3rd layer	40 mm thick machine sprayed Polyurethane Foam insulation
4th layer	Minimum 0.8 mm DFT (Dry Film Thickness) single component Polyurethane (PU) water proofing coating – top coat
5th layer	Geo-textile membrane
6th layer	PCC top protective finishing layer

6.1 Materials

6.1.1 Primer

Primer shall be polyurethane primer compatible to sprayed Polyurethane Foam insulation or single component Polyurethane water proofing coating as applicable (which shall be applied over the primer) and shall be as per approved Manufacturer/ system provider's standard specification and as approved by Engineer-In-Charge.

6.1.2 Polyurethane (PU) water proofing coating

Polyurethane water proofing coating/ membrane shall be single component (moisture cured, elastomeric, free from bitumen and tar) viscous liquid containing urethane polymers having following properties:

Property	Value	Testing Method
Solid content	Minimum 85%	ASTM C 836
Elongation	Minimum 400%	ASTM D 412
Tensile Strength	2-3 MPa	ASTM D 412

6.1.3 Sprayed Polyurethane Foam insulation

Polyurethane Foam insulation shall be CFC (Chlorofluorocarbons) and HCFC (hydro chlorofluorocarbon) free with closed cell structure having following properties. (Reference: Properties for type-1 foam as mentioned in Table-1 of ASTM D 7425.)

Property	Value	Testing Method
Thermal resistance of 25mm thickness	Minimum 0.98 K-sqM/W at mean temperature 24 degree C	ASTM C177, C1363 or C 518
Compressive strength	Minimum 276 KPa at yield or 10% deformation	ASTM C165 or ASTM D 1621
Density	Minimum 40 Kg/CuM	ASTM D 1622
Water absorption	Maximum volume % 5	ASTM D 2842
Tensile Strength	Minimum 276 KPa	ASTM D 1623
Closed cell content	Minimum 90%	ASTM D 6226

6.1.4 Geo-textile membrane

Geo textile membrane shall be of 150 GSM (grams per square meter) as per approved Manufacture/ system provider's specification and as approved by Engineer-In-Charge.

6.1.5 Top protective finishing layer

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Top protective layer shall be of PCC (plain cement concrete – 1 cement: 2 coarse sand: 4 aggregate) with 24 SWG chicken wire mesh. Thickness of the layer shall be minimum 50 mm thick

6.2 Workmanship

6.2.1 Base Surface Preparation

a. The entire base surface of the roof/ terrace shall be thoroughly cleaned with wire brush or mechanically and all foreign matter including loose concrete etc. shall be removed.

b. Well defined cracks on the surface shall be cut to "V" section, cleaned and filled up with polymerised mastic or a paste of liquid single component elastomeric waterproofing and fine sand mix or with Polysulphide Sealant.

c. Potholes or depressions shall be filled up after removing weak cement concrete or cement plaster etc. with PCC (1 cement :1.2 coarse sand :3.5 stone aggregate of 6mm & down size by volume,) laid over a coat of neat cement slurry @2.75 Kg of cement per Sq.M of area, to achieve a smooth prepared surface.

d. The finished surface shall be perfectly dry and any dampness should be allowed to evaporate.

6.2.2 Primer coat

Polyurethane primer shall be brush applied @ 6-8 square meter area/ Litre over the entire prepared roof surface.

6.2.3 Polyurethane (PU) water proofing base coating (1.5 mm DFT)

a. Polyurethane water proofing coating of specified thickness shall be spray or brush applied as directed by Engineer-In-Charge in minimum two layers over primer. If thickness is not mentioned specifically, thickness shall be minimum 1.5 mm DFT (dry film thickness) with coverage @ 2.5 kg/sq.mtr.

b. Scrim cloth reinforcement shall be provided in between the layers. Scrim cloth reinforcement shall also be provided in places where there is a change in surface profile. eg. junction of horizontal and vertical surface of wall, pedestal etc and also near openings for rainwater pipe etc. Scrim cloth to be placed for a distance of 150 mm on either side of junction. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

c. The coating shall be properly cured.

d. After the waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 metre x 2 metre and water ponding for minimum 72

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hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

6.2.4 Polyurethane Foam Insulation

Polyurethane Foam insulation shall be spray applied conforming to relevant international standard over the primer coat in layers with compatible spraying machine to form a seamless, crack free and monolithic insulation layer. Public movement shall be restricted over the insulation layer.

6.2.5 Polyurethane (PU) water proofing base coating (0.8 mm DFT)

a. Polyurethane water proofing coating of specified thickness shall be spray or brush applied as directed by Engineer-In-Charge in minimum two layers over primer. If thickness is not mentioned specifically, thickness shall be minimum 0.8 mm DFT (dry film thickness) with coverage @ 1.5 kg/sq.mtr.

b. Scrim cloth reinforcement shall be provided in between the layers. Scrim cloth reinforcement shall also be provided in places where there is a change in surface profile. eg. junction of horizontal and vertical surface of wall, pedestal etc and also near openings for rainwater pipe etc. Scrim cloth to be placed for a distance of 150 mm on either side of junction. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

c. The coating shall be properly cured.

6.2.6 Geo-textile membrane

Geo-textile membrane shall be provided over the cured Polyurethane water proofing coating as a separation layer for subsequent PCC layer after emptying the water used for ponding test for leakage.

6.2.7 Top protective finishing layer

a. Geo textile member shall be provided over the cured PU coating as a separation layer for subsequent PCC layer after emptying the water used for ponding test for leakage.

b. The top protective finishing layer of PCC (minimum 50 mm thick) with chicken wire mesh shall be laid over Geo textile member. The finished surface shall be in desired slope.

c. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces.

d. PCC shall be laid in panels of maximum 1200 x 1200 mm size.

e. The PCC layer and the angular fillet/ coving shall be cured in accordance with regular concrete curing practices.

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f. The joints between panels shall be raked out neatly (after stipulated curing period) to a minimum 10mm X 10mm V groove and shall be filled up approved quality polyurethane sealant.

g. Khura (minimum size 450 mm x 450 mm) shall be provided at every rain water outlets.

6.2.8 Waterproofing treatment over parapets/ vertical surfaces

Waterproofing treatment over Parapets/ Vertical surfaces shall comprise of Polyurethane water proofing coating (refer clause 6.1.2) over primer coat (refer clause 6.1.1) finished with cement plaster. Sand shall be sprinkled over the Polyurethane water proofing coating when still in tacky state, to form key for holding cement plaster finishing on polyurethane waterproofing coating.

a. Entire surface shall be prepared in accordance with clause 6.2.1.

b. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces. The angular fillet/ coving shall be cured by means of regular wetting.

c. Polyurethane Primer coat shall be applied over the prepared surface in accordance with clause 6.2.2.

d. The Polyurethane water proofing coating (minimum 1.5mm DFT -Dry Film Thickness) applied on roof shall be continued over parapet/ vertical surface over the primer coat.

e. The Polyurethane water proofing coating shall be continued over vertical surface as per drawing or as directed by Engineer-In-Charge subjected to upto minimum 300 mm height from the finished roof surface.

f. Scrim cloth reinforcement shall be provided in between the layers of the coating and in places where there is a change in surface profile. eg. junction of horizontal to vertical surfaces and also near openings for rainwater pipes/ outlets etc. Scrim cloth shall be placed for a distance of 150 mm on either side of junction.

g. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

h. The coating shall be properly cured.

6.2.9 Finishing of parapet/ vertical surfaces

a. Sand shall be sprinkled over the Polyurethane water proofing coating when still in tacky state, to form key for holding cement plaster finishing on polyurethane waterproofing coating.

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b. Minimum 12mm thick cement plaster (1 cement: 4 sand, with polypropylene fibers @ 125 gms per bag of cement or as per recommended dosage by manufacturer to avoid cracking and disintegration) finishing shall be provided over the Polyurethane water proofing coating.

6.2.10 Roofing treatment in concrete gutter

a. Roofing treatment over Parapets/ Vertical surfaces of gutter shall comprise of Polyurethane water proofing coating over primer coat finished with minimum 12mm thick cement plaster similar to clause 6.2.8 & 6.2.9. The treatment shall be done on entire vertical surfaces/Parapet including gutter facia top.

b. Roofing treatment on horizontal surface of gutter shall comprise of Polyurethane water proofing coating over primer coat, Geotextile membrane and top finishing layer of plaster or PCC as approved.

c. Entire surface shall be prepared similar to the base surface preparation of roof surface.

d. Necessary slope shall be provided by means of PCC or approved light weight material such as cinder concrete.

e. Continuous angular fillet/coving of minimum 75mm x 75mm size with PCC or cement sand mortar (in 1: 3 proportion) as approved shall be provided at all junction of horizontal and vertical surfaces. The angular fillet/ coving shall be cured by means of regular wetting.

f. Polyurethane Primer coat as per clause 6.1.1 shall be applied over the prepared surface in accordance with clause 6.2.2.

g. The Polyurethane water proofing coating (Minimum 1.5mm DFT -Dry Film Thickness) applied over roof shall be continued over horizontal and parapet/ vertical surface of gutter in accordance with clause 6.2.3 over the primer coat.

h. Scrim cloth reinforcement shall be provided in between the layers and in places where there is a change in surface profile. eg. junction of horizontal to vertical surfaces and also near openings for rainwater pipes/ outlets etc. Scrim cloth shall be placed for a distance of 150 mm on either side of junction.

i. Scrim cloth shall be continued upto minimum 100mm inside the rain water pipes.

j. The coating shall be properly cured.

k. After the waterproofing coating is cured, water ponding test for leakage in the gutter shall be done as directed by Engineer-In-Charge by making sand/mud bundhs and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

l. PU waterproof coating shall be finished with minimum 12 mm thick plaster or PCC as approved. PCC shall be laid in accordance with clause 6.2.7

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6.3 TESTING

Test for leakage shall be done as follows.

After the polyurethane waterproofing coating is cured, water ponding test for leakage shall be done on waterproof coated surface in locations as directed by Engineer-In-Charge by making sand/mud bundhs in panels of 2 meter x 2 meter and water ponding for minimum 72 hours. Any leakage or defect found in the test shall be rectified as directed by Engineer-In-Charge.

7.0 DELIVERABLES BY THE CONTRACTOR

The Contractor shall furnish product data sheets and test certificates (by Government or NABL approved Laboratories) in support of properties/ performance of specified materials/ systems. Method of tests shall be as mentioned in related standards.

8.0 WARRANTY

Warranty of minimum 10 years shall be provided by the contractor for leak proof roof or any other damage/ defect of the complete roofing system. Any leakage, damage, defect (excepting any leakage, damage caused by 3rd party and causes not attributable to waterproofing contractor) within the warranty period shall be rectified by the contractor at his own cost to the satisfaction of Engineer In charge.

9.0 MEASUREMENT

Measurement of waterproofing treatment shall be the measurement of actual surface area on which waterproofing has been done.

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पुताई, रंगीन पुताई, डिस्टेम्परिंग, पैन्टिंग और पालिशिंग का मानक विनिर्देश

STANDARD SPECIFICATION FOR WHITE/ COLOUR WASHING, DISTEMPERING, PAINTING AND POLISHING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	11.05.23	REAFFIRMED AND ISSUED AS STANDARD SPECIFICATION	TUSHAR SRIVASTAVA	ATUL GUPTA	SAMIR DAS	SANJAY MAJUMDAR
6	25.08.17	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	JS/ JKB	RAJAN SRIVASTAVA	R. NANDA
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Abbreviations:

ASTM	:	American Society for Testing and Materials
BS	:	British Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
BIS	:	Bureau of Indian Standards
EN	:	European Standards
RCC	:	Reinforced Cement Concrete
VOC	:	Volatile Organic Compounds
ISO	:	International Organization for Standardization
NFPA	:	National Fire Protection Association
POP	:	Plaster Of Paris

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1.0 GENERAL

1.1 This Specification covers requirements of White/ Colour Washing, Distempering, Painting & Polishing on building works as interior or exterior finishing or decorations etc.

1.2 Unless otherwise specifically mentioned in design basis, job specification, drawings, item descriptions etc. all plastered, wooden and bare metal surfaces shall be painted.

1.3 For energy efficient and green or sustainable buildings job specification, item descriptions specific to these buildings shall be referred.

2.0 REFERENCES

The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document title
IS 2395	Code of practice for painting concrete, masonry and plaster surfaces.
IS 6278	Code of practice for white washing and colour washing.
IS 712	Specification for building limes
IS 55	Specification for Ultramarine blue for paints.
IS 63	Specification for whiting for paint and putty.
IS 427	Distemper (dry), colour as required.
IS 428	Washable Distemper
IS 15489	Paint, Plastic Emulsion- Specification
IS 2338 Part-1	Code of practice for finishing of wood, and wood based materials. Part-1 : Operations & workmanship
IS 2338 Part-2	Code of practice for finishing of wood, and wood based materials. Part-2 : Schedule
IS 5410	Cement paint, colour as required.
IS 2524 Part-1	Code of practice for painting non-ferrous metals in buildings. Part-1 : Pre-treatment
IS 2524 Part-2	Code of practice for painting non-ferrous metals in buildings. Part-2 : Painting
IS 1477 Part-1	Code of practice for painting ferrous metals in buildings. Part-1 : Pre-treatment
IS 1477 Part-2	Code of practice for painting ferrous metals in buildings. Part-1 : Painting
IS 384	Brushes, paints and varnishes, flat.
IS 486	Brushes, sash, tool, for paints and varnishes.
IS 110	Ready mixed paint, brushing, grey filler enamels for use over primers
IS 3585	Ready mixed paint, aluminium brushing priming water resistant for wood work.
IS 110	Ready mixed paint, brushing, grey filler for enamels for use over primers
IS 2395 Part-1	Painting of concrete, masonry & plastered surface, code of practice. Part-1 : Operations and workmanship
IS 2395 Part-2	Painting of concrete, masonry & plastered surface, code of practice

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	Part-2 : Schedule
IS 3536	Ready mixed paint, brushing, wood primer - Specification
IS 109	Specification for ready mixed paint, finishing, priming, plaster, to indian standard colour no. 361 light stone and no. 631 light grey, white and off - White
IS 2074	Ready mixed paint air drying red oxide zinc chrome priming specification

3.0 TYPES OF PAINTS /POLISHING

3.1 Type of Painting/ polishing shall be as mentioned in design basis, job specification, drawings, item descriptions etc.

3.2 Unless otherwise specified in design basis, drawings, item descriptions, job specifications etc, Type of Painting/ polishing shall be as per following table.

Surface	Paint/ polishing type
Internal Masonry/ Block work/ RCC wall and ceiling surface	Interior grade Acrylic Emulsion paint
External Masonry/ block work/ RCC/ plastered surface	Exterior grade Acrylic Emulsion paint
Local/ Hard wood, engineered wood and bare metal surface	Synthetic Emulsion paint
Teak or superior wood surface	French polishing

Note :

For energy efficient and green or sustainable buildings job specification, item descriptions specific to these buildings shall be referred.

4.0 MATERIALS

4.1 All materials required for the execution of painting work shall be obtained direct from approved manufacturers and shall be brought to the site in makers drums, bags etc. with seals unbroken.

4.2 In case of ready mixed paints, thinning if necessary, the brand of thinner shall be as per recommendations of the manufacturer.

4.3 Wall putty shall be minimum 2 mm thick and white cement and polymer based wall putty type.

4.4 Primer shall be compatible with the finishing paint.

4.5 The allowable limits of quantity of VOC (Volatile Organic Compounds) in different types of paints and primer shall be as defined in the following parameters:

A. Primer

Type of Primer		**Allowable VOC Content**
Pink & Grey primer on wood	:	< 50 gms/ltr
Ready mix red oxide zinc chromate primer	:	< 250 gms/ltr

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Water thinnable cement primer on wall	:	<50 gms/ltr

B. Paints

Type of Paint		Allowable VOC Content
Acrylic Emulsion	:	<50 gms/ltr
Plastic Emulsion	:	<50 gms/ltr
Acrylic Distemper	:	<50 gms/ltr
Synthetic Enamel	:	<150 gms/ltr

5.0 WORKMANSHIP

5.1 Colour/ texture of the wash/ distemper/paint/ polishing shall be as approved by the Engineer-in-charge. Sample painting shall be done as directed by the Engineer-In- charge for approval/ selection of the colour/ texture.

5.2 Washed/ distempered/Painted/ polished surface shall be even and uniform without patches, marks, without any defect and of finish as desired by the Engineer-In-Charge. Any defect or shortcomings in the finishing shall be rectified to the satisfaction of the Engineer –In- Charge.

5.3 Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed.

For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

For ceiling, proper stage scaffolding shall be erected.

5.4 Surface preparation shall be done as mentioned for various type of wash/ distemper/paint/ polishing. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

5.5 Preparation and application of wash/ distemper/paint/ polishing shall be done as mentioned for various types. However, in case of excessive un-even surfaces, punning with Plaster of Paris shall be done on the surface if and as directed by the Engineer-In-Charge.

5.6 Paint shall be applied by brushing or spraying or by using rollers as directed by the Engineer-In-Charge. The brushing operations are to be adjusted to the spreading capacity advised by the manufacturer. During painting, every time after the paint has been worked out of the brush bristles, the bristles shall be opened up by striking the brush suitably.

Spray machine used may be of high pressure type or low pressure depending on the nature and location of work. After work, the brushes shall be completely cleaned of paint and shall be hung in a thinner if intended to be used afterwards. The spray guns shall be cleaned thoroughly after every break in work. The paint/ polish containers, when not used shall be kept close and free from air.

5.7 After the finishing of work, the adjacent surfaces not intended to be washed/ distempered/painted/polished shall be thoroughly cleaned of all paint patches and shall be

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finished in accordance with surface finishing of such surfaces. Doors, windows, floors, articles of furniture etc. and such other parts of the building not to be white washed, shall be protected from being splashed upon. Splashing and droppings, if any shall be removed by the contractor at his own cost and the surfaces cleaned.

5.8 Number of coats of paint as mentioned is the minimum number of coats. Additional coats shall be provided as required for obtaining desired colour and finishing.

5.9 The operation for each coat shall consist of stroke of the brush/ roller from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied.

5.10 The painting on ceiling should be done prior to that on walls.

6.0 WHITE WASHING

White washing in general shall conform to IS 6278.

6.1 Preparation of Surface

The surface shall be thoroughly cleaned of all dirt, dust, mortar dropping and other foreign matter before white wash is to be applied. Surfaces already white/colour washed shall be broomed down to remove all dust, dirt, loose scales of lime wash or other foreign matters.

All damaged portions of the surface plaster shall be removed to full depth of plaster in rectangular patches and plastered again after raking the joints in masonry properly. Such portions shall be wetted and allowed to dry before any operation.

All holes, cracks, patches etc. not exceeding 0.1 sq. m. in area shall be made good with material similar to that of the surface. Surfaces affected by efflorescence, moss, fungi, algae, lichen etc. shall be treated in accordance with IS: 2395.

6.2 Preparation of White Wash

The fat lime conforming to IS: 712 shall be slaked at site and shall be mixed and stirred with about 5 litres of water for 1 kg. of unslaked lime to make thin cream. This shall be allowed to stand for a period of 24 hours and then shall be screened through a clean coarse cloth. 4 kg of gum dissolved in hot water shall be added to each cubic metre of lime cream. Approved quality ultramarine blue conforming to IS 55 @ 3 gram per kg. of lime shall also be added to the solution. The whole solution shall be stirred thoroughly before use.

6.3 Application

White wash shall be applied with "MOONJ" brush to the specified number of coats. Minimum number of coats shall be three. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left.

7.0 COLOUR WASHING

7.1 Preparation of Surface shall be similar to clause no 6.1

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7.2 Preparation of colour wash

Sufficient quantity of colour wash enough for the complete job shall be prepared in one operation to avoid any difference in colour. The basic white wash solution shall be prepared in accordance with clause no 6.2. Mineral colours of approved shade and quality not affected by lime shall be added to the white wash solution in proportions as directed by Engg.in-charge. Solid lumps etc. in the colour powder shall be ground to fine powder, sieved and mixed evenly and thoroughly to the white wash solution. No colour wash shall be done until a sample of the colour wash of the required tint or shade has been got approved from the Engineer-in-Charge. The colour shall be of even tint or shade over the whole surface.

7.3 Application

Colour wash shall be applied with "MOONJ" brush to the specified number of coats. Minimum number of coats shall be three. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left.

For new work, a priming coat of white wash with lime or with whiting shall be provided. Three or more coats of colour wash shall then be applied on the entire surface till it represents a smooth and uniform finish.

For old work, after the surface preparation, a coat of colour wash shall be applied over the patches and repairs. Then coats of colour wash shall be applied over the entire surface. The colour washed surface shall present a uniform finish.

The finished dry surface shall not be powdery and shall not readily come off on the hand when rubbed.

8.0 ACRYLIC DISTEMPER

8.1 Preparation of Surface

The surface shall be thoroughly cleaned of dust, old finish by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of Plaster of Paris (POP) mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In case of distempering over existing distempered surface, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster-of-paris mixed with the colour to be used. The surface then shall be rubbed down again with a fine grade sand paper and made smooth. A coat of distemper shall be applied over the patches. The surface shall be allowed to dry thoroughly before the regular coat of distemper is allowed.

8.2 Priming Coat

The priming coat shall be with distemper primer or cement primer, as required. If the wall surface plaster has not dried completely, cement primer shall be applied before distempering the walls. But if distempering is done after the wall surface is dried completely, distemper primer shall be applied. For old work no primer coat is necessary.

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A priming coat of whiting conforming to IS 63 shall be applied over the prepared surface. The priming coat shall be prepared by mixing 2.5 kg. of whiting and one litre of glue solution (prepared by mixing 250 gm. glue conforming to IS: 852 with boiling water) together and placing it in a covered vessel with enough water to cover the mixture which shall be left to cool until it becomes a jelly.

Priming coat shall be applied with "MOONJ" brush or roller to the specified number of coats. Minimum number of coats shall be minimum one. The operation for each coat shall consist of stroke of the brush from the top to down wards, another from the down to upwards over the first stroke, similarly one stroke horizontally from right and another stroke from the left. Each coat shall be allowed to dry before the next coat is applied.

8.3 Preparation of Distemper

1st quality Acrylic distemper having VOC content less than 50 gms/litre of approved brand and manufacture shall be used for preparation of distemper. The Acrylic distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

8.4 Application of Distemper

For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes or roller in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade.

A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat.

For old work, the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade.

The finished surface shall be even and uniform without patches, marks, distemper drops etc.

9.0 WATERPROOF CEMENT PAINT

9.1 Preparation of Surface

Preparation of Surface shall be similar to clause no 6.1. The surface so prepared shall be thoroughly wetted with clean water before the paint is applied.

9.2 Preparation of Paint

Waterproof cement paint conforming to IS 5410 shall be mixed with water and stirred to obtain a thick paste which shall then be diluted to brushable consistency. The proportion of mixture shall be as per manufacturer's recommendation. The paint shall be mixed in such quantity which can be used up within an hour of mixing to avoid setting and thickening of the paint.

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9.3 Application of Paint

The surface shall be treated with waterproof cement paint in minimum three coats maintaining the coverage rate (kg/ square metre) as mentioned in approved Manufacturer's standard literature. No less than 24 hours shall be allowed between two coats and subsequent coats shall be applied only after the preceding coat has become hard to resist marking by subsequent brushing.

9.4 Curing

Curing shall be started after the paint has hardened. Curing shall be done as recommended by the approved Manufacturer and by sprinkling with water two or three times a day. This shall be done between coats and for at least two days following the final coat.

10.0 ACRYLIC/ PLASTIC EMULSION PAINTING (For interior surfaces)

10.1 Acrylic/ plastic emulsion paint (for interior surfaces) shall be of interior grade, premium quality conforming to IS: 15489 and having VOC less than 50 gm/ litre.

10.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

First coat of primer shall be applied over the surface and the surface shall be allowed to be dry for 6-8 hours.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

Once the surface is dried, second coat of primer shall be applied after sand papering and cleaning the surface.

After 6-8 hours, when the surface is dry, it shall again be sand papered and cleaned for a clean and smooth service.

In case of already painted surface, old paint and loose particles shall be removed before stating the above mentioned preparation process.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

10.3 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

10.4 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to

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the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.

11.0 ACRYLIC BASED EXTERIOR EMULSION PAINT (For exterior surfaces)

11.1 Acrylic/ plastic emulsion paint (for exterior surfaces) shall be of exterior grade, premium quality conforming to IS: 15489 and having VOC less than 50 gm/ litre.

It shall be an acrylic based wall coating for exterior surfaces to form a crack free, flexible, tough, alkali & fungal resistant and UV resistant waterproof coating with silicone additives.

11.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

Any old paint shall be removed with removing agent as per manufacturer's instructions. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

1-2 coats of primer shall be applied over the surface and the surface shall be allowed to be dry for 6-8 hours.

After 6-8 hours, when the surface is dry, it shall again be sand papered and cleaned for a clean and smooth service.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

11.3 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

11.4 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, velvety smooth finish, even and uniform shade without patches, marks, paint drops etc.

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12.0 ACRYLIC COPOLYMER AGGREGATE FINISH

12.1 It shall be an acrylic based textured wall coating system consisting of quartz and silica aggregate, inorganic pigments and other additives to form a crack free, flexible, tough, waterproof coating.

12.2 Preparation of Surface

The surface shall be thoroughly cleaned and dusted off. All rust, dirt, scales, smoke splashes, mortar droppings and grease shall be thoroughly removed before painting is started. It shall then be sand papered and cleaned to give a smooth and even surface.

Any old paint shall be removed with removing agent as per manufacturer's instructions. The surface affected by moss, fungus, algae, efflorescence shall be treated in accordance with IS: 2395.

All cracks, holes, undulations, unevenness shall be filled up and made even with putty. The surface then shall be allowed to be dry.

The prepared surface shall have received the approval of the Engineer-in-Charge after inspection, before painting is commenced.

12.3 Preparation of coating

Preparation of coating using various components shall be in accordance with procedures recommended by the approved Manufacturer to achieve the desired finish.

12.4 Application

Application of the system shall be in accordance with procedures recommended by the approved Manufacturer to achieve the desired finish. Sealing coat, primer etc. as recommended by the approved Manufacturer shall also be provided.

13.0 SYNTHETIC ENAMEL PAINTING

13.1 Synthetic Enamel paint shall conform to IS 2933

13.2 Preparation of surface

A. Preparation of wood surface

The woodwork to be painted shall be dry and free from moisture and any foreign matter. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by griding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used. The surface treated for knotting shall be dry before paint is applied.

Plywood, Block board, Particle board etc. shall be treated in the same manner as for wood work.

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B. Preparation of Iron and steel surface

All rust and scales shall be removed by scrapping or by brushing with steel wire brushes. Hard skin of oxide formed on the surface if any, shall be removed.

13.3 Priming

The primer shall be ready mixed primer and compatible to the paint.

Primer for wood work shall conform to IS 3536. Primer for Iron and steel shall be Red Oxide Zinc Chromate primer conforming to IS 2074, for cement, concrete and plastered surfaces primer shall conform to IS 109.

Dirt or any other extraneous material on the surface shall be removed and the priming shall be applied in minimum two coats.

13.4 Preparation of Paint

Preparation of paint shall be as per manufacturer's instructions.

13.5 Application of Paint

The paint mix shall be continuously stirred while applying for maintaining uniform consistency. Number of coats shall be minimum two. The painting shall be laid evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard at first, then brushing alternately in opposite direction 2 to 3 times and then finally brushing lightly in a direction at right angles to the same. In this process, no brush marks, no hair marks no clogging of paint puddles shall be permitted. The full process of crossing and laying off will constitute one coat. The paint shall be applied by means of brush or roller.

The surface on finishing shall present a flat, smooth finish, even and uniform shade without patches, marks, paint drops etc.

14.0 APPLICATION OF CLEAR FINISHES (Polishing, Varnishing)

14.1 For the application of clear finishes, the following procedures shall generally be adopted in accordance with IS: 2338 (Part-I)

A. Filling
B. Staining
C. Sealing
D. Finishing

14.2 Filling

Fillers shall be applied to prevent the excessive penetration of the finish to the surface for obtaining a smooth finish. Fillers shall be conforming to IS: 345.

Fillers shall be heavily applied to the wood surface by hand, using hessian or jute rag across the grain. It shall be rubbed when still wet to get better penetration. After 5-10 minutes it shall be wiped off by hand across the grain followed by a light wipe with the grain. The filled surface shall be dried preferably over night and smoothened with abrasive paper.

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14.3 Staining

A. Spirit Stains

Spirit stains are solutions of spirit soluble dyes in Industrial methylated spirit.

B. Oil Stains

Oil stains are solutions of oil soluble dyes in linseed oil, but, usually consist of insoluble, semi-transparent pigments ground in linseed oil and thinned with turpentine or other solvent.

14.4 Surface Preparation

Surface intended for staining shall be kept scrupulously clean and free from greasy finger marks. It shall be prepared by careful smoothing with fine abrasive paper used in the direction of the grain. Small cracks/nail holes shall be stopped with plastic wood/fine plaster of Paris. The stopping shall be rubbed down with fine abrasive paper when hard and touched with a thinned knotting before staining. In case of oil staining stopping shall be done after staining using tinted putty or wood filler.

14.5 Application of Stains

Stains shall be applied by brushing and wiping or by spraying. The stain shall be so thinned that it can be applied fairly, liberally without over staining and over lapping.

14.6 Sealing

A suitable sealer shall be applied on the filled and sanded surface to prevent absorption by the wood of the succeeding coats of finish and to seal stain and filler and thus preclude their bleeding into the finish coat.

Sealer may be sprayed on taking care not to flood the surface and it shall be allowed to dry hard. When fully dry the surface shall be sanded taking care not to cut through at corners and edges. Dust shall be blown off and surface wiped with a clean rag.

14.7 Finishing

The stained surface shall be varnished, wax-polished or French polished as required after it is dried.

A. Varnishing

Varnishing of wood and wood based material shall be in accordance with IS: 2338 (Part-I).

Surfaces to be varnished shall be prepared to produce a smooth, dry and matt surface and all dust and dirt shall be removed from the surface.

The Varnish shall be applied liberally with a brush and spread evenly over a portion of the surface with short light strokes to avoid frothing. It shall be allowed to flow out while the next section is being laid in. Excess Varnish shall be scraped out of the brush and then the first section be crossed, re- crossed and laid off lightly. The Varnish, once it has begun to set, shall not be retouched. In case of any mistake, the Varnish shall be removed and the work shall be started afresh.

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Where two coats of varnish are applied, the first coat shall be a hard drying under coating or flatting varnish which shall be allowed to dry hard and then be flatted down before applying the finishing coat. Sufficient time shall be allowed in between two coats.

When flat varnishing is used for finishing, a preparatory coat of hard drying undercoating of flatting varnish shall first be applied and shall be allowed to harden thoroughly. It shall then be lightly rubbed down before the flat varnish is applied. On larger areas, the flat varnish shall be applied rapidly, and the edges of each patch applied shall not be allowed to set, but shall be followed up whilst in free working conditions.

B. French Polish

French polish shall conform to IS :348. Suitable pigments shall be added to get the required colour.

The surface to be French polished shall be rubbed down to smoothness with sand paper and shall be well dusted. Pores in the surface shall be filled up with fillers.

A pad of woollen cloth covered by a fine cloth shall be used to apply the finish. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles applying the polish sparingly but uniformly over the entire area to give an even surface. A trace of linseed oil may be used on the face of the pad for the purpose. The surface shall be allowed to dry and the remaining coats applied in the same way. To finish off, the pad shall be covered with a fresh piece of clean fine cloth, slightly damped with methylated spirit and rubbed lightly and quickly with circular motions. The finished surface shall have a uniform texture and high gloss.

15.0 MEASUREMENT

Painting/ polishing shall be measured by the area of actual painted/ polished surface.

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STANDARD SPECIFICATION FOR ROOFING

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	04.03.22	REVISED & ISSUED AS STANDARD SPECIFICATION	ANISH MAHALA	ANISH KUNDU	SAMIR DAS	SANJAY MAZUMDAR
6	08.12.15	REVISED & ISSUED AS STANDARD SPECIFICATION	ANISH MAHALA	JKB	R. SRIVASTAVA	S. CHANDA
5	06.07.10	REVISED & ISSUED AS STANDARD SPECIFICATION	GB	JS	JKB	N. DUARI
4	21.03.07	REVISED & ISSUED AS STANDARD SPECIFICATION	SD	JKB	ARVIND KUMAR	V. CHATURVEDI
3	09.03.99	REAFFIRMED AS STANDARD SPECIFICATION	SD	MLB	SCJ	AS

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Abbreviations:

AS	: Australian Standards
ASTM	: American Society for Testing and Materials
BS	: British Standards
BS-EN	: British Standards European Norm
CGI	: Corrugated Galvanized Iron
EN	: European Standards
EPDM	: Ethylene Propylene Diene Monomer
GI	: Galvanized Iron
IS	: Indian Standards
ISO	: International Organization for Standardization
MS	: Mild Steel
NBC	: National building Code
SWG	: Standard Wire Gauge

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1.0 GENERAL

1.1 This Specification covers requirements of sheet roofing/ cladding and associated accessories for buildings and sheds. The specifications of metal sheets (with regards to material) are also applicable for barricades required during construction.

1.2 The roofing and cladding system shall ensure leak-proof enclosure by means lapping of sheets, closure of joints, junctions and gaps etc., efficient roof water drainage system etc. using necessary flashings, accessories and fittings.

1.3 The roofing and cladding system shall also have provisions for natural lighting and ventilation.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
IS: 277	Galvanized steel strips and sheets (Plain and corrugated)
IS: 513	Cold reduced carbon steel sheet and strip
IS: 737	Wrought aluminium and aluminium alloy sheet and strip for general engineering purposes
IS: 1254	Corrugated aluminium sheet
IS: 2676	Dimensions for wrought aluminium and aluminium alloys, sheet and strip
IS: 13592	Unplasticized Polyvinyl Chloride (PVC-U) Pipes for Soil and Waste Discharge System Inside and Outside Buiildings Including Ventilation and Rainwater System
IS: 14871	Products in fibre reinforced cement - Long corrugated or asymmetrical section sheets and fittings for roofing and cladding - Specification
IS: 15961	Hot dip aluminium - Zinc alloy metallic coated steel strip and sheet (Plain)

3.0 CORRUGATED GALVANISED STEEL SHEET (C.G.S) ROOFING

3.1 Material

3.1.1 C.G.S. Sheets

C.G.S sheet shall conform to IS: 277.

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Unless otherwise specified in drawings, item descriptions, job specifications etc. the sheets shall be 1.00 mm thick and with zinc coating (total on both sides) not less than 275 gm/ sqm.

The sheets shall be free from cracks, split edges, twists, surface flaws etc. They shall be clean, bright and smooth. The galvanising shall be non-injured and in perfect condition. The sheets shall not show signs of rust or white powdery deposits on the surface. The corrugations shall be uniform in depth and pitch and parallel with the side.

3.1.2 Ridges, hips, valley, flashing and gutter of plain galvanised steel sheets

Leakproof roofing system with efficient rain water drainage of the roofing system shall be ensured by providing ridges, hips, valley, flashing and gutter etc. (all bent and fabricated to required shape) made of plain galvanized steel sheets.

Unless otherwise specified in drawings, item descriptions, job specifications etc. thickness and width etc. of these shall be as below:

Item	Thickness (mm)	Minimum overall width (mm)
Ridge	0.8	600
Hip	0.8	600
Valley	1.60	900
Flashing	1.00	400
Gutter	1.00 (minimum)	Profile, dimensions shall be as required for roof drainage

3.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

3.2 Laying and Fixing

3.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

3.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

3.2.3 The sheets shall be laid with a minimum lap of 150 mm at the ends and 2 ridges of corrugations at each side. The above minimum end lap of 150 mm shall apply to slopes of 1 vertical to 2 horizontal and steeper slopes. For flatter slopes the minimum permissible end lap shall be 200 mm. The minimum lap of sheets with ridge, hip and valley shall be 200 mm measured at right angles to the line of the ridge, hip and valley respectively. These sheets shall be cut to suit the dimensions or shapes of the roof, either along their length or their width or in a slant across their lines of corrugations at hips and valleys. They shall be cut carefully with a straight edge chisel to give a smooth and straight finish.

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3.2.4 Lapping in C.G.S. sheets shall be painted with a coat of approved steel primer and two coats of painting with approved paint suitable for G.S. sheet, before the sheets are fixed in place.

3.2.5 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with anticorrosive polymer coated J or L hook bolts and nuts, 8 mm diameter, with polymer cap, seal and thrust washer. J hooks shall be used for fixing sheets on angle iron purlins, and L hooks shall be used for fixing the sheet to R.S. joists, timber or precast concrete purlins. The length of the hook bolt shall be varied to suit the particular requirements.

The bolts shall be sufficiently long so that after fixing they project above the top of the nuts by not less than 10 mm. The grip of J or L hook bolt on the side of the purlin shall not be less than 25 mm. There shall be a minimum of three hook bolts placed at the ridges of corrugations in each sheet on every purlin and their spacing shall not exceed 300 mm. Coach Screws shall not be used for fixing sheets to purlins.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

3.2.6 Where slopes of roofs are less than 21.5 degrees (1 vertical to 2.5 horizontal) sheets shall be joined together at the side laps by bolts and nuts 25 × 6 mm size. As the overlap at the sides extends to two corrugations, these bolts shall be placed zig-zag over the two overlapping corrugations, so that the ends of the overlapping sheets shall be drawn tightly to each other. The spacing of these seam bolts shall not exceed 600 mm along each of the staggered rows. Holes for all bolts shall be drilled and not punched in the ridges of the corrugations from the underside, while the sheets are on the ground.

3.2.7 Ridges and hips of C.G.S. sheet roofing shall be covered with ridge and hip sections of plain G.S. sheet (properly bent in shape for fitting over roofing sheet) with a minimum lap of 200 mm on either side over the C.G.S. sheets. The end laps of the ridges and hips and between ridges and hips shall also be not less than 200 mm. They shall be fixed to the perlins with 8mm dia hooks, bolts, nuts and washers (similar to those used in laying the roofing sheets)

3.2.8 Valley shall lap with the C.G.S. sheets not less than 250 mm width on other side. The end laps of valley shall also be not less than 250 mm.

3.2.9 Flashings shall lap not less than 150 mm over the roofing sheets. The end laps between flashing pieces shall not be less than 250 mm.

3.2.10 Valley and flashings shall be fixed to roof structural members with 8mm dia hooks, bolts, nuts and washers (similar to those used in laying the roofing sheets)

3.2.11 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Hooks/ bolts/ nuts (minimum 6 mm dia) and washers for fixing shall be similar to those used in laying the roofing sheets. Connecting bolts shall be above water line of the gutter.

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Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of G.S. sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

3.2.12 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

3.2.13 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins.

3.2.14 The roof when completed shall be true to lines and slopes and shall be leak proof.

4.0 ALUMINIUM ALLOY SHEET ROOFING/ CLADDING

4.1 Material

4.1.1 Corrugated Aluminium alloy sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of corrugated Aluminium alloy sheet for roofing and cladding shall conform to following specification.

Alloy Grade	31500 B, H4 as specified in IS: 737: 2008
Profile	Profiled/corrugated sheet shall be Industrial troughed sheet Conforming to IS: 1254 -2007
Thickness	20 SWG (0.91mm) for roofing 22 SWG (0.71mm) for wall cladding (Thickness, tolerances shall be as per IS: 2676-1981)
Pitch	125 mm
Crest Height	38 mm

Finishing of the sheets shall be plain mill or stucco embossed finish. Unless otherwise specified in drawings, item descriptions, job specifications etc, the finishing shall be stucco embossed finish in approved colour.

4.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain Aluminium alloy sheet of grade 31500 B / H2 conforming to IS: 737.

Unless otherwise specified in drawings, item descriptions, job specifications etc the dimensions and other specifications shall be as mentioned in the following table.

Accessory	Dimension
Ridge piece	0.91 mm thick, minimum 600 mm wide
Apron piece	0.71 mm thick, minimum 150 mm x 150 mm

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Eaves piece	0.71 mm thick, minimum150 mm x 150 mm
Corner piece	0.71 mm thick, minimum 150 mm x 150 mm
Gutter	2 mm thick, width as required.

Finishing of accessories shall be similar to that of the roofing/ cladding sheet.

4.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

4.2 Laying and fixing

4.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

4.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

4.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm on roofs and one corrugated for sides lap. If the roof slope is less than 15 degrees, end lap shall be increased to 230 mm. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

4.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with stainless steel (SS 304 grade) or carbon steel or aluminium alloy hex head self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

If not mentioned specifically, carbon steel screws shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

4.2.5 Carbon steel screws shall be hex head, self drilling type with multi-layered high density anti-corrosive coating of Aluminium & Zinc (AZ), fitted with AZ150 GSM 0.8mm thick Alu-Zinc coated EPDM bonded washer.

4.2.6 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leakproof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

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4.2.7 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

4.2.8 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

4.2.9 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

4.2.10 The roof when completed shall be true to lines and slopes and shall be leak proof.

5.0 PRECOATED GALVANIZED STEEL SHEET ROOFING / CLADDING

5.1 Material

5.1.1 Pre-coated galvanized steel sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of pre-coated galvanized steel sheet for roofing and cladding shall conform to following specification and performance properties.

Base metal	Cold rolled steel sheet conforming to IS : 513, galvanized (275 g/SqM total on both side) by hot dip process as per IS : 277.
Profile	Profiled/corrugated sheet
Pitch	195 to 255 mm (with intermediate ribs)
Crest Height	Not less than 28 mm
Base metal thickness	0.60 mm (+/- 0.03)
Overall coated thickness	0.65 mm
Weight	Minimum 5.80 Kg/ SqM
Finishing – top surface	Regular modified polyester of minimum 20 (+/- 2) microns over primer coat of 5 microns.
Finishing – bottom surface	Polyester coat of minimum 5 microns over primer coat of 5 microns
Yield strength	Minimum 550 MPa
Pencil hardness	H-2H
Bending test	2-4 T

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Salt spray test	750 hours (exposed top side)
QUV – Wealterometer test	1000 hours
Humidity test	Minimum 750 hours

The sheets shall be of approved colour.

5.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain pre-coated galvanized steel sheet similar (except corrugation) to the sheet specified for roofing/ cladding.

5.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

5.2 Laying and fixing

5.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

5.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

5.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm to 250 mm for a slope more than 15 degree (1 in 4) and 200 mm to 300 mm for slope less than 15 degree. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

5.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

If not mentioned specifically, Zinc coated or Zinc- Tin alloy coated, hex head screws as per AS 3566 class -3 fasteners with EPDM washers shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

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5.2.5 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leakproof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

5.2.6 Gutters shall be made leak proof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

5.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes

5.2.8 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

5.2.9 The roof when completed shall be true to lines and slopes and shall be leak proof.

6.0 PRECOATED ZINC ALUMINIUM STEEL SHEET ROOFING / CLADDING

6.1 Material

6.1.1 Pre-coated Zinc- Aluminium steel sheet

Unless otherwise specified in drawings, item descriptions, job specifications etc, the material of pre-coated galvanized steel sheet for roofing and cladding shall conform to following specification and performance properties.

Base metal	The base metal of the roofing shall be cold rolled steel sheet conforming to AS: 1397 or IS : 513. It shall be coated with Al-Zn alloy (55.00% Aluminium, 43.40% Zinc, 1.60% Si) / Zincalume by Hot-dip process as per IS :15961 or AS:1397 or ASTM : A792M. (class AZ 150, having minimum 150 g/SqM AZ coating mass total on both sides).
Profile	Profiled/corrugated sheet
Pitch	195 to 255 mm (with intermediate ribs)
Crest Height	Not less than 28 mm
Base metal thickness	0.45 mm (+/- 0.03)

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Overall coated thickness	0.52 mm
Weight	Minimum 4.50 Kg/ SqM
Finishing – top surface	Super durable polyester of minimum 20 (+/- 2) microns over polyester primer coat of 5 microns.
Finishing – bottom surface	Polyester coat of minimum 5 microns over primer coat of 5 microns.
Yield strength	Minimum 550 MPa
Pencil hardness	H-2H
T-Bending test	Maximum 5T
Salt spray test	1000 hours (exposed top side)
QUV – Wealterometer test	1000 hours
Humidity test	Minimum 1000 hours

6.1.2 Accessories

The material for accessories like ridge, gutter, flashings etc. shall be of plain Pre-coated Zinc- Aluminium steel sheet sheet similar (except corrugation) to the sheet specified for roofing/ cladding.

6.1.3 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

6.2 Laying and fixing

6.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

6.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

6.2.3 The sheets shall be laid and with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm to 250 mm for a slope more than 15 degree (1 in 4) and 200 mm to 300 mm for slope less than 15 degree. Overlap of sheets shall be minimum 150 mm. Care shall be taken to match profiles and maintain alignment of profiles while overlapping the sheets.

6.2.4 Sheets shall be fixed to the purlins or other roof members such as hip or valley rafters etc. with self-drilling screws and EPDM washer. For inserting the fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown/ crest of profile sheets.

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If not mentioned specifically, Zinc coated or Zinc- Tin alloy coated, hex head screws as per AS 3566 class -3 fasteners with EPDM washers shall be used.

Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

6.2.5 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leak proof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing sheets)

6.2.6 Gutters shall be made leakproof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

6.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes

6.2.8 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

6.2.9 The roof when completed shall be true to lines and slopes and shall be leak proof.

7.0 FIBRE CEMENT CORRUGATED SHEET ROOFING/ CLADDING

7.1 Material

7.1.1 Fibre cement corrugated sheet

Fibre cement corrugated sheets shall conform to IS :14871 and following specification.

Composition	The sheets shall be asbestos free and reinforced by organic and /or inorganic synthetic fibres. The product shall be composed essentially of an inorganic hydraulic binder (in case of Portland pozzolana cement Portland slag cement, addition of pozzolanic materials and slag shall not be permitted) or a calcium silicate binder formed by the chemical reaction of a silicate binder formed by the chemical reaction of a.

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	siliceous (includes ground silica, pulverized fuel ash and amorphous silica) and calcareous material reinforced by organic and /or inorganic synthetic fibres. Pozzolanic materials process aids, fillers and pigments which are compatible with the fibre reinforced cement may be added. The inorganic hydraulic binder shall be either ; 33 grade ordinary Portland cement conforming to IS : 269 or 43 grade ordinary Portland cement conforming to IS :8112 or 53 grade ordinary Portland cement conforming to IS :12269 or Portland pozzolona (fly ash based) cement conforming to IS :1489 - part 1 or Portland pozzolona (calcined clay based) cement conforming to IS :1489 - part 2 or Rapid hardening cement conforming to IS :8041 or Portland slag cement conforming to IS :455 Fly ash used shall conform to IS 3812.
Thickness	Unless otherwise specifically mentioned, the thickness shall be 6 mm (tolerance : +/- 10%)
Pitch	146 mm (tolerance : + 6 mm, - 2 mm)
Depth	48 mm (tolerance : + 4 mm, - 5 mm)
Finishing	The sheets shall be free from cracks, chipped edges or corners and other damages. Top exposed surface shall have pre-painted finish with minimum 30 micron thick exterior grade premium quality acrylic emulsion paint. Bottom surface shall have factory finish.

7.1.2 Accessories

Accessories such as adjustable ridges, hips, finishing pieces, eaves filler pieces, north light and ventilator curves, barge boards, expansion joint sheets, "S" type louvers, gutters etc. shall be of the same Manufacturer (unless approved otherwise by Engineer- In- Charge) as the sheet used for roofing/ cladding and as per Manufacturer's standard specification.

7.1.3 In case, sizes of readymade non-metallic gutters by the same Manufacturer of the sheet are not adequate/ suitable for roof drainage, gutters of required size fabricated out of minimum 1 mm thick G.S. sheet (painted in same colour as that of roofing sheet or as approved) shall be provided.

7.1.4 Rain water pipes

Unless otherwise mentioned specifically, rain water pipes shall be unplasticised rigid PVC rain water pipes conforming to IS : 13592 Type A with fittings/ accessories.

7.2 Laying and fixing

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7.2.1 The sheets shall be laid and fixed in accordance with Manufacturer's recommendations/ guidelines and in the manner described below, unless otherwise shown in the working drawings or directed by the Engineer-in-Charge.

7.2.2 The sheets shall be laid on the purlins to a true plane, with the lines of corrugations parallel or normal to the sides of the area to be covered unless otherwise required as in special shaped roofs.

7.2.3 The sheets shall be laid with side and end laps as recommended by the sheet manufacturer. End lap shall be minimum 150 mm in cases of roof with a pitch flatter than 1 vertical to 2.5 horizontal. In the cases of very exposed situations, minimum end lap shall be 200 mm. Side lap shall be minimum half a corrugation.

7.2.4 Sheets shall be fixed to the purlins or other roof members by means of 8 mm diameter polymer coated GI J or L hook bolts, nuts and EPDM washers or with self drilling fasteners and EPDM washers. For inserting the bolts/fasteners, screw driving machine to be used at permissible rpm, punching is not permissible. All drills shall be done on the crown of the sheets. Number, spacing, length, location of hooks/ screws shall be in accordance with Manufacturer's recommendations/ guidelines.

7.2.5 The free overhang of the sheets at the eaves shall not exceed 300mm.

7.2.6 Accessories like Ridges, apron pieces, corner pieces, flashings and eaves pieces etc. shall be provided at ridge, corners, eaves etc. (properly bent in shape for fitting over roofing sheet) for ensuring leak proof construction. They shall be fixed with screws and washers (similar to those used in laying the roofing/cladding sheets)

7.2.7 Unless otherwise mentioned specifically, roof water drainage shall be through gutter and rain water pipes.

7.2.8 Metal sheet gutters shall be made leak proof and shall be supported on and fixed to mild steel flat iron (minimum size 40 mm x 3 mm) brackets bent to shape and fixed to the requisite slope. The maximum spacing of brackets shall be 1000 mm.

Pieces of gutters shall be argon welded ensuring leak proof continuous gutter length.

Screws and washers for fixing shall be similar to those used in laying the roofing sheets.

Gutters shall be provided with connection (drop ends/ nozzles/ funnels) to down take pipes, stop ends (made of sheets similar to the gutter) riveted to the gutter.

Gutters shall be laid with a minimum slope of 1 in 120.

7.2.9 Wind ties shall be of 40 x 6 mm flat iron section or of other size as specified shall be fixed at the eaves of the sheets. The fixing shall be done with the same hook bolts which secure the sheets to the purlins. Wind ties shall be painted with synthetic enamel paint matching the colour of the roofing/ cladding sheets.

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7.2.10 The roof when completed shall be true to lines and slopes and shall be leak proof.

8.0 MEASUREMENT

8.1 Measurement of sheets in roofing and cladding shall be the measurement of superficial area of the sheets on the flat without allowance for laps and corrugations. No deductions shall be made for openings upto 0.4 SqM. For opening areas exceeding 0.4 SqM, such areas shall be deducted.

8.2 If not mentioned otherwise, measurement of metal flashings, ridge/hip pieces, corner pieces, gutters (including all fittings and fixtures) etc. shall be the measurement of surface areas of these.

8.3 If not mentioned otherwise, measurement of readymade accessories and fittings (having standard size/profile) of fibre cement sheet shall be the measurement of their lengths.

8.4 If not mentioned otherwise, measurement of rain water pipes (including all fittings and fixtures) shall be the measurement of their actual lengths

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सेनिटेरी फिटिंगों और फिक्सचर का मानक विनिर्देश

STANDARD SPECIFICATION FOR SANITARY FITTINGS & FIXTURES

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
7	13.10.23	REVISED & ISSUED AS STANDARD SPECIFICATION	AKHILESH MAURYA	ATUL GUPTA	SAMIR DAS	SANJAY MAZUMDAR
6	03.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	RH	RG	JKB	D MALHOTRA
5	03.04.12	REVISED & ISSUED AS STANDARD SPECIFICATION	RH	RG	JKB	D MALHOTRA

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Abbreviations:

ASTM	:	American Society for Testing & Materials
BS	:	British Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
BIS	:	Bureau of Indian Standards
EN	:	European Standards
ISO	:	International Organization for Standardization
ABS	:	Acrylonitrile Butadiene Styrene
HDPE	:	High density polyethylene

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1.0 GENERAL

1.1 This Specification covers requirements of sanitary fixtures and fittings such as Water Closets, Wash Basins, Urinals, Water Taps etc.

1.2 In case of Green rated buildings water efficient fixtures shall be used as required to reduce water consumption and for obtaining the green rating. All fixtures installed within the project shall have flow rates at 45 psi or 3.10 bar pressure.

1.3 Other than faucets, which are installed in spaces with water head heights less than 5m/17ft, in a gravity-fed system, flow rates for the fixtures shall not exceed as mentioned in the following table.

Plumbing Fixture	Flow rate
Water Closet (Solid Flush)	6 liter per flush
Water Closet (Liquid Flush)	3 liter per flush
Urinal	3.8 liter per flush
Shower head	10 liter per minute
Lavatory Faucet	8 liter per minute
Kitchen Faucet	8 liter per minute

1.4 The water closets/ cisterns/wash basins/ Urinals shall be of approved colour.

1.5 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

1.6 Associated plumbing works shall be concealed type.

1.7 Sanitary fittings and fixtures shall be procured from Manufacturer approved by the Engineer-In-Charge

2.0 REFERENCES

The codes and standards listed below contain provisions, which through reference in this specification constitute provisions of this standard specification, if not explicitly mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document Title
IS : 2556 Part 1-17	Specification for Vitreous Sanitary appliances (Vitreous China, Part 1-17)
IS : 2267	Specification for Polystyrene Moulding and Extrusion Materials
IS : 407	Specification for Brass Tubes for General Purposes.
1S :774	Specification for Flushing cisterns for water closets and urinals (other than plastic cisterns)

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IS: 775	Specification for cast iron brackets and supports for wash basins and sinks
IS :781	Specification for Cast copper alloy screw down bib taps and stop valves for water services
IS : 1300	Specification for Phenolic moulding materials.
IS :2064	Code of Practice for Selection, Installation and Maintenance of Sanitary appliances
IS :2548 Part-1	Specification for Plastic Seats and Covers for water closets Part-1: Thermoset seats and covers
IS :2548 Part-2	Specification for Plastic Seats and Covers for water closets Part-2: Thermoplastic seats and covers
IS :2326	Specification for automatic flushing cistern for urinals (other than plastic cisterns)
IS : 3389	Specification for Urea-formaldehyde Moulding Materials.
IS :7231	Specification for plastic flushing cisterns for water closets and urinals.
IS : 7328	Specification for High Density Polyethylene Materials for Moulding and Extrusion.
IS : 9758	Specification for flush valves and fittings for water closets and urinals.
IS : 13983	Specification for stainless steel sinks for domestic purposes.

3.0 WATER CLOSET SYSTEMS

3.1 General

3.1.1 Water closet Systems shall be a water tight and leakage free system consisting of squatting pans/commodes complete with water supply, flushing and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

3.1.2 Flushing and disposal of the waste shall be by means of water either from direct water supply line or from flushing cisterns/ tanks through flush valves as mentioned.

3.1.3 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

3.2 Flushing Cisterns/ Tanks

3.2.1 Flushing cisterns shall either be integral with the squatting pan/ commode and shall be open or concealed tank type as mentioned. Connection between cistern and closet shall be made by means of flush pipe/ bend. Flush pipe/ bend shall be firmly fixed with clamps etc. and shall be concealed both in wall and floor.

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3.2.2 The cisterns shall be complete with all necessary fittings/ fixtures etc. as required and mentioned in the table below.

Component	Material
Cisterns/ Tanks	Minimum 3 mm thick High density polyethylene (HDPE) conforming to IS 7328 or polystyrene, high impact or polypropylene conforming to IS 2267. (In case of cisterns integral with wash down type closets, the material shall be vitreous china)
Flush pipe/ bend	40mm dia High density polyethylene pipe conforming to IS 407 or unplasticised PVC plumbing pipe conforming to IS 2501
Siphon/ valve	High density polyethylene (HDPE) Conforming to IS 7328 or polystyrene, high impact or polypropylene conforming to IS 2267.
Operating mechanism/ lever	Non- ferrous, corrosion resistant material
Float valve	Polyethylene conforming to IS 7328
Coupling nut and lock-nut	Non- ferrous material
Capacity	Minimum 5 litre
Connection pipes/ tubes	Reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.2.3 Flushing cisterns shall be dual valve type with dual pushing button plates. In case of open type of cisterns, the valve shall be integral with the cistern. In case of concealed cistern/ tank, the valve plate (made of non ferrous metal or ABS (Acrylonitrile Butadiene Styrene) and having same finishing of the Faucets, taps etc.) shall be provided on the concealed surface at suitable location. Stop cocks/ valves shall be provided in the system for installation/ maintenance.

3.3 INDIAN WATER CLOSET (IWC)

3.3.1 Squatting Pan shall be of vitreous china and Orissa Pan type conforming to IS: 2556. The closet shall be fixed in the floor with 150 mm thick sand cushion and shall be connected with CI `S' or `P' trap with approximately 50 mm water seal.

3.3.2 Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlets hall be of the self draining type. It shall have weep hole at the flushing inlet to the pan. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing.

3.3.3 Water tap or health faucet with stop cock, valve shall be provided near the closet at suitable location. Connection pipes/ tubes of health faucets shall be flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.4 WASH DOWN TYPE EUROPEAN WATER CLOSETS (EWC)

3.4.1 The commode shall be of vitreous china conforming to IS: 2556.

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3.4.2 The closets shall be of one piece construction and shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flushing pipe. The flushing rim and inlet shall be of the self draining type. The water closet shall have a weep hole at the flushing inlet. Each water closet shall have an integral trap with either 'S' or 'P' outlet with at least 50 mm water seal. The inside surface of water closets and traps shall be uniform and smooth in order to enable an efficient flush.

3.4.3 The closets shall be floor or wall mounted with flushing cisterns either integral with the commode or separately mounted on wall or concealed cisterns/tanks connected with flush pipe as mentioned.

3.4.4 The commodes shall be provided with a hinged seat and cover/ lid. The seat and cover made of thermosetting or thermoplastic conforming to IS 2548. Thermosetting plastic used shall conform to grade 2 or 3 of IS 1300 when it is phenolic plastic or IS 3389 when it is of urea formaldehyde. The seat and cover shall be fitted with plastic buffers. The cover shall be hydraulically operated type.

3.4.5 Water tap or health faucet with stop cock, valve shall be provided near the closet at suitable location. Connection pipes/ tubes of health faucets shall be flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

3.4.6 Superior quality EWCs shall be of approved design and shall have following features with respect to clause nos 3.4.1 to 3.4.5 :

Installation type	Wall hung
Commode/ Pan	Rimless with quite close seat cover having anti-bacterial coating.
Cistern	Concealed type, made of high density polyethylene, joint less construction. Water consumption – maximum 2 and 4 litre for partial and full flush respectively. Capacity – upto 10 litre. Valve/ Actuation plate – Separate pressing button for dual flushing, made of ABS (chromium plated)
Health faucet	Chromium plated ABS body with reinforced plastic/ PVC pipe in SS-304 grade jacket.

3.4.7 Premium quality EWCs shall be of approved design and shall have following features with respect to clause nos 3.4.1 to 3.4.5 :

Installation type	Wall hung
Commode/ Pan	Fully skirted (Traps not visible), Rimless with quite close seat cover having anti-bacterial coating.
Cistern	Concealed type, made of high density polyethylene, jointless construction. Water consumption – maximum 2 and 4 litre for partial and

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	full flush respectively. Capacity – upto 10 litre. Valve/ Actuation plate – Separate pressing button for dual flushing, made of ABS (chromium plated)
Health faucet	Chromium plated ABS body with reinforced plastic/ PVC pipe in SS-304 grade jacket.

4.0 URINAL SYSTEM

4.1 General

4.1.1 Urinals shall be a water tight and leakage free system consisting of urinals complete with water supply, flushing and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

4.1.2 Flushing and disposal of the waste shall be by means of water from direct water supply line if not mentioned otherwise.

4.1.3 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

4.1.4 The urinals shall be made of vitreous China and half stall type conforming to IS 2556.

4.1.5 The urinals shall be of one piece construction, full stall type with integral flushing rim and of approved colour.

4.1.6 All pipe, fittings, plumbing of water supply connection to the urinals, drainage/ disposal pipes shall be concealed. Stop cock shall be provided just above the urinal for flushing.

4.1.7 Bottle trap and union fittings shall be provided for waste disposal from the urinals.

4.1.8 Urinal partitions shall be provided in between the urinals. If not mentioned specifically elsewhere, partitions made of polished granite stone shall be provided.

4.2 Sensor operated Urinals

4.2.1 With reference to clause no 4.1, in case of sensor operated urinals, the flushing system shall be by means of concealed type electronic type sensors. The power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In-Charge.

4.2.2 Sensor operated urinals shall have pre-flush facility also.

4.3 Waterless Urinals

4.3.1 Waterless urinals shall be made of vitreous china having antibacterial /germs free ceramic surface, fixed with cartridge having debris catcher and hygiene seal.

5.0 WASH BASINS / SINKS

5.1 General

5.1.1 Wash basins and sinks shall be water tight and leakage free system complete with water supply and drainage/ disposal system including all fittings/ fixtures required to be connected to the water supply and waste disposal system.

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5.1.2 Stop cock/ valves shall be provided in all water supply lines for maintenance and operation purpose.

5.1.3 The wash basins shall be made of vitreous China conforming to IS 2556.

5.1.4 The wash basins/sinks shall be of one piece construction and of approved colour with nickel chromium plated brass waste fitting for connecting with waste pipe.

5.1.5 All pipe, fittings, plumbing of water supply connection to the basins/ sinks, drainage/ disposal pipes shall be concealed.

5.1.6 Wash basins/ sinks shall be wall mounted or mounted over/ under counters as mentioned in the tender document or construction drawings. In case of wall mounted fitting, the basin/ sink shall be fixed to wall with metal (painted) brackets.

5.1.7 Shape, design and size of the wash basins/ sinks shall be as approved by the Engineer-In-Charge.

5.1.8 Wash basins shall be provided with taps/ pillar cocks/ faucets of approved design. Mixer type tap/ pillar cock shall be provided in case of hot and cold water supply.

5.1.9 Bottle trap and union fittings shall be provided for waste disposal from the wash basins.

5.1.10 In case of Sinks, taps with long and swinging neck shall be provided so that water reaches in all the areas of the Sink.

5.1.11 Connection pipes/ tubes shall be of flexible and of reinforced PVC/ Plastic with chrome plated non-ferrous metallic jacket matching with the finish of valves/ stop cocks etc.

5.2 Superior quality Wash Basins and faucets

5.2.1 Superior quality Wash Basins shall be round or oval shaped under counter top type with either electronic sensor operated or pressmatic type faucets as mentioned.

5.2.2 In case of sensor operated basins, power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In- Charge.

5.2.3 Faucets shall be of brass body, chromium plated of approved design and shall be mounted over the counter or mounted on the basin itself as decided by Engineer-In-Charge.

5.3 Premium quality Wash Basins and faucets

5.3.1 Premium quality Wash Basins shall be over the counter top and thin rim type, of approved shape with electronic sensor electronic sensor operated.

5.3.2 Power supply to the sensor shall be by means of direct electrical connection or by battery cell as decided by the Engineer- In- Charge.

5.3.3 Faucets shall be of brass body, chromium plated of approved design and shall be wall mounted or mounted over the counter as decided by Engineer-In-Charge.

5.4 Kitchen/ Pantry/ Laboratory sinks

Kitchen/ Pantry/ Laboratory sinks shall be of stainless steel (304 -18/8) conforming to IS 13983. Nominal thickness of SS sheet shall not be less than 1 mm before forming. Thickness

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at any point of the sink, after forming shall not be less than 0.75mm. Depth of the bowl shall not be less than 150 mm. Minimum internal dimensions, when measured on the bowl centre lines across the top of the bowl shall be 380mm x 340 mm for rectangular bowls and 360 mm for round bowls.

6.0 FITTINGS & FIXTURES

6.1 General

6.1.1 Fittings/ fixtures such as Taps/ Valves/ Faucets/Shower roses/ bib, stop, pillar cocks etc shall be of approved design and finish and shall be procured from approved Manufacturer.

6.1.2 Fittings/ fixtures shall be provided as per table below :

WC cubicles	Bib cock or health faucet, Coat/ Robe hook, Toilet paper holder
Shower cubicles	Towel rail, Coat/Robe hook, Soap tray, Shower rose
Wash Basins	Mirror and Faucets for each wash basin, Touch less type Soap dispenser (Tissue paper dispenser in locations decided by the Engineer-In-Charge) and Hand drier near wash basin.

6.1.3 Removable floor trap covers made of stainless steel shall be provided over all floor traps.

6.1.4 Fittings/ fixtures shall be made of non-ferrous anti corrosive metallic materials with chromium plated finish if not mentioned otherwise.

6.2 Specifications of sanitary fittings/ fixtures

6.2.1 Sanitary fittings/ fixtures shall meet the following specifications if not mentioned otherwise specifically in the tender/ bid documents and construction drawings.

Fittings/ fixtures	Specification
Bib Cocks, Stop Cocks, Pillar cocks, Taps, valves, Faucets, mixers etc.	15mm dia, chromium plated Brass body conforming to IS : 781 Faucets for superior and premium quality wash basins shall be as mentioned.
Health Faucets	Chromium plated Brass body with bracket
Shower rose	Chromium plated Brass body conforming to IS : 2064 with adjustable rose and supporting arm.
Toilet paper holder	Chromium plated Brass body or stainless steel (grade – 304)
Liquid soap dispenser	Plastic body
Towel ring/ rail/ rack	Stainless steel (grade – 304)
Mirror	Made of minimum 5mm thick glass with beveled/ rounded edge.
Coat/Robe hook	Stainless steel (grade – 304)

7.0 INSTALLATION

7.1 Sanitary fittings/ fixtures shall be installed by licensed plumber.

7.2 The fixtures/ fittings shall be installed in accordance with the Manufacturer's recommendation and as approved by the Engineer-In-Charge.

7.3 All fittings/ fixtures shall be installed ensuring water tightness using sealers/ gaskets etc. as required.

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7.4 All holes/ punctures in walls due to installation shall be concealed by stainless steel round covers matching with the fixture/ fittings.

7.5 Pedestals of WCs/ wash basins etc. in contact with the floor finish shall be suitably sealed.

7.6 All screws for fixing/ fitting etc. shall be of stainless steel fixed with anchor fasteners.

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बनावटी छत, बनावटी तल, अंडरडेक इन्सुलेशन और पार्टीशनिंग का मानक विनिर्देश

STANDARD SPECIFICATION FOR FALSE CEILING, FALSE FLOORING, UNDERDECK INSULATION & PARTITIONING

Rev. No	Date	Purpose	Prepared by	Checked by	Approved by: Standards Committee Convener	Approved by: Standards Bureau Chairman
8	18.09.25	REVISED & ISSUED AS STANDARD SPECIFICATION	PIYALEE DAS	ATUL GUPTA	ANISH KUNDU	MAINAK NANDI
7	08.03.22	REVISED & ISSUED AS STANDARD SPECIFICATION	PIYALEE DAS	ATUL GUPTA	SAMIR DAS	SANJAY MAJUMDAR
6	22.03.17	REVISED & ISSUED AS STANDARD SPECIFICATION	AM	JS/JKB	R. SRIVASTAVA	R. NANDA
5	23.11.11	REVISED & ISSUED AS STANDARD SPECIFICATION	GB	JS/SD	JKB	D. MALHOTRA

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Abbreviations:

ASTM	:	American Society of Testing of Materials
BS	:	British Standards
CISCA	:	Ceilings & Interior Systems Construction Association
CRCA	:	Cold Rolled Close Annealed
EN	:	European Standards
GI	:	Galvanized Iron
IS	:	Indian Standards
ISO	:	International Organization for Standardization
MS	:	Mild Steel
NABL	:	National Accreditation Board for Testing and Calibration Laboratories
NRC	:	Noise Reduction Coefficients
NBC	:	National Building Code
NFPA	:	National Fire Protection Association
PVC	:	Polyvinyl Chloride
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel

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1.0 GENERAL

This standard specification lays down requirements of false ceiling, false flooring, under deck insulation, and partitioning system.

2.0 REFERENCES

2.1 The codes and standards listed below contains provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Sr. No.	Standards	Document Title
1	ASTM C423	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
2	ASTM C635	Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
3	ASTM C636	Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
4	ASTM E1414	Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
5	ASTM E1477	Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
6	BS 476 part 6/7	Fire Test
7	CISCA	The Ceilings & Interior Systems Construction Association Acoustical ceilings: Use and Practice
8	IS 277	Galvanized Steel Sheets (Plain and Corrugated)
9	IS 2095	Gypsum plaster boards
10	IS 2676	Dimension for wrought aluminium and aluminium alloy sheet and strip
11	IS 12436	Specification for. Preformed rigid polyurethane (pur). And polyisocyanurate (pir) foams
12	IS 8183	Bonded mineral wool - specification.

3.0 FALSE CEILING SYSTEMS

3.1 GENERAL

3.1.1 False or suspended ceiling systems shall be complete with supporting frame work / suspension system and ceiling boards/ panels/ tiles. Following types of false ceiling systems (either with only one type or in combination of various types) shall be provided as specified in design basis, job specifications, item descriptions, drawings etc.

1. Mineral Fibre board false ceiling system.
2. Gypsum board seamless false ceiling system.

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3. Calcium Silicate board false ceiling system.
4. Calcium Silicate tile false ceiling system.
5. Aluminium false ceiling system. (square grid type)
6. Aluminium false ceiling system. (linear plank type)

If false ceiling type is not mentioned specifically, Mineral Fibre board false ceiling system shall be provided.

3.1.2 False or suspended ceiling systems shall be installed at desired heights and levels in designs, patterns and shapes in accordance with approved fabrication drawings. Fabrication drawings shall be prepared and submitted by the Contractor and approved by Engineer-In-Charge.

3.1.3 Fabrication drawings shall be prepared based on drawings issued by Engineer-In-Charge and in co-ordination with other system providers such as lighting, HVAC, Fire-fighting system components, fittings and fixtures of which are accommodated on the ceiling or above and below.

3.1.4 The ceiling system shall be sturdy, finished, levelled and aligned as per approved drawings without any undulations, sagging or other defects. Zig-zag alignment of visible supporting system or ceiling panels/ tiles shall not be permitted.

3.1.5 All components of the ceiling system shall be from the approved Manufacturers of the whole and full system only. Materials / components procured from other Manufacturers shall not be permitted.

3.1.6 The ceiling systems shall be installed by agencies approved by Engineer-In-Charge.

3.2 MINERAL FIBRE BOARD FALSE CEILING SYSTEM

The Mineral Fibre board ceiling system shall be in square grid (exposed) type with tiles having bevelled tegular edges.

3.2.1 Ceiling boards/ panels/ tiles

Ceiling boards/ panels/ tiles shall be standard product of the approved Manufacturer and as per following specification.

Sr. No.	Item/ Property	Specification
1	Base Material	Mineral Fiber
2	Panel Dimensions	600 mm x 600 mm
3	Panel Thickness	16 mm
4	Dimension tolerances	+- 0.5 mm
5	Noise Reduction co-efficient	0.55
6	Fire Properties	Class 0/1 as per BS 476 part 6/7
7	Light Reflectance	85%
8	Humidity Resistance	RH 99%

3.2.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of interlocked main, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling panels and shall be standard product of the Manufacturer and as per following specification.

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Members of the grid work shall be of galvanised steel (120 gsm on both sides as per IS: 277) mild steel, power pressed to required profile.

The exposed visible surfaces of the suspension system shall be finished with minimum 25 micron pre-painted polyester baked paint.

Mineral Fiber Tile Grid Ceilings Framework Details:

Sl. No.	Ceiling Drop (mm)	Hanger Size (mm)	Distance of hangers in both directions (mm)
1	0 to 1500	Minimum 4mm dia wire rod with level adjuster as per site requirement	1200
2	1500 to 3000	Minimum 6mm Dia Threaded Rod with level adjuster as per site requirement	1200

Note : For ceiling drop exceeding 3000mm, MS section supports shall be provided at appropriate levels, creating a grid with dimensions of 1200x1200mm to support the false ceiling suspension framework. The MS framework must be capable of bearing a load of 40 kg/sqm.

3.2.3 Installation

3.2.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.2.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of threaded hanger rod and level adjuster) at 1200 mm maximum. For ceiling drops greater than 3000mm main members shall be placed at a spacing of 1200x1200 mm (both directions) fixed to the structural suspension arrangement.

3.2.3.3 Cross members shall be interlocked between main runners at 600mm to form 1200 mm x 600mm module.

3.2.3.4 Short cross members shall be fixed between main runners at 600mm to form in the 1200 mm x 600 mm modules to form 600 mm x 600 mm modules.

3.2.3.5 Perimeter sections shall be secured to perimeter walls/ partitions.

3.2.3.6 Ceiling panels/ tiles shall be provided in the suspended grid work.

3.3 GYPSUM BOARD SEAMLESS FALSE CEILING SYSTEM

The gypsum board false ceiling system shall be of seamless finish.

3.3.1 Gypsum boards

Gypsum boards shall conform to IS : 2095 and shall have following properties.

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Sr. No.	Item/ Property	Specification
1	Board Thickness	12.5 mm
2	Dimension tolerances	+- 0.5 mm
3	Fire Properties	Non combustible as per BS 476 part 4
4	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.3.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components shall be made of galvanized steel (120 gsm on both sides as per IS: 277) power pressed to required profile.

Gypsum Ceilings Framework Details:

Table -1

Sl. No.	Ceiling Drop (mm)	Bracing	Hanger Size (mm)	Distance of hangers in both directions (mm)	Distance of Interme diate (mm)
1	0 to1500	Not Required	25x10x0.5	1200	1200
2	1500 to 3000	Bracing with L Angle at every 1500mm in Horizontal direction	25x10x0.5	900	900

Note : For heights exceeding 3000mm, MS section supports shall be provided at appropriate levels, creating a grid with dimensions of 1200x1200mm to support the false ceiling suspension. The MS framework must be capable of bearing a load of 40 kg/sqm.

3.3.3 Installation

3.3.3.1 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of cleats and suspension angle member) at 1200 mm maximum.

3.3.3.2 Cross members shall be fixed main runners at the spacing of 450 mm. Additional bracing to be provided as per the ceiling drop from true ceiling as mentioned in the Table No 1.

3.3.3.3 Perimeter sections shall be secured to perimeter walls/ partitions.

3.3.3.4 Ceiling boards shall be fixed to the grid frame work by means of drywall screws. edges of the ceiling boards shall be jointed and finished flush with jointing tapes and compounds as recommended by the approved Manufacturer. The finished surface shall be seamless.

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3.3.3.5 The ceiling board surfaces shall be finished with paint etc. as specified.

3.4 CALCIUM SILICATE BOARD FALSE CEILING SYSTEM

The Calcium Silicate board false ceiling system shall be of seamless finish by fixing the ceiling boards on the suspension system.

3.4.1 Calcium Silicate ceiling boards

The calcium Silicate ceiling boards shall be with durable tapper edge type board having following specification.

Sr. No.	Item/ Property	Specification
1	Board Thickness	8 mm
2	Dimension tolerances	+- 0.8 mm
3	Fire Properties	Class 0/1, Class A as per BS 476 part 6/7
4	Humidity Resistance	RH 99%
5	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.4.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components shall be made of galvanized (120 gsm on both sides as per IS: 277) mild steel, power pressed to required profile.

3.4.3 Installation

3.4.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.4.3.2 Main members of grid framework shall be suspended from the soffit @ 1200 mm maximum by means of angle hangers with nuts and bolts, angle hangers being fixed to angle cleats fixed on the soffit by means of dash fasteners.

3.4.3.3 Intermediate members of grid framework shall be fixed to main members @ 450 mm maximum in a direction perpendicular to the main members with connecting clips.

3.4.3.4 Perimeter members shall be fixed on perimeter surfaces.

3.4.3.5 Ceiling boards shall be fixed to the grid frame work by means of drywall screws. Tapered and square edges of the ceiling boards shall be jointed and finished flush with jointing tapes and compounds as recommended by the approved Manufacturer. The finished surface shall be seamless.

3.4.3.6 The ceiling board surfaces shall be finished with paint etc. as specified.

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3.5 CALCIUM SILICATE TILE FALSE CEILING SYSTEM

The Calcium Silicate tile false ceiling system shall be of square grid type laid on the suspension system.

3.5.1 Calcium Silicate ceiling tiles

The calcium Silicate ceiling tiles shall be of approved texture having following specification.

Sr.No.	Item/ Property	Specification
1	Tile thickness	8 mm
2	Tile size	595 mm x 595 mm or 610 mm x 610 mm
3	Humidity Resistance	RH 99%
4	Fire Properties	Non combustible as per BS 476, part -4 Class 1 as per BS 476 part 7
5	Finishing	Acrylic emulsion paint or laminates as specified. If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.

3.5.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling tiles and shall be standard product of the Manufacturer.

The components shall be made of galvanized (120 gsm on both sides as per IS: 277) mild steel.

Visible areas of the frame work shall be pre-painted with polyester paint.

3.5.3 Installation

3.5.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.5.3.2 Main and cross members of grid framework shall be interlocked (as required to form the square grid suitable for the tile size) and suspended from the soffit by means of slotted galvanized steel cleats, adjustable rods fixed to soffit with anchor fasteners in accordance with approved Manufacturer's standard practice.

3.5.3.3 Perimeter members shall be fixed on perimeter surfaces.

3.5.3.4 Ceiling tiles shall be laid in the grid frame work.

3.5.3.5 The ceiling board surfaces shall be finished with paint etc. as specified.

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3.6 ALUMINIUM FALSE CEILING SYSTEM (SQUARE GRID TYPE)

Aluminium false ceiling system (square grid type) shall be standard product of the approved Manufacturer, clip-in type in square grid consisting of Alumium alloy ceiling panels and suspension system.

3.6.1 Ceiling Panels

Ceiling panels shall be made of aluminium alloy AA 3003- H14 (tempered) grade as per IS 2676 having following specification.

Sr.No.	Item/ Property	Specification
1	Panel type	Bevel edged, Perforated type with non-woven acoustical fleece
2	Panel dimension	600 mm x 600 mm
3	Panel thickness	0.7 mm
4	Dimension tolerances	+- 2 mm
5	Fire Properties	Class 0/1 as per BS 476 part 6/7 or class A2-s1, d0 according to EN 13501-1
6	Light Reflectance	63% as per ASTM 1477
7	Perforations	Hole diameter- 1.5 mm, open area- 18%, linear pitch 4.3 mm, diagonal pitch – 3 mm, border area – 9.5 mm
8	Finishing	Polyester powder coating (minimum 60 micron)
9	Salt spray test	750 hours as per ASTM B 117

3.6.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main, intermediate, cross members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components of the system shall be made of galvanized (90 gsm as per IS 277) steel and finishing shall be baked polyester paint.

3.6.3 Installation

3.6.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.6.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of hanger wire/ threaded rod and level adjuster).

3.6.3.3 Cross members shall be interlocked between main runners to form 600 mm x 600 mm grid.

3.6.3.4 Perimeter sections shall be secured to perimeter walls/ partitions.

3.6.3.5 Ceiling panels/ tiles shall be laid in the suspended grid work.

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3.7 ALUMINIUM FALSE CEILING SYSTEM (LINEAR PLANK TYPE)

Aluminium false ceiling system (linear plank type) shall be standard product of the approved Manufacturer, single grid type in concealed system consisting of Aluminium alloy ceiling panels and suspension system.

3.7.1 Ceiling Panels

Ceiling panels shall be made of aluminium alloy AA 3105- H14 (tempered) grade as per IS 2676 having following specification.

Sr.No.	Item/ Property	Specification
1	Panel type	Perforated type with non-woven acoustical fleece with bevel edge and upturn
2	Panel dimension	150 mm (width)
3	Panel thickness	0.7 mm
4	Dimension tolerances	+- 2 mm
5	Fire Properties	Class 0/1 as per BS 476 part 6/7 or class A2-s1, d0 according to EN 13501-1
6	Light Reflectance	63% as per ASTM 1477
7	Perforations	Hole diameter- 1.5 mm, open area- 18%, linear pitch 4.3 mm, diagonal pitch – 3 mm, border area – 9.5 mm
8	Finishing	Polyester powder coating (minimum 60 micron) If not specified otherwise, premium quality acrylic emulsion paint in approved colour shall be provided.
9	Salt spray test	750 hours as per ASTM B 117

3.7.2 Suspension system

Suspension system/ framework of the ceiling system with all required components (grid work consisting of main members and perimeter members etc suspended suitably from the ceiling/ roof) shall be suitable/ compatible for the ceiling boards and shall be standard product of the Manufacturer.

The components of the system shall be made of galvanized (120 gsm as per IS 277) steel and finishing shall be baked polyester paint.

3.7.3 Installation

3.7.3.1 Installation of the system shall be in accordance with approved drawings, standard practice of the system Manufacturer and following specifications.

3.7.3.2 Main members shall be placed at the spacing of maximum 1200 mm securely fixed to the structural soffit using suspension arrangement (by means of hanger wire/ threaded rod).

3.7.3.3 Perimeter sections shall be secured to perimeter walls/ partitions.

3.7.3.4 Ceiling panels shall be clipped on to the main members of the suspended grid work.

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4.0 UNDERDECK INSULATION SYSTEM

Insulating material of underdeck insulation system shall be of glass wool boards or Polyisocyanurate (PIR) foam boards/slabs as specified in the design basis, item description, job specification drawings etc.

If nothing is mentioned specifically, glass wool boards shall be used.

4.1 POLY- ISOCYANURATE (PIR) FOAM INSULATION SYSTEM

4.1.1 Poly- Isocyanurate (PIR) foam

Poly-Isocyanurate (PIR) foam insulation shall be in the slab form with lining of glass fibre tissue or aluminium foil lining (having 50 mm overlap) on one side.

Poly-Isocyanurate (PIR) foam shall conform to IS: 12436 and shall have following specification.

Sr.No.	Item/ Property	Specification
1	Slab thickness	Minimum 30 mm
2	Density	Not less than 32 kg/ CuM
3	Thermal conductivity (K value)	Not more than 0.023 w/mk at 10 degree C
4	Fire Properties	Class 0/1 as per BS 476 part 6/7

4.1.2 Installation

4.1.2.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's and following specification.

4.1.2.2 Hot blown bitumen (grade 85/25) over a bituminous priming or approved cold adhesive shall be applied over the soffit and PIR board surface after cleaning the surfaces.

4.1.2.3 PIR slabs shall be pressed in position over the bitumen coat when it is still tacky or over the cold adhesive and shall be fixed to the soffit by means of approved fasteners (at four corners and at the centre of the slabs) without damaging the slabs.

4.1.2.4 Overlaps shall be covered with approved sealing compound.

4.1.2.5 The PIR shall be further secured by chicken wire mesh (24 gauge) fixed to the fasteners and tightened with lacing wire.

4.2 GLASS WOOL INSULATION SYSTEM

4.2.1 Glass wool insulation

Glass wool insulation shall be in rolls or boards and shall be pre-laminated on one side with aluminum foil.

Glass wool insulation shall conform to IS: 8183 and shall have following specification.

Sr. No.	Item/ Property	Specification
1	Thickness	Minimum 75 mm
2	Density	Not less than 24 kg/ CuM
3	Thermal conductivity (K value)	Not more than 0.034 w/mk at 25 degree C mean
4	Fire Properties	Class 0/1 as per BS 476 part 6/7

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4.2.2 Installation

4.2.2.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's and following specification.

4.2.2.2 The insulation boards/roll shall fixed underside soffit with the help of polyamide based long insulation fasteners @ 450 mm c/c.

4.2.2.3 The joints shall be sealed with self-adhesive aluminum foil tape

5.0 FALSE (RAISED ACCESS) FLOORING SYSTEM

False flooring system shall be modular and removable type and shall consist of floor panels and supporting/ understructure system.

The system shall be factory made and the full system including all components shall be sourced from approved single Manufacturer.

The system shall be strong and durable for movement and other operations.

This specification is applicable for false floorings upto 1000 mm high.

The flooring system shall be capable of supporting following loading conditions when tested as per CISCA test procedure.

i. Concentrated load of 675 Kg. with maximum allowable deflection of 2.5mm and a factor of safety of 2.5.
ii. Uniform load of 2025 Kg/ Square meter.

For details reference shall be made to standard no 7-75-0049.

5.1 Floor panels

Sr. No.	Item/ Property	Specification
1	Material	CRCA steel with cementitious core with hemispherical and reverse cones and 1 mm thick epoxy painted CRCA steel sheet on top. The inner empty core shall be injected with light weight fire retardant non combustible cementitious compound.
2	Size	600 mm x 600 mm x 35 mm thick. (Dimensional tolerance : +- 0.8 mm).
3	Finishing	Top sheet shall be finished with 2 mm thick high pressure laminate or 2 mm thick conductive PVC or stone or other type of tiles as specified. If nothing is mentioned specifically, high pressure laminate shall be provided.
4	Edging	All edges of the panels shall have conductive PVC trims
5	Fire resistance/ property	Class 0 & class 1 conforming to BS 476-part-6 (Fire propagation) and BS 476-part-7 (Surface spread of flame).

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5.2 Understructure/ supporting system

False floor understructure shall be installed to support the panels and shall be suitable to achieve required cavity height from the existing floor level. The system shall ensure speedy assembly and removal for relocation and maintenance. The system shall also ensure easy adjustment of levelling (±25mm) and accurate alignment of panels in the vertical direction.
False floor understructure shall consist of Base plate, pedestals, pedestal head assembly, stringers and necessary fittings, fixtures and accessories as specified below.

Sr. No.	Item/ Property	Specification
1	Pedestal Base Assembly .	Powder coated. hot dip galvanized (60-80 micron) mild steel base plate with not less than 150mm x 150mm x 4 mm of bearing area, mechanically riveted to a 32mm dia. of 2 mm thick CRCA steel pedestal designed to engage the head assembly
2	Pedestal Head Assembly	Zinc electroplated CRCA steel pedestal head assembly shall be 90mm x 90mm x 4 mm thick profiled head, mechanically riveted to a 19 mm dia. threaded bright rod, fixed to pedestal by specially designed zinc electroplated steel forged adjusting nut for leveling, locking and changing the height setting.
3	Stringers	Stringers shall be of hot dip galvanized (60-80 microns) steel, minimum 20mm x 32mm x 1.20mm thick CRCA steel.

5.3 Installation

5.3.1 False flooring systems shall be installed by agencies approved by Engineer-In-Charge.

5.3.2 False flooring systems shall be installed at desired heights and levels in designs, patterns and shapes in accordance with approved fabrication drawings. Fabrication drawings shall be prepared and submitted by the Contractor and approved by Engineer-In-Charge.

5.3.3 Fabrication drawings shall be prepared based on drawings issued by Engineer-In-Charge and in co-ordination with other system providers such as which are accommodated in the cavity of the false flooring.

5.3.4 Installation shall be done in accordance with approved system Manufaturer's standard practice, as directed by the Engineer-In-Charge and as mentioned below:

5.3.5 Installation of under structure

a) The base floor and cavity between false flooring and base floor shall be properly cleaned and made dust free and dry. The base cement concrete floor shall be treated with one component polyurethane based coating.

b) Pedestal base assembly shall be fixed to the base floor by fixing base plates to the base floor by minimum 50mm x 8mm anchor fasteners (4 nos. for each plate).

c) The pedestal stud locations shall ensure the grid work as per flooring pattern which in general shall be of 600 mm x 600 mm dimension. The length of the pedestal studs shall be such that clear cavity between false flooring and base flooring is of desired depth. Additional pedestals as needed to support panels where floor is disrupted by columns, walls and cutouts shall be provided. Perimeter pedestal studs shall be provided along the periphery. Pedestal assemblies including pedestal heads shall be weld-free construction, corrosive resistant and shall provide an adjustment range of ±25mm from the specified finished floor heights.

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d) The threaded bright rod with the top head attachments shall be inserted into the studs and shall be adjusted to obtain proper level of the finished floor panels by means of the adjustment nut. The nut shall provide location lugs to engage the pedestal base assembly, such that deliberate action is required to change the height setting. Threaded rod shall provide a specially designed anti-rotation device, such that when the head assembly is engaged in the base assembly, the head cannot freely rotate.

e) The pedestal head shall have an anti vibration PVC cap for panel and stringer location. Stringers shall support each edge of panel. The stringers shall have counter sunk holes at both ends to accommodate bolting of M6 machine screws to the pedestal head assembly. Stringers shall be individually and rigidly fastened to the pedestal with one machine screw for each end of stringer. Bolts shall provide positive electrical contact between the stringers and pedestals. Stringer grid shall ensure maximum lateral stability in all directions. All the field cut panels shall be installed with an appropriate PVC end cap specially designed to accommodate the stinger and arrest Panel beam movement and will ensure the integrity and stability of the system.

5.3.6 Installation of floor panels

a) Floor panels shall be placed over the stringer channels and bolted to pedestal head. All four edges of panels shall be finished with black conductive 5mm wide PVC edge beadings. These edge beadings are glued and sealed in place to avoid detachment.

Floor panels which are field cut (at ends, Console/ Rack location etc.) shall be marked with positional numbering on the underneath and the adjoining wall. The finished floor panels shall be perfectly levelled and aligned without any gaps in between the panels.

b) All accessories such as outlet boxes and grommets as required, Panel lifters (at least one for each building, one number for every 500 Square meter of access floor area) etc. shall be provided in accordance with approved Manufacturer's recommendations.

c) Each individual panel shall be removable for the purpose of maintenance of the cavity. Panel shall be easily removed by one person with a lifting device and shall be fully transferable and totally inter changeable and replaceable in any of the 4 directions at 90 degrees increments, except where cut for special conditions.

d) Necessary cut-outs shall be made in the panels for cable routing, control panel fixation etc. as per drawing.

e) Necessary ramps, slopes, steps etc. shall be also provided for as per drawing with raised access floor components as per approved manufacturer recommendations.

f) Around a control panel/rack, the residual space left out shall be filled up with cut panels of uniform size as required to fully close the gap between the adjacent full panel and the control panel base channel. In this case the part floor panel shall extend upto the full width of the base channel and the cut size shall be determined accordingly. An additional structural steel framework shall be provided along the cut out on which the edge of the floor panel shall rest and over which the base channel of control panel shall be placed.

g) Earth bonding of the system shall be in accordance with approved Manufacturer's standard practice as approved by the Engineer-In- Charge. After completion of the floor and association services, tests shall be arranged to demonstrate that the floor is electrically continuous and fully earth bonded. Points chosen for testing shall include randomly selected pedestals, stringers tops and bottoms of panels, etc.

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6.0 PARTITIONING

Partitioning shall rigid, stable, true to the plumb and in accordance with design and approved drawings for all heights.

6.1 GYPSUM BOARD PARTITIONING

Partitioning shall be of gypsum partition boards fixed on galvanized steel frame work. The partitions shall be rigid and stable.

6.1.1 Gypsum partition boards

Gypsum partition boards shall conform to IS : 2095 and shall have following properties. Overall thickness of the finished partition shall be minimum 75 mm.

Sr. No.	Item/ Property	Specification
1	Board Thickness	12.5 mm
2	Dimension tolerances	+- 0.5 mm
3	Fire Properties	Non combustible as per BS 476 part 4

6.1.2 Partition frame

Partition framework shall be in accordance with standard system of the approved Manufacturer and shall consist of profiled floor & ceiling sections and vertical sections of power pressed/ roll formed galvanized steel (minimum 120 gsm, both side inclusive as per IS:277). Minimum thickness of the sections shall be 0.5 mm.

6.1.3 Installation

6.1.3.1 Installation of the system shall be in accordance with standard practice of the approved Manufacturer's, approved fabrication drawings (prepared by the Contractor) and following specification.

6.1.3.2 Thickness, size, spacing of the frame sections shall be as required for desired height in accordance with recommendations/ standard practice of the approved Manufacturer.

6.1.3.3 Floor and ceiling sections shall be fixed with fasteners of 12.5 mm diameter, 50 mm length @ 600 mm c/c. Vertical sections shall be fixed in the floor and ceiling sections @ 610 mm c/c.

6.1.3.4 Gypsum partition boards shall be fixed on both sides of the framework by drywall screws @ 300 mm c/c.

6.1.3.5 All vertical and horizontal joints of the boards shall be staggered to avoid cracks with provisions of galvanized steel sections fixed to the vertical sections at the horizontal joints of the boards.

6.1.3.6 The jointing and finishing of the boards shall be finished using approved jointing compound, paper tape, metal corner tapes etc. and two coats of primer suitable for the boards.

6.1.3.7 Arrangements of wires/ conduits running through the cavity of the system shall be made. Cut/outs, openings for doors, windows, switches etc. shall be made with necessary framing/ stiffening of the openings.

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6.1.3.8 Gypsum plaster boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified. If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour

7.0 MEASUREMENT

7.1 Measurement of false/ suspended ceiling system shall be measurement of actual surface area covered by the ceiling boards/ panels/ tiles.

7.2 Measurement of underdeck insulation system shall be measurement of actual surface area covered by insulation slab/ roll/ board.

7.3 Measurement of false/ raised floor system shall be measurement of actual surface area covered by floor panels.

7.4 Measurement of partitioning system shall be measurement of actual surface area covered by partition boards of one side.

7.5 Area of cut our/ openings for door/ window, various fittings etc. shall be deducted.

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अग्निरोधक दरवाजों, खिड़कियों व पार्टीशन के लिए मानक विनिर्देशन

STANDARD SPECIFICATIONS FOR FIRE CHECK/ FIRE RESISTANT DOORS, WINDOWS & PARTITIONS

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Abbreviations:

ASTM	: American Society for Testing and Materials
BS	: British Standards
CBRI	: Central Building Research Institute
EN	: European Standards
IS	: Indian Standard
ISO	: International Organization for Standardization
GI	: Galvanized Iron
NABL	: National Accreditation Board for Testing and Calibration Laboratories
NBC	: National building Code
NFPA	: National Fire Protection Association
PVC	: Polyvinyl Chloride
PUF	: Polyurethane foam
SS	: Stainless Steel
UL	: Underwriters Laboratories
CuM	: Cubic Meter

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1.0 GENERAL

This standard specification lays down requirements of fire rated/ check/ resistant door, window and partition assemblies intended to provide safety and safe exit from buildings in case of fire.

2.0 REFERENCES

2.1 The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.2 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.3 Reference codes and standards:

Standards	Document title
IS 2095, Part-I	Gypsum plaster boards – plain gypsum plaster boards
IS 3614	Fire Doors and Doorsets - Specification
IS 16945	Fire resistance test for glass walls
IS 16947	Fire resistance tests for doors with glass panes, openable glass, glass windows and sliding glass doors
IS 277	Galvanized steel sheets (plain and corrugated)-Specification
IS 287	Permissible moisture content for timber used for different purposes-Recommendations
IS 513	Cold reduced low carbon Steel sheet and strip
IS 8183	Bonded Mineral Wool - Specification
IS 14862	Fibre Cement Flat Sheets — Specification
BS 476, Part- 4	Fire tests on building materials and structures. Non-combustibility test for Materials.
BS 476, Part- 7	Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products.
BS 476, Part- 20	Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction. (general principles).
BS 476, Part- 22	Fire tests on building materials and structures. Method for determination of the fire resistance of non-load bearing elements of construction.
BS 6206	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.
SP-7 (Part-40)	National Building Code of India – part-4 – Fire & life safety
EN-1363-1	Fire resistance tests. General requirements
EN-1364-1	Fire resistance tests for non-load bearing elements. Walls
EN 1634-1	Fire resistance and smoke control tests for door and shutter assemblies, openable windows and elements of building hardware. Fire resistance test for door and shutter assemblies and openable windows
EN 10346	Continuously Hot Dip Coated Steel Strip And Sheet Products.
EN 12600	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings.
ISO 834-1	Fire resistance tests: Elements of Building construction- General requirement.
ISO 3008	Fire resistance tests: Door and shutter assemblies, Part 1: General requirements.
ISO 3009-1	Fire-resistance tests: Elements of building construction: Glazed elements.

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3.0 FIRE CHECK/ RESISTANT/ RATED DOORS, WINDOWS & PARTITIONS

3.1 Fire check/ resistant/ rated door, window & partition assemblies (termed as "Fire doors, windows, partitions" hereafter) shall be of fire resistance/ rating and type (wooden/ metallic/ glazed etc.) mentioned in the drawings, job specification, item descriptions etc. and shall be complete assembly with frame, shutter/ leaves, glazing, partition panel, hardware etc.

3.2 If type and fire resistance/ fire rating is not specifically mentioned in the drawings, job specification, item descriptions etc., following types of fire doors/ windows/ partitions shall be provided.

Doors:

Steel fire doors having fire resistance/ fire rating of two hours (120 minutes) for Integrity and 30 minutes for insulation.

Windows:

Fully glazed fire windows having fire resistance/ fire rating of two hours (120 minutes) for Integrity and 20 minutes for insulation.

Partitions:

Solid type fire partitions made of calcium silicate board having fire resistance/ fire rating of two hours (120 minutes) for Integrity and insulation.

3.3 The fire doors, windows and partitions shall be in accordance with test certificate or test validity or evaluation report or assessment report (termed as "test report" hereafter) with regards to fire resistance/ rating, material, design, construction, dimension, sizes etc. and shall be complete assembly with frame, shutter/ leaf, glazing, partition panels and hardware.

3.4 Each Fire door, window & partition shall be provided with appropriate label mentioning name of the Manufacturer, fire rating, and year of Manufacturing/ installation.

4.0 TESTING AND CERTIFICATION

4.0 Prototype/ type test repot shall be submitted for each type (such as wooden, steel, glazed etc.), size range and fire resistance / rating of fire doors, windows and partitions.

4.1 Testing for fire resistance / rating of steel and wooden doors shall be done by subjecting a full size construction to test in accordance with the procedures laid down in ISO 3008 or BS 476: part 22.

4.2 Testing for fire resistance/rating of glazed doors, windows and partitions shall be done by subjecting a full size construction to test in accordance with the procedures laid down in following codes as applicable:

1. EN 1634-1
2. EN-1364-1
3. ISO 3009
4. BS 476 : part 20, part 22
5. IS 16945
6. IS 16947

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4.4 Testing for fire resistance / rating of solid type partition shall be done by subjecting a full size construction to test in accordance with the procedures laid down in BS 476 : part 20 and part 22.

4.5 Hardware if not tested with the door/ window/ partition, shall be type tested or shall be certified for use on specified fire rated door/ window/ partitions.

4.6 These prototype/ type test reports shall be issued by CBRI or NABL accredited laboratories or renowned National/ International Laboratories/ Test houses. Certifications of hardware shall be by renowned national/ international certification agencies.

4.7 The prototype/ type test certificate/ certifications etc. shall be valid at the time of submission and shall not be older than five years and shall be submitted by the supplier or manufacturer.

4.8 In case of change in design, material, construction, increase in dimensions (width, breadth, height, overall perimeter) or area of the complete assembly (including frame, shutter/leaves, glazing, partition panels and other individual components) as mentioned in the submitted prototype/ type test report, test reports appropriate to the changes shall be submitted.

4.9 However, refer to specific clauses of this specification pertaining to various type of doors, windows and partitions for allowable changes with respect to clause no 4.8

5.0 MATERIAL

5.1 Timber

Timber and timber boards/ composite material used in the construction of the fire doors shall be of thoroughly seasoned hardwood. The moisture content of any material used in the construction including frame and shutter shall not be more than 15 percent, in accordance with IS 287.

5.2 Calcium Silicate board

Calcium Silicate board shall conform to IS 14862 and shall have following properties:

Density	Not more than 900 kg/ cuM
Material class	Non-combustible, in accordance with BS 476: Part 4
Surface spread of flame	Class 1 in accordance with BS 476: Part 7
Thermal conductivity	K factor - 0.15W/mK
Nominal Mixture content (air-dried)	<15%

5.3 Fire Resistant Gypsum plaster board

Fire Resistant Gypsum Plaster boards shall conform to IS 2095 Part 1 and BS- 1230 (Part-1). Density shall be minimum 960 Kg/cuM (+/- 50).

5.4 Galvanized steel sheet

Galvanized steel sheet shall be zinc coated, alloyed type and shall conform to IS 277. The coating weight shall meet or exceed the minimum requirements for coatings of 120 gram/ square meter, total of both sides.

5.5 Cold rolled low carbon steel sheet

Cold rolled low carbon steel sheets shall conform to IS 513 or EN 10346. Drawing quality shall be DX52D and shall have following properties:

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Property	Value
Yield strength	Minimum 255 MPa
Tensile strength	Minimum 350 Mpa
Elongation	Minimum 38.5 %

5.6 Glass

The glass panels shall be clear, non-wired, interlayered and toughened type suitable for required fire rating/ resistance of the door/ window / partition assembly.

Each Glass panel shall carry a non-removable marking with the name of the product & the manufacturer inscribed on it.

Thickness of glass lesser than the thickness mentioned in the test report shall not be permitted.

Increase in width, height and overall area of the glass, when compared to dimensions mentioned in the test report shall also be not permitted.

Make, size and thickness of the glass panels shall be as mentioned in the test report for required assembly (door/ window/ partition) of required fire rating and shall have following properties.

Property	Value
Impact resistance	Minimum 2B2 category (When tested in accordance with EN 12600)
Light transmission ratio	Minimum 85% (When tested in accordance with EN 410)

5.7 Insulation

Insulation or infill material shall be resin bonded like resin bonded honeycomb paper core, mineral wool or ceramic wool as mentioned in the test report. Proprietary material may be used, provided they satisfy the requirement of fire resistance/ rating and is mentioned in the test certificate.

Polyurethane foam (PUF) shall not be permitted as infill or insulation material.

Mineral wool and Rock Wool used for insulation shall conform to IS 8183 and density shall be minimum 48Kg/ CuM. Higher density of insulation is permitted.

5.8 Fire & smoke seal

Fire & smoke seals shall be of the same dimensions and configuration as mentioned in the test report.

6.0 WOODEN FIRE DOORS

6.1 Wooden fire doors shall conform to IS: 3614 and this specification. In case of contradiction, this specification or decision by Engineer- In-Charge shall govern.

6.2 Door assembly

6.2.1 The door assembly including door frame, shutter/ leaf, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/

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rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

6.2.2 Door frame

Door frames shall be of first grade teakwood and shall be fixed in position by means of anchor fasteners on jambs and head member. Sizes and profiles of the members of the frames shall be as mentioned in the test report. Intumescent fire and smoke seal shall be fitted in the frame in accordance with test certificate.

6.2.3 Door shutter/ leaves

Door shutters/ leaves shall be non-metallic and asbestos free type. They shall be composed of Calcium Silicate boards on both sides and insulation core. Overall thickness of the shutter, thickness of insulation and thickness of calcium silicate boards shall be as mentioned in the test report.

The shutter composition shall have painted/ polished teak wood lipping around the periphery fitted with intumescent fire & smoke seal in accordance with test certificate. The intumescent fire seal may not be required at the bottom of the door leaf.

If not mentioned otherwise, vision panels shall be provided in the door shutters.

6.3 Finishing

The door frames and teak wood lipping around the periphery of the shutters shall be finished with approved quality fire resistant paint conforming to IS 12777 including primer in desired colour.

Both sides of the door shutters/ leaves shall be faced with 3mm thick commercial ply finished with either 1mm thick laminate of approved color, texture and design, or teak ply (finished with fire retardant transparent paint conforming to IS 12777) as mentioned in the drawings, job specification, item descriptions etc.

If finishing of door shutter/ leaf is not specifically mentioned in the drawings, job specification, item descriptions etc., laminate finishing shall be provided.

6.4 Hardware

Reference shall be made to clause no 13.0

6.5 Fire resistance/ rating

If not mentioned otherwise, wooden fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 30 minutes for insulation.

7.0 STEEL FIRE DOORS

7.1 Steel fire doors shall conform to IS: 3614 and this specification. In case of contradiction, this specification or decision by Engineer- In-Charge shall govern.

7.2 Door assembly

7.2.1 The door assembly including door frame, shutter/ leaf, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/

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rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

7.2.2 Door frame

Door frames shall be of galvanized steel sheet press formed to required profile. The minimum sheet thickness for frames shall be 1.2 mm (18 gauge) for frame depth upto 150mm. for depth of frame higher than 150 mm, minimum sheet thickness shall be 1.6 mm (16 gauge).

Dimensions and profile of the door frames shall be as mentioned in the test report. However, increase in sheet thickness and frame profile size (compared to the test certificate) is permitted

Door frame shall be provided with stiffeners for hardware/ lock mounting and for fixing of fasteners. Necessary provisions for fixing fire/ smoke seal shall also be kept in the frame.

Hollow door frames shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Door frames shall be fixed in position by means of anchor fasteners on jambs and head member.

7.2.3 Door Shutter/ leaf

Door shutters shall be minimum 45 mm thick with outer skins made of minimum 1.2 mm (18 gauge) thick galvanized steel sheet with infill/ insulation. Internal construction of the shutter shall be provided with rigid reinforcement in addition to the core/ infill. Rigid reinforcement pads shall be provided for receiving hardware like hinges, locks, door closers etc.

Higher thickness of the outer screens (compared to the test certificate) is permitted.

Double leaf shutters shall be provided with astragals.

Intumescent seals shall be provided on all three sides of the leaves and on the meeting stiles of the double leaf door or as per test certificate. Alternatively, the same can provided on the frame and meeting stile of the double leaf door.

If not mentioned otherwise, vision panels shall be provided in the shutters/ leaves.

Louvers shall be provided in the shutters/ leaves if mentioned specifically and test report of the doors with louver is available.

7.3 Finishing

The frame and the shutters shall be finished with minimum 50 microns powder coating in desired colour.

7.4 Fire resistance/ rating

If not mentioned otherwise, steel fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 30 minutes for insulation.

7.5 Hardware

Reference shall be made to clause no 13.0.

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8.0 VISION PANEL

Glass for vision panels shall be in accordance with test certificate Maximum area of vision panel shall be 0.06 square meter. Maximum width shall be 200 mm, maximum height shall be 400mm.

In case of change in glass with respect to test report, the changed glass shall be appropriate to the specified fire resistance/ rating and supporting test report of the changed glass shall be submitted.

9.0 LOUVERS

Louvers shall be in accordance with test certificate when tested as a complete assembly on the fire door. Maximum area of the louvers shall not exceed 0.135 square metre. Maximum width and height shall be 300 mm and 450 mm respectively.

10.0 GLAZED FIRE DOORS

10.1 Door assembly

10.1.1 The door assembly including door frame, shutter/ leaf, stiles, rails, glazing, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

10.1.2 The glazed fire doors shall be fully glazed type with required frame, shutter/ leaf, stiles, top and bottom rails, insulation, fire & smoke seal, hardware etc. Intermediate middle/ lock rails shall not be provided.

10.1.3 Door Frame

Door frame shall be either of galvanized steel sheet or cold rolled low carbon steel sheet press formed to requisite profile.

Minimum thickness of galvanized steel sheet for frames shall be 1.2 mm (18 gauge) for frame depth upto 150mm. for depth of frame higher than 150 mm, minimum sheet thickness shall be 1.6 mm (16 gauge).

Minimum thickness of cold rolled low carbon steel sheet for frames shall be 1.5 mm.

However, increase in steel sheet thickness (compared to the test certificate) is permitted.

Dimensions and profile of the door frames and frame members shall be as mentioned in the test report. Increase or reduction in dimensions and change in profile when compared to the test report shall not be permitted.

Hollow door frames shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Door frame shall be provided with stiffeners for hardware/ lock mounting and for fixing of fasteners. Necessary provisions for fixing fire & smoke seal shall also be kept in the frame.

Door frames shall be fixed in position by means of anchor fasteners on jambs and head member.

10.1.4 Door Shutter/ leaf

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The shutter/ leaf frame (stiles and rails) shall be shall be either of galvanized steel sheet or cold rolled low carbon steel sheet press formed to requisite profile. Thickness of steel sheet shall be minimum 1.2 mm.

Dimensions and profile of the stiles and rails shall be as mentioned in the test report. Increase in dimensions and change in profile when compared to the test report shall not be permitted.

However, increase in steel sheet thickness (compared to the test certificate) is permitted.

Width of the stile and rail shall not exceed 100mm. In case of bottom rail width/ height may be upto 125mm.

Intermediate middle/ lock rails shall not be provided.

Hollow sections of stiles and rails shall be filled up with insulation as and if mentioned in the test certificate. Even if the insulation filling is not mentioned in the test certificate, such filling is permitted.

Glass shall be single piece and increase in glass panel size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips/ screw etc. in accordance with test reports.

10.2 Finishing

The frame and the shutters/ leaves shall be finished with minimum 50 microns powder coating in desired colour.

10.3 Hardware

Reference shall be made to clause no 13.0.

10.4 Fire resistance/ rating

If not mentioned otherwise, glazed fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

11.0 GLAZED FIRE WINDOW

11.1 Window assembly

11.1.1 The window assembly including frame, glazing, insulation, fire/smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

11.1.2 Specification of window frame shall be similar to the specification of door frame as mentioned in clause 10.0

11.1.3 The glazed fire windows shall be fully glazed type (fixed glazing) with required frame, hardware etc. Glass shall be single piece and increase in glass panel size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips etc. in accordance with test reports.

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11.2 Finishing

The frame shall be finished with minimum 50 microns powder coating in desired colour.

11.3 Fire resistance/ rating

If not mentioned otherwise, glazed fire doors shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

12.0 GLAZED FIRE PARTITION

12.1 Partition assembly

12.1.1 The partition assembly shall consist of metal framework and glass panels in accordance with approved design and pattern.

12.1.2 The partition assembly including frame, glazing, insulation etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

12.1.3 Glazed fire partitions shall be fully glazed unless otherwise mentioned specifically. Specification of partition frame shall be similar to the specifications of door frame mentioned in clause no 10.0. Specification of glass shall be as mentioned in clause 5.5.

12.1.4 Glass shall be single piece in a panel and increase in glass size compared to the size mentioned in the test report shall not be permitted. Glass shall be fixed with beading, clips/ screws etc. in accordance with test reports.

12.1.5 Size of individual glass panels and overall size of the partition shall not exceed the sizes mentioned in the test report.

12.1.6 The partition shall cover the full height and length mentioned in the drawing etc and shall be fixed on top and bottom also. In case, the height and length mentioned in the drawing etc are more when compared to the test report, solid type partition or other construction having fire rating (120 minutes for both integrity and insulation) shall be provided as/ approved design so that dimensions of both glazed and solid partition/ other construction do not exceed the dimensions mentioned in the test report.

12.1.7 Doors provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

12.1.8 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

12.2 Finishing

The partition frame shall be finished with minimum 50 microns powder coating in desired colour.

12.3 Fire resistance/ rating

If not mentioned otherwise, glazed fire partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and 20 minutes for insulation.

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13.0 HARDWARE

13.1 Fire Doors, windows and partitions shall be provided with all required hardware for stability, proper operability and safety ensuring the fire resistance / rating.

13.2 All hardware used on Fire doors, windows and partitions shall be fire rated and certified except for hinges, if it is of minimum 100 mm x 75 mm x 3 mm size and in stainless steel of grade 304 and above. Similarly, pull handles may not require specific fire rating if it is in stainless steel of grade SS 304 and above.

13.3 All other hardware like locks, panic devices, lever handles, door closers etc. if not tested with the fire door, window or partition shall be type tested and certified for use on those specific fire rated doors, windows and partitions.

13.4 Tower/ flush bolts, Aldrops, side bolts and chain with padlocks shall not be provided in Fire doors. However, in case of double shutter/ leaf doors without panic bar, tower/ flush bolts shall be provided on inactive leaf.

13.6 Fire doors in exits (component of means of egress which is between the exit access and the exit discharge), doors opening into exits, staircase enclosure, exit access and exit discharge shall be provided with following hardware.

Sr. No	Hardware	Specific requirement
1	Hinges	Hinges shall be as per test report, If not mentioned in the test report, hinges shall be as per Manufacturer's standard practice. No. of hinges : 1. For doors upto 2400 mm height – 04 Nos per leaf 2. For doors above 2400 mm height – as per Manufacturer's practice.
2	Panic Bar	1. For single leaf door : - Single point panic bar "push to open" push bar, single leaf type – 01 No. 2. For active leaf of double leaf door : - Single point panic bar "push to open" push bar type – 01 No. 3. For inactive leaf of double leaf door Openable locks, trims with handle for panic bars to operate the bar from outside shall also be provided.
3	Door closer	Heavy duty type - 01 No. per leaf
4	Door Stopper	Floor mounted, 45 mm dia, half dome in SS 304 grade - 01 No. per leaf
5	Flush/ Tower bolt	Not required for Doors with Panic Bar, in case of double shutter/ leaf doors without panic bar, SS 304 grade, minimum 300mm long concealed tower/ flush bolts shall be provided on inactive leaf at top and bottom.

13.7 Internal fire doors which are not in the exits and do not open into the exits shall be provided with following hardware.

Sr. No	Hardware	Specific requirement
1	Hinges	Hinges shall be as per test report, If not mentioned in the test report, hinges shall be as per Manufacturer's standard practice. No. of hinges : 1. For doors upto 2400 mm height – 04 Nos per leaf 2. For doors above 2400 mm height – as per Manufacturer's

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		practice.
2	Mortice lock	Heavy duty mortice dead lock and D type (SS 304 grade, minimum length 300mm and 22mm dia) handle on both faces (Offset type handle – For all Glazed fire doors) Note: Instead of door handle with mortice dead lock, SS 304 grade lever handle with mortice sash lock on both faces (Offset type handle – For all Glazed fire doors) may be used.
3	Door closer	Heavy duty type - 01 No. per leaf
4	Door Stopper	Floor mounted, 45 mm dia, half dome in SS 304 grade - 01 No. per leaf
5	Flush/ Tower bolt	SS 304 grade minimum 300mm long concealed flush bolt (in inactive shutter of double shutter Doors) at top and bottom.

14.0 SOLID TYPE FIRE PARTITION (Calcium Silicate)

14.1 Partition assembly

14.1.1 The partition assembly shall be made of frame work of galvanized steel or cold rolled low carbon steel sheet profiled horizontal and vertical members, layers of calcium silicate partition boards on both sides and insulation in-fill all as mentioned in the test report in accordance with approved design and pattern. However, increase (when compared to test certificate) in sheet thickness or profile size of steel sections, thickness of insulation, thickness and number of layers of partition) is permitted.

14.1.2 The partition assembly including frame, partition boards, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

14.1.3 Overall size of the partition shall not exceed the sizes mentioned in the test report.

14.1.4 Doors and windows provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

14.1.5 The partition framework shall comprise of vertical studs, intermediate horizontal members, floor and ceiling channels as mentioned in test certificates with regards to material, sizes, thickness, spacing etc.

14.1.6 Minimum thickness of the calcium silicate boards shall be 12mm.

14.1.7 The board's joints shall be staggered, horizontally as well as vertically, to avoid through passage.

14.1.8 Minimum thickness of insulation shall be 50 mm. Insulation material, density etc. shall be as mentioned in test certificates.

14.1.9 Over all thickness of the partition shall not be less than 93 mm and shall be as mentioned in the as mentioned in test certificates. Increase in the thickness is permitted.

14.1.10 If mentioned specifically, this partition system may be used in combination of fire rated glazed partition system with suitable detailing for combining these two partition systems.

14.1.11 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

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14.2 Finishing

14.2.1 Calcium Silicate partition boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified.

14.2.2 If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour.

14.2.3 The calcium silicate boards shall be jointed and finished with jointing compound, fibre tape etc. so as to have a flush and even look after finishing.

14.2.4 Any cut-out (such as for switchbox, AC duct etc.), gap in the periphery on the partition and joints between structural member and partition shall be properly sealed with fire sealant as mentioned in the test certificates or in accordance with Partition manufacturer's standard practice.

14.3 Fire resistance/ rating

If not mentioned otherwise, solid type partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and insulation.

15.0 SOLID TYPE FIRE PARTITION (Gypsum Plaster Board)

15.1 Partition assembly

15.1.1 The partition assembly shall be made of frame work of galvanized steel or cold rolled low carbon steel sheet profiled horizontal and vertical members, layers of fire resistant Gypsum plaster boards on both sides and insulation in-fill all as mentioned in the test report in accordance with approved design and pattern. However, increase (when compared to test certificate) in sheet thickness or profile size of steel sections, thickness of insulation, thickness and number of layers of partition) is permitted.

15.1.2 The partition assembly including frame, partition boards, insulation, fire & smoke seal etc. shall be in accordance with test report which is appropriate to the required type, size and fire resistance/ rating (with regards to material, design, construction, dimensions, size range etc.) and following specification.

15.1.3 Overall size of the partition shall not exceed the sizes mentioned in the test report.

15.1.4 Doors and windows provided in this partition system shall also be fire rated and shall meet the requirements mentioned in relevant causes in this specification.

15.1.5 The partition framework shall comprise of vertical studs, intermediate horizontal members, floor and ceiling channels as mentioned in test certificates with regards to material, sizes, thickness, spacing etc.

15.1.6 Minimum thickness of the fire resistant Gypsum plaster boards shall be 12.5 mm.

15.1.7 The board's joints shall be staggered, horizontally as well as vertically, to avoid through passage.

15.1.8 Minimum thickness of insulation shall be 50 mm. Insulation material, density etc. shall be as mentioned in test certificates.

15.1.9 Even if insulation in-fill is not mentioned in the test certificate, minimum 50 mm thick insulation of density 48kg/cuM shall be provided in the cavity of the framework.

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15.1.10 Over all thickness of the partition shall not be less than 102 mm and shall be as mentioned in the as mentioned in test certificates. Increase in the thickness is permitted.

15.1.11 If mentioned specifically, this partition system may be used in combination of fire rated glazed partition system with suitable detailing for combining these two partition systems.

15.1.12 The partition assembly shall be sturdy, rigid, stable and shall be installed plumb in true alignment.

15.2 Finishing

15.2.1 Gypsum plaster boards on both sides shall be sealed with paper tape, corner edges with metal corner tape and with three-layers of all purpose jointing compound to reinforce the board joints so as to have a flush and even look.

15.2.2 Gypsum plaster boards on both sides of the partition frame shall be finished with painting or laminates etc. as specified.

15.2.2 If finishing type is not specifically mentioned anywhere, acrylic emulsion paint finish conforming to specification of masonry paint finish in adjoining masonry shall be provided in approved colour.

15.2.4 Any cut-out (such as for switchbox, AC duct etc.), gap in the periphery on the partition and joints between structural member and partition shall be properly sealed with fire sealant as mentioned in the test certificates or in accordance with Partition manufacturer's standard practice.

15.3 Fire resistance/ rating

If not mentioned otherwise, solid type partitions shall have fire resistance/ fire rating of two hours (120 minutes) for integrity and insulation.

16.0 INSTALLATION

16.1 Shop drawings of the Fire doors, windows and partitions in accordance to the prototype/ type test report and design drawings shall be prepared and submitted for approval by the Engineer-In-Charge. The shop drawings shall include all details of construction, anchoring, connections, fastenings etc. The fire doors, windows, partitions shall be fabricated in accordance with the approved shop drawings.

16.2 Fire doors, windows, partitions shall be installed by the Manufacturer or agency recommended by the Manufacturer and approved by the Engineer- In-Charge.

16.3 Frames shall be installed plumb, level, rigid and in true alignment and shall be fixed to the adjacent construction so as to retain their position and stability. Fixing of the frames with masonry/ concrete may be done with suitable fasteners. The complete assemblies shall also be installed plumb, level, rigid and in true alignment.

16.4 The maximum allowable gap between the frame and masonry/ concrete work shall not be more than 5-8 mm and shall be sealed with sealant as mentioned in the test certificates/codes & standards or in accordance with the manufacturer's standard practice if not mentioned in the certificates and codes/ standards.

16.5 The door shutters/ leaves, window and partition panels shall be installed and fastened to maintain alignment with frames to achieve maximum operational effectiveness and appearance.

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16.6 Installation of hardware shall be in accordance with hardware Manufacturer's recommendations.

16.7 When the smoke/ fire/ intumescent seals are fitted on site, they shall be fitted strictly in accordance with the Manufacturer's recommendations.

17.0 DELIVERABLES BY THE CONTRACTOR

Following documentation/ drawings shall be furnished by the Manufacturer:

1. Prototype/ type Test Certificate of the door, window and partition assembly from test laboratory/ house.
2. Shop drawings.
3. Specification/ Manufacturer's literature, Test certificates and other documentation for materials and items used in the system.
4. Certificate indicating that design and installation of Doors and hardware as per the test reports submitted.
5. Manufacturer's inspection report
6. Manufacturer's Guarantee.

18.0 GUARANTEE

The door/ window/ partition assembly including all hardware shall be guaranteed for a period of 12 months from the date of installation against any manufacturing defect.

In case of any such defect within the guarantee period, the defected part shall be replaced or repaired as required by the Contractor at his own cost.

19.0 MEASUREMENT

Unless otherwise mentioned, measurement of fire doors, windows and partition shall be as below:

19.1 Fire rated doors shall be measured by area of the doors (inclusive of the frame, fixing arrangement, glazing and all fittings).

19.2 Fire rated windows shall be measured by area of the windows (inclusive of the frame, fixing arrangement, glazing and all fittings).

19.3 Fire rated partition shall be measured by area of the partitions (only one side, inclusive of the frames, partition panels, fixing arrangement, glazing and all fittings. Area of doors, windows and other openings shall be deducted).

19.4 Hardware such as door closer, door stopper, locks and trims, panic bar etc., shall be measured in numbers.

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एल्यूमीनियम समग्र पैनल (एसीपी) क्लैडिंग सिस्टम के लिए मानक विनिर्देश

STANDARD SPECIFICATION FOR ALUMINIUM COMPOSITE PANEL (ACP) CLADDING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
0	03.03.23	ISSUED AS STANDARD SPECIFICATION	SANDEEP	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR

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Abbreviations:

ASTM	:	American Society for Testing and Materials
AAMA	:	American Architectural Manufacturers Association
ACP	:	Aluminium Composite Panel
BS	:	British Standard
BIS	:	Bureau of Indian Standards
EN	:	European Standards
IS	:	Indian Standards
NBC	:	National Building Code of India
PVDF	:	Polyvinylidene Fluoride
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel

Architecture Standards Committee

Convenor: Mr. Samir Das

Members:
Mr. Rajesh Gujral
Mr. Anish Kundu
Mr. Sandeep Sharma
Mr. Maitrayee Majumdar (Strl)
Mr. Charanjeet Singh (Proj.)
Mr. Ravindra Kumar (Construction)

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1.0 GENERAL

This Specification covers requirements of ACP cladding on building facades, building or Architectural or structural elements and as interior or exterior finishing or decorations etc. This specification shall be read in conjunction with project specific job specification.

2.0 REFERENCES

The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document title
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
AAMA 501.1	Standard Test Method For Water Penetration Of Windows, Curtain Walls And Doors Using Dynamic Pressure
AAMA 501.4	Recommended static testing method for evaluating curtain wall & storefront systems subjected to seismic & wind induced interstory drift
AAMA 501.2	Quality assurance & Diagnostic Water leakage field check of Installed storefronts, curtain walls , and sloped glazing systems
ASTM E547	Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential.
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E547	Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential.
EN 485	Aluminium and aluminium alloys - Sheet, strip and plate - Part 1: Technical conditions for inspection and delivery
EN 13501-1	Fire classification of construction products and building elements - Part 1
IS 1608	Metallic materials - tensile testing at ambient temperature
IS 8402	Methods of Sampling and Test for Pressure Sensitive Adhesive Tapes
IS 17682	Aluminium Composite Panel Specification
ISO 868	Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness)

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3.0 MATERIALS

3.1 Aluminium Composite Panel (ACP)

ACP shall be external grade mineral core fire retardant type. The panels shall consist of two outer aluminium alloy skins and mineral filled core in between the skins and shall meet the requirements below:

Property	Specification
Grade of the panel	Grade 3 (external grade mineral core fire retardant ACP) conforming to IS 17682 Or Grade B- s1, d0 conforming to EN- 13501-1
Thickness	Overall thickness – 4 mm (+/- 0.2mm)
Outer skins	0.5 mm thick aluminium alloy sheets of any of the following designations. 1. 3150B with conditions H x 6 or H x 8 conforming to IS 737 2. 3105 with H14/16 conforming to EN485
Mineral core	Minimum 3 mm thick, Non combustible type, comprising of 70% inorganic compound 30% virgin polymer laminated and bonded to outer skins. Density of core – 1.5-1.7 gram/ cubic centimeter
Weight of the panel	Minimum 7.5 Kg per square metre
Tensile strength	Minimum 45 N/ square mm when tested as/ IS 1608 (part 1)
Yield strength	Minimum 38 N/ square mm when tested as/ IS 1608 (part 1)
Elongation %	Minimum 5 when tested as/ IS 1608 (part 1)
Peel strength N/10 mm width	Minimum 6 when tested as/ IS 8402
Coating on front side of aluminium alloy skin	PVDF – Minimum 25 microns Pencil hardness – 2H The coating shall consist of chromate conversion, inhibitive primer and fluoropolymercolour coats in approved colour, texture.
Finishing on backside of aluminium alloy skin	Bare aluminium finish
Peel-off protection	The finished surfaces of ACP shall be factory protected with self adhesive peel-off foil having a thickness of 80 microns.
Profiling of panels	The panels shall be in tray/pan profiles. They shall be adequately reinforced at their back side meeting structural design and deflection criteria.

3.2 Supporting frame work

Materials for supporting framework shall be as tabulated below:

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Aluminium sections and profiles	Aluminium profiles shall be of Aluminium (6063 T 5 grade as per EN 485-2).Permissible deflection shall be L/175. They shall be coated with PVDF (minimum 45microns).
Brackets	Mild steel or Aluminium
Screws and fasteners	Stainless steel (SS), 304 grade
Anchor bolts	Stainless steel (SS), 316 grade
Weather sealant	Non bleeding and non staining type having minimum tearing strength of 4.00 N/ mm and shore A hardness of 24 (as/ ISO 868) as approved by the Engineer-In- Charge.
Structural sealant	In accordance with design load as approved by the Engineer-In-Charge.

Other components of the frame work not listed in the table shall be in accordance with the detail design and specification of the system prepared by the Contractor and approved by Engineer- In- Charge.

4.0 DESIGN AND DETAILING OF ACP CLADDING SYSTEM

4.1 Design, structural analysis and detailing including preparation of fabrication drawings of the complete system shall be done by the Contractor or agencies engaged by the Contractor subjected to approval by the Engineer- In- Charge.

4.2 The design, finished surface (pattern, shape, colour, texture etc.)and detailing shall be in accordance with the drawings, requirements of this specification and other requirements issued by Engineer-In-Charge for the purpose.

4.3 ACP cladding system shall comprise of ACP fixed on background (such as masonry, block-work, RCC, steel etc) by means of supporting framework in accordance with approved design and drawings.

4.4 Design shall also include structural analysis and design of the supporting frame work in accordance with relevant Indian or International codes as mentioned or as agreed by the Engineer-In-Charge considering stability, durability, water tightness and other design conditions.

4.5 Contractor or agency engaged by him shall do and submit all necessary structural analysis, calculations and prepare all detailed fabrication drawings for approval by the Engineer-In-Charge.

4.6 The finished surface shall be either with open type grooves or with closed grooves (silicone filled grooves) as mentioned in drawings, item descriptions etc.

If not mentioned specifically, open type grooves shall be provided.

In both the cases grooves shall be in the pattern / design in accordance with approved design and drawing.

5.0 INSTALLATION

5.1 Installation of the complete system shall be done by agency approved by the Engineer-In-Charge.

5.2 Installation shall be done in accordance with design and drawings approved by the Engineer-In- charge.

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5.3 The finished surface shall be true to the plane, water-tight. The groove lines of panels shall be uniform and truly aligned in the continuity.

5.4 The aluminium profiles of framework shall be fixed to background surface by means of fixing to brackets (fixed to the background surface) with SS bolts and nuts. The brackets shall be with serrations and serrated washers for arresting wind load movement.

5.5 Nylon separators shall be provided to prevent bi-metallic contacts in the system.

5.6 The panels shall be cut to size and shape, routed, corners notched and bent as required. Aluminium cleats shall be fixed to the backside edges of the panels using aluminium pop rivets. The panels shall be fixed to the framework using SS screws.

5.7 The gaps (12 – 16 mm) in between the panels shall be uniform in width.

5.8 In case of closed groove system, the gaps between panels shall be filled up with closure profile, backer rod and weather sealant.

5.9 Gaps upto 10 mm between the peripheral panels and backing surface shall be sealed by inserting adequate sized backer rod and sealant. Gaps more than 10 mm shall be sealed by providing and fixing of 2 mm thick aluminium sheet (finished with 60-8- micron thick super durable polyester coating) flashing profiled as per site requirement.

5.10 The termination of the panels shall be suitably detailed and executed using flashing, bending/ continuing the panels etc. for stopping water ingress.

5.11 Necessary weep holes shall be provided in the system for draining out trapped water/ moisture.

5.12 After the installation is completed, peel-off foils shall be removed from the panels and the panel surfaces shall be cleaned and washed with mild soap water with soft dry cotton cloth.

6.0 TESTING

The completed ACP system shall be tested for water tightness as per following method.

Testing Method	Document title
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
ASTM E331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
AAMA 501.1	Standard Test Method For Water Penetration Of Windows, Curtain Walls And Doors Using Dynamic Pressure
AAMA 501.4	Recommended static testing method for evaluating curtain wall & storefront systems subjected to seismic & wind induced interstory drift
AAMA 501.2	Quality assurance & Diagnostic Water leakage field check of Installed storefronts, curtain walls , and sloped glazing systems
ASTM E547	Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Cyclic Static Air Pressure Differential.

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In case water penetrations are noticed, necessary rectifications shall be done by the Contractor to stop such water ingress as acceptable to the Engineer- In – Charge.

7.0 DELIVERABLES BY THE CONTRACTOR

With regards to documents and drawings, the Contractor shall furnish following deliverables:

1. Structural analysis and calculations
2. Fabrication or shop drawings
3. Test certificates in support of compliance with the specifications.

8.0 WARRANTY

The complete system including ACP, framework, sealants, fittings and fixtures and all components shall be warranted by the Contractor for a period of 5 years. Any defective work or material found within this period shall be repaired/ replaced/ re-done by the Contractor at his own cost.

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STANDARD SPECIFICATION FOR STRUCTURAL GLAZING SYSTEM

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
0	03.03.23	ISSUED AS STANDARD SPECIFICATION	SANDEEP	ANISH MAHALA	SAMIR DAS	SANJAY MAZUMDAR

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Abbreviations:

ASTM	:	American Society for Testing and Materials
AAMA	:	American Architectural Manufacturers Association
BS	:	British Standard
BIS	:	Bureau of Indian Standards
EN	:	European Standards
EPDM	:	Ethylene propylene diene monomer
IS	:	Indian Standards
NBC	:	National Building Code of India
NFPA	:	National Fire Protection Act
PVDF	:	Polyvinylidene Fluoride
RCC	:	Reinforced Cement Concrete
SS	:	Stainless Steel
SHGC	:	Solar Heat Gain Coefficient
UV	:	Ultra Voilet
WWR	:	Window Wall Ratio
VLT	:	Visual Light Transmittance

Architecture Standards Committee

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1.0 GENERAL

This Specification covers requirements of the semi-unitized and unitized Curtain wall Structural Glazing System of buildings. This specification shall be read in conjunction with project specific job specification.

2.0 REFERENCES

The codes and standards listed below contain provisions which through reference in this specification constitute provisions of this standard specification if not specifically mentioned otherwise.

2.1 In case of similar codes of different organizations such as IS, ISO, BS, EN, BS-EN, ASTM, NFPA, NBC etc. conformity with any of the similar codes is acceptable.

2.2 Reference codes and standards:

Standards	Document title
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
ASTM E 331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
AAMA 501.1	Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors Using Dynamic Pressure.
AAMA 501.4	Recommended static testing method for evaluating curtain wall & storefront systems subjected to seismic & wind induced inter story drift.
AAMA 501.2	Quality assurance & Diagnostic Water leakage field check of Installed storefronts, curtain walls, and sloped glazing systems.
ASTM E283	Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
BS 1474	Specification for Wrought Aluminium and Aluminium Alloys for General Engineering Purposes: Bars, Extruded Round Tubes and Sections.
BS 4255	Rubber Used in Preformed Gaskets for Weather Exclusion from Buildings - Part 1: Specification for non-cellular gaskets.
EN 573 -3	Aluminium and aluminium alloys - Chemical composition and form of wrought products - Part 3: Chemical composition and form of products.
EN 13501-1	Fire classification of construction products and building elements - Part 1
IS 3400	Methods of Test for Vulcanized Ruber
IS 8183	Bonded Mineral Wool - Specification
IS 15601	Automotive Vehicles – Flammability requirements
ISO 868	Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness).

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3.0 MATERIALS

3.1 Aluminium Extrusions

3.1.1 Aluminium alloy extrusions, sections and profiles such as Transom, Transom Connector, Mullion, Mullion Sleeve, Glazing insert, Toggle cleat, Pressure plate, Pressure cap, Aluminium bracket, etc. shall be made of Aluminium alloy and temper 6063 T5 or T6 grade as per BS 1474 or EN AW 6060 T66 conforming to EN 573 part-3 as mentioned in drawings, item descriptions or job specifications.

If not mentioned specifically, they shall be made of Aluminium alloy and temper 6063 T5 or T6 grade as per BS 1474.

3.1.2 All extruded aluminium sections exposed to outside environment shall be anodized in approved color to a minimum thickness of 20 microns or shall be PVDF coil / spray coated in approved colour and shade with metallic colours to a minimum thickness of 35 microns as mentioned in drawings, item descriptions or job specifications.

If not mentioned specifically they shall be PVDF coil / spray coated in approved colour and shade with metallic colours to a minimum thickness of 35 microns.

3.1.3 The colour and the finish shall be uniform and free of streaks. The aluminium sections, before coating, shall be suitably cleaned, rinsed, buffed properly and sealed and protected after anodizing / PVDF coating, till the completion of the work.

3.1.4 The members of aluminum extruded sections for mullions, transoms, members of sub frames & sash frames shall be in single piece. Jointing of pieces in length and height shall not be permitted excepting the cases where the required length is more than maximum length as manufactured.

3.2 Glass

3.2.1 The infill glazing panel shall be factory made glazed unit of size, thickness and type and in compliance with climatic zones, vertical fenestration requirements (as mentioned below) for all three incremental energy efficiency levels, i.e. ECBC, ECBC+, and Super ECBC as mentioned in drawings, item descriptions or job specifications.

a) Maximum allowable Window Wall Ratio (WWR) is 40% (applicable to buildings showing compliance using the Prescriptive Method, including Building Envelope Trade-off Method)
b) Minimum allowable Visual Light Transmittance (VLT) is 0.27
c) Assembly U-factor includes both frame and glass area weighted U-factors.

Vertical Fenestration Assembly U-factor and SHGC Requirements for ECBC Buildings in various climates:

	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor ($W/m^2.K$)	3.00	3.00	3.00	3.00	3.00
Maximum SHGC Non-North	0.27	0.27	0.27	0.27	0.62
Maximum SHGC North for latitude $\geq$ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.27	0.27	0.27	0.27	0.62

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Vertical Fenestration U-factor and SHGC Requirements for ECBC+ buildings and Super ECBC buildings in various climates:

	Composite	Hot and dry	Warm and humid	Temperate	Cold
Maximum U-factor ($W/m^2.K$)	2.20	2.20	2.20	3.00	1.80
Maximum SHGC Non-North	0.25	0.25	0.25	0.25	0.62
Maximum SHGC North for latitude $\geq$ 15°N	0.50	0.50	0.50	0.50	0.62
Maximum SHGC North for latitude < 15°N	0.25	0.25	0.25	0.25	0.62

3.2.2 However, as a minimum requirement, glass shall be toughened type and 6mm thick.

3.3 Gaskets

3.3.1 Gaskets and seals shall be of approved quality compatible with substrates, finishes and other components they are in contact with. All gaskets exposed directly on the exterior face shall be silicon gaskets, which are UV resistant. They shall not degenerate, discolour or leach on exposure to solar radiations/ rains/ pollutants etc.

3.3.2 Gaskets shall have following properties:

Property	Value	Reference code/ standard
Material	Microwave cured EPDM	BS 4255
Performance capability	Temperature range of -40 Deg C to +120 Deg C	-
Fire resistance (Horizontal burning)	Not exceeding 35 mm/Minute	IS 15601
Fire resistance (Vertical burning)	Not exceeding 15 mm/Minute	IS 15601
Heat stability, mechanical properties etc	Compliance with reference code/ standard	IS 3400
Ozone resistance	Passing the test for 200 hours	-

3.4 Sealants

3.4.1 Sealants shall be in conformity with the performance requirements specified in job specification etc. as per the recommendations of the sealant manufacturer and as approved by the Engineer-In-Charge.

3.4.2 Structural sealant

The silicone bite for the structural sealant shall be designed for the design loads as specified and likely to come during the life of the curtain glazing system. It shall be two part pump-filled Silicone sealant.

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3.4.3 Weather sealant

Weather sealant shall be Non bleeding and non staining type silicone sealant having minimum tearing strength of 4.00 N/ mm and shore A hardness of 24 (as/ ISO 868) as approved by the Engineer-In- Charge.

3.5 Fire smoke seal

Smoke seal/fire stop using extruded aluminum channel with cap shall be provided for continuous structurally glazed framing system. The thickness of channel shall be 2 mm and material and coating finish shall be similar to extruded profile section as per clause no. 3.1.

3.6 Insulation on spandrel panel

Insulation on spandrel system shall be 50 mm thick semi-rigid fibre glass wool insulation panel of minimum density of 48 kg per cubic metre conforming to IS 8183 and 1.5 mm thick anodized (10 microns) solid aluminium sheet tray by using suitable stainless steel rivets/ nuts, bolts and washers to hold the insulation panel in position.

3.7 Flashing

All flashings shall be made from minimum 1.0 mm thick solid aluminium sheet anodized to a minimum thickness of 10 microns. It shall be fixed using stainless steel screws dipped in weather silicone sealant or by welding,

3.8 Aluminium decorative capping

Aluminium decorative capping etc. shall be made out of extruded profile section and material and coating finish per clause no. 3.1 and as per approved design.

3.9 Brackets/supports

The brackets shall have suitable lengths and sections to align curtain glazing in one face, as required as per the Architectural drawings. The brackets shall be fabricated from M.S rolled sections / plates to have the design strength. The quality of the weld shall also be ensured as per the standards. These shall be provided corrosion protection treatment by Hot Dipped Galvanizing. The mass of the zinc coating to be not less than 610 gm. per sqm of steel area to be galvanized.

Each bracket shall be fixed to the R.C.C using anchor fasteners of suitable capacities and in numbers as required as per the design requirements. The brackets shall be fixed to the structural steel members of the building using stainless steel bolts & nuts / fasteners of required capacity and in numbers as per the design requirement.

3.10 Fasteners

Bolts, anchors and other fastening devices like screws, nuts, washers etc. shall be of stainless steel and of approved types as required for the strength of the connections, shall be self-locking, unless otherwise specified.

Anchor fasteners shall be of stainless steel grade 316. Screws, Nuts, Bolts, Washers shall be of stainless steel grade 304. Rivets, toggles and the like shall be of stainless steel grade 304.

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3.11 Fittings

All hardware and fittings such as patch fittings, handles, locks, stay-arms, floor springs, friction stays etc. for doors , windows and open able panels shall be of heavy duty type and of approved make as specified.

Hinges for open able panels shall be heavy duty top hung stainless steel friction hinges selected for specified wind load and dead loads.

3.12 Others

Other materials not mentioned above shall be in accordance with the detail design and specification of the system prepared by the Contractor and approved by Engineer- In- Charge.

4.0 DESIGN AND DETAILING OF STRUCTURAL GLAZING SYSTEM

4.1 Design, structural analysis and detailing including preparation of fabrication drawings of the complete system shall be done by the Contractor or agencies engaged by the Contractor subjected to approval by the Engineer- In- Charge.

4.2 The design and detailing shall be in accordance with the drawings, requirements of this specification and other requirements issued by Engineer-In-Charge for the purpose.

4.3 Design shall also include structural analysis and design of the supporting frame work in accordance with relevant Indian or International codes as mentioned or as agreed by the Engineer-In-Charge considering stability, durability, water tightness and other design conditions.

4.4 Contractor or agency engaged by him shall do and submit all necessary structural analysis, calculations and prepare all detailed fabrication drawings for approval by the Engineer-In-Charge.

4.5 The system shall consist of structural framing and supporting system to support glazed/non glazed panels including transoms, mullions, vision panels and spandrel panels, openable top hung window, swing glazed doors, decorative capping, fire & smoke seal, flashing including gaskets, sealants, fasteners, brackets, necessary fittings & accessories as part of the system in accordance with approved design and drawings.

4.6 The System shall be designed for maximum design wind pressure and lateral forces, moments, stresses, deflections, thermal expansion, weather resistant etc. (test pressure equivalent to 1.5 time the maximum design wind pressure) considering stability, durability, water tightness and other design conditions.

4.7 The System shall be designed with air pressure equalization chamber and concealed continuous gutter vertically and horizontally at all levels as self drainage barrier to achieve water tightness besides providing EPDM gaskets on the frame and EPDM gasket/ sealant on the external groove as air and water barrier.

4.8 The system shall be designed to meet the requirements of thermal performance.

4.9 The system shall be aesthetically pleasant and in accordance with approved design.

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5.0 FABRICATION, PROCURMENT & TRANSPORTATION

5.1 Fabrication including procurement & transportation of all material shall be done in accordance with the approved system design, detailing & drawings and requirements the specification (s).

5.2 Before fabrication, Contactor or agency shall conduct the site survey prior to and after preparation of shop drawing and accommodating the site conditions in the system at appropriate levels etc shall lies solely with the agency executing the work.

5.3 Before the fabrication and site installation is taken up and after the approval of shop drawings by the Engineer-in-Charge, a mock-up of the system shall be prepared by the Contractor. The mock-up shall be essentially put up at site for final approval of all materials and installation details by the Engineer-in-Charge. It shall be dismantled and taken away by the contractor as directed by the Engineer-in-Charge.

5.4 The system shall be erected on extruded main frame & transom fixed on supporting system at site. The panels shall be supplied and fabricated with the specified glass on the secondary frame at factory.

5.5 Factory made glazing units /components shall be transported , handled, stored in a manner to prelude damage of any nature.

5.6 All materials delivered to site shall be stored in allocated spaces where it shall not be exposed to rainwater, moisture or damage. All Material shall be stored neatly and properly handled . Defective/damaged components shall be replaced by contractor.

6.0 INSTALLATION

6.1 Installation of the complete system shall be done by agency approved by the Engineer-In-Charge.

6.2 Installation shall be done in accordance with approved design and drawings.

6.3 The finished surface shall be true to the plane and water-tight. The lines of panels shall be truly aligned in the continuity or as per drawings.

6.4 The aluminium profiles of framework shall be fixed to building structure and background surface by means of fasteners as per approved design and drawing.

6.5 Nylon/ inert polymeric material separators shall be provided to prevent bi-metallic contacts in the system.

6.6 Transom connectors shall be fixed to the mullions using screws/ other suitable method as recommended by the system supplier. Mullion Sleeve shall be used in mullion-mullion joints.

6.7 Glazing gaskets shall be installed and compressed into the cavity as applicable.

6.8 The glazing panels shall be cut to size and shape, routed. Glass shall be fixed using pressure plate (with gaskets)/ any other approved vendor detail on horizontals and verticals. There shall be provisions of Horizontal and Vertical Capping as per the design intent.

6.9 The gaps (12 – 20 mm) in between the panels shall be uniform in width.

6.10 The gaps upto 10 mm between the peripheral panels and backing surface shall be sealed by inserting adequately sized backer rod and weather sealant. Gaps more than 10 mm shall be

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sealed by providing and fixing of 2 mm thick aluminium sheet (finished with 60-8- micron thick super durable polyester coating) flashing profiled as per site requirement.

6.11 The cover caps shall be clipped on to the pressure plates and secured by screws where recommended by manufacturer.

6.12 The termination of the panels shall be suitably detailed and executed using flashing, bending/ continuing the panels etc. for stopping water ingress.

6.13 All the joints in aluminium framing system and factory glazed panels shall be fully sealed and made air, water and weather tight preventing seepage of rain water under heavy wind pressures.

6.14 Gap between the building face and structural glazing system at soffit level between the successive floors shall be closed with required fire rated fire stop cum smoke seal.

6.15 After the installation is completed, panel surfaces shall be cleaned with soft dry cotton cloth.

7.0 DELIVERABLES BY THE CONTRACTOR

With regards to documents and drawings, the Contractor shall furnish following deliverables:

1. Structural analysis and calculations
2. Fabrication or shop drawings
3. Test certificates in support of compliance with the specifications.
4. Samples for materials, components, accessories.
5. Product data sheets, installation & maintenance manuals.
6. Mock-up of complete structural glazing system including glass depicting all important components
7. U-Value Calculation for the proposed Glazing.
8. U-Value (composite) calculation for the proposed structural glazing system including glazing and framework.
9. Report on Stability analysis of Glazing panel of all sizes.

8.0 TESTING

The following performance tests are to be conducted on structural glazing system if area of structural glazing exceeds 2500 Sqm from the certified laboratories accredited by NABL (National Accreditation Board for Testing and Calibration Laboratories) or Department of Science & Technologies, India.

1.	Performance Laboratory Test for Air Leakage Test (-50pa to -300pa) & (+50pa to + 300 pa) as per ASTM E-283-04 testing method for a leakage limit of 1 to 200 mVhr.
2.	Static Water Penetration Test (50 pa to 1500 pa) as per ASTM E -331-09 testing method for a range up to 2000 ml.
3.	Dynamic Water Penetration (50 pa to 1500 pa) as per ASTM E -331-09 testing method for a range upto 2000 ml.
4.	Structural Performance Deflection and deformation by static air pressure test (1.5 times design wind pressure without any failure) as per ASTME-330-10 testing method for a range upto 50 mm.
5.	Seismic Movement Test (upto 30 mm) as per AAMA 501.4-09 testing method for Qualitative test. Tests to be conducted at site.
6.	Onsite Test for water leakage for a pressure range 50kpa to 240 kpa (35psi) upto 2000ml.

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9.0 WARRANTY

The complete structural glazing system including Glazing, framework, sealants, fittings and fixtures and all components shall be warranted by the Contractor for a period of 10 years. Any defective work or material found within this period shall be repaired/ replaced/ re-done by the Contractor at his own cost. In case of any damage, water leakage etc. due to deficiencies in design, materials and workmanship, the contractor shall replace or rectify the damaged works at his own cost to the acceptance of approving authority.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL AND STRUCTURAL WORKS

सामान्य परिधि
GENERAL SCOPE

Rev No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	28.02.2025	REVISED AND REISSUED AS SPECIFICATION	RVA	VIKRAM	AS	MN
5	04.07.2019	REAFFIRMED AND REISSUED AS SPECIFICATION	AVM	AJS	RS	RKT
4	28.03.2013	REAFFIRMED AND REISSUED AS SPECIFICATION	AJS	RS	PKM	DM
3	26.02.2008	REAFFIRMED AND REISSUED AS SPECIFICATION	PKB	PKM	VK	VC
2	08.06.2001	REAFFIRMED AND REISSUED AS SPECIFICATION	DPN	RPM	SCJ	MI
1	02.03.1994	ISSUED AS STD. SPECIFICATION		HM	GPL	AS

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Abbreviations:

IS : Indian Standards

Structural Standards Committee:

Convenor: Mr. Anurag Sinha

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Mr. Charanjit Singh (Projects)
Mr. Indrajit Neog (Construction)
Ms. Papia Mandal
Mr. Vikram Kumar Gupta

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1. These specifications establish and define the material and constructional requirements for CIVIL and STRUCTURAL WORKS.

2. Methods of measurements are indicated in these specifications; however, if not specified, latest revision of IS 1200 shall be applicable.

3. Providing and operating all necessary measuring and testing devices/ equipments including all materials and consumables are included in the scope of work. No separate measurement or payment for testing the quality of work and materials shall be made; rates quoted for various items shall be deemed to include the cost of such tests which are required to ensure achievement of specified quality.

4. All materials shall be of standard quality, manufactured by renowned concerns conforming to Indian Standards or equivalent, and shall have IS mark as far as possible unless otherwise approved by the Engineer-in-Charge. Wherever Vendor List is attached in the Tender document, the same shall be followed. The Contractor shall get all materials approved by the Engineer-in-Charge prior to procurement and use. The Contractor shall furnish manufacturer's certificates for the materials supplied by him when asked for. Further to that he shall get the materials tested from an approved test house if asked for by the Engineer-in- Charge. The cost for all the tests and test certificates for the material procured by the Contractor shall be borne by the Contractor. No separate payment shall be made for the testing. The Engineer-in-Charge shall have the right to determine whether all or any of the materials are suitable. Any materials procured or brought to site and not conforming to specifications and satisfaction of the Engineer-in-Charge shall be rejected and the Contractor shall have to remove the same immediately from site at his own expense and without any claim for compensation due to such rejection.

5. Wherever referred to in the tender document, only the latest version of BIS Specifications, Codes of Practice, etc. shall be applicable.

6. Wherever the Contractor executes civil and structural works involving buildings, equipment foundations, supporting structures, pipe racks, etc., the following works are deemed to have been included in the quoted rates for various works.

   - Marking of centre lines of foundations etc.
   - Establishing layout and levels of foundations and superstructure etc., including establishment of reference lines, bench marks on various floors, platforms etc.
   - General upkeep of the construction site, till completion of works and handing over.
   - Preparation of BBS.
   - Preparation of Fabrication drawings and getting approval from Engineer-in-Charge after incorporating all the comments.
   - Preparation of "As-Built" scheme of civil-structural drawings indicating constructed details including levels, centre lines, layouts, member sizes, MTO etc. complete.

7. The provisions of Schedule of Rates, specifications and drawings shall be read in conjunction with each other and in case of conflict amongst them, clarification shall be obtained from the Engineer-in-Charge whose decision shall be final and binding. However, the following procedure may generally be followed:

   - Description of items in schedule of rates shall be followed when provisions therein are different from those in specifications.

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- Where the description of item does not call for some specific requirement but the same is given in specifications, the specifications shall be followed in addition to the requirement given in description of item.

- Where drawings call for requirements different from or additional to those given in item description and specifications, the decision of the Engineer-in-Charge shall be obtained as to what shall be followed.

- All relevant General notes and Safety notes shall be followed

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सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

सामग्री
MATERIALS

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
7	13.03.25	UPDATED & REISSUED	MI	AJS	ANURAG SINHA	M. NANDI
6	25.02.21	UPDATED & REISSUED	TK	AJS	AS	S.MAZUMDAR
5	16.05.16	UPDATED & REISSUED	MK	AJS	RS	R.NANDA
4	21.08.14	UPDATED & REISSUED	ASR	AS	PKM	S.CHANDA
3	19.06.09	REAFFIRMED & REISSUED	AS	SCH	VINAY KUMAR	N. DUARI
2	18.02.00	UPDATED & REISSUED	DPN	SKP	SC JAIN	A. SONI

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Abbreviations:

API	:	American Petroleum Institute
ASTM	:	American Society for Testing & Materials
BIS	:	Bureau of Indian Standards
BS	:	British Standard
C&D Waste	:	Construction and Demolition Waste
DIN	:	Deutsches Institut' für Normung
EC	:	Emulsifiable Concentrate
IS	:	Indian Standards
PCC	:	Plain Cement Concrete
PVC	:	Poly Vinyl Chloride
RA	:	Recycled Aggregates
RCA	:	Recycled Concrete Aggregates
RCC	:	Reinforced Cement Concrete

Structural Standards Committee

Convenor: **Mr. Anurag Sinha**

Members:
Mr. Virender Goel
Mr. Deepak Agrawal
Ms. Alpana Srivastava
Dr. Sudip Paul
Ms. Papia Mandal
Mr. Vikram Kumar Gupta
Mr. Charanjit Singh (Projects)
Mr. Indrajit Neog (Construction)

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1.0 SCOPE

1.1 This specification establishes and defines the requirements of various materials to be used in Civil and Structural works.

1.2 Whenever any reference to BIS Codes is made, the same shall be taken as the latest revision (with all amendments issued thereto) as on the date of submission of the bid.

1.3 Apart from the BIS Codes mentioned in particular in the various clauses of this specification, all other relevant codes related to specific job under consideration regarding quality, tests, testing and/ or inspection procedures shall be applicable. Reference to some of the Codes in the various clauses of this specification does not limit or restrict the scope of applicability of other referred or relevant codes.

1.4 In case of any variation/contradiction between the provision of BIS Codes and this specification, the provision given in this specification shall be followed.

1.5 All materials shall be of standard quality and shall be procured from renowned sources/ manufacturers approved by the Engineer-in-Charge. It shall be the responsibility of the Contractor, to get all materials/ manufacturers approved by the Engineer-in-Charge prior to procurement and placement of order.

1.6 Whenever called for by the Engineer-in-Charge all tests of the materials as specified by the relevant BIS Codes shall be carried out by the Contractor in an approved laboratory and test reports duly authenticated by the laboratory, shall be submitted to the Engineer-in-Charge for his approval. If so desired by the Engineer-in-Charge, tests shall be conducted in the presence of the Engineer-in-Charge or his authorized nominee.

1.7 Quality and acceptability of materials not covered under this specification shall be governed by the relevant BIS Codes. In case BIS code is not available for the particular material, other codes e.g. BS or DIN or API/ ASTM shall be considered. The decision of Engineer-in-Charge, in this regard, shall be final and binding on the Contractor.

1.8 Whenever asked for, the Contractor shall submit representative samples of materials to the Engineer-in-Charge for his inspection and approval. Approval of any sample does not necessarily exempt the Contractor from submitting necessary test reports for the approved material, as per the specification/relevant BIS Codes.

1.9 The Contractor shall submit manufacturer's test reports on quality and suitability of any material procured from them and their recommendation on storage, application, workmanship etc. for the intended use. Submission of manufacturer's test reports does not restrict the Engineer-in-Charge from asking fresh test results from an approved laboratory of the actual material supplied from an approved manufacturer/ source at any stage of execution of work.

1.10 All costs relating to or arising out of carrying out the tests and submission of test reports and or samples to the Engineer-in-Charge for his approval during the entire tenure of the work shall be borne by the contractor and included in the quoted rates.

1.11 Materials for approval shall be separately stored and marked, as directed by the Engineer-in-Charge and shall not be used in the works till these are approved.

1.12 All rejected materials shall be immediately removed from the site by the Contractor at his own cost.

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2.0 REFERENCES

As mentioned in the respective clauses.

3.0 WATER

3.1 Water used in construction for all civil & structural works shall be clean and free from injurious amount of oil, acids, alkalies, organic matters or other harmful substances which may be deleterious to concrete, masonry or steel. The pH value of water sample shall be not less than 6. Potable water shall be considered satisfactory. Underground water can also be used with the prior approval of Engineer-in-Charge, if it meets all the requirements of IS 456.

3.2 Tests on water samples shall be carried out in accordance with IS 3025 and they shall fulfill all the guidelines and requirements given in IS 456.

3.3 The Engineer-in-Charge may require the Contractor to prove, that the concrete prepared with water, proposed to be used, shall have average 28 days compressive strength not lower than 90% of the strength of concrete prepared with distilled water.

3.4 The Engineer-in-Charge may require the Contractor to get the water tested from an approved laboratory before starting the construction work and in case the water contains any oil/ organic matter or an excess of acid, alkalies or any injurious amount of salts etc., beyond the permissible maximum limits given in IS 456, the Engineer-in-Charge may refuse to permit its use. In case the water is supplied by the owner, contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense. In case there is any change in source of water, water samples shall be tested again to meet the specified requirements.

3.5 Water shall be stored in tin barrels, steel tanks or water-tight reservoirs made with bricks / stone or reinforced concrete. Brick/ stone masonry reservoirs shall have RCC base slab and shall be plastered inside, with 1 part of cement and 4 parts of sand and finished with neat cement punning. These reservoirs shall be of sufficient capacity to meet the water requirement, at any stage of construction.

3.6 Water for curing shall be of the same quality as used for concreting and masonry works. Sea water shall not be used for preparation of cement mortar, concrete as well as for curing of plain/reinforced concrete and masonry works. Sea water shall not be used for hydrotesting and checking the leakage of liquid retaining structures also.

4.0 AGGREGATE

4.1 General

4.1.1 Coarse and fine aggregates for Civil and Structural Works shall conform in all respects to IS 383 (Specification for coarse and fine aggregate for concrete). Aggregates shall consist of naturally occurring (crushed or uncrushed) stones, gravel and sand or a combination thereof or manufactured aggregates produced from other than natural sources. These shall be chemically inert, hard, strong, dense durable, clear and free from veins, adherent coatings, injurious amount of disintegrated pieces, alkalies, free lime, vegetable matter and other deleterious substances such as iron pyrites, coal, lignite, mica, shale, sea shells etc. Naturally occurring aggregates shall be obtained from an approved source known to produce the same satisfactorily.

Manufactured aggregates shall consist of Iron and Steel slag aggregates, Copper slag aggregates or aggregates made from Construction & Demolition (C&D) waste such as Recycled Aggregates (RA) and Recycled Concrete Aggregates (RCA). RA shall comprise of waste from concrete, brick, tiles, stone, etc. and RCA shall be derived from concrete after requisite processing. Extent of utilization of manufactured aggregates in RCC and PCC works shall be as per Table-1 of IS 383.

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4.1.2 Source and type of aggregates shall be got approved by the Engineer-in-Charge prior to procurement. Change in source and type of aggregates, at later stage, shall not be generally permitted; but under specific circumstances, Engineer-in-Charge can allow a change in source and type of aggregate. Contractor shall produce necessary test certificates from approved laboratories regarding the quality and suitability of the proposed aggregates and submit fresh mix design for approval of the Engineer-in-Charge. Any such change, if permitted by the Engineer-in-Charge, shall be without any time and cost implication to the owner.

4.1.3 Aggregates which may chemically react with alkalies of cement or might cause corrosion of the reinforcement, shall not be used. If so desired by the Engineer-in-Charge, the Contractor shall carry out alkali reactivity tests and submit the results to him for approval.

4.1.4 The maximum quantities of deleterious materials in the aggregates as determined in accordance with IS 2386 - Part II (Methods of Test for aggregates for concrete), shall not exceed the limits defined in IS 383. No special test is required to prove the absence of such deleterious matters if the aggregates are from a known source with satisfactory prior data on the properties of concrete made with them. In case of newly developed quarry sites, the contractor shall submit necessary test results as per IS 383 and IS 2386 to the Engineer-in-Charge prior to his acceptance and approval. The method of Sampling shall be in accordance with the requirements given in IS 2430.

4.1.5 Coarse and fine aggregates shall be batched separately. All-in-aggregate shall be used only where specifically permitted by the Engineer-in-Charge.

Separate sieve analysis and grading curves shall be prepared by the Contractor for any/ all batches of coarse and fine aggregates, and submitted to the Engineer-in- Charge, whenever asked for, to ensure conformity with those submitted along with the mix design.

4.1.6 Whenever required by Engineer-in-Charge, the aggregates (coarse/ fine) shall be washed and/ or sieved by the contractor before use in the works to obtain clean and graded aggregate at no extra cost to the owner.

4.1.7 Aggregates not in conformity with the specifications shall be rejected and the Contractor shall immediately remove them from the site of work.

4.2 Coarse Aggregates

4.2.1 Coarse aggregates are the aggregates, which are retained on 4.75 mm BIS Sieve. It shall have a specific gravity not less than 2.6 (saturated surface dry basis).

The grading of the aggregates shall be as per IS 383 or as required by the mix design, to obtain densest possible concrete. For this purpose, the contractor shall submit to the Engineer-in-Charge at least three sets of mix design and test results, each with different gradings of coarse aggregates, proposed to be used. The Engineer-in-Charge may allow "All-in-aggregates" to be used provided they satisfy the requirements of IS 383.

4.2.2 Coarse aggregates may be obtained from

a) Uncrushed gravel or stone which results from natural disintegration of rock

b) Crushed gravel or stone which results from crushing of gravel or hard stone

c) Partially crushed gravel or stone which results from blending of (a) and (b) above

d) Manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured coarse

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aggregate may be RCA or RA processed from C&D waste and may be supplied as single sized or graded.

4.3 Fine Aggregates

4.3.1 Fine aggregates are the aggregates which pass through 4.75 mm BIS sieve but not more than ten percent (10%) pass through 150 micron BIS sieve. These shall comply with the requirements of grading zones I, II and III of IS 383. Fine aggregates conforming to grade zone IV shall not be used for reinforced concrete works.

Sand from sea shores, creeks or river banks affected by tides, shall not be used for filling or concrete works.

4.3.2 Fine aggregates shall consist of

a) Natural Sand : Fine aggregate resulting from natural disintegration of rock and which has been deposited by streams or glacial agencies. This may also be called as uncrushed sand.

b) Crushed Sand –
   i) Crushed Stone Sand : Fine aggregate produced by crushing hard stone
   ii) Crushed Gravel Sand : Fine aggregate produced by crushing natural gravel

c) Mixed Sand : Fine aggregate produced by blending natural sand and crushed stone sand or crushed gravel sand in suitable proportions.

d) Manufactured Fine Aggregate : Fine aggregate manufactured from other than natural sources, by processing materials, using thermal or other processes such as separation, washing, crushing and scrubbing. Manufactured fine aggregate may be RCA processed from C&D waste.

4.4 Sampling and Testing

The Contractor shall carry out all tests including mix designs of concrete, at his own expense, at the start of work as well as during any stage of construction as required by the Engineer-in-Charge. Test shall be carried out in accordance with IS 516 - Methods of test for strength of concrete and IS 2386 - Methods of test for aggregates for concrete. Testing shall be carried out from laboratories approved by the Engineer- in-Charge. The method of sampling shall be in accordance with the requirements given in IS 2430.

4.5 Storage of Aggregates

4.5.1 Storage of all types of aggregates at site of work shall be at contractor's expense and risk and shall be stored as specified in IS 4082. Aggregates shall in no case be stored near to the excavated earth or directly over ground surface.

4.5.2 The Contractor shall maintain sufficient quantities of aggregates, near to the place of work, required for the continuity of the work. Each type and grade of aggregate shall be stored separately on hard, firm surface having adequate slope for drainage of water.

4.5.3 Aggregates delivered at site in wet condition or becoming wet due to rain or any other means, shall not be used for atleast 24 hours. The Contractor shall obtain prior approval of the Engineer-in-charge for the use of such aggregates and shall adjust the water content in accordance with IS 2386 to achieve the desired mix. In the absence of test results, and to allow variation in mass of aggregates and water content on account of moisture content, the

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Contractor can make suitable adjustment in the masses as per IS 456, for preparation of nominal mix concrete only.

5.0 SAND

5.1 Sand for Masonry Mortars

5.1.1 The sand shall consist of natural sand, crushed stone sand or crushed gravel sand or a combination of any of these. The sand shall be hard, durable, clean and free from adherent coatings and organic matter and shall not contain the amount of clay, silt and fine dust more than specified in IS 2116.

5.1.2 The sand shall not contain any harmful impurities such as iron pyrites, alkalis, salts, coal or other organic impurities, mica, shale or similar laminated materials, soft fragments, sea shells in such form or in such quantities as to affect adversely the hardening, strength or durability of the mortar.

5.1.3 Unless found satisfactory as a result of further tests as may be specified by the Engineer-in-Charge, or unless evidence of such performance is offered which is satisfactory to him, the maximum quantities of clay, fine silt, fine dust and organic impurities in the sand, when tested in accordance with IS 2386, shall not be more than 5% by mass in natural sand, or crushed gravel sand or crushed stone sand. For organic impurities, when determined in accordance with IS 2386, colour of the liquid shall be lighter than that indicated by the standard solution specified in IS 2386.

5.1.4 **Grading of Sand**

The particle size grading of sand for use in mortars shall be within the limits as specified below:

GRADING OF SAND FOR USE IN MASONRY MORTARS

IS SIEVE DESIGNATION IS 460 (PART I)	PERCENTAGE PASSING BY MASS	REF. TO METHOD OF
4.75 mm	100	IS 2386 (Part I)
2.36 mm	90 to 100	
1.18 mm	70 to 100	
600 micron	40 to 100	
300 micron	5 to 70	
150 micron	0 to 15	

In case of a sand whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles, this shall be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of natural sand particles or crushed stone screenings which are by themselves unsuitable. Based on test results and in the light of practical experience with the use of local materials, deviation in grading of sand may be considered by the Engineer-in-Charge. The various sizes of particles of which the sand is composed shall be uniformly distributed throughout the mass.

5.1.5 **Sampling and Testing**

The method of sampling shall be in accordance with IS 2430. The amount of material required for each test shall be as specified in relevant parts of IS 2386. Any test which the engineer-in-charge may require in connection with this, shall be carried out in accordance with the relevant parts of IS 2386.

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If further confirmation as to the satisfactory nature of the material is required, compressive test on cement mortar cubes (1:6) may be made in accordance with IS 2250 using the supplied material in place of standard sand and the strength value so obtained shall be compared with that of another mortar made with a sand of acceptable and comparable quality.

5.2 Sand for Filling

Sand for filling shall meet the requirements of IS 383 and shall be natural sand, hard, strong, free from any organic and deleterious materials. Any sand proposed for filling, shall be used only after it is approved by the Engineer-in-Charge. Sand obtained from sea shores, creeks or river banks affected by tides, shall not be used for filling. Fine aggregates suitable for concreting works shall be suitable for filling also. No sand below grading zone-III as per IS 383 shall be allowed for filling.

6.0 CEMENT

Cement to be used for civil and structural works shall be one of the following. Specific requirement for the type of cement to be used shall be as shown in the drawings or as specified in the contract or as directed by the Engineer-in-Charge.

- Specification for 33/43/53 grade ordinary portland cement — IS 269
- Specification for portland slag cement — IS 455
- Specification for Portland pozzolana cement (fly ash based) — IS 1489 Pt.1
- Specification for Portland pozzolana cement (calcined clay based) — IS 1489 Pt.2
- Specification for Masonry Cement — IS 3466
- Specification for high alumina cement for structural use — IS 6452
- Specification for rapid hardening portland cement — IS 8041
- Specification for Sulphate Resisting Portland cement — IS 12330

6.1 Storage at Site

6.1.1 The storage of cement (lifted from the Owner's godown or procured by the Contractor himself) at the site of work shall be at contractor's expense and risk and shall meet the requirements of IS 4082. The cement shall be stored above ground in a suitable weather tight building or godown and in such a manner as to permit easy access for proper inspection and also to prevent deterioration due to moisture. In the event of any damage occurring to the quality of cement due to faulty storage or on account of negligence on the part of the contractor, such damages shall be borne by the contractor himself.

6.1.2 All approved cement shall be arranged in batches with type, brand and date of receipt flagged on them. A maximum of eight bags shall be stacked one over the other. Cement bags shall be used in the same order as received from the manufacturer/ owner. The contractor shall maintain a register, on day-to-day basis, giving the details of the receipt/ consumption, source of supply and type of cement etc. The register shall always be accessible to the Engineer-in-Charge for verification.

6.2 Tests after Delivery

Each consignment of cement supplied by Owner or contractor, shall, after delivery at site and at the discretion of the Engineer-in-Charge, be subjected to any or all of the tests and analyses, required by the relevant Indian Standard Codes. In case the cement is supplied by the owner, the contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense. The contractor shall carry out and bear the cost of all tests and

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analyses required to ensure quality of cement before using in actual works, irrespective of the fact whether the cement is supplied by the Owner or procured by him.

6.3 Rejection

The Engineer-in-Charge may reject at his discretion any cement, notwithstanding the manufacturer's certificate or failing to meet the requirements of relevant BIS Codes for testing of cement. He may similarly reject any cement which has deteriorated owing to inadequate protection from moisture or due to intrusion of foreign matter or any other cause. Any cement which is considered defective, shall not be used and shall be promptly removed from the site by the contractor.

7.0 STEEL

7.1 General

All steel bars, sections, plates, and other miscellaneous steel materials, etc shall be free from loose mill scales, rust as well as oil, mud, paint or other coatings. The materials, construction specifications such as dimensions, shape, weight, tolerances, testing etc, for all materials covered under this section, shall conform to respective BIS Codes. Steel sections shall be conforming to IS 808 or IS 12778.

7.2 Reinforcement Bars

Reinforcement bars, to be used for civil and structural works shall be one of the following or in combination thereof.

- Mild Steel and Medium Tensile Steel Bars and Hard-Drawn Steel Wire for Concrete Reinforcement — IS 432
- Specification for hard drawn steel wire fabric for concrete reinforcement — IS 1566
- Specification for plain hard-drawn steel wire for prestressed concrete. — IS 1785
- Specification for High strength deformed steel bars and wires for concrete reinforcement. — IS 1786
- Specification for indented wire for prestressed concrete. — IS 6003
- Specification for fusion bonded epoxy coated reinforcing bars — IS 13620

7.3 Structural Steel

Structural steel to be used for general structural purposes shall be one of the following or in combination thereof.

Structural steel sections shall conform to following BIS Codes:

- Steel tubes for structural purposes. — IS 1161
- Mild Steel Tubes, tubulars and other wrought steel fittings. — IS 1239
- Steel for general structural purposes (Grade A/BR/B0). — IS 2062
- Hollow steel sections for structural use. — IS 4923

7.4 Miscellaneous Steel Materials

Miscellaneous steel materials shall be conforming to the following BIS Codes.

- Expanded Metal Steel Sheets for General purposes. — IS 412
- Mild steel bars of anchor bolts, rungs, metal inserts, grating etc.) — IS 2062
- Hexagonal head bolts, screws & nuts of product grade C. — IS 1363

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- Cold formed light gauge structural steel sections. IS 811
- Technical supply conditions for threaded steel fasteners. IS 1367
- Plain washers IS 2016
- Steel wire ropes for general engineering purposes IS 2266
- Thimbles for wire ropes. IS 2315
- Bulldog grips. IS 2361
- Mild Steel Tubes, tubulars and other wrought steel fillings. (For Hand rail tubular sections). IS 1239
- Drop forged sockets for wire ropes for general engineering purposes. IS 2485
- Steel chequered plates. IS 3502
- Hexagonal bolts and nuts (M42 to M150). IS 3138
- High Strength Structural Bolts IS 3757
- High Strength Bolts IS 4000

7.4.1 Anchor Bolts

Material for Anchor Bolts such as MS bars, washers, nuts, pipe sleeves and plates etc. shall be as per relevant BIS Codes mentioned above.

7.5 Storage

The storage of all materials at site of work shall be at the contractor's expense and risk and shall be done as per the requirements given in IS 4082. The contractor shall maintain the proper records of receipt/consumption. The records shall always be accessible to the Engineer-in-Charge for verification.

The reinforcement bars, structural steel sections and other miscellaneous steel materials etc, shall be stored in such a way as to avoid and prevent deterioration, corrosion, bending, twisting and wrapping. In case of any damage occurring to the material on account of faulty storage or negligence by the contractor, same shall be borne by the contractor himself.

7.6 Tests after Delivery

Materials supplied by the Owner or Contractor, shall, after delivery at site and at the discretion of Engineer-in-Charge, be subjected to any or all of the tests, required by the relevant BIS Codes. The Contractor shall carry out and bear the cost of such tests irrespective of the fact whether the material is procured by the Owner or the contractor. In case steel is supplied by the Owner, the Contractor shall get himself satisfied regarding its quality before using the same in his works at his own expense.

7.7 Rejection

The Engineer-in-charge may reject at his discretion any material, not withstanding the manufacturer's certificate or failing to meet the requirements of relevant BIS Codes for testing of materials. He may similarly reject any material, which has deteriorated or corroded etc., due to improper storage, handling or transport. Defective materials shall not be used and removed from the site by the contractor at his own expense.

8.0 BRICK

8.1 General

All Bricks used for masonry works shall conform to the requirements of following BIS Codes:

- Common Burnt Clay Bricks- Specifications IS 1077

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- Pulverized Fuel Ash Cement Bricks- Specifications IS 16720
- Pulverized Fuel Lime Ash Bricks- Specifications IS 12894
- Burnt Clay Fly Ash Bricks- Specifications IS 13757

8.1.1 Common Burnt Clay Bricks

Bricks for masonry works shall conform to IS 1077 - Specification for common burnt clay building bricks and shall be of class 5.0 (with minimum compressive strength of 5.0 N/mm^2). Specific requirement for any other class of bricks shall be as shown in drawings or as described in the contract for a particular site or type of work. Physical requirements, quality, dimensions, tolerances etc. of common burnt clay building bricks shall conform to the requirements of IS 1077.

Bricks shall be hand - moulded or machine moulded and shall be made from suitable soils. The bricks shall have smooth rectangular faces with sharp corners and shall be well burnt, sound, hard, tough and uniform in colour. These shall be free from cracks, chips, flaws, stone or humps of any kind.

8.1.2 Pulverized Fuel Ash Cement Bricks

Pulverized fuel ash-cement bricks shall conform to IS 16720. The bricks shall be sound, free from visible cracks and uniform in shape and colour. The brick shall have total pulverized fuel ash content not less than 35 percent of the mass of bricks. Pulverized fuel ash shall conform to IS 3812 (Part 1) or IS 3812 (Part 2).

8.1.3 Fly Ash Lime Bricks (FALG Bricks)

The Fly Ash Lime Bricks (FALG Bricks) shall conform to IS 12894. Visually the bricks shall be sound, compact and uniform in shape free from visible cracks, warpage, flaws and organic matter. Fly ash shall conform to IS 3812.

8.1.4 Burnt Clay Fly Ash Bricks

The burnt clay fly ash bricks shall conform to IS 13757. The bricks shall be sound, compact and uniform in shape and colour. Bricks shall have smooth rectangular faces with sharp and square corners. The bricks shall be free from visible cracks, flaws, warpage, nodules of free lime and organic matter, the bricks shall be hand or machine moulded. The bricks shall have frog of 100 mm in length 40 mm width and 10 to 20 mm deep on one of its flat sides. If made by extrusion process may not be provided with frogs. Fly Ash shall conform to grade I or grade II of IS 3812.

8.1.5 Mechanized Autoclave Fly Ash Lime Brick

These bricks shall be machine moulded and prepared in plant by appropriate proportion of fly ash and lime. The autoclave fly ash bricks shall conform to IS 12894. Visually, the bricks shall be sound, compact and uniform shape, free from visible cracks, warpage and organic matters. The brick shall be solid with or without frog, and of 100/80 mm in length, 40 mm width and 10 to 20 mm deep one of its flat side as per IS 12894. The brick shall have smooth rectangular faces with sharp corners and shall be uniform in shape and colour. Fly ash shall conform to IS 3812 and lime shall conform to class 'C' hydrated lime of IS 712.

8.2 Tests after Delivery

The Contractor shall take samples of each type of brick as directed by the Engineer-in-Charge as per the requirements of IS 5454 and tests shall be carried out as per IS 3495. The cost for carrying out any or all the tests, shall be borne by the Contractor. The bricks, when tested, as

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per IS 3495 shall have a minimum average compressive strength, as given in the Code, for a particular class of brick. Water absorption shall not be more than 20% by its dry weight, when soaked in cold water for 24 hours.

Brick samples so approved, shall be deposited with the Engineer-in-Charge. All subsequent deliveries shall be upto the standards of the approved samples.

8.3 Stacking of Bricks

Bricks shall be stored at site as per the requirements given in IS 4082 and shall not be dumped at site. They shall be unloaded from trucks to a place on a levelled surface near to the work site. They shall be stacked in regular tiers even as they are unloaded, to minimise breakages and defacement of bricks. The supply of bricks shall be so arranged that as far as possible, at least two days' requirements of bricks are available at site at any time. Bricks, of different class & types, shall be stacked separately.

8.4 Local Bricks/ Class 3.5 Bricks.

Where shown on drawings, locally available bricks of non modular size (230 mm x 110 mm x 70 mm) in place of bricks of modular size (190 mm x 90 mm x 90 mm) can be used in case the bricks satisfy the other requirements of respective BIS codes. Minimum compressive strength of these bricks shall not be less than 3.5 N/mm^2.

8.5 Concrete Block Masonry

Concrete Block Masonry shall be as per EIL Specification No. 6-68-0016.

9.0 STONE

9.1 General

All Stones used for masonry works shall conform to the requirements of following BIS Codes.

- Method of identification of natural building stones. IS 1123
- Recommendations for dimensions and workmanship of natural building stones for masonry work. IS 1127
- Recommendations for dressing of natural building stones. IS 1129

9.2 Quality of Stones

Stones shall be of approved quality, hard, dense, strong, sound, durable, clean and uniform in colour. They shall also be free from veins, adherent coatings, injurious amount of alkalies, vegetable matters and other deleterious substances such as iron pyrites, coal, lignite, mica, sea shells etc. Unless otherwise approved, stones from one single quarry shall be used for any one work. The strength of stones should be adequate to carry the imposed load and shall meet all the requirements of IS 1905, taking into account the appropriate crushing strength of stone and type of the mortar used. The percentage of water absorption, when tested in accordance with IS 1124, shall not exceed 5 percent.

Stones normally used, shall be small enough to be lifted and placed by hand. The length of the stone shall not exceed 3 times the height. Width of stone on base shall not be less than 150 mm and in no case exceed $3/4^{th}$ thickness of the wall. Height of the stone shall not be more than 300 mm.

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9.3 Unloading/Stacking

The stones shall be unloaded from the trucks to a site near to the place of work as defined in IS 4082 and shall be stacked on a firm ground having adequate stope for drainage. The supply of stones shall be so arranged that as far as possible, at least two days' requirements of stone are available at site at any time.

10.0 ADMIXTURES

10.1 General Requirements for Admixtures

10.1.1 All concrete admixtures shall in general comply with the following BIS Codes unless otherwise stipulated in this specification.

- Specification for integral cement water proofing compounds. IS 2645
- Specification for other admixtures for concrete. IS 9103

10.1.2 Generally, admixtures shall have ISI certification marks. However, even in case of BIS certified admixtures, Engineer-in-Charge may require the Contractor to carry out and submit any or all the tests (as specified in relevant BIS Codes), from BIS approved laboratories, over and above the manufacturer's test certificate, before giving his final approval.

In case, admixtures certified by BIS are not available, the contractor shall submit to the Engineer-in-Charge the type and/or proprietary brand of the admixture from only reputed manufacturers along with necessary test certificates from BIS recognized/ BIS approved laboratories or any other document directed by Engineer-in-Charge for the latter's final approval. In such cases, names of at least two manufacturers shall be submitted to the Engineer-in-Charge for his selection. In case, both the names are rejected, the contractor shall submit a fresh list of two manufacturers for approval by the Engineer-in-Charge.

The Engineer-in-Charge may direct the contractor to submit test results as required by IS 2645 or IS 9103 for any admixture proposed to be used in the concrete in any approved laboratory at his discretion at any stage of the work. The cost of any/all tests required to satisfy compliance with this specification shall be borne by the Contractor.

In case of non-availability of any BIS code for testing and acceptability criteria, relevant American, British or German Code shall be applicable.

10.1.3 Prior approval of the Engineer-in-Charge shall be obtained while using water reducing admixtures in the concrete (PCC/ RCC) or mortar. Other type of admixtures such as accelerating admixtures, retarding admixtures or air entraining admixtures, shall not be used unless specified on the design drawings or prior approval taken from the design approving authority. Once approved, utmost care shall be exercised at site by the Contractor to maintain the consistency in the quality of admixture and the concrete/ mortar so produced.

10.1.4 The suitability and effectiveness of any admixture shall be verified by trial with the designed concrete mixes using cement, aggregates together with any other materials to be actually used in the works as per the direction of Engineer-in-Charge. If two or more admixtures are to be used simultaneously in the same concrete mix, the Contractor must submit necessary test results from an approved laboratory to show their interaction and compatibility. Any/all tests specified in BIS Codes shall be carried out only with the type of material and mix design, to be actually used in the work site.

10.1.5 No admixture shall impair the durability of the concrete nor combine with the ingredients to form harmful compounds nor increase the risk of corrosion of reinforcement. Use of admixtures shall not reduce the dry density of concrete. Once the proportion of admixture has

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been established, strict check shall be maintained not to alter the proportions of ingredients and water-cement ratio of the Design Mix during execution.

10.1.6 The chloride contents in admixtures shall not exceed 2% by mass of the admixture or 0.03% by mass of the cement.

10.1.7 Admixtures which do not meet the requirements stipulated in this specification shall be rejected and shall not be used.

10.2 Water Proofing Compounds

10.2.1 Water proofing compounds shall be mixed with cement only.

10.2.2 The permeability of the specimen with the admixture shall be less than half of the permeability with similar specimen without the use of these compounds. These compounds shall be used in such proportion as recommended by manufacturer but in no case it shall exceed 3% by weight of cement.

10.2.3 The initial setting time of the cement with the use of these compounds shall not be less than 30 minutes and final setting time shall not be more than 10 hours. Test shall be carried out in accordance with IS 4031.

10.2.4 Compressive strength of specimen at 3 days shall not be less than 160 kg/sq.cm nor 80% of the 3 days compressive strength of mortar cubes prepared with same cement and sand only, whichever is higher. Similarly compressive strength at 7 days shall not be less than 220 kg/sq.cm nor less than 80% of the 7 days compressive strength prepared with the same cement and sand only, whichever is higher. The test to determine the compressive strength shall conform to IS 4031.

10.3 Concrete Penetrating Corrosion Inhibiting Admixture shall be as per EIL Specification No. 6-68-0017.

11.0 WATER BARS (WATER STOPS)

11.1 PVC water bars shall be used in reinforced concrete construction of liquid retaining structures or any other structure to safeguard them from hydrostatic pressure and water leakage and any relative movement between two parts of the structure due to thermal loading shrinkage or differential movement of foundations. Wherever desired or shown in the drawings, they shall be used at expansion/contraction/construction joints. These shall be pre-formed and shall provide a permanent water tight seal along the entire joint in the poured concrete structures. These shall also be flexible enough to withstand deflection/displacements at joints arising due to variation of temperatures or settlement of foundations. The minimum thickness of water bar shall be as shown on drawings or described in the schedule of rates and unless otherwise mentioned, these shall be able to withstand a water head of at least 12 meters.

11.2 Performance requirements of PVC water bars shall meet the requirements of IS 12200. These shall be of approved make and of ribbed/ serrated/ plane type with a bulb at the centre. The thickness and width of water bars shall be as per schedule of rates/ drawings but in no case the thickness shall be less than 5 mm and width less than 150 mm. The joining of the water bars shall be carried out by vulcanising strictly as per the manufacturer's specifications. Lapped joints shall not be allowed under any circumstances.

12.0 BITUMEN/BITUMINOUS MATERIALS

Bitumen to be used for various types of work shall meet all the requirements of relevant BIS Codes as given below:

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- Specification of Paving Bitumen IS 73
- Specification for bitumen mastic for flooring IS 1195
- Specification for Bitumen felts for water proofing and damp proofing IS 1322
- Specification for Bituminous compounds for water proofing and caulking purposes IS 1834
- Specification for preformed fillers for expansion joint in concrete pavements and structures IS 1838
- Specification for bitumen mastic for use in water proofing of roofs IS 3037
- Specification for bitumen primer for use in water proofing and damp proofing IS 3384
- Specification for Bitumen Mastic for Tanking and Damp proofing IS 5871
- Specification for Glass fibre base coal tar pitch & bitumen felts IS 7193
- Code of practice for damp proofing using bitumen mastic IS 7198
- Specification for bitumen Mastic, Anti-Static and electrically conducting grade IS 8374

The type and grade shall be as shown on the drawings or as indicated in schedule of quantities or as directed by Engineer-in-Charge. Tests and acceptable criteria shall be as per relevant BIS Codes.

13.0 PVC PIPES

PVC Pipes shall conform to the requirements of IS 4985.

14.0 WOOD/ TIMBER

14.1 Wood recommended for platforms of cold vessels or below cold vessels/ exchangers shall be hard and shall be of group A, grade I, and shall have safe permissible stress of 7 N/mm^2 in compression, perpendicular to grains on outside location as per IS 883. General characteristics like durability, treatability etc. shall conform to IS 883 and IS 3629.

14.2 Timber required to be used for formwork shall be fairly dry before use. It should maintain its shape during the use and even when it comes into contact with moisture from the concrete. Storage of Wood/Timber shall be as per the requirements of IS 4082.

For proper identification and selection of suitable timber for formwork, following codes shall be referred.

- Classification of commercial timbers and their zonal distribution IS 399
- Specification for ballies for general purposes. IS 3337
- Specification for Ply wood for concrete shuttering work. IS 4990

15.0 EPOXY COMPOUNDS

Refer EIL Specification No. 6-68-0056.

16.0 PAINT

16.1 Refer EIL Specification No. 6-79-0020 or the job specification whichever applicable.

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17.0 ANTITERMITE COMPOUNDS

17.1 Following chemicals as per IS 6313 (Part 2 & 3) shall be used for treatment of soil for protection of buildings against attack by subterranean termites:

S.No.	Chemical	Relevant Standard	Dosage* (Chemical Emulsion)
1	Chlorpyrifos 20% Emulsifiable Concentrate (EC)	IS 8944	250ml in 5 litre water 50ml in 1 litre water
2	Imidacloprid 30.5% Suspension Concentrate (SC)	IS 16131	10.5ml in 5 litre water 2.1ml in 1 litre water
3	Bifenthrin 2.5% Emulsifiable Concentrate (EC)	IS 15936	100ml in 5 litre water 20ml in 1 litre water

(*Dosage as specified above or as per Manufacturer's recommendation, whichever is stringent)

18.0 POLYSULPHIDE SEALANTS

Polysulphide Sealants shall conform to IS 12118 and be of approved make. Test conditions and requirements shall be as given in the above referred BIS code.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

मिट्टी का कार्य

EARTHWORK

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
6	18.03.21	REVISED & REISSUED	TK	AJS	AS	SM
5	21.08.14	REVISED & REISSUED	AJS	AS	PKM	SC
4	19.06.09	REVISED & REISSUED	AS	SCH	VINAY KUMAR	N. DUARI
3	22.01.02	UPDATED & REISSUED	R SOOD	R SOOD	H MATHUR	GRR
2	AUG'94	UPDATED & REISSUED	-	H MATHUR	GP LAHIRI	A. SONI

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Abbreviations:

CNS : Cohesive Non Swelling

Structural Standards Committee

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Members:
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Mr. V.K.Panwar
Mr. Samir Das
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1.0 SCOPE

This specification deals with earth work in excavation and filling.

2.0 CLASSIFICATION OF SOIL

2.1 Ordinary Soil

2.1.1 Soft Soil/ Loose Soil

Generally any soil which yields to the ordinary application of pick and shovel, or to phawra, rake or other ordinary digging implements such as:

a) Sand, gravel, loam, clay, mud, black cotton soil
b) Vegetables or organic soil, turf, peats, soft shale or loose murrum
c) Mud concrete below ground level
d) Any mixture of soil mentioned above.

2.1.2 Hard/ Dense Soil

Generally any soil, which requires close application of picks or jumpers or scarifier and rippers to loosen the same, such as:

i) Stiff heavy clay, hard shale or compact murrum requiring grafting tool and/ or pick and shovel
ii) Shingle and river or nallah bed boulders
iii) Soling of roads, paths etc. and hard core
iv) Macadam surface of any description (water bound, grouted tarmac etc.)
v) Lime concrete, stone masonry in lime or cement mortar below ground level
vi) Soft conglomerate when the stone can be detached from the matrix with picks and shovels

2.2 Soft Rock

This is fissured/ disintegrated rocky strata, boulders (volume more than 0.028 m^3 and less than 0.400 m^3) and also which cannot be quarried/ excavated by using above manual tools but can be quarried/ excavated manually by using crow bars is classified as soft rock. Soft rock shall include all kinds of stiff and stratified rock, such as shales, thinly bedded phillites, laterite hard conglomerate, lime stone, sand stone and unreinforced cement concrete below ground level. Soft rock may be quarried or split with crow bar or picks and can also be excavated by rippers, dozers and other mechanical equipment, but without the aid of blasting. If required and permitted, light blasting may be restored to, for loosening the materials, but this will not, in any way entitle the material to be classified as "Hard Rock".

2.3 Hard Rock

2.3.1 Hard Rock (Not Requiring Blasting)

This shall include all types of hard and compact rock, having closely spaced fissures or joints, on account of which blasting is not considered necessary and shall not be resorted unless permitted by the Engineer-in charge.

2.3.2 Hard Rock (Requiring General Blasting)

This shall include all types of hard and compact rock occurring in unfissured masses or similar foundations, boulders (volume more than 0.4 m^3) for excavation in which blasting is

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considered necessary such as quartzite, granite, basalt stones, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

2.3.3 **Hard Rock (Requiring Controlled Blasting (Explosive/ Non-explosive)**

This type of excavation becomes necessary when excavation is done in formations, mentioned in Clause 2.3.2, in the vicinity of existing foundations/ structures. Mode of blasting shall be decided by Engineer-in-Charge, keeping in view the sensitivity of structures.

2.3.4 **Hard Rock (Blasting Prohibited)**

Hard rock requiring blasting as described in clause 2.3.2 above, but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging, pneumatic/ hydraulic/ electro-mechanical breaking by using splitter or by chemical means or any other agreed method.

The use of excavation shall not be considered as a reason for classification under hard rock requiring blasting unless clearly found necessary in the opinion of Engineer-in-Charge.

3.0 BACKFILLING MATERIAL

3.1 Suitable Materials:

3.1.1 Back filling suitable material shall be approved by the Engineer-in-charge. Additionally, they shall be free from refuse, large stones or rocks or other material which might prevent proper compaction or cause the compacted fill or embankment to perform inadequately or to have insufficient stability or bearing capacity for the superimposed loads to which it is likely to be subjected.

3.1.2 Back filling of excavation in trenches, foundations and elsewhere shall consist of one of the following materials as shown on drawing, or directed by the Engineer-in-charge.

i) Soil
ii) Selected earth from heaps or brought from borrow areas.

In case i) or ii) are not available, the Engineer-in-charge may approve use of any of the following:

iii) Stone/ Gravel
iv) Sand
v) CNS material.

3.1.3 The material shall be free from refuse, debris, roots, hard lumps and any other foreign organic material.

3.2 Unsuitable Materials

Unsuitable material shall include particles in excess of 75 mm size and that which is:

a) Organic material, logs, stumps and perishable materials.
b) Material susceptible to spontaneous combustion
c) Materials with undefined properties
d) Materials having a moisture content greater than the maximum specified
e) Building rubble and domestic and industrial wastes
f) Soils and rock susceptible to deterioration/ change of their properties.

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g) Clay, silt and other loose or soft soils not in accordance with compaction criteria.
h) Dredged material
i) Material containing gypsum or other soluble salts.

4.0 SETTING OUT

4.1 The Contractor shall be responsible for the true and proper setting out of the work in relation to original points, ***lines**** and ***levels**** of reference and for the correctness of the levels, dimensions and alignment of all parts of the work. If at any time during progress of the work any error appears or arises in the position of level, dimension, or alignment of part of the work, the Contractor at his own expense shall rectify such errors to the satisfaction of the Engineer-in-Charge. The checking of any line or level by the Engineer-in-Charge shall not in any way relieve the Contractor of his responsibilities.

4.1.1 Tolerances*

The grade shall be properly shaped to the required elevations and parallel to the required surface. The elevation of any point and the line of any edge or center of the earthworks shall conform to that shown on the drawings within the tolerances stated below:

	Tolerances from True Level	Tolerances from True Line
Basic Grading	- 25 mm	- 75 mm
Embankments	+75 mm - 0	+75 mm - 75 mm

4.2 The Contractor shall lay out and construct one or more permanent bench marks in some central place before the start of the work, from which all important levels for the excavations will be set.

These permanent bench marks shall consist of masonry pillars with top neatly plastered and leveled as per the directions of the Engineer-in-Charge. Bench marks shall be well connected with triangular grid system or any other bench mark approved by the Engineer-in-Charge.

5.0 EARTHWORK IN EXCAVATION

5.1 Excavation shall be carried out in any material met on the site to the lines, levels and contours shown on the detailed drawings and the Contractor shall remove all excavated materials to spoil heaps on site or transport for use in filling on the site or stack them for reuse as directed.

5.2 Excavated material shall not be deposited within 1.5 m from the top edge of the excavation.

5.3 The sides of the excavation may be cut sloping, or shored and strutted to hold the face of earth as per site requirements and as directed by the Engineer-in- Charge.

5.4 Foundation pits/ trenches shall not be excavated to the full depth unless construction is imminent. The last 15 cm depth of the excavation shall not be done until concreting work is imminent. The full depth may at the discretion of the Engineer-in-Charge be excavated and the bed covered with a 50 mm (minimum) thick (or as indicated on drawing) layer of lean concrete 1:5:10 mix (1 cement : 5 coarse sand : 10 crushed stone aggregate) or as specified in schedule of rates/ shown on drawing, after watering if required, and consolidating the bed.

5.5 If the bottom of any excavation has been left exposed by the Contractor and in the opinion of the Engineer-in-Charge, that has become badly affected by the atmosphere or by water, then the Contractor shall remove such portions of the deteriorated material as the Engineer-

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in-Charge may direct and shall make good with lean concrete 1:5:10 mix (1 cement : 5 coarse sand : 10 crushed stone aggregate). All expenses for such additional concrete and excavation shall be borne by the Contractor.

5.6 Where excavation is made in excess of the depth required, the Contractor shall, at his own expense, fill upto required level with lean concrete 1:5:10 mix (1 cement : 5 coarse Sand : 10 crushed stone aggregates) or as decided by Engineer-in-Charge.

5.7 The Contractor shall provide suitable drainage arrangement to prevent surface water from any source entering the foundation pits at his own cost.

5.8 The Contractor shall make all arrangements for dewatering during excavation and subsequent works, the accumulated water from any source (including subsoil water) in the excavated pits/trenches and keeping the excavated pits/ trenches dry for subsequent works.

5.9 The Contractor shall make necessary arrangements for lighting, fencing and other suitable measures for protection against risk of accidents due to open excavation.

5.10 Where the excavation is to be carried out below the foundation level of an adjacent structure, the precaution to be taken such as under pinning, shoring and strutting etc. shall be determined by the Engineer- in-Charge. No excavation shall be done unless such precautionary measures are carried out as per directions of the Engineer-in-Charge. The payment for such precautionary measures shall, however, be made separately.

5.11 Loose or soft bed ground encountered in excavation at the required depth shall on the Engineers-in-Charge's instructions be excavated to a firm bed and difference made up to the required level with lean concrete 1:5:10 mix (1 cement : 5 coarse Sand : 10 crushed stone aggregates).

5.12 In those cases where during excavation, side slips occur for reasons not attributable to the Contractor (e.g. side slips which take place on their own but not due to surcharge of earth kept near the edge of excavation and cracking of excavation top strata due to clay drying out leading to collapse of excavation sides), the Engineer-in-Charge shall admit payment at his discretion.

5.13 Any obstacle encountered during excavation shall be reported immediately to the Engineer-in-Charge and shall be dealt with as instructed by him. Removal of buried pipes or cables shall not be done without prior permission of the Engineer-in-Charge and the Contractor shall provide all measures to protect the same. Cost of such protective measures are deemed to be included in the rates for various items of excavation.

5.14 The Contractor shall not undertake any concreting in foundation until the excavation pit/trench is approved by the Engineer-in-Charge.

5.15 The specification for earth work shall also apply to excavation in rock in general.

5.16 In case of hard rock requiring blasting, the provisions mentioned below shall be strictly followed.

5.16.1 **General**

Where hard rock is met with and blasting operations are considered necessary, the Contractor shall intimate about the same to the Engineer-in-Charge, and obtain his approval in writing for resorting to blasting operation.

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The Contractor shall obtain license from the district authorities for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Rules 2008, corrected upto date. He shall purchase the explosives, fuses, detonators etc. only from a licensed dealer. He shall be responsible for the safe custody and proper accounting of the explosive materials. The Engineer-in-Charge or his authorised representative shall have the access to check the Contractor's store of explosive and his accounts.

In case where explosives are required to be transported and stored at site, relevant clauses of the Explosive Rules, 2008 as amended subsequently, shall apply.

The Contractor shall be responsible for any accident to workmen, public or property, due to blasting operations.

5.16.2 **Precautions**

Blasting operations shall be carried out under the careful supervision of a responsible authorised and licensed blaster of the Contractor (referred subsequently as "blaster" only) during specified hours, as approved in writing by the Engineer-in-Charge. The blaster shall be fully conversant with the rules of blasting.

Proper precautions for safety of persons shall be taken. Red flags shall be prominently displayed around the area to be blasted and all the people on the work except those who actually light the fuses, shall withdraw to a safe distance of not less than 200 m from the blast. Precautions as per Explosive Rules 2008 with amendment shall be followed.

5.16.3 **Fuses**

All fuses shall be cut to the lengths required before being inserted into the holes. Joints in fuses shall be avoided. Where these are unavoidable, a semicircular niche shall be cut in one piece of fuse about 2 cm. deep from the end and the end of other piece inserted into this niche, and the two pieces then wrapped together with a string. All joints exposed to dampness shall be wrapped with rubber tape. Fuse and detonators shall be kept separated from the explosives.

5.16.4 **Blasting with Gun Powder**

Blasting shall normally be done with gun powder. Dynamite, gelatine or any other high explosive shall only be used in special cases with the written permission of the Engineer-in-Charge.

In case of blasting with gun powder, the position of all bore holes to be drilled shall be marked out in circles with white paint. The bore holes shall be jumped or drilled in the rock face. The depth of bore hole shall be about the same as that of the line of least resistance and its size shall be such that the cartridges can easily pass down to the bottom. The bore holes must be dried before being charged and these shall be inspected by the Contractor's agent.

Gun powder may be used in the form of pellet blasting cartridges or as powder or granules. Cartridges are provided with tapered central hole. One end of fuse is passed through the narrow end of the hole and a sufficient length of the fuse is doubled back so that when the fuse is pulled, it is held tight in the tapered hole of the cartridge. Other cartridges are then inserted in the fuse to make up the required charge. The cartridge along with the fuse is lowered down in the bore hole, placed in position and gently filled and pressed home with dry hay or turf. The rest of the bore shall then be filled with dry clay, which shall be tamped with copper or brass rod until it becomes compact. Care shall be taken to avoid any possibility of an air space around the fuse. The safety fuses shall be taken to the required distance so as to allow the blasting to take place after the person lighting the fuse has withdrawn to a safe distance.

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Where gun powder is used in the form of powder or granules it shall be introduced in the bore hole by means of funnel or copper tube. The bore holes shall be loaded with two thirds of the quantity of charge required, and safety fuse then directly introduced over the charge. Remaining one third charge shall then be introduced, and gently filled and pressed home with dry hay or turf. The rest of the bore hole shall be filled with dry clay in the same way as for cartridges, and the safety fuse taken to the required distance.

The charges shall be fired by igniting the fuse. The number of charges to be fired and the actual number of shots heard, shall be compared, and the Contractor's blaster shall satisfy himself by examination that all the charges have exploded, before workmen are permitted to approach the site. The charge which has not exploded, shall not be permitted to be withdrawn. The tamping and charge shall be flooded with water and the holes marked with a red cross (X) over it. Another hole shall be jumped at a distance of about 45 cm from the old hole and fired in the usual way. This operation shall be continued, till the original and any subsequent unfired charges are exploded.

5.16.5 **Blasting with Dynamite or any other High Explosive**

In case of blasting with dynamite or any other high explosive the position of all bore holes to be drilled shall be marked out in circle with white paint. These shall be inspected by the Contractor's blaster. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the blaster shall re-inspect the holes to see that the holes marked out by him have been drilled. The Blaster shall then prepare all charges necessary for the bore holes. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Wooden tamping rods (not pointed but cylindrical throughout) shall be used, in charging holes. Metal rods shall never be used for tamping. One cartridge shall be first placed in the bore hole, gently pressed and not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuse of required length.

The maximum of eight (8) bore holes shall be loaded and fired on each occasion. The charges shall be fired successively and not simultaneously.

Immediately before firing a blast, due warning shall be given and the blaster shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the blaster, who shall see that all the fuses are properly ignited.

Careful count shall be kept by him and others of each blast as it explodes. After the blast the blaster shall inspect the work and ascertain that all the charged holes have been exploded. In case of misfired holes, the Blaster shall inspect the same after half an hour and mark red crosses (X) over the holes. During this interval of half an hour, no body shall approach the misfired holes. None of the drillers shall work near such holes, until one of the two following operations has been done by the blaster.

a) Either the Contractor's blaster shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator, after which a fresh detonator, primer and fuse shall be placed in the misfired holes and fired.

OR

b) The hole shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired hole should also explode along with the new one.

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Before leaving the work, the blaster of one shift shall inform another blaster relieving him for the next shift, of any cases of misfire, and shall point out their positions denoted by red crosses and also state the action, if any, to be taken in the matter.

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

5.16.6 **Controlled Blasting (Explosive/ Non-explosive)**

Whenever required by the Engineer-in-Charge, rock blasting shall be carefully controlled so that vibrations generated during the blasting do not cause damage to the buildings and installation around. Similarly, the rock pieces should not fly off and endanger the buildings and installations around. Apart from the general precautions mentioned in the preceding paragraphs, following protective measures and limits for use of explosive are suggested as guidelines. Bidders are requested to carefully check the site conditions and submit details of the scheme they propose to adopt for controlling the blast.

Following protective measures shall be adopted while carrying out blasting operations.

The hole shall be covered with mild steel plate of minimum 12 mm thickness.

Reinforcement rod mesh not less than 20 mm dia. at 150 mm centre in both directions shall be placed over the steel plates.

Steel plate and reinforcement shall be inspected after every blasting operation and all twists shall be removed before reuse to the satisfaction of the Engineer-in-Charge.

Sand filled bags of 6 to 8 layers shall be placed over the mesh suitably covering the whole region under blasting operation.

The thickness of covering plate and the kind of dead weight is to be duly approved by the Engineer-in-Charge.

5.16.7 Hard rock requiring blasting as described under Clause 2.3.2 above, but where blasting is prohibited for any reason(s), breaking up of rock can be done by using Splitter and/or chemical substances of approved manufacturer mixed in an appropriate proportion. The method involves drilling holes into rock and then inserting Splitter (hydraulic/ pneumatic/ electro-mechanical) or injecting Chemical solvents into the holes. The breaking-up of rock takes place in a controlled fashion without much noise and spark. Any other method as agreed with Engineer-in-Charge may also be used.

5.17 Excavation in areas where existing under ground cables are envisaged, to be carried out carefully by manual means taking proper safety precautions.

The earth work machinery be deployed after ensuring from the trial pits that no cable is crossing the proposed area of excavation.

5.18 Payment (applicable for item rate tenders only)

5.18.1 The payment clause shall be operated only if the earthwork is to be measured separately as per relevant tender item.

5.18.2 Payment for earth work in excavation shall be made on cubic meter (m^3) basis on the measurement of volume of pit/ trench of excavation with working space as per relevant Indian Standards (IS:1200) and slopes/ steppings as permitted by the Engineer-in-Charge. The rate shall include cost of all the operations of blasting with explosives & accessories, making of all

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arrangements for dewatering the accumulated water from any source in the excavated pit or trench, removal and disposal of surplus excavated soil within a lead of 100 m from construction areas. The rate shall also include setting out and line out work required for the excavation.

5.18.3 The following works shall not be measured separately and allowance for the same shall be deemed to have been made in the description of main item:

a) Setting out works, profiles, etc.;
b) Site clearance, such as cleaning grass and vegetation;
c) Unauthorized battering or benching of excavation;
d) Forming (or leaving 'dead men' or 'tell-tales' in borrow pits and their removal after measurements;
e) Forming (or leaving) steps in sides of deep excavation and their removal after measurements;
f) Excavation for insertion of planking and strutting;
g) Unless otherwise specified, removing slips or falls in excavations;
h) Bailing out or pumping of water in excavation from rains;
i) Bailing out or pumping of water in excavation from sub-soil water, and
j) Slinging or supporting pipes, electric cables, etc, met during excavation.

5.18.4 Special pumping other than what is included in 5.18.3 (h and i) and well point dewatering where resorted to, shall each be measured separately, unless otherwise stated, in Kilo Watt Hour against separate specific provision(s) made for the purpose.

5.18.5 The Contractor shall intimate to the Engineer-in-Charge as soon as different classification of soils are met with. The measurements of various soil classifications then shall be worked out by either of the following alternatives in the order of their decreasing importance.

a) Joint levels shall be taken as to the levels of different soil classifications and volume worked out on the basis of levels only.

b) Where levels of different strata cannot be clearly marked and defined, the Contractor shall stack different soils of various classifications separately for measurement purpose and then dispose it off.

c) If the quantum of work involved in (b) above is extensively large & time consuming, then the total area may be divided into various zones and reasonably representative samples as in (b) above may be taken and quantities of soils of various classifications finalized for the entire zone based on the representative.

If soil of any classification other than that specified in the Schedule of Rates is met with during excavation, the decision of the Engineer-in-Charge as to the classification of soil, levels of the strata of different classifications and their location shall be binding.

In above case, the total quantity of excavation shall be computed from the measurement of the pit/ trench excavated. The hard rock and soft rock shall be measured separately from the relevant stacks and each shall be reduced by fifty percent for voids, and paid under the relevant items. The balance, that is the total quantity of excavation minus the reduced (for voids) quantity of excavation for rocks shall be paid as soft/ hard soil as per the direction of the Engineer-in-Charge (However, the maximum payment shall be limited to the volume of the excavated pit/ trench as approved by Engineer-in-Charge).

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6.0 SHORING AND STRUTTING

6.1 The shoring and strutting of the sides to withhold the face of excavation pits/trenches shall be done when approved or directed by the Engineer-in-Charge.

6.2 The shoring shall be of close or open timbering type or by Sheet Piling, Soldier Piling, etc. depending upon the site requirements and as directed by the Engineer-in-Charge whose decision shall be final and binding as to the type of shoring to be used.

6.3 The arrangement of the shoring and strutting shall be sound and safe and shall be got approved from the Engineer-in-Charge before installation. The approval shall not absolve the Contractor of his responsibilities of safety and any other requirements of the contract.

6.4 The shoring and strutting shall be kept in position till all the relevant work in the excavated area is completed and approved. It shall be dismantled and removed only after the permission to do so is obtained from the Engineer-in-Charge.

6.5 Sheet Piling

The contractor shall design, supply and install hot rolled steel sheet piles including all associated structural steel members viz. waler & runner beams, strut, cross ties, vertical members, guide frames, suitable interlocks, suitable corner sections, splicing & cutting of sheet piling. The contractor shall also apply recommended sealant for complete water tightness (as required) and ensure pre-drilling for installation into bedrock (as necessary), etc. as per site conditions.

The contractor shall mobilize/ demobilize all necessary tools & tackles, hammer (vibratory/ impact), crane(s) etc., shifting plant/ machinery and carryout all ancillary works (as required) and ensure subsequent removal of entire arrangement after completion of works.

6.6 Payment (applicable for item rate tenders only)

Payment for shoring and strutting by close and open timbering shall be made on square meter (m^2) basis as separate items. In both the cases, the measurement shall be done on the basis of the surface area of the sides of the excavation actually shored and strutted.

The rate shall include all labour, materials, erection of the poling boards, wales, struts, ballies etc., fixing and keeping the same in position as required, dismantling and removing the same after the work is over as directed.

Payment for shoring and strutting by sheet piling shall be made on the basis of shoring area of sheet pile exposed after complete excavation.

The rate shall include all labour, design, supply and installation of hot rolled steel sheet piles including all associated structural steel members, application of recommended sealant, pre-drilling for installation into bedrock etc., mobilization/ demobilization of all necessary tools & tackles, hammer, crane(s) etc., shifting plant/ machinery & all ancillary works, fixing and keeping the sheet piling in position, dismantling and removing the same after the work is over, etc. all complete as directed by the Engineer-in-Charge.

No extra payment shall be made for cost of extraction and replacement for installing of sheet pile deviating the specification or rejected by Engineer-in-charge. Extracted sheet piles shall be contractor's property and contractor shall remove the same from site without any extra cost to client.

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7.0 BACK FILLING AROUND FOUNDATIONS AND IN PLINTH

7.1 Back filling around completed foundations, structures, trenches and in plinth shall be done to the lines and levels shown on the drawings including any trimming of the surfaces, as may be necessary. This shall be done with selected and approved earth from excavation or otherwise with suitable materials described under Clause 3.1 as directed by the Engineer-in-Charge. Where sufficient suitable material is not available from the excavation, the Engineer-in-Charge may direct to import suitable earth from other sources. The filling shall be done in layers of thickness not exceeding 15 cm with watering, rolling and ramming by manual methods/ mechanical compactors to grade and level as shown on drawings to obtain 90% laboratory maximum dry density.

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

7.3 Backfilling around liquid retaining structures and pipes shall be done only after approval of the Engineer-in-Charge is obtained.

7.4 **Payment (applicable for item rate tenders only)**

Payment for backfilling with earth shall be based on volume in cubic meters (m^3) of consolidated fill. This volume shall be derived from the difference between the volume of excavation and the structure or trenches as the case may be. The rate shall include cost of extracting suitable approved earth from available excavated soil from spoil heaps within a lead of 100 m, placing, watering, rolling, ramming compacting in layers, trimming and dressing finished surface and disposal of surplus material upto a lead of 100 m.

However, backfilling done with materials other than earth shall be paid separately under relevant items.

8.0 TRANSPORTATION OF SURPLUS EARTH

8.1 Surplus earth and soil from excavation shall be removed from construction area to the area demarcated by the Engineer-in-Charge.

8.2 **Payment (applicable for item rate tenders only)**

8.2.1 Payment shall be made only for the lead beyond initial 100 m from construction area. Rate shall include re-excavation, loading, transportation, dumping, stacking or spreading (as per directions of the Engineer-in-Charge) the surplus earth and the soil in the area demarcated by the Engineer-in-Charge. Payment shall be made on cubic metre (m^3) basis on the difference of measurements of the volume of the excavated pits and the measurement of the back filling. Quantity generated due to voids in back filled volume of earth shall also be removed by the Contractor at no extra cost and this disposal of earth shall not be measured and paid under any item.

8.2.2 In exceptional circumstances the Engineer-in-Charge may direct the Contractor to remove surplus earth, concrete debris or any other waste material from site to the areas of disposal on the basis of truck measurement. In such cases volume of material shall be calculated on the basis of truck volume reduced by 30% for voids in case of soft/hard soils and 50% for soft/ hard rock. All other provisions of disposal such as spreading, levelling, grading shall apply in this case also.

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9.0 PROTECTION OF PROPERTY AND PERSONNEL

9.1 The Contractor shall protect all active utility lines shown on the drawings or encountered during the excavation. If he damages those lines, the Contractor shall repair or replace them. If existing utilities interfere with his work, the Contractor shall inform to the Engineer-in-charge and secure written instructions for further action.

9.2 The Contractor shall barricade open holes and depressions which he creates or exposes as part of this, and he shall post warning signs and lights on property adjacent to or with public access. He shall operate warning lights during hours from dusk to dawn each day and as otherwise required for safety.

9.3 The Contractor shall protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, washout, and other hazards created by his operations.

9.4 The Contractor shall plan and execute all aspects of the earthwork so that the safety of personnel, the work and adjacent property is guaranteed and such that a minimum of inconvenience is caused.

10.0 CLEAN UP

Upon completion of work, the Contractor shall leave the project site clear of debris and surplus materials off plant limits in a manner meeting all location authority requirements.

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मानक विनिर्देशन
सिविल एवं संरचनात्मक कार्य

STANDARD SPECIFICATION
CIVIL & STRUCTURAL WORKS

सादा एवं प्रबलित सीमेंट कंक्रीट

PLAIN AND REINFORCED CEMENT CONCRETE

Rev. No	Date	Purpose	Prepared by	Checked by	Standards Committee Convenor	Standards Bureau Chairman
					Approved by	
8	07 DEC 22	UPDATED & REVISED	DK	DA	AS	SM
7	29h JAN 16	UPDATED & REISSUED	AJS	AS	RS	SC
6	15th DEC 14	UPDATED & REISSUED	SP	AS	PKM	SC
5	28th DEC 12	UPDATED & REISSUED	CDS	AJS	PKM SC	DM
4	23rd NOV 07	UPDATED & REISSUED	YPC	PKM	VK	VC
3	APR,01	UPDATED & REISSUED	RPM7097	SCS	SCJ1151	MI

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Abbreviations:

ACI	:	American Concrete Institute
ASTM	:	American Society for Testing and Materials
BS	:	British Standards
GI	:	Galvanized Iron
IS	:	Indian Standard
ISO	:	International Organization for Standardization
PVC	:	PolyVinyl Chloride
RCC	:	Reinforced Cement Concrete
SCC	:	Self Compacting Concrete
SWG	:	Standard Wire Gauge

Structural Standards Committee

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1.0 SCOPE

This specification is applicable for Concrete Grade up to M60 and establishes the requirements of materials, mix proportioning, placing, curing, etc. of all types of cast-in-situ and precast concrete (ref. section 1.6) used in foundations, underground and above ground structures, floors, pavements etc. Any special requirements as shown or noted on the drawings shall supersede the provisions of this specification.

1.1 Reference Codes and Specifications

Apart from this specification, construction of plain and reinforced concrete works shall be in accordance with the Indian Standard Code of Practice for "Plain and Reinforced Concrete" IS 456 along with all amendments till date and other relevant codes mentioned therein.

1.2 For Liquid Retaining Structures, EIL Specification No. 6-68-0005 shall be applicable.

1.3 For Structural Steel works, EIL Specification No. 6-68-0006 & 0008 shall be applicable.

1.4 For Bipolar Concrete Penetrating Corrosion Inhibiting Admixture, EIL Specification No. 6-68-0017 shall be applicable.

1.5 For Self Compacting Concrete, EIL Specification No. 6-68-0019 shall be applicable.

1.6 For precast concrete manufacturing refer EIL Specification No. 6-68-0014.

1.7 In case of conflict between the clauses mentioned in this specification and those in the Bureau of Indian Standards (BIS), this specification shall govern.

2.0 MATERIALS

2.1 Materials for concrete viz cement, Pozzolanas, Fly Ash, Ground Granulated Blast Furnace Slag, Sand, Coarse aggregate, Water, etc. shall be as described in EIL Specification No.6-68-0002.

2.2 Materials for all reinforcements, embedment, inserts, water bars etc. shall conform to EIL Specification 6-68-0002.

2.3 Materials to be used as additive to concrete shall conform to EIL specification 6-68-0002 & 6-68-0017.

3.0 GRADES OF CONCRETE

Characteristic Compressive strength for different grades of concrete shall be as per Table-1.

TABLE – 1
GRADES OF CONCRETE

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm^2)
Ordinary Concrete	M10 M 15 M 20	10 15 20

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TABLE – 1 (CONT.)
GRADES OF CONCRETE

Group	Grade Designation	Specified Characteristic Compressive Strength of 150 mm cube at 28 days (N/mm^2)
Standard Concrete	M 25	25
	M 30	30
	M 35	35
	M 40	40
	M 45	45
	M 50	50
	M 55	55
High Strength Concrete	M 60	60

Note: The characteristic strength is defined as the strength of material below which not more than five (5) percent of the test results are expected to fall.

4.0 TYPE OF CONCRETE MIX

4.1 Unless otherwise noted on drawings, all lean/plain concrete shall be of Nominal Mix type and reinforced concrete shall be of Design Mix type.

4.2 Nominal Mix Concrete

This concrete shall be made (without preliminary tests) by adopting nominal concrete mix with proportions of materials as specified in Table 9 of IS 456.

4.3 Design Mix Concrete

The mix shall be designed as per IS: 10262 in an approved laboratory to produce the grade of concrete having the required workability and characteristic strength not less than appropriate values given in Table-1. The target mean strength of concrete mix shall be equal to the characteristic strength plus 1.65 times the standard deviation.

As long as the quality of materials does not change, a mix design done earlier but not prior to one year may be considered adequate for later work. However, in case the source & quality of materials changes or there is a break in the continuity of construction, the Engineer-In-Charge shall ask for a new design mix.

Irrespective of the grade of concrete required to be produced as per characteristic strength criteria, the minimum cement content and maximum water cement ratio in the design concrete shall be strictly maintained as stipulated in Table 5 of IS 456.

5.0 CONCRETE MIX PROPORTIONING

Proportioning, as used in this specification, shall mean the process of determining the proportions of the various ingredients to be used to produce concrete of the required workability when fresh/green and strength, durability & surface finish, when hardened. The following information shall be collected prior to design of the concrete mix:

a) Grade designation.
b) Type of cement.
c) Maximum nominal size of aggregate.
d) Minimum cement content.
e) Maximum water cement ratio
f) Workability requirements.

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g) Exposure condition as per Table 3 & Table 4 of IS 456
h) Maximum temperature of concrete at the time of placing.
i) Method of Placing.

The Engineer-in-Charge shall verify the strength of the concrete mix, before giving his sanction of its use. However, this does not absolve the Contractor of his responsibility as regards achieving the prescribed strength of the mix. If during the execution of the work, cube tests show lower strengths than required, the Engineer-in-Charge shall order fresh trial mixes to be made by the Contractor. No claim to alter the rates of concrete work shall be entertained due to such changes in mix variations. Any variation in cement consumption shall be taken into consideration for material reconciliation. Preliminary mix designs shall be established well ahead of start of work.

5.1 Maximum Density

Suitable proportions of sand and the different sizes of coarse aggregates for each grade of concrete shall be selected to give as nearly as practicable the maximum density as per clause 10.2.3 of IS 456. This shall be determined by mathematical means, laboratory tests, field trials and suitable changes in aggregate gradation. The contractor shall ensure the same to the satisfaction of Engineer-in-Charge.

5.2 Consistency

The concrete shall have a consistency such that it shall be workable in the required position and when properly vibrated it flows around reinforcing steel, all embedded fixtures, etc.

5.3 Workability

"Workability of Concrete" shall be as per clause 7 of IS 456.

5.4 Durability

For achieving sufficiently durable concrete, strong, dense aggregates, low water-cement ratio and adequate cement content shall always be used. Workability of concrete shall be such that concrete can be completely compacted with the means available. Leak-proof formwork shall be used so as to ensure no loss of cement-slurry during pouring and compaction. Cover to reinforcement shall be uniform. Concrete mix design shall always take into account the type of cement, minimum cement content irrespective of the type of cement and maximum water cement ratio and minimum grade of concrete conforming to environmental exposure conditions (refer Table 3 of IS 456) as given in Table 5 of IS: 456.

Generally, following types of cement shall be used for Plain and Reinforced concrete works:

a) 43/ 53 Grade Ordinary Portland Cement conforming to IS 269.
b) Rapid hardening Portland Cement conforming to IS 8041.
c) Portland Slag Cement conforming to IS 455.
d) Portland Pozzolana Cement(fly ash based) conforming to IS 1489(Part 1)
e) Portland Pozzolana Cement (calcined clay based) conforming to IS 1489(Part-2).
f) Sulphate Resisting Portland Cement conforming to IS 12330

Sulphate Resisting Portland Cement shall be used only for specific requirements depending on environmental and process exposure conditions to which the structures may be subjected to like high Sulphate concentrations, processes involving Sulphur handling etc.

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5.4.1 Water Cement Ratio

Once a mix, including its water cement ratio, has been determined and approved for use by the Engineer-in-Charge, that water cement ratio shall be maintained. The Contractor shall determine the water content of the aggregates frequently as the work progresses, and the amount of mixing water shall be adjusted so as to maintain the approved water cement ratio. Maximum water-cement ratio shall be as per Table 5 of IS 456 for different exposure condition.

The minimum cement content as mentioned in Table 5 of IS 456 shall be adjusted for aggregates other than 20 mm nominal maximum size as defined in Table 6 of IS 456.

For maximum cement content refer Cl.8.2.4.2 of IS 456.

5.4.2 Where specified, Bipolar concrete penetrating corrosion inhibiting Admixture in reinforced concrete as per EIL specification No. 6-68-0017 shall be used for protecting the reinforcement from corrosion.

5.5 Limits to Deleterious Constituents

Careful selection of the mix and the constituent materials shall be made to limit the presence of deleterious constituents in concrete. The total acid soluble chloride content calculated from the mix proportion and the measured chloride content of each of the constituents shall not exceed 0.6 kg/m^3 at the time of placing of concrete. The total water soluble Sulphate content of the concrete mix shall not exceed 4 percent by mass of the cement in the mix.

6.0 BATCHING

Refer clause 10.2 of IS 456.

7.0 CONCRETE MIXING

7.1 Ready Mixed Concrete supplied by Ready Mixed Concrete Plants or from on/off-site batching plants (IS 4926) shall be used for structural concrete.

All records and charts for the batching and mixing operations shall be prepared and maintained by the contractor in accordance with IS 4926 or as per the instructions of Engineer-in-Charge.

In case Ready Mixed Concrete is not available, the mixing of concrete shall be strictly carried out in an approved type of mechanical concrete mixer. The mixer shall be fitted with water measuring devices. The mixing shall be continued until there is a uniform distribution of the material and the mass is uniform in colour and consistency. If there is segregation after unloading from the mixer, the concrete shall be remixed.

7.2 Mixer

7.2.1 Mechanical Mixers shall comply with IS 1791 and 12119 and shall be maintained in satisfactory operating condition. These shall be used only for producing lean/ plain concrete and/ or nominal mix concrete wherever permitted.

7.2.2 Mixing Time

Mixing time shall be as indicated in the following Table-2. Excessive mixing requiring additions of water shall not be permitted. Time shall start when all solid materials are poured in the revolving mixer drum, provided that all of the mixing water shall be introduced before one-fourth of the mixing time has elapsed. The Engineer-in-Charge may, however, direct a change in the mixing time, if he considers such a change necessary.

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TABLE-2

MINIMUM MIXING TIME FOR MIXERS

Capacity of mixer	Minimum mixing time
2 m^3 or less	2 minutes
Above 2 m^3	3 minutes or as recommended by the mixer manufacturer.

7.3 Hand Mixing

Hand mixing of concrete shall not be permitted. However, for non-critical applications namely foundations for crossovers, isolated operating platforms etc., using concrete upto grade M20 and located at far away isolated places, this may be permitted by the Engineer-in-charge as a special case. Mixing shall be carried out on a water tight platform and care shall be taken to ensure that mixing is continued until the mass is uniform in colour and consistency. No extra payment shall be made to the Contractor for mixing by hand or for using extra cement due to hand mixing.

7.4 Additives

Additive in concrete shall be used only with the prior approval of the Engineer-in-Charge and shall comply with Cl. 5.5 of IS 456. Any additive used for obtaining proper workability or leak proofness of concrete or repair/rendering works of concrete due to non-conformance to the specifications, shall not be measured and paid for. All costs relating to such usage shall be borne by the Contractor.

8.0 TRANSPORTATION, PLACING AND COMPACTION

8.1 General

The entire concrete placing programme including transportation arrangements, deployment of equipment, layout, proposed procedures and methods, shall be submitted to the Engineer-in-Charge 24 hours prior to concreting for approval. No concreting shall be placed until his approval has been received. Approval of the Engineer-in-Charge for pouring concrete shall be taken as 'conveyed', when the concrete pour card is signed by him.

8.1.1 Chuting

The use of long troughs, chutes and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization from the Engineer-in-Charge. In case an inferior quality of concrete is produced by the use of such conveyors, the Engineer-in-Charge may order discontinuance of their use and the substitution of a satisfactory method of placing the concrete. Open troughs and chutes shall be equipped with baffles and be in short lengths to avoid segregation. Chutes shall be designed so that the concrete is, to some extent, remixed at the lower end by passing down through a funnel shaped pipe or drop chute. Alternatively, they shall discharge into a storage hopper from which the concrete shall be transported to the point of placing by wheel barrows or other means. Where drop chutes are used, a sufficient number of these must be provided, so that the concrete discharged from the chute is not required to flow laterally more than 1.0 metre. Where a drop chute is swung from the vertical, the bottom two sections must be maintained in a vertical position to avoid segregation. The addition of water at any point in the system of transportation, to facilitate the movement of concrete shall not be permitted. All chutes, troughs and pipes, shall be kept clean and free from coatings of hardened concrete by thoroughly flushing them with water after each run; water used for flushing shall be discharged clear of the structure.

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8.1.2 Vibrators

8.1.2.1 Concrete shall be compacted with mechanical vibrating equipment supplemented, if necessary to obtain consolidation, by hand spreading, rodding and tamping. The vibrators shall be of immersion type with operational frequency ranging between 8,000 to 12,000 vibrations per minute. All vibrators shall comply with IS 2505. Screed board concrete vibrators or concreting vibrating tables or form vibrators conforming to IS 2506, 2514 and 4656 respectively shall be used where specifically required and directed by Engineer-in-Charge.

8.1.2.2 Immersion type vibrators shall be inserted in a vertical position at intervals of about 600 mm, depending upon the mix, the equipment used, and experience on work. The vibrators shall be withdrawn slowly. The spacing shall provide some overlapping of the area vibrated at each insertion. In no case shall vibrators be used to transport concrete inside the forms. Over vibration or under vibration shall not be permitted as both are harmful. Hand tamping in some cases may be allowed subject to the approval of the Engineer-in-Charge.

8.1.2.3 In placing concrete in layers which are advancing horizontally as the work progresses, great care shall be exercised to ensure adequate vibration, bonding and moulding of the concrete between the succeeding batches.

8.1.2.4 The vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

8.1.2.5 Care shall be taken to prevent contact of vibrators against all embedded reinforcing steel or inserts. Vibrators shall not be allowed to come in contact with forms.

8.1.2.6 The use of form vibrators shall not be permitted for compaction of in-situ concrete without specific authorization of the Engineer-in-Charge.

8.1.2.7 The use of surface vibrators of screed board type shall not be permitted for consolidation of concrete under ordinary conditions. However, for thin slabs (of thickness less than 200 mm) surface vibration by such vibrators may be permitted, upon approval of the Engineer-in-Charge.

8.1.2.8 Whenever vibration has to be applied externally, the design of formwork and the disposition of vibrators shall be carefully planned to ensure efficient compaction and to avoid surface blemishes.

8.2 Transportation

8.2.1 All concrete shall be conveyed from the mixer to the place of final deposit such as formwork as rapidly as possible using suitable buckets, dumpers, pumps, transit mixers containers or conveyors which shall be mortar leak tight. Care shall be taken to prevent the segregation or loss of the ingredients and maintaining the required workability. For structural concrete produced from Ready Mixed Concrete/ Batching Plants, concrete shall be transported from the plants to the sites only by transit mixers and Delivery Ticket for each delivery of concrete shall be maintained by the contractor.

8.2.2 During hot or cold weather, concrete shall be transported in deep containers. Other suitable methods to reduce the loss of water by evaporation in hot weather and heat loss in cold weather may also be adopted. All equipment used for transporting and placing of concrete shall be maintained in clean condition. All buckets, hoppers, chutes, dumpers and other equipment shall be thoroughly cleaned after each use.

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8.3 Placing and Compaction

8.3.1 Before placing concrete, all soil surfaces upon which or against which concrete is to be placed shall be well compacted and free from standing water, mud or debris. Soft or yielding soil shall be removed and replaced, with lean concrete or with selected soils/sand and compacted to the density as directed by Engineer-in-Charge. The surface of absorptive soil (against which concrete is to be placed) shall be moistened thoroughly so that moisture is not drawn from the freshly placed concrete. Similarly, for concrete to be placed on formworks, all chippings, shavings and sawdust etc. shall be removed from the interior of the forms before the concrete is placed.

8.3.2 Concrete shall not be placed until the formwork, the placement of reinforcing steel, embedded parts; pockets etc. have been inspected and approved by the Engineer- in-Charge. Any accumulated water on the surface of the bedding layer shall be removed by suitable means before start of placement. No concrete shall be placed on a water covered surface.

8.3.3 Concrete shall be discharged by vertical drop only and the drop height shall not normally exceed 1.5 metre throughout all stages of delivery until the concrete comes to rest in forms. However, drop height can be relaxed by the Engineer-in-Charge as per the provisions given under Cl. 8.1.1. For continuous concreting operation windows of suitable size shall be kept in the formwork or chutes shall be used to avoid segregation of concrete.

8.3.4 Concrete shall be deposited as near as practicable in its final position to avoid rehandling. Concrete shall be placed in successive horizontal layers. The bucket loads, or other units of deposit, shall be placed progressively along the face of the layer with such over-lap as will facilitate spreading the layer of uniform depth and texture with a minimum of hand shoveling. Any tendency to segregation shall be corrected by shovelling coarse aggregates into mortar rather than mortar on the coarse aggregates. Such a tendency for segregation shall be corrected by redesign of mix, change in process or other means, as directed by the Engineer-in-Charge.

8.3.5 All struts, stays and braces (serving temporarily to hold the forms in correct shape and alignment pending the placing of concrete at their locations) shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. These shall not be buried in the concrete. Concrete shall be thoroughly compacted with vibrators and fully worked around the reinforcement, embedded fixtures and into corners of formwork before setting commences and shall not be subsequently disturbed. Methods of placing shall be such as to preclude segregation and avoid displacement of reinforcement or formwork. The formation of stone-pockets or mortar bondage in corners and against face forms shall not be permitted. Should these occur, they shall be dug out, reformed and refilled to sufficient depth and shape for thorough bonding as directed by the Engineer-in-Charge. Care shall be taken to avoid displacement of reinforcement and embedded inserts or movement of formwork.

8.3.6 Unless otherwise approved, concrete shall be placed in single operation to the full thickness of foundation rafts, slabs, beams and similar members. Concrete shall be placed continuously until completion of the part of the work between approved construction joints or as directed by the Engineer-in-Charge.

8.3.7 The method of placing and compaction employed in any particular section of the work shall be to the entire satisfaction of the Engineer-in-Charge.

8.3.8 During hot weather (atmospheric temperature above 40 degree Celsius) or cold weather (atmospheric temperature below 5 degree Celsius, the concreting shall be done as per the procedure set out in IS 7861).

8.3.9 Concrete that has set standing and becomes stiffened shall not be used in the work.

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8.3.10 Continuous Concreting

Where called out on the drawings, continuous concreting shall be done in a single operation as per the requirements of IS 456 and IS 2974. Sufficient "Windows" shall be left in the formwork for pouring & compaction of concrete and inspection. These windows shall be fixed tight once the level of concrete reaches their levels.

8.3.11 Concreting under special conditions

a) Work in extreme weather conditions during hot or cold weather, the concreting shall be done as per procedure set out in IS 7861(Part 1) or IS 7861 (Part2).

b) Under water concreting shall be as per clause 14.2 of IS 456.

8.4 Items Embedded in Concrete

8.4.1 Concreting shall not be started unless the electrical conduits, pipes, fixtures etc., wherever required, are laid by the concerned agency. The Contractor shall afford all the facilities and maintain co-ordination of work with other agencies engaged in electrical and such other works as directed by the Engineer-in-Charge.

8.4.2 Before concreting, the Contractor shall provide, fabricate and lay in proper position all metal inserts, anchor bolts, pipes etc. (which are required to be embedded in concrete members) as per relevant drawings and directions of Engineer-In-Charge.

8.4.3 All embedment, inserts etc. shall be fully held and secured in their respective positions by the concerned agencies to the entire satisfaction of Engineer-in-Charge so as to avoid any dislocation or displacement during the concreting operations. The Contractor shall take all possible care during concreting to maintain these embedment/inserts in their exact locations.

9.0 CONSTRUCTION JOINTS

9.1 Construction joints shall be provided in position as shown or described on the drawings or as directed by the Engineer-in-Charge. Such joints shall be kept to the minimum. These shall be straight and at right angles to the direction of main reinforcement and shall be placed at accessible locations to permit cleaning out of laitance, cement slurry and unsound concrete.

9.2 In a column, the joint shall be formed about 100 mm to 150 mm below the lowest soffit of the beams framing into it. Concrete in a beam and slab shall be placed throughout without a joint but if the provision of a joint is unavoidable, the joint shall be vertical and located within 1/3 to 1/4 of the span, unless otherwise shown on the drawings.

9.3 When stopping the concrete on a vertical plane in slabs and beams, an approved stop board shall be placed with necessary slots for reinforcement bars. The construction joints shall be keyed by providing a triangular or trapezoidal fillet nailed on the stop board. Inclined joints shall not be permitted. Any concrete flowing through the joints of stop board shall be removed soon after the initial set. When concrete is stopped on a horizontal plane, the surface shall be roughened and cleaned after the initial set and a triangular or trapezoidal groove shall be provided for keying with the new concrete later.

9.4 When the work has to be resumed on a surface which has hardened, such surface shall be cleared of any foreign materials and roughened to expose the tips of the coarse aggregate. This may be done by manual chipping of concrete, with a high pressure water jet or by any other appropriate means as per Engineer-in-Charge's directions. It shall then be swept clean and thoroughly washed and wetted before any new concrete is poured. Any set mortar or concrete sticking to the exposed reinforcing rods in and around such joints shall be thoroughly removed. The reinforcements shall be wire brushed and washed just before

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pouring any cement slurry or mortar. For vertical joints neat cement slurry shall be applied on the surface before it is dry. For horizontal joints the surface shall be covered with a layer of mortar about 10 to 15 mm thick composed of cement and sand in the same ratio as the cement and sand in concrete mix. This layer of cement slurry or mortar shall be freshly mixed and applied immediately before placing new concrete.

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

10.0 SEPARATION JOINT

10.1 Separation joint shall be obtained by using an approved Alkathene sheet stuck on the surface against which concrete shall be placed. Adequate care shall be taken to cause no damage to the sheet.

11.0 EXPANSION JOINTS/ISOLATION JOINT

11.1 Expansion/ Isolation joints in structures shall be formed in the positions and to the shapes shown in the relevant drawings. Joints shall be filled with joint filling material as stipulated in the drawings/schedule of rates. Isolation joints shall be provided around all equipment foundations, columns, pedestals, trenches etc. on grade.

12.0 WATER STOPS

PVC water stops as per EIL Specification No. 6-68-0002 for materials shall be accurately cut, fitted and integrally joined as per manufacturer's specifications to provide a continuous, watertight diaphragm at all points.

The water stops shall be located and embedded at expansion/contraction/ construction joints as indicated in the drawings or directed by the Engineer-in-Charge.

Adequate provision shall be made for the support and protection of water stops during the progress of the work. Damaged water stops shall be replaced and/or repaired as directed.

13.0 PROTECTION OF FRESHLY LAID CONCRETE

13.1 Newly placed concrete shall be protected, by approved means, from rain, sun and wind. Concrete placed below the ground level shall be protected from falling earth during and after placing. Surface shall be kept free from contact with such ground or with water draining from such ground during placing of concrete for a period of at least 3 days, unless otherwise directed by the Engineer-in-Charge. The ground water around newly poured concrete shall be kept to an approved level by pumping or other approved means of drainage and adequate steps shall be taken to prevent floatation and flooding. Steps shall be taken to protect immature concrete from damage by debris, loading, vibration, abrasion, mixing with deleterious materials that may, in the opinion of the Engineer-in-Charge, impair the strength and/or durability of the concrete.

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14.0 CURING

14.1 Concrete shall be cured by keeping it continuously moist wet for the specified period of time to ensure complete hydration of cement and its hardening. Curing shall be started after 8 hours of placement of concrete in normal weather, and in hot weather after 4 hours. The water used for curing shall be of the same quality as that used for making of concrete.

Curing shall be assured by use of an ample water supply under pressure in pipes, with all necessary appliances such as hose, sprinklers etc. A layer of sacking, canvas, hessian, or other approved material, which will hold moisture for long periods and prevent loss of moisture from the concrete, shall be used as covering. Type of covering which would stain, disfigure or damage the concrete, during and after the curing period, shall not be used. Only approved covering shall be used for curing.

Exposed surfaces of concrete shall be maintained continuously in a damp or wet condition for at least the first 7 days after placing of concrete.

The Contractor shall have all equipment and materials required for curing on hand and ready to use before concrete is placed.

For curing the concrete in pavements, floors, flat roofs or other level surfaces, the ponding method of curing shall be used. For the first 24 hours after concreting, the concrete shall be cured by use of wet sacking, canvas, hessian etc. The minimum water depth of 25 mm for ponding shall be maintained. The method of containing the ponded water shall be approved by the Engineer-in-Charge. The ponded areas shall be kept continuously filled with water, and leaks, if any, shall be promptly repaired. Areas cured by ponding method shall be cleared of all debris and foreign materials after curing period is over.

Alternatively, membrane curing may be used in lieu of moist curing with the permission of the Engineer-in-Charge. Such compounds shall be applied to all exposed surfaces of the concrete by spraying or brushing as soon as possible after the concrete has set. Minimum film thickness of such curing compounds shall be as per the recommendation of the manufacturer so as to obtain an efficiency of 90% as specified by BS-8110. This film of curing compound shall be fully removed from the concrete surface after the curing period specified earlier. Engineer-in-Charge may not allow curing by curing compounds for those surfaces where use of curing compound may be detrimental to application of future finishes over the concrete. Impermeable membranes such as polyethylene sheeting closely covering the concrete surface may also be used.

14.2 For concretes containing Portland pozzolana cement or Portland slag cement, the curing period as given in Cl. 14.1 shall be doubled. Curing by ponding shall, however, commence after the first 24 hours of concreting.

15.0 FIELD TESTS

15.1 Materials Testing

15.1.1 Aggregates

Grading test on fine and coarse aggregates shall be carried out as per IS 2386 at intervals specified by the Engineer-in-Charge.

The mandatory tests and their frequencies shall be done as given in Table-3A & 3B below:

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TABLE – 3A
(For Concrete prepared at site by using Mechanical mixers)

MANDATORY TESTS ON SAND & STONE AGGREGATES

S. No	MATERIAL	TEST	FIELD / LAB TEST	MIN. QTY OF MATERIAL/ WORK FOR CARRYING OUT TEST	FREQUENCY OF TESTING*
1.	Sand	(a) Bulking of sand	Field Test	20 m^3	Every 20 m^3 or part thereof or more frequently as decided by the Engineer-in-Charge
		(b) Silt content	Field Test	20 m^3	
		(c) Particle size distribution	Field or Lab as decided by the Engineer-in-Charge	40 m^3	1) Every 40 m^3 of fine aggregate/sand required in RCC works only 2) Every 80 m^3 of fine aggregate/ sand required for other items
2.	Stone aggregate	a) Percentage of soft or deleterious materials	General visual inspection, laboratory test where required by Engineer -in-Charge or as specified	As required by Engineer-in-Charge	For all quantities
		b) Particle size distribution	Field or lab. as required by Engineer-in-Charge	45 m^3	For every 45 m^3 or part thereof as decided by Engineer-in-Charge
		c)Ten percent Fine value	Laboratory	45 m^3	Initial test and subsequent test as & when required by Engineer-in-Charge

* Fresh testing is mandatory whenever there is change in Source of materials.

TABLE – 3B
(Refer Cl. 4.4 & 4.6.1 of IS 4926)

(For Ready Mixed Concrete supplied by Ready Mixed Concrete Plants or from on/off-site Batching Plants)

MATERIALS TESTING REQUIREMENTS

S. No	AGGREGATE PROPERTY/ PARAMETER	TYPE OF AGGREGATE	ASSESSMENT OF TYPICAL PROPERTIES AND HIGH TEST RATE*	NORMAL MONITORING AND LOW TEST RATE*	REQUIREMENT FOR NORMAL MONITORING AND LOW TEST RATE
1.	**Grading**	Sand/Fine	Weekly	Monthly	Last 8 results conform to IS 383 or representative values
		Coarse-Single sized/ Graded	Weekly	Monthly	
2.	**Particle density** -Oven Dry -Saturated Surface Dry -Apparent	All Types	Weekly	3 Monthly	Last 4 results ±0.04 percent
3.	**Absorption**	All Types	Weekly	3 Monthly	Last 4 results ±0.04 percent

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S. No	AGGREGATE PROPERTY/ PARAMETER	TYPE OF AGGREGATE	ASSESSMENT OF TYPICAL PROPERTIES AND HIGH TEST RATE*	NORMAL MONITORING AND LOW TEST RATE*	REQUIREMENT FOR NORMAL MONITORING AND LOW TEST RATE
4.	**Bulk Density** - Loose - Compacted	All Types	Monthly	6 Monthly	Last 4 results ± 75kg/m³
5.	**Fines(Silt) Content**	Sand	Weekly	Monthly	Last 10 results <75 percent maximum allowed
		Coarse	Monthly	3 Monthly	
6.	**Aggregate Impact Value**	Coarse	As specified	As specified	-
7.	**10 % Fines**	Coarse	Yearly	Yearly	-
8.	**Flakiness**	Coarse	2 Weekly	6 Monthly	Last 3 results conform to standard
9.	**Chloride Content**	All Types	Weekly	6 Monthly	Last 3 results < 0.01 percent
10.	**Aggregate Abrasion Value** (Los Angeles Method)	Coarse	-	Yearly/ Source Change	-
11.	**Soundness**	Fine and Coarse	-	Yearly/ Source Change	-
12.	**Potential Alkali Aggregate Reactivity Including Petrography**	Fine and Coarse	-	5 Yearly/ Source Change	-
13.	**Petrographic Description** (General)	All Types	-	5 Yearly	-

***Note** : The high or low test rates apply in accordance with the following conditions:

a) High test rate
   i) To establish the typical characteristics of an aggregate, and
   ii) When significant changes in properties occur outside the tolerances for low test rates given.

b) Low test rate
   i) When the typical characteristics of the aggregate have been established, and
   ii) When subsequent tests lie within the tolerances for low test rates given

15.1.2 Water

The minimum testing frequencies shall be as follows:

SOURCE	PARAMETERS	FREQUENCY	REQUIEMENT
Non mains water (Untreated water extracted from wells, ponds, lakes, rivers, underground, etc.)	p^H value, Chloride ion content, Sulphate content and any other parameter in accordance with IS 456	Initially every week for first 6 weeks (average of test results to be taken) and then at 3-monthly interval	Need further investigation in case significant deviation observed in test results of 3-monthly interval samples from the original 6 weeks average
Mains water (Treated water supplied through piped network)	Same as above	Annual basis once all tests for source are satisfactory	In case Chloride content > 0.01%, testing frequency shall be reduced to 3 months

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15.2 Compaction Factor Test /Slump Test of Concrete

15.2.1 For structural quality concrete (excluding pavements, flooring etc.) at least one Slump Test shall be made for every compressive strength test carried out. More frequent tests shall be made if there is a distinct change in working conditions or if required by the Engineer-in-Charge.

In case of Ready Mixed Concrete, provisions of IS 4926 shall be followed.

15.2.2 For structural quality concrete for pavements & floorings, measurement of workability shall be by determination of compacting factor. Value of compacting factor of 0.75 to 0.8 shall generally be acceptable.

15.3 Strength Test of Concrete

15.3.1 Samples from fresh concrete shall be taken as per IS 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS 516.

15.3.2 In order to get a relatively quicker idea of the quality of concrete, optional tests on beams for modulus of rupture at 72±2 hours or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests. For this purpose, the values shall be arrived at based on actual testing. In all cases, the 28 days compressive strength specified in Table-1 shall alone be the criterion for acceptance or rejection of the concrete in accordance with clause 15.3.9.

15.3.3 Sampling Procedure

A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested that is, the sampling should be spread over the entire period of concreting and cover all mixing units.

15.3.4 Frequency of Sampling

The minimum frequency of sampling of concrete for each grade shall be in accordance with Table-4.

TABLE – 4
(Refer Cl. 15.2.2 of IS 456)

FREQUENCY OF CONCRETE SAMPLING

Quantity of concrete in the work (m^3)	Number of samples
1-5	1
6-15	2
16-30	3
31-50	4
51 & above	4 plus one additional sample for each additional 50m^3 or part thereof.

At least one sample shall be taken from each shift.

When concrete is produced at continuous production units such as ready mixed concrete/ batching plants, atleast one sample shall be taken for every 50m^3 of concrete or after every 50 batches, whichever occurs at a greater frequency or as decided by the Engineer-in-Charge. Samples shall be avoided from the first and the last cubic metre of concrete mix in a lot.

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15.3.5 Test Specimen

Three test specimens shall be made for each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the formwork or to check the testing error. Additional samples may also be required for testing samples cured by accelerated methods as described in IS 9013. The specimen shall be tested as described in IS 516.

15.3.6 Identification mark on concrete test cubes:

The following numbering system shall be adopted on each 150 mm cube:

First line: ZZ	(Alpha code assigned by the Engineer -in-Charge to the Contractor for a particular contract starting with AA and progressing to AB, AC and so on).
Second line: XXXX	(Unique integer in ascending order starting from 1).
Third line: DD-MM-YY	(Date of casting of cube)

15.3.7 Test Results of Sample

The test results of the sample shall be the average of the strength of three specimens. The individual variation should not be more than ± 15 percent of the average. If more, the test results of the sample shall be considered invalid.

15.3.8 Standard Deviation

Standard deviation for each grade of concrete shall be calculated separately.

Standard deviation based on test results of samples:

a) The total number of test samples required to constitute an acceptable record for calculation of standard deviation shall be not less than 30. Attempts shall be made to obtain the 30 samples, as early as possible, when a mix is used for the first time.

b) For design of mix in the first instance, the value of standard deviation given in Table 8 of IS 456, Amendment No. 4 may be assumed.

c) As soon as sufficient results of samples are available, actual calculated standard deviation shall be used and the mix design shall be revised/ updated. However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in Table 8 of IS 456, Amendment No. 4, it shall be permissible to use that value.

d) For additional requirement on standard deviation refer clause 9.2.4 of IS 456.

15.3.9 Acceptance Criteria

15.3.9.1 Compressive Strength

The concrete shall be deemed to comply with the strength requirement when both the conditions as given in col. 2 & col.3 of Table-5 for that particular grade of concrete are simultaneously met. For working out standard deviation compressive test result of date wise serially logged 30 sample test result shall be used.

15.3.9.2 Flexural Strength

The concrete shall be deemed to comply with flexural strength requirements when both the following conditions are simultaneously met:

a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm².

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