I.S. standard.
The brickbats should preferably be slightly over burnt or thoroughly well burnt, deep red in colour with some proportion of deep blue or black veins. Spongy or vitrified material, as a result of excessive over burning, is useless and shall be rejected. Brickbats bigger than specified size shall be reduced to required size (40 to 50mm) before filling in soak pit and no extra payment shall be made for this. It shall be stacked at site as directed by Engineer-in-Charge. Soak pit & septic tank shall be connected with required piping.

12.0 SEPTIC TANK

Septic tanks shall be provided as per drawings and directions of Engineer-in-Charge. The sizes shall vary depending on the no. of users.

Alternatively, ready made RCC pipe septic tank, consisting of sewage receiving chamber, inspection door, vent pipe, inlet & outlet connections, manhole cover, C.I. steps etc. shall be used.

Design, testing & commissioning shall conform to IS: 2470 Part-I.

Access opening shall be provided for desludging & inspection.

The ventilating pipe shall be provided with pipe of at least 50mm dia extended 2 meters above the nearest working platform level.

In case where water table is shallow and soak pits are not recommended, upflow filters, as per drawings shall be provided.

13.0 PAYMENT

13.1 H.C.I. Nahni Trap (Floor Trap)

Payment shall be made per number basis. The rate shall include supplying and fixing Nahni trap, including cement mortar, cutting walls and floors and making good the same, providing and fixing chromium plated pressed steel grating etc. all complete.

13.2 Stoneware Gully Trap Chamber

Payment shall be made on per number basis. The rate shall include supplying and fixing of stoneware gully trap, CI grating, construction of masonry chamber, providing and fixing CI frame and cover, earthwork in excavation, foundation concrete, backfilling and removal of surplus earth up to a lead of 30m and labour and material etc. all complete.

13.3 Valve Chamber, Inspection Chamber & Manholes

Payment shall be made as per number basis including excavation, backfilling, removal of earth, construction of the valve chamber, inspection chamber and manhole, making connections of pipes through the walls including grouting, cost of M.S. rungs, cover slab, cost of CI cover and frame etc. as per specifications and directions of the Engineer-in-Charge.

The rate shall include breaking concrete or brick masonry work and making good the same with 1:4 cement mortar if necessary, finishing, painting, etc. as per directions of Engineer-in-Charge.

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13.4 C.I. Soil / Waste Pipes

The payment shall be on running meter basis of pipes laid with fittings as required on site. The rate shall include supplying and fixing of pipes and necessary specials including cowl with hemp and lead, jointing & testing, bat clamps, fixtures, painting, cutting of walls, floor and making good the same and necessary scaffolding, encasing of pipes below ground or floor with 50mm thick PCC M20 concrete earth work in excavation, backfilling & removal of surplus earth etc. complete.

13.5 C.I. Soil / Waste Vent Pipes

The payment shall be on running meter basis of pipes laid. The rate shall include supplying and fixing pipes, jute gaskets dipped into bitumen and cement mortar and necessary specials including jointing with clamps, painting, cutting of walls, floor and making good the same, necessary scaffolding etc. complete.

13.6 GI Pipes and Fittings

Payment shall be made on running meter basis of actual pipeline laid. In addition to the sectional testing of water supply piping, the contractor shall test entire installation on completion of the job, to the entire satisfaction of the Engineer-in-Charge. No extra payment shall be made for testing. The contractor shall make his own arrangement for supply of water for testing, at his own cost. The rate for this item shall include supply and laying of G.I. pipes with necessary fittings, cutting of pipes to required lengths, threading, making holes in walls and floors and making good the same, jointing, painting, excavation and refilling including testing as directed by the Engineer-in-Charge.

13.7 Gun Metal Valve

The payment shall be made per number basis, including surface box. The rate shall include, supplying and fixing valve & surface box in position, as per drawings and directions of Engineer-in-Charge.

13.8 M.S. Rungs/ C.I. Steps

Payment for rungs shall be made on per number basis and the rate shall include supply, fixing, finishing the walls, painting etc. all complete.

13.9 Soak Pits

Payment of soak pit/ up flow filter shall be made per number basis. Rate quoted shall include brick masonry work, providing & filling brick bats, earthwork in excavation, backfilling, making inlet connection with pipe and connecting the same to septic tank etc. complete as shown in drawing.

13.10 Septic Tank

Payment of septic tank shall be made per number basis & rate shall include all accessories like inlet, outlet, vent pipe, manhole cover & C.I. steps, earthwork in excavation & backfilling, removal of surplus earth etc. all complete.

13.11 The above payment clauses are not applicable in case of LSTK Jobs

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के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR

ACID RESISTING BRICK / TILE LINING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	16.08.21	REVISED & ISSUED AS STD. SPEC.	ADP	GYAS	ANURAG SINHA	SANJAY MAZUMDAR
5	06.07.18	REAFFIRMED & ISSUED AS STD. SPEC.	LP	VG	RAJANJI SRIVASTAVA	R K TRIVEDI
4	27.09.13	REVISED AND ISSUED AS STD. SPEC.	RB	RKS	RBB	DM

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Abbreviations:

ASTM	:	American Society for Testing and Materials
BIS	:	Bureau of Indian Standards
IS	:	Indian Standard
LSTK	:	Lump Sum Trunkey
mm	:	Millimeter

Structural Standards Committee:

Convenor: Mr. Anurag Sinha

Members:
Mr. C. Damodaran
Mr. VK Panwar
Mr. Samir Das
Mr. Amitabh Kishore
Mr. Gyasuddin
Mr. Charanjeet Singh (Projects)
Mr. Ravindra Kumar (Construction)

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1.0 SCOPE

This specification covers the requirement of material and laying of Acid Resisting Brick/ tile lining for flooring on acid storage areas.

2.0 REFERENCES

2.1 Codes & Standards

IS 4457 Specification for ceramic unglazed vitreous acid resisting tile.
IS 4832 (Part-I) Chemical resistant mortar silicate type
IS 4832 (Part-II) Chemical resistant mortar Resin type
IS 4860 Acid resistant bricks
IS 9510 Specification for Bitumen Mastic, Acid resistant grade.

2.2 Specifications

ASTM D41-94 Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and waterproofing

Note: - Latest Edition of IS / codes and standards shall be followed

3.0 MATERIAL

3.1 Acid Resisting Bricks / Tiles

The Bricks shall conform to IS: 4860 – Class I quality. All bricks shall be dense, homogeneous and manufactured out of special raw material which shall have low lime, flint, sand and iron contents. These shall be specially fired and vitrified at high temperature to have qualities of low absorption. The size of the bricks shall normally be 230mm x 114mm x 64 mm or as per IS 4860. Ceramic unglazed Acid resisting tiles shall confirm to IS 4457. The size of Acid resisting tile shall be as per IS: 4457 or as defined in SOR.

3.2 Chemical Resistant Mortar

3.2.1 Silicate Mortar

It shall consist of selected potassium silicate solution and inert filter powder. Both mixed well to enable to set at ambient temperature. The mortar shall conform to IS 4832 (Part – I). The mixing proportion and other instructions for use shall be as specified standard manufacturers. Silicate mortar from standard manufacturers only shall be used. Contractor shall obtain approval from Engineer – in – charge prior to order and supply of the material. This type of Mortar is resistant to most acids except hydro-fluoric acid and concentrated ortho-phosphoric acid; they are not resistant to alkalies of any concentration or to boiling water or stream.

3.2.2 Resin Mortar

The furane and phenolic mortar for jointing consist of inert powder synthetic resin syrup. No water shall be used during mixing. This mortar shall conform to IS 4832 (Part – II). The mixing proportion and other instructions shall be as specified by standard manufacturers. Resin mortar from standard manufacturers only shall be used. Contractor shall obtain approval from Engineer – in – charge prior to order and supply of the material. This type of Mortar has a good resistance to non-oxidising mineral acids, and poor resistance to oxidising mineral acids. They are fairly resistant to inorganic alkalies and water.

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3.3 Bitumen Primer

A bitumen primer is an asphalt based material thinned with petroleum solvent (conforming to ASTM D-41) should be applied over the surface. Primers from standard manufacturers only shall be used.

3.4 Bitumen Mastic

The bitumen mastic shall consist of a mixture of asphalt cement mineral filler, and mineral aggregate, which are acid alkali resistant. The composition, preparation and properties of the bitumen mastic shall be as per IS 9510 for resisting acid. The bitumen mastic shall be insoluble in Benzol and the matter soluble in diluted hydrochloric acid should not be more than five percent. "Prodorphalte" by Coromandal Prodorite or equivalent may be used.

4.0 LAYING

4.1 Surface Preparation

a) All damaged or questionable areas should be chipped out and replaced.
b) Adequate floor slope for good drainage is important.
c) Low spot should be avoided because finished floor will follow contour or sub floor.
d) Concrete should be dry, clean and well cured before application of membrane is started.

4.2 Primer Application

A bitumen primer should be applied over the prepared surface. It should be allowed to dry before applying the membrane material.

4.3 Membrane Application

Bitumen mastic is used to build up the membrane. It is heated to 120-205° C and applied to the primed surfaces. Multiple coat application should be made to thickness requirements. The thickness of the mastic layer shall be to suit the acid concentration and expected load or as specified by the Engineer-in-charge. Each coat should be inspected for blisters and pinholes. If present, they should be broken and before applying subsequent coats. Bitumen mastic should not be used as the membrane material where solvents are involved.

4.4 Reinforcement Application

Bitumen coated glass cloth can be used for membrane reinforcements at the corners, edges, walls, etc. depending on the requirements.

4.5 Application of Mortar and Bricks/Tile

There are two ways of lining Acid resisting linings:

4.5.1 When Bedding and Jointing Material are the same

A thin layer of about 3mm suitable resinous mortar is spread on the back of the acid resisting tiles and the tiles are pressed down on the bed. Suitable joint thickness of about 3mm should be maintained. Jointing is done with suitable resin mortar.

4.5.2 When Bedding and jointing material are different

A thin layer of about 6mm suitable silicate type mortar is spread on the back of the acid resisting tiles and the tiles are pressed down on the bed. Proper joint thickness of about 3mm

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should be maintained and filled up with suitable resin type mortar. In case of pointing the joint thickness should be 6mm and depth of the pointing should be 19mm.

In this case, joints with silicate mortar should be acid cured with 20 to 25 percent hydrochloric acid or with 30 to 40 percent sulphuric acid before applying the resin type mortar. After acid curing, the free acid in the joints shall be cleaned with water and sufficient time should be allowed should be allowed for thorough drying. After curing resin mortar is used for filling up the joints.

5.0 GUARANTEE

The Vendor shall give material and performance guarantee for a period of minimum one year from the date of commissioning of the plant.

6.0 PAYMENT

6.1 Payment shall be on square meter basis of area covered.

6.2 The payment clause 6.1 is not applicable for LSTK Jobs.

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अर्थिंग डालने के लिए विनिर्देश

SPECIFICATION FOR EARTHING INSTALLATION

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convenor	Approved by: Standards Bureau Chairman
5	26 02 19	REVISED AND ISSUED AS SPECIFICATION	DC	RS	BRB	RKT
4	26 03 14	REVISED AND ISSUED AS SPECIFICATION	FA	SA	BRB	SC
3	25 04 08	REVISED AND ISSUED AS SPECIFICATION	RKS	SSM	JMS	VC
2	28 02 03	REVISED & ISSUED AS SPECIFICATION	HKM	RSG	VPS	SKG
1	16 07 97	REVISED & ISSUED AS STANDARD SPECIFICATION	RR	VPS	SG	AS

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Abbreviations:

BIS	:	Bureau of Indian Standards
CD	:	Compact Disc
CEA	:	Central Electricity Authority
DGMS	:	Director General Mines and Safety
GI	:	Galvanized Iron
IEC	:	International Electrotechnical Commission
IS	:	Indian Standard
MS	:	Mild Steel
OISD	:	Oil Industry Safety Directorate
PESO	:	Petroleum and Explosive safety organization.
UPS	:	Uninterrupted Power Supply

Electrical Standards Committee

Convenor: Mr. BR Bhogal

Members: Ms. S. Anand
Mr. Parag Gupta
Mr. M.K. Sahu
Mr. Saeed Akhtar (Inspection)
Ms. N.P. Guha (Projects)
Ms. NS Bhattacharya

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