

NEYVELI LIGNITE CORPORATION LIMITED

(A GOVERNMENT OF INDIA ENTERPRISE)

BLOCK-1, P.O NEYVELI -607801

CUDDALORE DISTRICT, TAMIL NADU, INDIA



THERMAL POWER PROJECT AT BARSINGSAR, RAJASTHAN 2 X 125 MW UNITS

**TENDER SPECIFICATIONS FOR
220kV SWITCHYARD AND POWER TRANSFORMERS
(PACKAGE CODE RA7)**



VOLUME - IIIB



**TECHNICAL REQUIREMENTS
CIVIL WORKS & MECHANICAL WORKS**







**TCE CONSULTING ENGINEERS LIMITED
73/1, ST.MARK'S ROAD
BANGALORE 560 001**



JULY 2005



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<p style="text-align: center;">SECTION I - GENERAL</p> <ol style="list-style-type: none"> 1. This specification is to cover the design, preparation of general arrangement, construction as well as Fabrication drawings, supply of all labour as well as materials and construction of all civil, structural as well as architectural work on a turnkey basis for new 220kV Switch yard, Construction of new switch yard control room, Execution of Transformer yard civil works including construction of transformer foundations based on the drawings to be issued by the Owner /Consultant for 2x125 MW thermal Power project at Barsingsar, promoted by M/s. Neyveli Lignite corporation in the state of Rajasthan, India. 2. Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as CIVIL WORKS. The detailed scope of works covered under civil & Structural works are given in Section II. 3. The work to be performed under this specification consists of design, engineering for switch yard structures/foundations, switch yard control room as well as providing all labour, materials, consumables, equipment, temporary works, temporary labour and staff colony, constructional plant, fuel supply, transportation and all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work. 4. Supply of all materials including cement, reinforcement steel, structural steel and other materials are included in the scope of the Contractor. 5. The scope shall also include setting up by the BIDDER a complete testing laboratory in the field to carry out all relevant tests required for the civil works for the project. 6. The work shall be carried out according to the design/drawings to be developed by the BIDDER and approved by the CONSULTANT/OWNER. For all building and structures, foundations, etc., necessary layout and details are to be developed by the BIDDER keeping in view the statutory & functional requirements of the plant and facilities and providing enough space and access for operation, 		
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<p>use and maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Bidder's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the OWNER. However for all Transformer foundations, oil pits, fire barrier walls, cable trenches in side the transformer yard, design and construction drawings will be supplied by the purchaser/consultant and hence design and drawing preparation for these works are not included in this scope of works. The works for the design and construction of interbus transformer foundation situated inside the switchyard is included in the scope of the bidder.</p> <p>7. BIDDER shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, tidal / flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site conditions shall not be accepted by the Owner as basis for any claim for compensation or extension of time. The submission of a bid by the BIDDER will be construed as evidence that such an examination was made and any later claims / disputes in regard to price quoted shall not be entertained or considered by the OWNER on account of ignorance of prevailing site conditions.</p> <p><u>GEOTECHNICAL INVESTIGATION</u></p> <p>8. The OWNER has carried out a preliminary Geotechnical Investigation at the site and the same is available with OWNER for reference. A few typical bore logs based on the investigations carried out are enclosed as annexure to this section.</p> <p>BIDDER may also verify the content of report by taking few boreholes at site at his own cost and analyse the same before submission of bids. Alternatively BIDDER may make his own assessment for the type of foundations envisaged based on this report at his own risk. In any case, the BIDDER has to carryout detailed geotechnical investigation after the award of contract, through some approved / reputed agency to be approved by Owner/Consultant, and submit geotechnical investigation report with recommendation for Owner's review & approval. In case if there is variance between the soil report furnished by he Owner/Consultant and the contractor after carrying out the soil investigations, the safer of the two values shall be considered</p>		
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<p>for the design. The CONTRACTOR is not eligible to increase his cost or demand any extension of time because the final report is in variance from preliminary report furnished by OWNER.</p> <p><u>SURVEY DATA</u></p> <p>9. The OWNER has carried out a preliminary survey of the area and drawings indicating the survey detail along with contour are available with OWNER for reference.</p> <p>The bid drawing enclosed indicates grade levels and the contours based on the preliminary survey work. Bidders scope shall include for grading of the area with in the battery limits as indicated in the drawing.</p> <p>10. <u>STATUTORY REQUIREMENT</u></p> <p>CONTRACTOR shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Loss prevention association, Water act for Pollution control, Explosives act etc. Provisions of Safety, health and welfare according to Factories act shall also be complied with. Statutory clearances and norms of State Pollution Control Board shall be followed. Statutory body /Act requirements shall be fulfilled by the CONTRACTOR and in case any modifications /additions to the building /Structures are to be made as per the above, shall be carried out by the Contractor at no extra cost to the owner.</p> <p>10.1 The technical specifications for civil work furnished in section D4.8 are intended as guidelines for execution of works. In case of conflict between clauses of section D4.6 under specific technical requirements and clauses of section D4.8, the requirements given under section D 4.6 will govern.</p>		
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SECTION II - SCOPE OF WORK

The works covered in this section consists of collection of all site related data, conducting site investigations, design, preparation of all construction drawings, supply of all materials, construction, fabrication, erection and testing where necessary, of all structures required for housing all equipment and civil works for all services required for the 220kV Switchyard as defined in the specification document. It shall be clearly understood that Power Transformer yard civil works as defined in the specification document shall be carried out based on the construction drawings to be issued by the Owner /Consultant. The Civil works shall include those required for Installation, Commissioning, testing, operation and maintenance of RA7 package . The Scope will cover but not limited to the following buildings / structures / systems / facilities.

1. Site related investigations, consisting of
 - (a) Confirmatory Geotechnical Investigation
2. Site clearance & survey
 - (a) Site clearance
 - (b) Site grading
3. Construction enabling works
4. Design and construction of Switch yard tower &equipment foundations situated inside the switchyard including cable trenches, for the switchyard.
5. Design and construction of inter-bus transformer foundation situated inside the switchyard along with fire barrier walls, oil collection pits, cable trenches, burnt oil pits, roads with rails for the movement of transformer up to the main road near transformer yard and all related civil works inside the switchyard.
6. Design, Fabrication &erection of Galvanised structural steel towers &equipment structures
7. Design and construction of Switch yard control building for the 220kV switch yard
8. Fencing , gates, Paving and drainage of switch yard
9. Construction of All transformer foundations inside the transformer area, Fire barrier walls ,Oil collection pits, cable trenches fencing ,

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<p>gates , Paving ,drainage , Roads with rails for the movement of transformer and all related civil works based on the drawings to be issued by the Owner/Consultant after award of work.</p> <p>10. Design and construction of RCC box culverts of required size and shape, RCC railroads and RCC duct banks as and where required for CW pipe lines.</p> <p>This specification covers entire civil engineering work including design as specified, supply and construction for all buildings, all technological/equipment supporting structures, foundations for all buildings, structures and equipment, roads, ramps, paving, , storm water drainage and faecal sewers and all other miscellaneous civil engineering work as will be necessary for completing this package on a turnkey basis within the battery limit.</p> <p>All civil works for the buildings, equipment foundations, facilities and miscellaneous civil works to be provided for the project will include but not be limited to the following:</p> <p>Cable trenches, duct banks, within the battery limit.</p> <p>Surface drains are to be connected to storm water drainage system of the plant.</p> <p>Supporting structures and platforms with access</p> <p>Stairs and exits for all buildings meeting LPA norms.</p> <p>All plumbing, sanitary and water supply fittings, toilets, manholes, etc. rainwater drainage, sanitary faecal sewerage and connection to manholes / junction boxes of general drainage and sewerage and disposal under the scope of this contract.</p> <p>All necessary waterproofing, fire-proofing and anticorrosive treatment to buildings, structures and foundations, including underground construction.</p> <p>All necessary protective civil works below for roadways and other services inside battery limit.</p> <p>All temporary facilities, building, offices, labour colonies, staff quarters, roads and services for construction for this package.</p>		
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<p>Removal of debris, micro levelling of the site up to battery limits all-round buildings and premises within the scope of contract prior to completion of work.</p> <p>All necessary civil work required for road lighting within the battery limit</p> <p>The materials and services will include but not be limited to the following:</p> <ol style="list-style-type: none"> Earthwork for buildings, towers, transformers and equipment foundations, trenches, pits, sewers and other construction work Site clearing including removal of trees, shrubs, loose soil including blown down sand and conveying to an average distance of 5km and disposing etc, dressing, levelling and grading of formation to required levels and soil compaction as necessary within the battery limits as shown in the bid drawing. Backfilling, soling and sub-grade work for all foundation, grouting, flooring, trenches, pits and other underground structures. Concrete and reinforced concrete work in sumps, pits, trenches and other underground structures. Concrete and reinforced concrete work in columns tie beams, beams slabs frames and other superstructures. All masonry work in sub structure and super structure including plastering as required. All finishing work to flooring walling ceiling false flooring and false ceiling as required. All finishing and painting work to masonry, concrete structures, steel works and wood works. All fencing and gates as required. Doors, windows, ventilators, rolling shutters, fire check doors, gates shutters etc. Supply ,fabrication and erection of galvanised steel structures for 		
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the switchyard towers ,beams and other equipment .



- (I) Hand railing, inserts, kerb angles, bolts etc.

It is not the intent to specify herein all the works in the scope of this contract. The scope also includes all other buildings, structures and works necessary, which are not specifically mentioned here but required, for construction, operation and maintenance of the power plant are deemed to be included in the scope of the CONTRACTOR. It shall be clearly understood that all the civil works in the transformer yard shall be based on the construction drawings to be released by the Owner/Consultant. Bidder shall make his own judgement of the items and quantities involved and no claim will be entertained on account of bidders assumption in being variance with the construction drawings. All works shall conform to the specification. The works shall conform to high standards of design, engineering and workmanship. Design and construction shall conform in every respect to all local and state regulations governing such works and to stipulations of Indian Standards unless stipulated otherwise in detail specification.

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SECTION III - DOCUMENTS TO BE SUBMITTED BY BIDDER
WITH TURN KEY BID PERTAINING TO CIVIL WORKS

For the list of documents to be submitted along with the bid please refer
Clause 3.0 of Section C12 of Volume II of the specifications.

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**SECTION – IV DOCUMENTS TO BE SUBMITTED BY
CONTRACTOR AFTER THE AWARD OF CONTRACT**

For the list of documents to be submitted along with the bid please refer clause number 4.0 of Section C13 of Volume II of the specifications.

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SECTION –V DESCRIPTION OF BUILDINGS, STRUCTURES AND FACILITIES

The description against each building / system is indicative only and not exhaustive. Although most of the systems are covered here in, any other system (Civil, Structural and Architectural) required for successful completion of the works shall form a part of this contract and shall be deemed to be included in the scope of works.

1.0 **SITE RELATED INVESTIGATION**

1.1 **Topographical Surveying**



1.1.1 Surveying has already been carried out in the proposed site and the details of the survey are available with the owner for reference.

1.1.2 One permanent benchmark and two baselines, North-South line and East-West line at right angles to each other will be provided to the CONTRACTOR. It will be the responsibility of the CONTRACTOR to ensure that the base lines are identified with grid pillars constructed at 200 meters c/c in both directions in such a way that these pillars will not be disturbed during construction. Coordinates shall be painted on these grid pillars. It will also be the responsibility of the CONTRACTOR to transfer the levels from the benchmark provided to the site. Benchmark pillars shall be provided at least at 10 locations. These pillars shall be properly protected to prevent their disturbance during construction activities. BM shall be distinguished from grid pillars with different type of painting.

1.2 **Geotechnical Investigations**

Detailed geotechnical investigation to verify the results of the investigations already carried out by the OWNER shall be carried out by the CONTRACTOR on award of work. Based on the plot plan developed, the CONTRACTOR shall identify proposed borehole location and obtain the approval of OWNER prior to commencing the investigation.

The boreholes shall be spread judiciously to cover all major building as well as equipment foundations. Generally, a grid of 50 meters c/c both ways is recommended.

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1.2.1 Following field tests shall be conducted:



- (a) Bore Holes
- (b) Static Plate load tests
- (c) Field Permeability tests
- (d) Field Density tests
- (e) Static Cone Penetration tests.

1.2.2 During boring, the level at which ground water is struck shall be carefully noted. Ground water samples shall be collected for chemical analysis. Boring shall be carried out without the use of water or drilling mud up to the depth of ground water table. Bore log shall be continued to a minimum depth of 15m or up to refusal level.

1.2.3 All necessary laboratory tests required to fix the design parameters shall be conducted

1.2.4 The geo technical investigation report shall necessarily include but not be limited to the following information:

- a) Recommended types of foundation.
- b) Allowable safe bearing capacities and settlement values in different strata for shallow foundations indicating relevant design criteria adopted, method of analysis adopted etc.
- c) If Pile Foundation is necessary, type of pile recommended with reasons for the same, length, diameter, allowable capacity (lateral, pullout and vertical) of individual and groups of piles, negative skin friction if any and magnitude of estimated negative skin friction.
- d) Recommendations for values for modulus of sub grade reaction for foundation design by elastic method.
- e) Type of cement to be used for concrete with reference to the chemical nature of subsoil and ground water.
- f) Recommendations regarding excavations (shallow and deep), embankment, covering safe side slopes for excavation and embankment, site drainage, etc.

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2.0 **SITE DEVELOPMENT WORK**

2.1 **Site Clearance**



2.1.1 The site shall be cleared of all trees, shrubs or other vegetation, rubbish, slush etc. and other objectionable matters. If any roots or stumps of trees are met during excavation, they shall also be removed. Where earth fill is intended, the area shall be stripped of all loose / soft patches or topsoil containing objectionable matter and blown sand before fill commence. Any structure or services existing at the site required to be removed / rerouted shall be removed / rerouted by the Contractor with the permission of the Owner at no extra cost. Existing wells, pits, marshy areas etc shall be filled up with sand /PCC as directed by the ENGINEER.



2.1.2 The CONTRACTOR shall be deemed to have visited and carefully examined the site and surroundings to have satisfied himself about the nature of the existing structures, underground services, general site conditions, the site for disposal of surplus materials, debris etc. and all other materials affecting the work. Claims due to ignorance of site condition will not be considered after submission of Bid.

2.2 **Site Grading**

2.2.1 Site grading work shall be carried out within the battery limits to the levels as indicated in the bid drawing. The top soil is found to be loose sand and shall be replaced with a good backfill material from approved borrow areas. The approximate lead for borrow area shall be 5km, however this shall be established by the Contractor before bid.

2.2.2 Fills shall normally be made up of CNS material capable of being compacted up to 90% Proctor density. Filling may also be made using sand in which case a relative density of 85% shall be achieved. In case earth has to be borrowed from outside the plant boundary, the same shall be arranged by the CONTRACTOR himself at no extra cost. Earth from Swamps, marshy as well as lagoons, expansive type of clays, peats, organic material, material susceptible for combustion, material which will react with other material already used in work shall not be used as borrow material. A minimum side slope of 1 vertical: 2 horizontal shall be maintained at all slopes.

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<p>3.0 <u>CONSTRUCTION ENABLING WORKS</u></p> <p>3.1 <u>Construction Water</u></p> <p>Please refer General Conditions of Contract</p> <p>3.2 <u>Construction Power</u></p> <p>Please refer General Conditions of Contract</p> <p>3.3 <u>Temporary Site Building</u></p> <p>Land will be allotted free of charge for the purpose of site office, stores, site fabrication and site lab. The Contractor shall provide at his cost the following building facilities for proper execution and quality control of the job, while meeting the provision stipulated by Factory Rules regarding staff welfare facilities. All these building shall have brick cladding, Steel / AC sheet roofing over steel roof truss with cement concrete flooring and false ceiling.</p> <p>3.3.1 <u>Site office</u></p> <p>The CONTRACTOR shall establish a site office at the area allotted by the Owner.</p> <p>3.3.2 <u>Stores</u></p> <p>A covered store shall be provided with brick cladding and. G.I. / colour coated sheeting to store at least one month requirement of cement. Cement in bags shall be stored on a raised floor well away from outer walls and insulated from the floor to avoid moisture. Not more than 15 bags shall be stacked in any tier. Each consignment of cement shall be stored separately and consumed in its order of receipt.</p> <p>3.3.3 Covered storage area may also be provided to store other construction material, which will be affected on exposure to wind, sun and rain.</p> <p>3.3.4 Reinforcement shall be stacked on top of timber sleepers to avoid contact with ground / water.</p> <p>3.3.5 Storage yard paved or unpaved shall be provided within the stores complex for storage of other material.</p>		
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3.3.6 Proper fencing and security arrangement shall be provided for the stores complex.

3.3.7 Proper welfare facilities for Staff and work men of Contractor shall be arranged by the Contractor.

3.4 **Temporary Workshop and Garage**

The CONTRACTOR shall provide a temporary workshop and garage to attend to routine maintenance and repair of the construction equipments as well as his fleet of vehicles used for construction activities.

3.5 **Fabrication Yard**



Depending on the extent of fabrication envisaged at site, the CONTRACTOR should establish a full-fledged structural fabrication yard with adequate handling facility during and after the fabrication. A fully equipped testing laboratory providing radiography, ultrasonic, dye penetration, magnetic particle test facilities shall be ensured adjacent to the fabrication yard to ensure strict quality control.

3.6 **Quality Control Laboratory**

A fully equipped quality control laboratory shall be established at site with qualified personnel to conduct acceptance test on all construction material, weldments, concrete cubes, soil and rock samples etc. This laboratory shall be housed in a covered building with A/C facility as required by the testing facility. All testing equipment shall be periodically calibrated to the satisfaction of the OWNER.

3.7 **Fuel Storage Area**

CONTRACTOR shall obtain necessary permission from competent authorities and establish and operate a POL outlet with proper storage, dispensing and adequate fire fighting facility. Such outlets for petroleum product are required only if no regular petrol bunk is available in the near vicinity.

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3.8 **Staff Welfare Facility**

3.8.1 CONTRACTOR shall provide adequate facility for his staff inside the plant boundary such as toilets for both gents and ladies, canteen, drinking water facility, First Aid Centre, rest places, crèches etc.

3.8.1.1 Necessary approach roads to the construction facility complex and internal roads within the complex as well as proper drainage of the area shall be the Contractor's responsibility. He shall also provide for proper disposal of sewage and other wastewater to meet with the requirement of Pollution Control Board.

3.8.2 OWNER shall identify sufficient area outside the plant boundary to the BIDDER to locate his staff and labour colony. But construction and maintenance of the staff and labour colony to satisfy all statutory requirements is the sole responsibility of CONTRACTOR.



4.0 **PRINCIPAL FEATURES OF THE BUILDING /STRUCTURES**

The extent of transformer yard and the layout of the yard, which has been outlined in the bid drawings are enclosed.



4.1 **TRANSFORMER YARD**

4.1.1 Generator Transformer, station auxiliary transformer and Unit auxiliary transformer shall be located in front of the power house building. Transformers shall be founded on RCC foundations with rails on the top with oil soak pits and filled with blue metal aggregate. Burnt oil pit shall be provided to convey leaked oil from the soak pits to the burnt oil pit. RCC blast wall / RCC framed brick wall of adequate thickness and height to satisfy LPA regulations shall be provided in between transformers. The burnt oil pit shall have a provision for mounting a portable pump. The scope shall also include for necessary piping to convey the oil mixed water to the effluent collection pit located in the boiler area at approximately 500 m from the burnt oil pit.

4.1.2 RCC foundations shall be provided with rail to transport transformer out of transformer yard during maintenance. Entire area shall be surrounded with 3 m high PVC coated chain link fencing with gates. Where rails cross the fencing, fencing shall be made of removable type to facilitate transport of transformer.

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- 4.1.3 RCC anchor blocks shall be provided at suitable locations for hauling the transformer during the movement of the transformer into the maintenance area.
- 4.1.4 All trenches shall be of RCC. Trench wall shall be designed to withstand a surcharge load of 1500 kg/ sq.m. Trench wall shall project 150 mm above the paved / graded level to prevent ingress of storm water.. MS inserts shall be provided along the walls of the trenches for fixing the cable trays. All trenches shall be given a slope of minimum 1 in 750 and the slope shall lead to a sump,. The scope shall include supplying and installing of the dewatering pumps of adequate capacity. The cable trenches shall be constructed upto the power house building with end walls and pipe sleeves to be provided as per the requirements for necessary continuation of the cables as required by the power house vendor.
- 4.1.5 The latticed towers consisting of masts and booms required for the conductor stringing and equipment supporting structure in the transformer yard shall be hot double dip galvanised structure with welded / bolted connection at shop and bolted connection at site. All bolts and nuts shall also be galvanised. Minimum zinc consumption shall be 900 gms per square meters of exposed surface. Design criteria for supporting structures and foundations shall be similar to the criteria adopted for the switchyard structures and as furnished in clause 5.0 of this document.
- 4.1.6 Cable racks used for road crossing shall have a minimum road clearance height of 7m from the top of road. These shall be structural steel. RCC cable duct banks shall be provided for all cables crossing below the road.
- 4.1.7 The uncovered area in the transformer yard within the fencing shall be provided with heavy duty paver blocks on sand bedding with a mild slope towards peripheral RCC drains, which in turn shall be connected to the plant drainage system
- 4.1.8 RCC roads of grade M25 and minimum of 350mm thickness with rails(90lbs) is to be provided from the transformer foundation up to the main road including connecting the same with the main road. The underbed shall consist of well compacted ground supporting 230 thick well compacted rubble soling with interstices properly filled with grits, followed by a layer of PCC of M 7.5, 50 mm thick. The compacted

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subgrade shall have the required CBR value to withstand the movement of loads.

- 4.1.9 Earth pits shall be constructed as per the requirements given in section D2.18 of volume IIIA.

5.0 SWITCH YARD

Extent of the Switch yard and the layout of the switch yard which has been outlined in the bid drawings enclosed..

5.1 Galvanised Steel Structure



- 5.1.1 All steel structure for the Switch yard shall be hot double dip galvanised structure with welded / bolted connection at shop and bolted connection at site. All bolts and nuts shall also be galvanised. Minimum zinc consumption shall be 900 gms per square meters of exposed surface. Design criteria of Switch yard structure are furnished in section D4.6A & D of this document.

- 5.1.2 Major steel structures are towers, beams, lighting masts etc. They shall be all of latticed construction using angle sections. In addition supporting structure for equipment, such as isolator, lightning arresters, etc shall also be provided. These structures may be of tubular section or latticed as the case may be. Lighting masts shall be provided with cage ladder. Where platforms are provided on lighting masts for mounting of lighting fixtures, they shall have protection hand rails formed of galvanised section. Platforms shall be of galvanised gratings. Further necessary galvanised platforms with ladder shall be provided for operating the equipment.

Switchyard structures shall be designed for the worst combination of loads as given in section D4.6A & D of this document. The factors of safety for design of members shall be considered as 2 for normal and broken wire conditions and 1.5 for combined short circuit and broken wire conditions. Short circuit forces and wind forces shall not be considered simultaneously.

5.2 Foundations for Structures and Equipments



All the Steel Structures in switch yard viz towers, equipment etc. shall be provided with RCC foundation. Criteria for design of foundations are given in clause 2.2 under Section D 4.6-Part C. Foundations may be open foundation or any other type as per soil investigation report. Net SBC for the switchyard area shall be taken as 27.0 t/sqm at a



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depth of 2.0m and 62 t/sqm at a depth of 3m. RCC foundations for latticed towers, equipment supporting structures, cable racks shall be designed for the worst combination of loads. The RCC foundations shall be designed for a factor of safety against overturning of 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire conditions. Design of foundations shall be carried out as per IS 4091. All other factors of safety for the design of foundations shall be as given in section D4.6C of this document.

5.3 **Trenches / Paving / Fencing**

- 5.3.1 Main/sub cable trenches shall be provided to cover the entire switch yard area. All trenches shall be of RCC. Trench wall shall be designed to withstand a surcharge load of 1500 kg / sq.m. Trench wall shall project 150 mm above the paved / graded level to prevent ingress of storm water. MS inserts shall be provided along the walls of the trenches to fix the cable tray supports. All trenches shall be given a slope of minimum 1 in 750 and the slope shall lead to a sump, where pump can be installed for drainage.
- 5.3.2 The complete area within the fencing shall be provided with a mild slope towards peripheral RCC drains, which in turn shall be connected to the plant drainage system. 100 mm thick PCC over 150mm thick well compacted granular soil/kankar sub-base paving shall be provided for the uncovered areas of entire switchyard area. Inside the yard, approach roads all round and in between shall be provided to facilitate placing and removal of equipment and shall be connected to main plant roads with necessary drains/culverts etc. The approach roads will be of RCC construction over 230mm thick rubble soling. Further, raised kerbstones shall be provided at regular intervals.
- 5.3.3 Fencing around switch yard area shall comprise of PVC coated chain link fencing of minimum 8 G (including PVC coating) of mesh size 75 mm and of height 2500 mm above toe wall. Other details of fencing such as fencing, toe wall etc. shall be as per the technical specifications. The switchyard fence shall be provided with gates of width as specified in the drawings. Contractor shall furnish the drawings for gates for approval by owner / consultant. one main gate of 7m width for vehicular movement and one gate for personnel movement shall be provided.

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<p>5.3.4 Earth pits shall be constructed as per the requirements given in section D2.18 of volume IIIA.</p> <p>5.4 Switch Yard Control Room</p> <p>5.4.1 The building shall be provided with RCC foundations suitably designed based on the approved geo technical report .</p> <p>5.4.2 This shall be two storied RCC framed structure. The ground floor shall house the 33kv Switchgear room, 415v switchgear room, Battery room, and battery charger room. The first floor shall accommodate control room, relay room and communication room, Records room, operators room and a toilet .</p> <p>5.4.3 The RCC floor of the control room and communication room shall be lowered by 800mm for cable laying and shall be provided with false flooring.</p> <p>5.4.4 Cable trenches shall be provided inside the building and shall have inserts for supporting the cable tray arms and shall be covered with chequered plates.</p> <p>5.4.5 False ceiling of cement bonded particle board as per specifications shall be provided in the Control room. Under deck insulation shall be provided as per specifications above false ceiling. Cable trenches inside the building shall be covered with chequered plates.</p> <p>5.4.6 Two stair cases shall be provided on either side of building for access to first floor. One of the stair cases shall be continued up to roof level..</p> <p>5.4.7 Roof shall be given a slope of minimum 1 in 100. Roof shall be given elastomeric membrane type water proofing treatment as per specifications. Parapet shall be avoided to prevent accumulation of dust. Suitable hand railing shall be provided around the roof. Adequate number of rain water down take pipe shall be provided using UPVC pipes as per IS 4985.. Garland drain as well as plinth protection shall be given around the building.</p> <p>5.4.8 Main door to switchgear room shall be steel doors having adequate area to admit switchgear. There shall be minimum two doors to the switchgear room of flush welded type. Fire proof doors as per LPA norms shall be provided wherever necessary. Control room shall have</p>		
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one swing type aluminium double panel door and one single panel door. Steel windows with sheet glass glazing shall be provided for the building.

- 5.4.9 Toilet block shall be provided in both ground floor and first floor of the control building

5.5 CABLE TRENCHES FOR OUTGOING CABLES

Cables have to be extended from the 33kV terminal poles for the raw water system and 33kV pole for mines and township situated inside the power plant area, to the switchyard control room. These cables shall be taken through buried cable trench as indicated in Dwg no: TCE-4556A-738-GA-3011.

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SECTION VI – SPECIFIC TECHNICAL REQUIREMENTS

PART B – GENERAL REQUIREMENTS

1.0 **GENERAL**

- 1.1 Design and construction of buildings, structures etc. shall take into account requirements for operation and maintenance of all equipment and its users. The buildings shall have good architectural features. The surrounding areas shall be properly micro levelled and graded.

1.2 **Architectural Concept for Buildings**

- 1.2.1 The architectural design concept of buildings shall be evolved considering the functional, technical and other requirements for efficient operation, ensuring proper lighting and ventilation for comfortable working environment for personnel, satisfying the aesthetic requirements. The extension of the existing switch yard control room shall have matching architectural features of the existing building.



- 1.2.2 The CONTRACTOR shall obtain and be conversant with all laws, by-laws and regulations of local and Statutory Bodies as applicable to the project. The architectural concept evolved should also take care of these requirements. The CONTRACTOR shall provide the drawings and documents for such statutory approvals.



2.0 **ROOF ACCESS**

All roofs shall be provided with access through a staircase.



3.0 **PLATFORMS AND WALKWAYS**



- 3.1 Platforms shall be provided to all equipment wherever necessary, which are not directly accessible from the floors, for maintenance. Platforms and connecting walkways shall have a minimum width of 750 mm. Platforms in front of the entry shall be at least 1200 mm wide. Platforms located close to each other shall be connected with walkways.


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3.2	All steel platforms above grade level shall be constructed with kick plates at edge of the platform to prevent tools or materials from falling off. It shall consist of 8 mm thick steel plate projecting 100 mm above the platform surface.	
4.0	<u>STAIRS AND LADDERS</u>	
4.1	<u>Steel Ladders</u> Ladders shall be provided to platforms, walkways, and equipments, which do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5°. Ladders shall be of minimum 450 mm clear width with 20 mm diameter MS rungs spaced at 300 mm (maximum). Ladders shall be provided with a safety cage of minimum 750 diameter clear when the top of ladder is more than 4.5 m above the landing level. Safety cages shall start at 2.5 m above the lower landing level.	
4.2	<u>RCC Stairs</u> All stairs shall have maximum riser of 180 mm and a minimum tread of 250 mm. However, for public buildings riser shall be limited to 150 mm and tread width of 300 mm. Minimum width of stairs shall be 1200 mm generally. All stairs normally shall have not more than 15 risers in one flight. Aluminium angle nosing with minimum 50X25X3 angle shall be provided for edge protection of RCC stairs.	
5.0	<u>HANDRAILS</u>	
5.1	Handrails shall be provided at appropriate places to ensure safety e.g. around all floors/roof openings, projections / balconies, walkways, platforms, steel stairs etc.	
5.2	All handrails shall be of 32 mm nominal bore MS pipes (medium class) as per IS1239. Handrails for platforms, walkways and projections shall be a two-rail system with the top rail 1000 mm above the walkway surface and the intermediate rail 450 mm below the top rail. Handrail post spacing shall be limited to 1500 mm as far as possible but can be proportioned to the length of the protected horizontal opening. In such a case spacing shall not exceed 1850 mm centre to centre of posts. Handrails shall be shop fabricated for	
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<p>specific locations and field welded or bolted to the erected structural steel. For platforms at elevation more than 30 m, three rail system with top rail at 1500 mm shall be adopted. All handrails shall be provided with 100mm high x 8mm thick kick plate throughout at platform / landing locations.</p> <p>5.3 For RCC stairs, handrails with 20 mm square MS bar balustrade with suitable MS flat & PVC handrail shall be provided, unless specifically mentioned otherwise.</p> <p>6.0 <u>EDGE PROTECTION</u></p> <p>Wherever possible around floor openings an RCC kerb of 100 mm wide 150 mm high shall be provided. All concrete edges, where breakage of concrete corner is expected, shall be provided with angles at least L 75x75x6 with lugs for edge protection e.g. all round the cut-outs/openings in floor slab, edges of drains supporting grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers and supporting edges of precast covers etc.</p> <p>7.0 <u>ANCHOR BOLTS AND INSERT PLATES</u></p> <p>7.1 Anchor bolts shall be designed for working stress, in tension and shear, for embedded length of the anchor bolts and pipe sleeves. Shear and crushing strength of concrete shall also be checked. Increase in allowable stress for loading including seismic and wind loads shall not be permitted in design of anchor bolts.</p> <p>7.2 Insert plates shall be designed/checked for shear and bending moment. All lugs shall be checked for tension. Bond strength of concrete shall also be checked. Lugs using steel bars shall preferably be fillet welded to the plate to transfer full strength of the lug.</p> <p>8.0 <u>VERTICAL HEADROOM</u></p> <p>8.1 All accessible areas shall be provided with a minimum clear headroom as follows, unless otherwise specified:</p> <table> <tr> <td>Doors, Walkways, Platforms, Stairs etc.</td><td>:</td><td>2100 mm</td></tr> <tr> <td>Safety cage for ladders</td><td>:</td><td>2500 mm</td></tr> </table>			Doors, Walkways, Platforms, Stairs etc.	:	2100 mm	Safety cage for ladders	:	2500 mm
Doors, Walkways, Platforms, Stairs etc.	:	2100 mm						
Safety cage for ladders	:	2500 mm						
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<p> Main road crossings & crane access : 7000 mm Other plant roads and truck access : 5000 mm Cable & Pipe rack : 3000 mm (Except Road crossings) </p> <p> 9.0 <u>EXPANSION / CONSTRUCTION JOINTS</u> </p> <p> 9.1 Expansion and construction joints shall be provided wherever required. Two part polysulphide sealant conforming to IS: 12118 shall be used for sealing of joints in contact with water. For other cases, bitumen sealing compound conforming to IS: 1834 can be used. Preformed bitumen impregnated fibre board conforming to IS: 1838 shall be used as joint filler. </p> <p> 10.0 <u>BRICK MASONRY AND PARAPET WALL</u> </p> <p> 10.1 All masonry works shall be designed in accordance with IS: 1597, IS: 1905, IS: 2212, IS: 4326 and other relevant IS codes as applicable. Structural design of load bearing and non-load bearing walls constructed with chamber burnt clay bricks satisfying the requirements of IS 1077. </p> <p> 10.2 All walls shall be non load bearing infill panel walls. External walls of all buildings shall be at least one brick thick. All internal walls shall be at least one brick thick except for internal partition walls for office area, change rooms, first aid rooms and toilets, which may be half brick thick. </p> <p> 10.3 50 mm thick DPC (1:1.5:3) with water proofing admixture shall be provided at plinth level before starting masonry work. </p> <p> 10.4 Average 50 kg/sq.cm compressive strength brick shall be used for super structure brickwork. Cement sand mortar 1:5 for one brick thick wall and 1:4 for half brick thick wall shall be used. Half brick walls shall be constructed as per technical specifications. </p> <p> 10.5 Type, thickness and height of external wall, facing the transformer yard to take care of fire accidents in transformer yard shall be according to the requirements of LPA.. </p> <p> 10.6 All up stands and parapet walls on roof shall be of RCC construction, minimum height of parapet walls shall be 750 mm and thickness 125 mm. </p>		
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<p>11.0 <u>DRAINAGE</u></p> <p>11.1 Garland drains shall be provided around all buildings and yard to receive the drainage water from roof and floor and lead them to the plant storm water drainage system.</p> <p>11.2 <u>Roof drainage</u></p> <p>11.2.1 Roof drainage system shall be provided for quick and efficient draining of rainwater from roof to avoid seepage and damage to roof. The runoff gradient for the roof shall not be less than 1 in 100. Roof drainage system shall consist of roof drain heads, rainwater down take pipes and fixtures. System shall be designed to handle design requirements for the specific site and shall be in accordance to stipulations of IS: 1742 and IS: 2527. Roof drains shall conduct water to storm drains through down take pipes.</p> <p>11.2.2 Rain water down take pipes shall be UPVC.</p> <p>11.3 <u>Sumps</u></p> <p>In case of underground structures such as trenches / basements, sumps shall be provided at suitable location to collect and pump out any incidental water collection to nearest storm water drains.</p> <p>12.0 <u>WATERPROOFING OF UNDERGROUND STRUCTURES</u></p> <p>12.1 All underground structures like basements, sumps ,pits ,trenches etc. shall have plasticiser cum waterproofing cement additives conforming to IS: 9103. In addition, limits on permeability as given in IS: 2545 shall also be met with. The concrete surface of these structures in contact with soil shall be provided with minimum two coats of bituminous painting of grade 85/25 conforming to IS: 702 @ 1.7 kg/sq.m (minimum) for water / damp proofing.</p> <p>13.0 <u>ANTI TERMITE TREATMENT</u></p> <p>Pre-constructional anti termite treatment shall be given to all vulnerable areas susceptible to termite attack and shall include column pits, wall trenches, foundations, filling below the floors etc. as per IS: 6313 and as per the General specifications.</p>		
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<p>14.0 <u>PLINTH LEVEL</u></p> <p>14.1 Finished ground floor level (plinth level) of all buildings shall be minimum 300 mm above the formation level/grade level.</p> <p>14.2 All cable vaults shall be located above ground level i.e. cable vaults shall not be provided as basements in the buildings.</p> <p>14.3 Finished floor levels of transformer area yard paving shall be kept 150mm lower than the finished floor level of power house building.</p> <p>14.4 Foundation pedestals shall be 300mm above finish ground level.</p> <p>15.0 <u>STATUTORY REQUIREMENTS</u></p> <p>15.1 All the applicable statutory rules pertaining to Indian Factories act, Factory rules of state government, Fire safety rules of LPA, Water act of Pollution Control Boards, Explosives act , stipulations of Electricity Authority etc. and stipulations of other relevant statutory authorities shall be taken into consideration at the time of design.</p> <p>15.2 Provisions of safety, health and welfare according to Factories act shall be complied with design stage. These shall include provision of continuous walkway (minimum 1000 mm wide) along crane-girder at crane girder level on both sides of the building, comfortable approach to EOT crane cabin, railings, fire escape, locker room for workmen, pantry, toilets, rest room etc.</p> <p>15.3 Adequate number of fire escapes shall be provided in a building. Fireproof doors, number of staircases, fire separation walls, lath plastering on structural steel member (in fire prone areas) shall be made according to the recommendation of LPA. For fire safety requirements of buildings IS: 1641 and IS: 1642 shall be followed in addition to LPA requirements. All masonry firewalls shall be minimum 345 mm thick and RCC firewall shall be minimum 200 mm thick.</p>		
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SECTION VI – SPECIFIC TECHNICAL REQUIREMENTS

PART A – LOADS AND LOAD COMBINATIONS

1.0 **GENERAL**

All structures shall be designed for the most critical combinations of dead loads, imposed loads, equipment loads, crane loads, steam piping (static & dynamic) and other piping loads, wind loads, seismic loads, temperature loads, forces developed due to differential settlement and any other loading conditions which can occur during the design life of the facility.



2.0 **DEAD LOADS**



- 2.1 Dead loads consist of the weights of the complete structure with finishes, fixtures, partitions, wall panels and all equipment of semi-permanent nature
- 2.2 The following unit weight of material shall be considered for computation of loads. Loads given in IS: 875 (part-I) shall be made use of for material not listed below.



Materials	:	Unit weight
Plain cement concrete	:	2.40 t/cum
Reinforced cement concrete	:	2.50 t/cum
Structural steel	:	7.85 t/cum
Brick work	:	1.9 t/cum
Cement plaster	:	2.1 t/cum
Floor Finish	:	2.4 t/cum
Lignite Dust	:	1.2 t/cum
Roof treatment	:	2.4 t/cum



3.0 **IMPOSED LOADS**

- 3.1 Imposed loads in different areas shall include live loads, dust loads, minor equipment loads, cable trays, erection loads, operation/maintenance loads, etc. The loads considered shall not be less than that specified in IS:875 (Part II). The loads listed hereunder are the minimum loads for the areas involved. Special use areas shall be investigated and loads revised upward as necessary. Floors and

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<p>supporting members which may be subjected to heavy equipment live loads shall be designed on the basis of the weight of equipment or specifically defined live loads, whichever is greater.</p> <p>3.2 The specific minimum floor live loads are listed below</p> <p>3.2.1 Roofs</p> <p>The following minimum live loads shall be adopted for design of buildings / structures :</p> <p>a) Flat roof : Accessible roof – 150 kg/m² (</p> <p>Non-accessible roof – 75 kg/m²</p> <p>500 kg/m² for accessible roofs with HVAC equipment etc</p> <p>50 kg/m² dust load for new switch yard control room</p> <p>b) Sloped Roof As per IS :875</p> <p>3.2.2 Control Room/Electrical Buildings</p> <p>a) Control Room floor : 1000 kg/m²</p> <p>b) MCC Room : 1500 kg/m²</p> <p>c) Cable vault floor : 500 kg/m²</p> <p>d) Battery Rooms : 2000 kg/m²</p> <p>e) AHU,AC & ventilation plant rooms : 1000 kg/m²</p> <p>f) Switchgear Room : 1500 kg/m²</p> <p>g) PLCC, relay room 1500 kg/m²</p> <p>3.2.3 Other Areas</p>		
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<p>a) For building floors : 500 kg/m² or equipment load (when where equipments are placed elsewhere) whichever is higher located</p> <p>b) For building floors : 500 kg/m² where equipment are not located</p> <p>c) Cable rack : Load due to cables / cable trays – 150 kg/m on platform supporting beam</p> <p>d) Culverts and their allied structures including RC pipes : As per IRC standard for Class ‘AA’ loading</p> <p>e) Staircases : 500 kg/m² or equipment load whichever is higher.</p> <p>f) Toilet blocks : 200 kg/m²</p> <p>g) Precast trench covers : 500 kg/m² inside buildings and 1000 kg/m² outside buildings</p> <p>Contractor shall ensure that his erection loads are less than the loads specified above. However, if the erection loads are higher than the specified live loads on any floor or part thereof, then the erection loads are to be considered for the design.</p> <p>3.2.4 Switchyard Structures</p> <p>The loading for the design of switchyard structures shall be as per IS:802 Part1/Sec1:1995(latest edition). Following loads shall be considered in addition.</p> <p>a) Dead load due to equipment and structure.</p> <p>b) Wind load on towers, conductors, ground wires and insulator strings calculated as per clause 8 and 9 of IS:802</p> <p>c) Temperature effects consisting of effect of temperature variation and sag tension as per clause 10 of IS:802</p> <p>d) Climatic loads as per clause 11.2 of IS:802</p> <p>e) Anti cascading loads as per clause 11.3.1 of IS:802</p> <p>f) Torsional and longitudinal loads caused by breakage of conductor as per clause 11.3.2 of IS:802</p> <p>g) Construction and maintenance loads</p>		
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<p>h) Seismic loads as per IS:1893</p> <p>i) Loads for broken wire condition producing worst effect on booms/towers shall appropriately be considered.</p> <p>Switchyard structure shall be designed for the worst combination of above loads. The factor of safety for design of members shall be considered as 2 for normal & broken wire conditions and 1.5 for combined short circuit and broken wire conditions. Short circuit forces and wind forces shall not be considered simultaneously.</p> <p>Foundation shall be designed for a factor of safety 2.2 for normal and broken wire condition and 1.65 for combined short circuit and broken wire conditions. Design of foundation shall be carried out as per relevant IS code.</p> <p>3.3 <u>Wind Loads</u></p> <p>3.3.1 Design for wind loads shall be calculated as per provisions of IS:875 (Part 3). The basic wind speed shall be considered as 47m/sec. In addition, structure shall be checked for diagonal wind.</p> <p>The wind shall be assumed to blow in any direction and most unfavourable condition shall be considered for design.</p> <p>3.4 <u>Seismic Loads</u></p> <p>Design for seismic loads shall be in accordance with IS:1893. Barsingsar falls under seismic zone III. Response spectrum method shall be performed using at least five modes of vibration. Zone factor shall be 0.16. The importance factor for all buildings and structures shall be taken as 1.5 and for other minor structures as per IS:1893.</p> <p>3.5 Culverts and allied structures including RCC pipes shall be designed for Class "AA" loading and checked for Class "A" loading as per IRC standards for two lane road and above.</p> <p>3.6 Covers for trenches & channels, which are not exposed to vehicular traffic, shall be designed for live load of adjoining area or 2 t/sqm whichever is higher. Where channels are likely to be exposed to vehicular traffic, the requirements of code of practice for road bridges shall be adhered to.</p>		
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3.7 Live load reduction shall be in accordance with the provisions of IS:875 and IS:1893 in case of seismic analysis.

4.0 EARTH PRESSURE LOADS

4.1 Earth pressure for all underground structures shall be calculated using coefficients of earth pressure at rest, coefficient of active or passive earth pressure (whichever is applicable).

4.2 In addition to earth pressure a minimum surcharge load of 2.0 t/sqm shall also be considered for the design of all underground structures including channels, sumps, cable and pipe trenches, etc. to take into account the vehicular traffic in the vicinity of the structure.



5.0 EQUIPMENT LOADS

5.1 Loads of major equipments. shall be based on the manufacturer's data of the specified equipments and shall be considered in design in addition to the live load. However, where the uniform floor live load adequately accounts for the equipment moving weight, the weight of such equipment as a dead load shall not be considered e.g. switchgear and control room floors are usually designed for a live load that includes the equipment weight.

6.0 BASIC LOAD CASES

The following basic load cases shall be considered for the analysis:

i)	Dead load	:	D
ii)	Self Weight of permanent equipment	:	EL
iii)	Live load on floor/walkway	:	L
iv)	Live load on roof	:	LR
vii)	Wind load	:	WL
viii)	Seismic load	:	SL
ix)	Load due to soil pressure	:	SP
x)	Load due to surcharge	:	SCL
xi)	Load due to hydrostatic pressure	:	HP
xii)	Special loads	:	SPL

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7.0 **LOAD COMBINATIONS**

- 7.1 The individual members shall be designed for worst combination of forces such as bending moment, axial force, shear force and torsion. Permissible stresses for different load combinations shall be taken as per IS:875 (Part-V) and other relevant IS codes. Wind and seismic forces shall not be considered to act simultaneously.
- 7.2 Criticality of erection / maintenance loads shall also be checked separately in combination with other simultaneously occurring loads for possible design loading..

8.0 **LOAD COMBINATIONS FOR UNDERGROUND STRUCTURES**

Following loading conditions shall be considered in addition to the loading from super structure for the design of sub structure of, sumps, tanks, reservoirs, trenches and other under ground structures.

- 8.1 Only liquid pressure from inside and no earth pressure and surcharge pressure from outside (applicable only to the structures which are liable to be filled with water or any other liquid).
- 8.2 Earth pressure, surcharge pressure from outside and no water pressure from inside.

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SECTION VI - SPECIFIC TECHNICAL REQUIREMENTS
PART C - REINFORCED CONCRETE STRUCTURES AND
FOUNDATIONS

1.0 GENERAL

All structures, building foundations, machines / equipment foundation, water retaining structures, trenches, pits, etc. shall be designed as per latest relevant IS codes in general. Construction in general shall follow provisions of IS: 456 and IS:3370 for normal and water retaining structures.

2.0 DESIGN METHODOLOGY

2.1 General

2.1.1 All designs of RCC structures shall be carried out by limit state method as per IS: 456 unless use of working stress method is specifically mentioned. Design strength of materials and design loads shall be calculated using appropriate partial safety factors over characteristic strength and characteristic loads as per IS: 456. Excluding transformer foundations, oil pits, fire barrier walls, cable trenches in side the transformer yard.



2.1.2 For reinforcement detailing IS:5525 and SP:34 shall be followed.



2.1.3 The walls shall be provided with reinforcement on both faces for sections 150 mm or more, even if not required from design consideration.



2.2 Foundation and Underground Structures



2.2.1 General



2.2.1.1 Type of foundation system, i.e. isolated, strip, raft shall be decided based on the loading arrangement, load intensity and soil strata. Design of foundations at various levels shall be dependent upon the soil bearing capacity at that level.



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<p>2.2.1.2 Foundation system adopted shall ensure that settlement / relative settlement is as per provision of IS:1904 and other Indian Standards. However, the settlement shall be restricted to a lower value, if necessary as per the system requirement.</p> <p>2.2.1.3 All foundation including equipment foundations shall be of RCC construction. All foundations shall be designed in accordance with relevant parts of the latest revisions of Indian standards IS: 2974 and IS:456. Raft foundations shall be designed as per IS:2950.</p> <p>2.2.1.4 All underground pits, tunnels, basements, cable and pipe trenches, etc. shall be designed as leak proof RCC structure.</p> <p>2.2.1.5 The contractor shall furnish in advance necessary design loads for transformer foundations, oil pits, fire barrier walls, cable trenches in side the transformer yard to enable the purchaser/consultant for design and issue of construction drawings as per BIS requirements. The contractor shall accept and abide by the detailed construction drawings and execute the works without any extra claims on this account'</p> <p>2.2.2 <u>Subsoil conditions</u></p> <p>The sub soil consists generally of medium to dense brown / greyish brown silty sand. The grain size distribution show predominantly sand size particles with significant presence of silt and gravel particularly at lower depths. For the purposes of foundation design, sub soil in the top 5 – 6m will be particularly relevant. Soil below this depth has 'N' valve consistently greater than 100 blows / 30cm. The static cone penetrometer data also shows very hard soil below 6m depth.</p> <p>2.2.3 <u>Average ground water table</u></p> <p>Ground water has not been observed till the termination of bore log of 20m depth.</p> <p>2.2.4 <u>Foundation system</u></p> <p>The soil investigations indicate that foundations can be designed with a Safe Bearing Capacity of 270kN/sqm at 2.0m and 620kN/sqm at about 3 m depth below the ground level. However</p>		
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<p>this shall be independently verified by the Contractor and the safe bearing capacity to be adopted for the foundations shall be subject to the approval of Owner / Consultant. Minimum founding level for all the major structures shall be 3m below the graded level.</p> <p>2.3 <u>Increase in Stresses</u></p> <p>2.3.1 Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel shall be increased by 33.33% in case of working stress design.</p> <p>2.3.2 Bearing capacity of the soil shall be allowed to be increased by 25 % under seismic/ wind load condition.</p> <p>3.0 <u>Stability of Structures</u></p> <p>3.1 All building sub-structures shall be checked for sliding and overturning stability during both construction and operating conditions for various combination of loads. Factor of safety for these cases shall be taken as mentioned in IS: 456 and other latest relevant IS codes. However following minimum factor of safety shall be followed:</p> <p> a) Factor of safety against overturning due to wind, seismic or other lateral load shall be 1.5 minimum</p> <p> b) Factor of safety against sliding shall be 1.5 minimum</p> <p> c) Factor of safety against uplift due to hydrostatic forces shall be 1.2 and due to any other loads shall be 1.5.</p> <p>3.2 Stability of the structure shall also be investigated for loading conditions during construction, repair or other temporary measures. Lower factor of safety may be used for such loading conditions as per relevant IS codes.</p> <p>3.3 In cases where dead load provides the restoring force, only 0.90 times characteristic dead load shall be considered. Imposed loads shall not be considered as restoring force.</p>		
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4.0 <u>MINIMUM THICKNESS OF CONCRETE STRUCTURAL ELEMENTS</u>		
4.1 The following minimum thickness shall be followed: <ul style="list-style-type: none"> a) Suspended floor / slab / walkways /canopy slabs, etc. : 125mm b) Ground floor slab (non-suspended) :150mm c) Cable/pipe trenches/underground pits/ : 125mm Launder walls and base slab d) All footings (including raft foundations) : 300mm e) Parapets : 125mm f) Sunshades : 75mm at edge g) Precast trench cover slabs / floor slabs / louvers : 75mm h) Paving : 100mm i) Basement walls and base slab : 200mm j) Underground sumps ,pits <ul style="list-style-type: none"> i. Below ground water table : 200mm ii.Above ground water table : 150mm 		
4.2 From fire resistance point of view minimum thickness of reinforced concrete members shall be as per fig.1 or Table 16A of IS: 456.		
5.0 <u>MINIMUM HEIGHTS FOR PEDESTALS OF STEEL COLUMNS</u>		
5.1 Pedestals to Steel Columns for building structures: Top of RCC foundations (pedestals) shall normally be kept at a lower level so that the column base plates together with gussets and stiffeners remain below finished floor level (FFL) unless specified otherwise. Foundation levels for columns shall be decided to accommodate underground services, pits, trenches, etc.		
5.2 Stair and ladder pedestal shall be kept 200 mm above the finished floor level.		
5.3 Pedestals to Steel Columns for Equipment structures: <ul style="list-style-type: none"> a) Equipment in open area : as required (300mm min) b) Equipment in covered area : as required (150mm min) c) Structures and equipment : as per vendor's data subject to supplied by vendor minimum as specified above. 		
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6.0	<u>MINIMUM HEIGHTS FOR ENCASEMENT OF STEEL COLUMNS</u> <p>In case the top of pedestal is kept at a lower level so that the column base plate together with gussets and stiffeners remain below finished floor level (FFL) the column bases as well as the column sections shall be encased in concrete above FFL as per following:</p> <p>a) Open area : Minimum 300 mm above paved level b) Covered area : Minimum 150 mm above FFL.</p>	
7.0	<u>CONCRETE MIX</u>	
7.1	Cement used shall be minimum ordinary portland cement 43 grade conforming to IS 8112, unless the chemical nature of the soil warrants special cement for structures below ground level.	
7.2	The proportions for nominal mix of concrete shall be as per Table 9 of IS: 456. The concrete grade used for different structures shall be as follows.	
	M5 : Fill concrete M7.5 : Blinding layer below foundations, trenches and under ground structures. M10 : Foundation below brick wall. M15 : Pavement around buildings including plinth protection work, damp proof course below brick masonry work etc. M20 : Base plate encasement, encasement of structural steel work, block area paving & grade slabs, screed concrete, etc.	
7.3	Minimum cement content and maximum water cement ratio of all grades of concrete shall be as specified in Section D4.8 D Clause 7.2. For minimum grade of concrete for different exposures shall be as per Table 5 and 6 of IS: 456.	
7.4	Inter mixing of different grade of concrete in the same structure shall not be allowed normally.	
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8.0	<u>REINFORCEMENT</u>	
8.1	Reinforcement bars shall be as per the following codes: High Yield Strength Deformed bars : IS:1786 Mild steel bars : Grade I of IS:432 Welded wire fabric : IS:1566	
8.2	Intermixing of different grades of rebars or rebars of different material composition in same structure shall not be allowed.	
9.0	<u>GROUTING</u>	
9.1	Non-shrink flowable grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticiser admixture shall be added in the grout. For grouting of base of machine foundation high strength ready mixed non-shrink flowable grout shall be used.	
9.2	Crushing strength of the non shrink grout shall generally be one grade higher than the base concrete.	
9.3	Nominal thickness of grouting shall be at least 50mm for building columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25mm thick.	
10.0	<u>MINIMUM COVER TO FOUNDATION BOLTS</u> Minimum distance from the centre line of foundation / anchor bolt to edge of pedestal shall be the maximum of the following: <ol style="list-style-type: none"> Clear distance from the edge of base plate / base frames to the outer edge of the pedestal shall be minimum 50mm. Clear distance from the face of pocket to the outer edge of pedestal shall be 75mm. Clear distance from the edge of sleeve or anchor plate to the edge of pedestal shall be 75mm. 	
11.0	<u>MISCELLANEOUS REQUIREMENT</u>	
11.1	Plywood formwork shall be used for all over ground concrete works. For other areas steel / plywood formwork shall be used.	
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<div> <div>11.2</div> <div>Unless specified 20 mm and down graded aggregates shall be used for all structural concrete works.</div> </div> <div> <div>11.3</div> <div>Tolerance for formed and concrete dimension shall be as per IS:456.</div> </div> <div> <div>12.0</div> <div> <u>MAJOR EQUIPMENT FOUNDATIONS</u> Special requirements for concreting of major equipment foundations shall be as given below: </div> </div> <div> <div>12.1</div> <div> <u>Coarse Aggregates</u> Sound and durable crushed blue granite aggregates shall be used. All aggregates shall be tested for alkali aggregate reaction. Materials, which contain high percentage of reactive silica, shall not be used. In exceptional cases of high percentage of reactive silica content, aggregate may be allowed where low alkali cement shall be used. </div> </div> <div> <div>12.2</div> <div> <u>Form work/Shuttering</u> Formwork/shuttering shall be as per the Technical specifications given. </div> </div> <div> <div>12.3</div> <div> <u>Scheme for Concreting</u> Weigh batching plants shall be mobilized for all major foundations. Arrangements for stand-by Plant and Equipments shall also be made. </div> </div> <div> <div>12.4</div> <div> <u>Placing of Concrete</u> Placing of concrete shall be as per the Technical specifications given. </div> </div>		
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<p align="center">SECTION VI – SPECIFIC TECHNICAL REQUIREMENTS</p> <p align="center">PART D - STEEL STRUCTURES</p> <p>1.0 <u>GENERAL</u></p> <p>1.1 Design of structural steel work shall include generally but not be limited to the steel constructions listed below:</p> <ul style="list-style-type: none"> i) Galvanised latticed/tubular structures for switchyard and transformer yard. ii) Cable racks iii) Platforms and walkways iv) Ladders, staircases, handrails etc. <p>2.0 <u>REQUIREMENTS FOR SWITCHYARD STRUCTURES</u></p> <p>2.1 Steel structural work for switchyard structures will include</p> <ul style="list-style-type: none"> a) The preparation and supply of all necessary design calculations, material indents, arrangement drawings shop details drawings, shop material lists site bolt / rivet lists and despatch documents for civil structures. b) Supply, fabrication, galvanising transportation delivery and storage of all steel structures including site bolt / rivets, electrodes etc. complete in all respects. c) Erection including any staging or false work required for erection, handling, transportation and rectification of damaged structures, fixing, bolting, welding alignment levelling, etc, of all steel structures materials etc. complete in all respects. <p>3.0 <u>DESIGN PARAMETERS</u></p> <p>3.1 The switchyard structures will be designed with adequate mechanical strength to meet the requirements of the equipment specified and the site and loading conditions stipulated.</p> <p>3.2 Structures will be of lattice type construction fabricated from rolled mild steel and plates. Three dimensional analysis shall be of carried out for structures like towers and gantries whereas two dimensional approach</p>		
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<p>may be followed for equipment support structures.</p> <p>3.3 Only bolted connections will be permitted at site. Necessary nuts, bolts, washers and foundation bolts will be supplied with the structures. All bolts and nuts shall be galvanised. In addition to heavy washers conforming to IS: 6610, spring washers conforming to IS:3063 shall be provided at all bolted connections. Bolts shall conform to IS:12427.</p> <p>3.4 The design of steel structures will be carried out as per IS: 802</p> <p>3.5 Superimposed load will be considered in the design of steel structures according to IS: 802 except wind load</p> <p>3.6 Wind load will be calculated as per IS:875 (Part -3) with following consideration.</p> <p>i) Basic wind speed $V_b = 47 \text{ m/s}$ (at 10 m ht)</p> <p>ii) $K_1 = 1.07$, $K_2 = \text{As per category 3}$, $K_3 = 1.0$</p> <p>3.7 Tension on conductor and ground wire Maximum working tension at strain connections = 1400 kg</p> <p>3.8 Slenderness ratio (l/r) Maximum slenderness ratio will not exceed the following values</p> <p>a) Leg members and main : 150 compression members</p> <p>b)Other members having : 200 calculated stresses only</p> <p>c)Secondary compression : 250 members / unstressed bracings</p> <p>d) Minimum thickness for : galavanised steel members</p> <p>i) Main members of a lattice beam : 4.4 mm or stanchion</p> <p>ii)bracings : 5 mm</p> <p>iii) Minimum diameter of bolts : 16 mm</p>		
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<p>3.9 Factor of safety :</p> <p>For switchyard steel structures : 2.5 based on maximum loading conditions (on elastic limit for tension members and crippling load for compression members)</p> <p>3.10 Factor of safety against overturning :</p> <p>Steel :2.5</p> <p>3.11 CABLE RACKS Cable rack shall consist of rigid main frame in transverse direction spaced longitudinally as required. In longitudinal direction, cable rack shall be divided into sections of suitable length. The main transverse frames shall be connected with longitudinal beams, which will transmit horizontal forces to braced bays. The cable rack bridge structure shall be adequately rigid to carry the without undue deflection.</p> <p>4.0 <u>MATERIALS OF CONSTRUCTION</u></p> <p>Structural steel will conform to the stipulation mentioned in IS:2062 - (Grade A)-1992</p> <p>Bolts, nuts, washers etc. will also conform to the stipulation mentioned in IS:802 (1977)</p> <p>Fabrication galvanised, Erection Inspection, packing and testing</p> <p>These will conform to the stipulation of IS: 802 (1977)</p> <p>5.0 <u>Galvanising</u></p> <p>5.1 All steel members including nuts and bolts, will be hot dip galvanized after all shop work is completed. Spring washers will be electric galvanized. Galvanising of the towers shall be as per IS:4759 and IS: 2633 and as given in the following paras.</p>		
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<p>5.2 Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process.</p> <p>5.3 Galvanised coating will be 900 grams/sqm on all steel structures.</p> <p>5.4 Galvanizing of each member will be carried out in one complete immersion. The galvanizing bath will contain only the approved standard shelter.</p> <p>5.5 The galvanizing bath will be reasonably free from dross and the steel will be dipped in the molten zinc in such a manner that it does not come in contact with the dross which might have collected at the bottom of the bath.</p> <p>5.6 The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from defects like discoloured patches, bare spots, globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.</p> <p>5.7 There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanised steel member shall withstand minimum four number of one minute successive dips in copper sulphate solution as per IS:2633 unless specified otherwise.</p> <p>5.8 All galvanised members shall be treated with sodium dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.</p> <p>5.9 Wherever galvanised bolts, nuts, washers, accessories, etc. are specified these shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.</p> <p>5.10 CONTRACTOR shall ensure that galvanising is not damaged in transit. In the event of occurrence of any damage, CONTRACTOR shall at his own cost adopt scrapping and re-galvanising the member to satisfy the specific requirements.</p>		
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PART E - OUTDOOR CIVIL WORKS



1.0 **ROADS, DRAINAGE AND SEWERAGE**



All the approach roads from the main road net work to the individual buildings and switchyard with in the battery limits shall be provided by the contractor. The roads shall be provided with kerbs and 1000mm wide shoulder on either side. All approach roads including all round roads in switch yard as well as the roads in between to facilitate placing and removal of equipment should be as per specifications and as described in section D4.5. RCC roads consisting of rails embedded in concrete for the movement of transformer shall be provided from the transformer foundations up to the main plant road and connected with the main road as shown in the drawings. The drainage lines for storm water collected from rain water down take pipes for the building shall be connected suitably to the nearest storm water net work of the plant., Sewage shall be collected from all the toilets and connected to the nearest sewage manhole of the plant net work, which may be approximately 125m away from switchyard control room. Separate network shall be provided for lines of storm water, sewage, and waste drainage.



1.1 **Surface Drainage**

- 1.1.1 All the paved areas shall be adequately drained. The surface drainage system shall be designed for surface washings and / or rain / fire water as the case may be.
- 1.1.2 The paved area shall be sloped towards the drains with a mild slope of 1 in 100. All drains in the paved area shall be connected to the plant drain net work with adequate slope.
- 1.1.3 The surface drainage from uncontaminated area shall be connected to the nearest open storm water drains through rectangular drains. The ground/paving shall be sloped towards the drain for the surface flow of water. In transformer yard area and switchyard area, if, islands are formed due to the provision of cable trenches, RCC rail roads and surrounding transformer foundations, the storm water shall be disposed by providing catch pits/PVC pipes and shall be connected

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<p>to the nearest surface drain. Contaminated area surface drainage shall be collected through separate network of catch pits with pipes and lead to a collection chamber from where the drainage shall be conveyed to the near effluent collection ponds(Approximate 500 m away) by pumping including the pumps / related piping upto the guard pond.</p> <p>1.1.4 The rectangular drains shall be sized for carrying the design discharge when running full.</p> <p>1.1.5 The rectangular drains shall be minimum 300 mm wide of RCC construction. The pipes for water drainage system shall be of RCC class NP2 conforming to IS:458 with minimum size of 250 mm NB. However for road crossings etc. RCC box culverts of suitable size shall be provided.</p> <p>1.1.6 The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8 m/sec respectively. However minimum velocity for self cleansing of 0.6 m/sec shall be ensured. Slope of drain shall not be milder than 1 in 1000.</p> <p>1.1.7 Garland drains, minimum 300 mm wide shall be provided all round the building to lead away roof drainage to plant drainage system. The system shall be designed to cater to the maximum rain fall in the area. Plinth protection in PCC grade M 15 shall be provided between brick wall and drain with appropriate slope.</p> <p>1.2 <u>Sewage System</u></p> <p>1.2.1 The main sewage system comprising of man holes and pipes and sewage treatment plant will be provided by the Owner. However, all the waste water pipes from toilets located in the buildings shall be lead by man holes on to the nearest man hole of the main sewer net work .</p> <p>2.0 <u>INTER PLANT TRENCHES</u></p> <p>2.1 All cable and pipe trenches shall be of RCC with minimum M25 grade. Trenches located outside the buildings shall project at least 150 mm above finished formation level to avoid entry of storm water into the trenches. The bottom of trench shall be provided with suitable slope for draining out collected water into a sump pit.</p>		
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<p>2.2 Trenches shall be covered using precast RCC cover of minimum M25 grade, each not weighing more than 75 kg and shall be provided with a lifting hooks.</p> <p>3.0 <u>PAVING</u></p> <p>3.1 <u>R C C Paving</u></p> <p>3.1.1 R.C.C paving of grade M20, minimum 125 mm thick laid to a slope of 1 in 100 towards the nearest drain, with reinforcement placed 50 mm from the top surface, shall be provided wherever specified.</p> <p>3.1.2 The under bed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits, followed by a layer of PCC of M 7.5, 50 mm thick.</p> <p>3.2 <u>P C C Paving</u></p> <p>3.2.1 PCC paving of nominal mix of grade M15, 100 mm thick that laid over 150 mm thick compacted rubble soling shall be provided as Plinth protection around all building to a width of 1200 mm or the distance between the brick wall to the garland drain. Kraft paper shall be provided over the rubble soling before laying the paving slab.</p> <p>3.2.2 Inside transformer yard, in areas which are not marked for vehicle and transformer movement, heavy duty concrete paver blocks shall be provided on 50mm thick sand bedding. The area shall be compacted and provided with a subgrade of 150mm thick rubble soling.</p> <p>3.2.3 Inside switchyard area, in areas which are not marked for vehicle and transformer movement, 100mm thick PCC paving of grade M10 shall be provided over a rubble soling. The rubble soling shall be 150mm thick layer consolidated to 115mm thick laid over a well compacted ground. The PCC paving slab and rubble soling shall be separated by kraft paper. The paving shall be laid to slope towards peripheral drain. Construction joints and expansion joints shall be provided in the paving slab. The paving slab shall be casted in panels of width not exceeding 4m x 4m. The paving slab shall be constructed in chequered pattern by constructing one panel followed by the construction of alternate panel after 3 days of construction of first</p>		
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<p>panel. 25mm wide expansion joints shall be provided at every 30m intervals in both directions. The expansion joint gap shall be filled up with premoulded joint filler board and 25mm thick bitumastic sealant. The PCC paving slab shall be provided with a rough finish.</p> <p>4.0 <u>ROADS</u></p> <p>4.1 Inside switchyard the area earmarked for vehicle movement shall be R.C.C Roads of grade M25, minimum 150 mm thick laid with reinforcement placed 50 mm from the top surface, shall be provided wherever specified.</p> <p>4.2 The underbed shall consist of well compacted ground supporting dry rubble soling of compacted thickness 230 mm with interstices properly filled with grits two layer of 150mm each, followed by a layer of PCC of M 7.5, 50 mm thick.</p>		
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SECTION VI - SPECIFIC TECHNICAL REQUIREMENTS

PART F - FINISHING WORKS

The minimum quality of finishes used for various building areas are furnished in this section. The bidder is at liberty to use superior finishes provided all specific requirements for the finish specified herein below are satisfied.



1.0 **FLOORING: GENERAL UNDERBED**



The nominal total thickness of floor finish shall be 50 mm including under bed and topping. The flooring shall be laid on already matured concrete base. The under bed for floors shall consist of cement concrete 1:2:4 with stone chips 12.5 mm down graded as coarse aggregates. The under bed shall be provided appropriate slope towards catch pit for floor drainage.



The grade slab shall be of RCC grade M20. The under bed for grade slab shall consist of well compacted 230 mm rubble soling over a well compacted sub grade with interstices properly filled with grits, followed by a layer of PCC of M 7.5, 50 mm thick.



1.1 **False Flooring System**



Removable type false flooring system shall be provided in computer rooms and control rooms as required. RCC floor slab will be sunk to the required depth which shall be the height of the false floor system. The flooring shall consist of high pressure laminate /vinyl tile composed of steel and cellular concrete tiles whose edges are protected with high wear resistant hard PVC edge profiles. The flooring system shall mounted on steel pedestals of adjustable height and supporting steel grid system to provide under floor space. The floor shall be capable of supporting a point load of 75kg/sq.cm and a maximum distributed load of 1000kg /sqm. The false flooring system shall be installed as per manufacturers specifications.



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<p>1.2 <u>PVC Floor Finish</u></p> <p>Two mm thick PVC as per IS:3462 and laid as per IS:5318 over concrete under bed of 48 mm shall be provided in all control room, electronic cubicle rooms, conference room, etc. PVC tiles shall ensure anti static surface.</p> <p>1.3 <u>Terrazo Tiles</u></p> <p>This shall be provided in general circulation areas such as lift entrance area, office area, laboratory etc. This finish shall be also provided in MCC and Switch gear rooms. Tiles shall generally be 250 x 250 x 20 mm laid over concrete bedding to result in an overall thickness of 50 mm.</p> <p>1.4 <u>Heavy Duty Ceramic Tiles</u></p> <p>Heavy duty ceramic tiles with matt finish conforming to IS: 13711 / 13712 shall be used in toilets, pantry, etc. The tiles shall be 300 x 300 x 10 mm of approved shade brand and colour.</p> <p>1.5 <u>Acid / Alkali Resisting Tiles</u></p> <p>Battery rooms and other areas coming into contact with acid / alkali vapours or fumes shall be given acid / alkali resistant tiles 25 mm thick, jointed with acid / alkali resistant cement mortar. Bedding shall comprise of potassium silicate mortar conforming to IS:4832 (Part-I) and resin based mortar like epoxy for jointing. Total thickness of flooring shall be 50 mm. Ceramic unglazed vitreous tiles conforming to IS:4457 with minimum thickness of 20 mm may also be used as acid / alkali resistant tile.</p> <p>1.6 <u>Integral Floor Finish</u></p> <p>For cable vaults floor finish integral to the concrete base shall be provided as per IS:2571.</p> <p>1.7 <u>Finish for stair cases</u></p> <p>Risers and treads of staircases shall be provided with matt finish Ceramic tiles. Total thickness of the finish shall be 25 mm. Staircase wall shall be given dado of same finish to a height of 2100 mm.</p>		
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<p>1.8 <u>Miscellaneous</u></p> <p>1.8.1 Aluminium nosing shall be provided for edge protection of R.C.C. stair treads.</p> <p>1.8.2 Angles 75x75x6 mm (minimum) with lugs shall be provided for edge protection of cut outs / openings in floor slabs, edge of drains covering gratings, edge of R.C.C cable / pipe trenches of any other place where breakage of edges / corners is expected.</p> <p>1.8.3 Floors of switchgear rooms shall have embedded steel channel suitable for easy movement of breaker panel.</p> <p>2.0 <u>SKIRTING / DADO</u></p> <p>2.1 Minimum 125 mm skirting matching with floor finish shall be provided in all areas unless specified otherwise elsewhere.</p> <p>2.2 Toilets shall be provided with dado up to the bottom of the ceiling with colour /design glazed tiles of minimum 5 mm thickness generally as per IS:777.</p> <p>2.2 For battery room and other areas coming in contact with acid / alkali spillage / fume, dado of acid / alkali resistant tiling 12mm thick as per IS:4457 shall be provided to a height of 2100 mm set in potassium silicate mortar and joints pointed with resin bonded mortar.</p> <p>3. 0 <u>PLASTERING</u></p> <p>3.1 External face of all walls shall be provided with 18 mm thick cement mortar plastering with an under layer 12 mm thick in CM 1:5 and top 6 mm thick layer in CM 1:4 with approved water proofing compound.</p> <p>3.2 For internal walls 18 mm thick plaster in CM 1:5 shall be provided on the uneven side of the wall and 12 mm thick plaster in CM 1:5 on the even side of the wall.</p> <p>3.3 Inside surfaces of walls shall be provided with 2 mm thick plaster of paris punning over the plastered surfaces in office areas, corridor, control room and all other air-conditioned rooms. All internal</p>		
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<p>surfaces of other areas shall be provided with wall putty of approved brand before painting.</p> <p>3.4 Ceiling of all buildings except over false ceilings shall be given 6 mm thick cement sand plaster 1:4.</p> <p>3.5 All plastering work shall conform to IS:1661.</p> <p>4.0 <u>PAINTING</u></p> <p>4.1 Details furnished here in below are the minimum acceptable standard for painting..</p> <p>4.2 Exterior emulsion paint of approved brand and shade shall be provided on external faces of walls, sunshades, etc.</p> <p>4.3 Inside surfaces shall be provided with Acrylic emulsion paint as per IS: 5411 for Control room, Control equipment rooms, all air-conditioned areas and all other areas and above dado in toilets etc.</p> <p>4.4 Inside surfaces shall be provided with oil bound distemper as per IS: 428 for plant buildings.</p> <p>4.5 All plastered ceilings shall be provided with oil bound distemper as per IS: 427. In false ceiling areas the ceiling shall be provided with cement primer paint .</p> <p>4.6 Painting for structural steel shall be as described in technical specifications.</p> <p>4.7 Battery rooms / laboratories shall be provided with chlorinated rubber based paint</p> <p>4.8 Following general instruction for painting shall be followed.</p> <p>i) For painting on concrete, masonry and plastered surfaces IS: 2395 parts I and II shall be followed.</p> <p>ii) All paints shall be of brand and make as per the approval of OWNER.</p> <p>iii) A minimum of two finishing coats of paint over a primer shall be provided to give a smooth uniform finish for the painted surface.</p>		
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<p>iv) All painting on masonry or concrete surfaces shall preferably be applied by rollers.</p> <p>v) All fire exits shall be painted in Post office red colour shade which shall not be used any where except to indicate emergency or safety measure.</p> <p>5.0 <u>ROOF</u></p> <p>5.1 Roof of all buildings having R.C.C. framework shall have cast in situ R.C.C. slab with conventional shuttering.</p> <p>6.0 <u>ROOF DRAINAGE AND WATER PROOFING</u></p> <p>6.1 For efficient drainage of rainwater, roof concrete shall be given a gradient of a minimum of 1 in 100. The gradient shall preferably provided by sloping the structural framing system itself. Gradient may also be provided using screed concrete of grade M20 using 12.5 mm downgraded aggregate. But the average thickness of such screed concrete shall be restricted to about 50 mm. In the case of metal roofing system the roof slope shall be 1 vertical: 4 horizontal.</p> <p>6.2 Roof waterproofing shall be provided using high solid content liquid applied elastomeric water proofing membrane with separate wearing course as per ASTM C-898. Thickness of the membrane shall be a minimum of 1.5 mm. The treatment includes application of polymerised mortar over sloped roof to achieve a smooth surface and a primer coat. Wearing course shall be 40 mm screed of concrete grade of M 20, as above cast in panels of 1.2mx1.2m and reinforced with 0.56 mm dia galvanised chicken wire mesh and joints sealed using sealing compound. The roof shall be provided with clay tiles over the entire area.</p> <p>6.3 Number and size of rainwater down take pipe shall be decided based on the provisions of IS: 1742 and IS: 2527. The pipes shall be UPVC pipes. It is recommended that the minimum diameter of the pipe be kept as 150 mm and there shall be a minimum of two pipes provided on each gutter. The down comer pipes shall be suitably concealed with masonry work, cement concrete or sheeting to match with the exterior finish.</p>		
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7.0	<u>FALSE CEILING AND UNDER DECK INSULATION</u>	
7.1	Laminated cement bonded particle board false ceiling system shall consist of 600x600x12.5 mm Cement bonded particle board. The suspension system shall consist of 6 mm diameter galvanised steel rods suspended from ceiling supporting aluminium grid of 38x25x1.5 mm and crosstie of 25x25x1.5 mm and aluminium angle of 25x25x1.5 mm.	
7.2	Suitable M.S channel (minimum ISMC100) grid shall be provided above false ceiling for movement of personnel to facilitate maintenance of lighting fixtures, AC ducts etc.	
7.3	CONTRACTOR shall prepare a layout of the false ceiling system incorporating light fixtures, supply air diffuser, return air grills, fire detectors, fire protection sprinklers etc. such that the ceiling looks aesthetically pleasing. Work shall commence only after the OWNER approves the layout.	
7.4	Under deck insulation shall be as detailed in the technical specifications.	
8.0	<u>DOORS & WINDOWS</u>	
8.1	Unless specified all doors, windows and ventilators of shall be of steel. View panels shall be provided in doors wherever required. Doors for the toilet shall be of made pre-laminated particle board (MDF exterior grade) shutter with aluminium frame work. The fixtures and hard ware shall be of best quality and shall be provided as detailed in the technical specifications.	
8.2	All steel doors shall consist of double plate flush door shutters. The door shutter shall be 45 mm thick with two outer sheets of 18 G rigidly connected with continuous vertical 20 G stiffeners at the rate of 150 mm centre to centre. Side, top and bottom edges of shutters shall be reinforced by continuous pressed steel channel with minimum 18 G. The door shall be sound deadened by filling the inside void with mineral wool. Doors shall be provided with all hardware and fixtures like door closer, tower bolts, handles, stoppers, aldrops, etc.	
8.3	Wherever functionally required rolling shutters with suitable operating arrangement manual / Electric shall be provided to	
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facilitate smooth operations. Rolling shutters shall conform to IS: 6248.

- 8.4 Fireproof doors shall be provided at all fire exit points as per the recommendations of LPA. These doors shall generally be as per IS: 3614 (Part I and Part II). Fire rating of the doors shall be as per LPA requirements. However minimum rating shall be 2 hours. These doors shall be double cover plated type with mineral wool insulation.

- 8.5 Hardware fittings for doors and windows :



Fittings for steel door

SI No	Nos. for Single leaf	Nos. for double leaf
1) M S Aldrop	1	1
2) M S Tower bolt for top	1	2
3) M S Hinge	3	6
4) M S Door handle (one on each face)	2	4



Fittings for MDF Doors in aluminium frame work



SI No	Nos. for Single leaf	Nos. for double leaf
6) Tower bolt 300mm for top	1	2
2) Tower bolt 150mm for bottom	1	1
3) Aldrop 300mm long with 16mm sliding bolt	1	1
4) Door handles of 12mmdia, 100 high mounted on a plate 150x38 mm	1	2
5) Butt hinge (125x63x4mm) with cadmium plated M.S screws	4	8
6) Butt hinge (75x45x3.2mm) for door cleat with cadmium plated M.S Screws	1	2

All openable steel windows will be provided with brass handles and brass peg stays.



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9.0	<u>Glazing</u>	
9.1	All ventilators and windows on external face of all the buildings covered in the scope shall be provided with wired glass of minimum 6 mm thickness conforming to IS: 5437.	
9.2	Ground glass / frosted glass of minimum 4 mm thickness shall be used for all windows / ventilators in toilets.	
9.3	All glazing work shall conform to IS: 1083 and IS: 3548.	
10.0	<u>WATER SUPPLY AND SANITATION</u>	
10.1	Roof water tank of minimum 1000 litres capacity shall be provided for control room building. Polyethylene water storage tank conforming to IS: 12701 shall be used. The tank shall be complete with all fittings including float valve, stop cock etc.	
10.2	Galvanised M.S. pipe of medium class conforming to IS: 1239 shall be used for internal piping works for potable water supply. For concealed pipes the pipes shall be of heavy class.	
10.3	UPVC pipes shall be used for sanitary works above ground level. The pipes shall be capable of withstanding minimum test pressure of 4 KSC.	
10.4	The toilet block shall have the following minimum facilities calculated based on minimum 25 persons as per stipulations of National building code . The facilities shall be suitably increased based on the stipulation of NBC for every increase of 25 users. Unless specified all the fittings shall be of chromium plated brass (fancy type).The toilet blocks shall be provided with adequate capacity exhaust fan.	
	i) All the facilities such as WC, Urinals, wash basins etc shall be of approved colour .	
	ii) WC (Indian type) Orissa pattern (580x440mm) as per IS: 2556 (Part-3) with all fittings including flushing arrangement of appropriate capacity and type – 2 no.	
	iii) Urinal with all fittings with photo voltaic control flushing system as per IS: 2556 (Part-6, Sec.1) – 2 nos.	
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<p>iv) Wash basin (oval shape) with all fittings as per IS: 2556 to be fixed on concrete platform finished with 12 mm thick polished granite stone – 2 nos.</p> <p>v) Bathroom mirror (5.5 mm thick float glass) with bevelled edges including all fittings – 2 nos.</p> <p>vi) Stainless steel towel rail (600 x 20mm) - 2 nos.</p> <p>vii) Stainless steel liquid soap holder cum dispenser – 2 nos.</p> <p>viii) Installation of water cooler of adequate capacity</p> <p>10.5 Unless specified all fittings and fixtures in the toilets shall have same specifications as stipulated in Cl.No.11.4.</p> <p>10.6 All plumbing ,sanitary fittings ,connections and service lines shall be provided as per requirement. All service lines ,water supply, plumbing lines and other utility lines shall be concealed with in the brick /concrete work . Two stack system shall be provided for the toilets .</p> <p>11.0 <u>MISCELLANEOUS REQUIREMENTS</u></p> <p>11.1 Doors and windows on external walls of buildings shall be provided with RCC sunshade over the openings with 300 mm projection on either side of the opening. Projection of sunshade from the wall shall be minimum 600 mm over window openings and 750 mm over door openings.</p> <p>11.2 Doors and windows on the external walls of buildings with metal cladding shall be fixed by creating recesses in the cladding system.</p> <p>11.3 Duct banks consisting of MS/PVC conduits for cables shall be provided with proper sealing arrangement consisting of fire retardant sealing compound.</p> <p>11.4 All floor openings for cables below electrical panel shall be sealed with fire sealing compound after cables are laid.</p> <p>11.5 All openings in external walls provided for pipes, cables, ducts etc. shall be effectively sealed to prevent water seepage, after the routing of the services are over.</p>		
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<div> <div>12.0</div> <div><u>NATURAL LIGHTING & VENTILATION</u></div> </div> <div> <div>12.1</div> <div>The area of windows shall be a minimum 15% of the floor area to ensure adequate natural lighting.</div> </div> <div> <div>12.2</div> <div>Fans shall be provided in general office area as per standard norms.</div> </div> <div> <div>12.3</div> <div>Sewerage system shall be provided with adequate ventilation for the pipe work as well as manhole.</div> </div> <div> <div>13.0</div> <div>Finishes schedule is enclosed as Annexure-1 and List of approved manufacturer's is enclosed as Annexure-2 to section D4.6-F.</div> </div>		
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	TITLE PART F –FINISHING WORKS ANNEXURE-1 : FINISHING SCHEDULE	

Building/ Structure	Floor Finish	Dado/false ceiling
MCC switch gear rooms,	Terrazo tiles	Skirting with terrazzo tiles wherever required
control room and communication room	False flooring over integral floor finish. False flooring shall be of high pressure laminate vinyl tiles	Laminated cement bonded particle board false ceiling
Relay room	PVC floor finish	Cement bonded particle board false ceiling
Engineer's room, Store, Office room	Terrazo tiles	Skirting with terrazzo tiles wherever required
Toilets ,Pantry	Heavy duty Ceramic tiles	Dado heavy ceramic tiles up to ceiling level
Battery rooms and areas coming in contact with acid alkali vapours or fumes.	Acid /alkali resisting tiles	Dado 2100 mm high of acid /alkali tiles



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	TITLE PART F –FINISHING WORKS ANNEXURE-2 : LIST OF APPROVED MANUFACTURERS	

LIST OF MATERIALS OF APPROVED BRAND AND/OR
MANUFACTURERS



Unless otherwise specifically mentioned in the Schedule of Items, Contractor has to use materials of only these brand names/Company's names, which are mentioned in the approved list for civil, water supply and sanitary items, as listed below, thereon.

A. BUILDING MATERIALS

1.	TILES (Terrazzo, Mosaic Plain)	Mehtab Tiles, "NITCO", Bangalore Shriram Tiles. Ahmednagar & any other approved brand conforming to IS:1237 –1980
2.	FLUSH DOORS	Vidarbha Veneer Industries. Western India plywood, Kit Ply, Godavari plywood, Art plywood, National Plywood Industries Pvt. Ltd., Kutty flush doors.
3.	PLYWOOD PRODUCTS	IPM, Novopan Particle Boards, Bhutan Boards, Nuwood Particle Boards
4.	STEEL DOORS WINDOWS AND VENTILATORS	San-Harvice Godrej-Boyce, Multiwyn, Supersteel Delhi, Chamundeshwari, Doorwyn, Agew Steel.
5.	ROLLING SHUTTERS AND ROLLING GRILLS	Standard, Swastik, Diana, Hercules, Prabhat
6.	ALUMINIUM DOORS, WINDOWS, PARTITIONS	Godrej, Ajit Alumilite, Aardee, Indal, Glaze India
7.	WATER PROOFING COMPOUNDS/ADMIXTURES/ EPOXY FLOORING	CICO, Impermo, Accoproof, Fosroc, Fairmate, SICA, Material of construction Baucheme, Fairmate
8.	HARDENERS	Ironite, Ferrok, Hardonate, CICO, Fosroc, SICA



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9.	PAINTS AND DISTEMPERS	Jenson & Nicholson, Asian Paints, Shalimar, ICI, Goodlass Nerolac, Garware, Berger Shalimar.
10.	WATER PROOF CEMENT PAINTS AND EXTERIOR EMULSION PAINTS	Super Snowcem, Berger, Jenson & Nicholson and Shalimar.(Only brand names given)
11.	PRESSED STEEL DOOR AND WINDOW FRAME	Shirke Polynorm, T.I. Frames, Madras, Mann, Jaipur, Chandan Metal Products, Baroda, Agew, Ahmedabad, multiwyn, Calcutta.
12.	DOOR CLOSERS	Everite, Gloster Engineering, Amar, A.K. 'Industries, Hardiwyn, vigvijay, Dewan industries.
13.	HARD PAVING.	Eurocon,Ultra,Hicon Pavers/Cochin.,High tech exteriors
14.	METAL CLADDING SYSTEM	Lloyd insulations (India) Pvt Ltd,Chennai,Roof &ceiling India Pvt Ltd,Mumbai,Inter Arch Noida,Colour roof (India)Pvt Ltd
15.	ALUMINIUM/ METAL FALSE CEILING SYSTEM	Lloyd insulations (India) Pvt Ltd,Chennai, Inter Arch, Noida.J C Industries (Supersyl),Mumbai
16.	FALSE FLOORING	United insulations(unitile), Delhi,Advance business Consultants,Mumbai



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	TITLE PART F –FINISHING WORKS ANNEXURE-2 : LIST OF APPROVED MANUFACTURERS	

B. SANITARY AND WATER SUPPLY WORK(INTERNAL) (FIRST QUALITY TO BE-USED.)

1.	Cast Iron Pipes and Fittings	Hindustan Engineering Products Company Calcutta, E.L.C., ALC,Standard approved manufacturers of any other brand of fittings having ISI marking .
2.	RCC Pipes	Indian Hume Pipe Company, Delhi/Allahabad/ Chandigarh/ Lucknow. Hindustan Pressure Pipes, Kolhapur, Dhere Concrete Products, Pune or any other approved manufacturer conforming B.I.S. Standard
3.	G.I. Pipe	Indian Tube Company, Calcutta; Kalinga Tubes Limited, Cuttack; Gujarat Steel Tube; Zenith Tube Co. Kolaba; Bharat Steel Tube, New Delhi; Jindal; Shivmoni Steel Tubes Limited, Bangalore; Sekhar Iron Works, Calcutta, Jain Tubes, Ghaziabad; Khandelwal Tubes, Nagpur. Jindal pipes
4.	G.I. Fittings	International Pipe Works, Calcutta; R.M. Engineering Works, Jalandhar; Bombay Metal Company, Bombay; Tarapada Das & Sons, Howrah; Annapurna Metal Works, Calcutta.
5.	Gun Metal Valves Alloy Valve Copper	Leader Engineering Works, and Jalandhar; Neta Engineering Works, Jalandhar; Lakshmi Metal Works, Jalandhar; Bombay Metal & Alloys, Bombay; Luster Sanitary Fittings, Jalandhar. Annapurna Metal Works, Calcutta.
6.	Sluice Valves, Check Valves etc.	Shiva Durga Iron Works, Howrah; Leader Engineering Works, Jalandhar; Kirloskar Bros. Limited, Pune; Indian Valve, Calcutta; Geeta Iron & Brass

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		Works, Barooda.
7.	Brass Fittings	Leader Engineering Jalandhar; L & K Mathura, Luster Sanitary, Jalandhar; Annapurna Metal Works, Calcutta; Neta Metal Works, Jalandhar; Honey Industrial Corporation, Bombay, Palladium , Jamnagar
8.	C.P., Fittings	Ego metal Works, Ballabgarh -Jaquar Industries, Delhi; Jupitar Aqua Lines Limited, Gem Sanitary Appliances Pvt. Ltd.,Delhi; Essco Sanitation.-S, Delhi; Bilmet, Bombay., Crystal Sanitary fittings (P) Ltd.,Marico,Water man
9.	W.C. Pan Wash Basin, Urinals Sink Low down flushing Cistern	E.I.D. Parrys, Madras; Hindustan Sanitaryware, Calcutta; Neiveli Ceramics, Tamil Nadu; Cera Ceramics, Raasi ceramics-Secundrabad
10.	E.W.C. Seats	Nuchem Plastics Limited, Faridabad; commander, Bombay; Bestolite Jasco Sales, Bombay; Agarwala Products, Bombay., Raasi Ceramics, Secundrabad.,Supreme industries
11.	Flushing Cistern	Arail Brothers, Delhi; Allied Industries, Jaipur; Fordham Pressing (India) Pvt. Limited, Bombay; Klassik:Enamellers, Bombay; Sushila Industries, Sundergarh Small Machine Tools Company, Howrah; Thakurdass Surekha Engg. corporation Pvt Ltd., Calcutta; E.I.D. Parry, (India) Pvt. Ltd., Madras;& Hindustan Sanitaryware industries Ltd., New Delh.
12.	Stainless Steel Sink	Oriental Metal Pressing (P) SinksLtd., Bombay; Neelkanth,A.M.C. Thakar

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		Equipment Compa'ny, New Delhi; Continental Equipment India, New Delhi
13.	Mirrors	Atul Glass Works, Vallabh Glass Works, Goldenfish
14.	White Glazed & Colour glazed ceramic tiles.	H&RJohnson Tiles, Spartek, Neycer Company, Somani Pilkingtons Co., Haryana, NITCO
15.	Stone Ware	HindCeramics Limited, (Salt-Glazed) Orissa; Ceramic Industries Pipes Limited, Sambalpur; Shrikamakshi Agencies, Madras; Binary Udyog Pvt. Limited, Howrah; Tirumati -Moulds Limited, Nagpur, Kiran Potteries, Hyderabad, Perfect Sanitary Pipes, Bharatpur.
16.	Glazing glass.	NITCO-Khajaria, Modi Float, Saint Gobain.
17	Vitrified ceramic tiles	Naveen ceramics, Bell ceramics, Kajaria tiles, H&R Johnson

C .STRUCTURAL STEEL

1	Welding electrodes	Advani Oerlekon ,D&H ,Essab
2	HSFG Bolts	GKW ,TVS, Unbrako
3	Gratings	TUFF Grate,Indiana



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SECTION VII - TECHNICAL SPECIFICATIONS FOR CIVIL WORKS

CODES, STANDARDS & REFERENCES

1.0 IS CODES AND REFERENCES

- 1.1 All the Indian Standards referred to shall be the latest revision (including all amendments issued thereto) on the date of opening of the price bid.
- 1.2 Reference to only some of the codes in this document and various clauses of design criteria shall not limit or restrict the scope or applicability of other relevant codes. It shall be ensured that all other codes relevant to a specific job, in addition to those already mentioned, are followed wherever applicable.
- 1.3 Where British / American / DIN or other codes and standards are referred to in this document, equivalent Indian Standards may be substituted if available.
- 1.4 In case of any deviation / conflict between provisions of IS codes and the design criteria, the provisions that are more stringent shall be followed unless specifically directed otherwise.
- 1.5 The Codes and Standards listed below are applicable for the design and construction of structures and buildings in general. Codes and Standards applicable for specific design and construction are listed elsewhere in reference sections.
- 1.6 Specifications for materials supplied from India shall follow the Indian Standard Specifications.
- 1.7 Field and laboratory testing procedures for materials follow Indian Standard Specifications.
- 1.8 The list of codes shall also be read in conjunction with the list of codes given in the respective detailed technical specifications.

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2.0 **LOADS**



- IS: 875 Code of Practice for design loads (other than earthquake) for Buildings and structure (All parts)
- IS: 1911 Schedule of unit weights of building materials
- IS: 1893 Criteria for earthquake resistant design of structure



3.0 **FOUNDATIONS**



- IS: 1080 Code of Practice for design and construction of shallow foundations on soils (other than raft, ring and shell)
- IS: 1904 Code of Practice for design and construction of foundations in soils general requirement
- IS: 2911 Code of Practice for design and construction of pile foundations: (All parts)
- IS: 2950 Code of Practice for design and construction of raft foundations
- IS: 2974 Code of Practice for design and construction of machine foundations (all parts)
- IS: 3764 Code of safety for excavation work
- IS: 8009 Code of Practice for calculation of settlement of foundations: (All parts)
- IS: 11089 Code of Practice for design and construction of ring foundation
- IS: 13301 Guidelines for vibration isolation for machine foundations



4.0 **RCC**



- IS: 456 Code of Practice for plain and reinforced concrete
- IS: 458 Specification for precast concrete pipes
- IS: 3370 Code of Practice for concrete structures for the storage of liquids: (All parts)



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<p>IS: 3414 Code of Practice for design and installation of joints in buildings</p> <p>IS: 3935 Code of Practice for composite construction</p> <p>IS: 4326 Code of Practice for earthquake resistant design and construction of buildings</p> <p>IS: 4995 Criteria for design of reinforced concrete bins for storage of granular (all parts) and powdery materials</p> <p>IS: 5525 Recommendation for detailing of reinforced concrete works</p> <p>IS: 1786 Specification for high strength deformed steel bars and wires for concrete reinforcement</p> <p>IS: 10262 Recommended guidelines for concrete mix design</p> <p>IS: 11384 Code of Practice for composite construction in structural steel and concrete</p> <p>IS: 13311 Non-destructive testing of concrete Part I- Ultrasonic pulse velocity Part II – Rebound hammer</p> <p>IS: 13920 Code of Practice for ductile detailing of reinforced concrete structures subjected to seismic forces.</p> <p>5.0 <u>STRUCTURAL STEEL</u></p> <p>IS: 800 Code of Practice for general construction in steel</p> <p>IS:802 Code of practice for use of structural steel in overhead transmission lines(all parts)</p> <p>IS: 806 Code of Practice for use of steel tubes in general building construction</p> <p>IS: 808 Dimensions for hot rolled steel beam, column channel and angle section</p> <p>IS: 813 Scheme of symbols for welding</p>		
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<div> <div>IS 814</div> <div>Covered electrodes for manual metal arc</div> </div> <div> <div>IS: 816</div> <div>Code of Practice for use of metal arc welding for general construction in mild steel</div> </div> <div> <div>IS: 1024</div> <div>Code of Practice for use of welding in bridges and structures subjected to dynamic loading</div> </div> <div> <div>IS: 1239</div> <div>Mild steel tubes, Tubulars and other wrought Steel fittings –specifications</div> <div>Part I – Mild steel tubes</div> <div>Part II – Mild Steel tubulars and other wrought steel pipe</div> </div> <div> <div>IS1599</div> <div>Method of Bend Test.</div> </div> <div> <div>IS 1608</div> <div>Method of Tensile Testing of Steel Products.</div> </div> <div> <div>IS: 2062</div> <div>Structural steel (fusion welding quality)</div> </div> <div> <div>IS: 4000</div> <div>High Strength bolts in steel structures – Code of Practice</div> </div> <div> <div>IS: 7215</div> <div>Tolerances for fabrication of steel structures</div> </div> <div> <div>IS: 8640</div> <div>Recommendations for dimensional parameters for industrial building</div> </div> <div> <div>IS: 9178</div> <div>Criteria for design of steel bins for storage of bulk material</div> <div>(All parts)</div> </div> <div> <div>IS: 9595</div> <div>Recommendation for Metal arc welding of carbon and carbon manganese steel</div> </div> <div> <div>IS: 12843</div> <div>Tolerances for erection of steel structures</div> </div> <div> <div>6.0</div> <div><u>MISCELLANEOUS</u></div> </div> <div> <div>IS: 774</div> <div>Specification for flushing cistern for water closets and urinals(other than plastic cistern)</div> </div> <div> <div>IS: 1038</div> <div>Specification for steel doors, windows and ventilators</div> </div>		
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<div> <div>IS: 1081</div> <div>Code of practice for fixing and glazing of metal(steel and aluminium) doors, windows and ventilators</div> </div> <div> <div>IS: 1172</div> <div>Code of basic requirements for water supply, drainage and sanitation</div> </div> <div> <div>IS: 1346</div> <div>Code of Practice for water proofing of roofs with bitumen felts</div> </div> <div> <div>IS: 1361</div> <div>Specification for steel windows for industrial buildings</div> </div> <div> <div>IS: 1742</div> <div>Code of Practice for building drainage</div> </div> <div> <div>IS: 1905</div> <div>Code of Practice for structural use of unreinforced masonry</div> </div> <div> <div>IS: 1948</div> <div>Specification for aluminium doors, windows and ventilators</div> </div> <div> <div>IS: 2210</div> <div>Criteria for design of reinforced concrete shell structures and folded plates</div> </div> <div> <div>IS: 3067</div> <div>Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings</div> </div> <div> <div>IS: 3614</div> <div>Specification for fire-check doors-part I- Platem Metal part-I covered and rolling type.</div> </div> <div> <div>IS:3614</div> <div>Specification for metallic and non-metallic fire check part-II doors-resistance test and performance criteria.</div> </div> <div> <div>IS: 7452</div> <div>Specification for hot-rolled sections for doors, windows and ventilators</div> </div> <div> <div>IS: 10440</div> <div>Code of Practice for construction of reinforced brick and reinforced brick concrete floors and roofs</div> </div> <div> <div>SP: 6</div> <div>Handbook for structural engineers (all parts)</div> </div> <div> <div>SP: 7</div> <div>National Building Code of India</div> </div>		
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	<small>TITLE</small> SPECIFIC TECHNICAL REQUIREMENTS FOR CIVIL WORKS SECTION VII-CODES, STANDARDS & REFERENCES	

IS 9918 Code of practice for in-situ water proofing and damp proofing treatments with glass fibre tissues reinforced bitumen.

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PART A : EARTH WORK IN EXCAVATION, GRADING AND BACK FILLING



1.0 SCOPE



This specification covers the general requirements of earthwork in excavation in different materials, site grading, filling in areas as shown in drawing, filling back around foundations and in plinths, conveyance and disposal of surplus soils or stacking them properly as shown on the drawings and as directed by the Engineer and all operations covered within the intent and purpose of this specification.



2.0 APPLICABLE CODES

The following Indian Standard Codes, unless otherwise specified herein, shall be applicable. In all cases, the latest revision of the codes shall be referred to.

- | | | |
|------------|---|--|
| 1. IS 783 | - | Code of practice for laying of concrete pipes. |
| 2. IS 1200 | - | Method of measurement of building and civil engineering works. |
| (Part 1) | | Part 1 Earthwork |
| (Part 27) | | Part 27 Earthwork done by mechanical appliances. |
| 3. IS 3764 | - | Excavation work-code of safety. |
| 4. IS 2720 | - | Methods of test for soils: |
| (Part 1) | - | Part 1 Preparation of dry soil samples for various tests. |
| (Part 2) | - | Part 2 Determination of water content. |
| (Part 4)- | - | Part 4 Grain size analysis. |
| (Part 5) | - | Part 5 Determination of liquid and plastic limit. |
| (Part 7) | - | Part 7 Determination of water content-dry density relation using light compaction. |

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<div> <div>Part (9)</div> <div>-</div> <div>Part 9 Determination of dry density - moisture content relation by constant weight of soil method.</div> </div> <div> <div>(Part 14)</div> <div>-</div> <div>Part 14 Determination of density index (relative density) of cohesion less soils.</div> </div> <div> <div>(Part 28)</div> <div>-</div> <div>Part 28 Determination of dry density of soils in place, by the sand replacement method.</div> </div> <div> <div>(Part 33)</div> <div>-</div> <div>Part 33 Determination of the density in place by the ring and water replacement method.</div> </div> <div> <div>(Part 34)</div> <div>-</div> <div>Part 34 Determination of density of soil in place by rubber balloon method.</div> </div> <div> <div>(Part 38)</div> <div>-</div> <div>Part 38 Compaction control test (Hilf Method).</div> </div> <div> <p>3.0 <u>DRAWINGS</u></p> <p>3.1 The enclosed bid drawing shows areas to be excavated/ filled to the specified grade level .</p> <p>4.0 <u>GENERAL</u></p> <p>4.1 The Contractor shall furnish all tools, plants, instruments, qualified supervisory personnel, labour, materials any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the job in accordance with the specification requirements.</p> <p>4.2 The excavation shall be done to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night for ensuring safety.</p> </div>		
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<p>4.3 Dumping of excavated materials shall be in regular heaps, bunds, riprap with regular slopes as directed by the Engineer, within the lead specified and levelling the same so as to provide natural drainage. Rock/ soil excavated shall be stacked properly as directed by the Engineer. As a rule, all softer material shall be laid along the centre of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.</p> <p>5.0 <u>CLEARING</u></p> <p>5.1 The site shall be cleared of all trees, stumps, roots, brushwood, bushes, blown sand and other objectionable materials. Useful and saleable material, if any, shall be the property of the owner and shall be stacked properly as directed by the Engineer. The areas to be covered with embankments shall be stripped of topsoil to required depths to expose acceptable founding strata. Top soil unsuitable for use in embankment construction and other fills shall be disposed off as directed. All combustible materials shall be stacked and burnt in locations sufficiently remote to eliminate all danger of fire hazards. All old concrete, brick works and drains which interfere with construction works shall be dismantled with the approval of the Engineer taking all necessary precautions prescribed in safety specification. Topsoil, which is suitable for use in construction work shall be stockpiled for later use. Surplus earth and other objectionable materials such as trash, debris, stones, brick, broken concrete, scrap metal etc shall be disposed off within in a lead of 5kms all as directed by the Engineer</p> <p>6.0 <u>PRECIOUS OBJECTS, RELICS, OBJECTS OF ANTIQUITY, ETC.</u></p> <p>6.1 All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the Owner and the Contractor shall duly preserve the same to the satisfaction of the Owner and from time to time deliver the same to such person or persons as the Owner may from time to time authorise or appoint to receive the same.</p>		
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7.0 **CLASSIFICATION**

- 7.1 The bid drawing enclosed shows the type of soil strata and is enclosed for reference only. The rates considered by the bidder shall be based irrespective of the type of classification.

8.0 **EXCAVATION**

- 8.1 All excavation work shall be carried out by mechanical equipment unless, in the opinion of the Engineer, the work involved and time schedule permit manual work.
- 8.2 Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by the Engineer. Rough excavation shall be carried out to a depth 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed even below the final level and extra excavation filled up as directed by the Engineer. The final excavation if so instructed by the Engineer, should be carried out just prior to laying the mud-mat.
- 8.3 The Contractor may, for facility of work or similar other reasons excavate, and also backfill later, if so approved by the Engineer, at his own cost outside the lines shown on the drawings or directed by the Engineer. Should any excavation be taken below the specified elevations, the Contractor shall fill it up, with concrete of the same class as in the foundation resting thereon, upto the required elevation. No extra shall be claimed by the Contractor on this account.
- 8.4 All excavation shall be done to the minimum dimensions as required for safety and working facility. Prior approval of the Engineer shall be obtained by the Contractor in each individual case, for the method he proposes to adopt for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, however, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the

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slipped material shall be removed and the slope dressed to a modified stable slope

- 8.5 Excavation shall be carried out with such tools, tackles and equipment as described here in before. Blasting or other methods may be resorted to in the case of hard rock; however not without the specific permission of the Engineer.

9.0 **STRIPPING LOOSE ROCK**



- 9.1 All loose boulders, semi detached rocks (along with earthy stuff which might move therewith) not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of the Engineer, to fall or otherwise endanger the workmen, equipment, or the work, etc., shall be stripped off and removed away from the area of the excavation. The method used shall be such as not to shatter, or render unstable or unsafe the portion which was originally sound and safe.



9.2 **Safety of existing work**

Before taking up any construction adjoining other property or existing work, the Contractor shall take all steps necessary for the safety and protection of such property or work at no extra cost to the owner.

9.3 **Protection of existing services**

The Contractor shall take all precautions necessary to prevent damage to or interference with underground or over ground services such as cables, drains, piping or piles, whether shown on drawings or not. Equipment etc., mounted in position shall be protected against falling debris etc., by means of tarpaulin or such other material at no extra cost to the owner.

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<p>10.0 <u>FILL, BACK FILLING AND SITE GRADING</u></p> <p>10.1 <u>General</u></p> <p>All fill material will be subject to the Engineer's approval. If any material is rejected by the Engineer, the Contractor shall remove the same forthwith from the site at no extra cost to the Owner. Surplus fill material shall be deposited/ disposed off as directed by the Engineer after the fill work is completed.</p> <p>No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with as directed by the Engineer.</p> <p>10.2 <u>Material</u></p> <p>To the extent available, selected surplus soils from excavated materials shall be used as backfill. Fill material shall be free from clods, salts, sulphates, organic or other foreign material. All clods of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of moorum or earth to fill up the voids and the mixture used for filling.</p> <p>10.3 If any selected fill material is required to be borrowed, the Contractor shall make his own arrangements at no additional cost for bringing such material from outside borrow pits. The material and source shall be subject to prior approval of the Engineer. The approved borrow pit area shall be cleared of all bushes, roots of trees, plants, rubbish etc. top soil containing salts/ sulphate and other foreign material shall be removed. The materials so removed shall be burnt or disposed off as directed by the Engineer. The Contractor shall make necessary access roads to borrow areas and maintain the same, if such access road does not exist, at his cost.</p> <p>10.4 Filling in pits and trenches around foundations of structures, walls etc. As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches etc. shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm., each layer being watered, rammed</p>		
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and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of the Engineer. Filling around foundation shall be compacted to achieve 85% Proctor density. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Engineer is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to proper profile as directed by the Engineer or indicated on the drawings.

10.5 **Plinth filling**



Plinth filling shall be carried out with approved material as described herein before in layers not exceeding 15 cm, watered and compacted with mechanical compaction machines. The Engineer may however permit manual compaction by hand tampers in case he is satisfied that mechanical compaction is not possible. When filling reaches the finished level, the surface shall be flooded with water, unless otherwise directed, for at least 24 hours allowed to dry and then the surface again compacted as specified above to avoid settlements at a later stage.

The finished level of the filling shall be trimmed to the level/ slope specified. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Engineer. As rolling proceeds water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fill.

The thickness of each unconsolidated fill layer can in this case be up to a maximum of 300 mm. The Engineer will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of the Engineer, but in no case less than 10 passes of the roller will be accepted for each layer.

The compacted surface shall be properly shaped, trimmed and consolidated to an even and uniform gradient. All soft spots shall be excavated and filled and consolidated.

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At some locations/ areas it may not be possible to use rollers because of space restrictions etc. The Contractor shall then be permitted to use pneumatic tampers, rammers etc. and he shall ensure proper compaction.

10.6 **Sand filling in plinth and other places**



At places backfilling shall be carried out with local sand if directed by the Engineer. The sand used shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. Any temporary work required to contain sand under flooded condition shall be to the Contractor's account. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Engineer has inspected and approved the fill.

10.7 **Filling in trenches**

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipes and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes. Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centreline of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centreline of the pipe shall be done with selected earth by hand compaction or other approved means in layers not exceeding 15 cm. Filling of the trenches shall be carried simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

11.0 **GENERAL SITE GRADING**



- 11.1 Site grading shall be carried out as indicated in the drawings and as directed by the Engineer. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under Clause 10.0 and elsewhere unless otherwise indicated below.

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- 11.2 If the fill has to be compacted, it shall be placed in layers not exceeding 150mm and levelled uniformly and compacted as indicated in Clause 10.0 before the next layer is deposited.
- 11.3 To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor at his cost.
- 11.4 Field compaction test shall be carried out at different stages of filling and also after the fill to the entire height has been completed. This shall hold good for embankments as well.
- 11.5 The Contractor shall protect the earth fill from being washed away by rain damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip at his cost.
- 11.6 The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

12.0 **FILL DENSITY**

The compaction, called for shall comply with the specified (Standard Proctor/ Modified Proctor) density at moisture content differing not more than 4 percent from the optimum moisture content. The Contractor shall demonstrate adequately at his cost, by field and laboratory tests that the specified density has been obtained.



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PART B: DEWATERING

1.0 SCOPE

This specification covers the general requirements of dewatering excavations in general.

- 1.1 All excavations shall be kept free of water. Grading in the vicinity of excavation shall be properly closed to prevent surface water running into excavated areas. Contractor shall remove by pumping or other means approved by Engineer any water inclusive of rain water and subsoil water accumulated in excavation and keep all excavations dewatered until the foundation work is completed and backfilled. Sumps made for dewatering must be kept clear of the excavations / trenches required for further work. Method of pumping shall be approved by Engineer; but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction.
- 1.2 Contractor shall submit to Engineer his scheme of dewatering for approval.

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PART C: ANTI TERMITE TREATMENT

1.0 SCOPE

The scope of work includes setting up a chemical barrier against attack by subterranean termites while the building is under construction.

2.0 EXECUTION

General Unless otherwise specified all work shall in general be executed as specified in IS: 6313 Part-II and as per approved specification of the agency having special know-how for the job.



All necessary work to ensure uniform distribution and proper penetration of treating solution shall be done according to the instruction of the Engineer. Soil treatment shall not be done when it is raining or when the soil is wet with rain or subsoil water. Once formed, the treated soil barrier shall not be disturbed.

3.0 CHEMICALS AND RATE OF APPLICATION

Chemicals, conforming to IS 8963 and from approved agency, shall be applied by pressure pumps, uniformly over the area treated. (1 part chemicals + 20 parts water = 1% emulsion).

4.0 TREATMENT OF PITS, TRENCHES & BASEMENT EXCAVATION

Foundations, basements etc. may either be fully enveloped by the chemical barrier or the treatment may start 500 mm below ground level. The bottom surface and sides of excavation up to a height of about 300 mm for column pits, walls, trenches and basements shall be treated with emulsion @ 5 liters per sq.m. of surface area. Backfills around columns, walls, etc shall be treated @ 7.5 liters per sq.m. of the vertical surface. Treatment shall be done in stages following the compaction of earth in layers. The treatment shall be carried out after the ramming operation is done by rodding the earth at 150 mm centres close to the wall surface and spraying the emulsion in the specified dose.

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5.0 **TREATMENT OF TOP SURFACE OF PLINTH FILLING**



Holes 50 mm to 75 mm deep at 150 mm centres both ways shall be made with crow bars on the surface of compacted plinth fill. Emulsion at the rate of 5 litre per sq.m of surface shall be applied prior to laying soling or subgrade. Special care shall be taken to maintain continuity of the chemical barrier at the junction of vertical and horizontal surfaces.

6.0 **TREATMENT OF DOORS, WINDOWS & SOIL SURROUNDING PIPES, WASTES AND CONDUITS.**

Special care shall be taken at the points where pipes and conduits enter the building and the soil shall be treated for a distance of 150 mm and a depth of 75 mm at the point where they enter the building. All the wooden door/window frames on the ground floor of the buildings shall be treated with the insecticidal solution.

7.0 **TREATMENT OF EXPANSION JOINTS**

These shall receive special attention and shall be treated in a manner approved by the Engineer.

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PART D : CONCRETE AND ALLIED WORKS

1.0 SCOPE

This Specification covers the general requirements for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting.



- 1.1 It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current engineering practices or as directed by ENGINEER from time to time. The decision of ENGINEER as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.



2.0 APPLICABLE CODES AND SPECIFICATIONS



- 2.1 The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/ edition/ revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.



2.2 Materials



- 1) IS:269 - Specification for 33 grade ordinary portland cement.
- 2) IS:455 - Specification for portland slag cement.
- 3) IS:1489 - Specification for portland-pozzolana cement (Parts 1 & 2)
- 4) IS:8112 - Specification for 43 grade ordinary portland cement.



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<p>5) IS:12330 - Specification for sulphate resisting Portland Cement.</p> <p>6) IS:383 - Specification for coarse and fine aggregates from natural sources for concrete.</p> <p>7) IS:432 (Parts 1 & 2) - Specification for mild steel and medium tensile steel bars and hard-drawn steel wires for concrete reinforcement.</p> <p>8) IS:1786 - Specification for high strength deformed steel bars and wires for concrete reinforcement.</p> <p>9) IS:1566 (Parts II) - Specification for hard-drawn steel wire fabric for concrete reinforcement.</p> <p>10) IS:9103 - Specification for admixtures for concrete.</p> <p>11) IS:2645 - Specification for integral cement waterproofing compounds.</p> <p>12) IS:4900 - Specification for plywood for concrete shuttering work.</p> <p>13) IS:12269 - Specification for 53 grade ordinary portland cement.</p> <p>14) IS 8041 - Specification for rapid hardening Portland Cement.</p> <p>15) IS 8042 - Specification for White Portland Cement.</p> <p>16) IS 8043 - Specification for Hydrophobic Portland Cement.</p> <p>17) IS 6452 - Specification for high alumina cement for structural use.</p> <p>2.3 <u>Material Testing</u></p> <p>1) IS:4031 (Parts 1 to 15) - Methods of physical tests for hydraulic cement.</p> <p>2) IS:4032 - Method of chemical analysis of hydraulic cement.</p>		
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<p>3) IS:650 - Specification for standard sand for testing of cement.</p> <p>4) IS:2430 - Methods for sampling of aggregates for concrete.</p> <p>5) IS:2386 - Methods of test for aggregates (Parts 1 to 8) for concrete.</p> <p>6) IS:3025 - Methods of sampling and test (physical and chemical) water used in industry.</p> <p>7) IS:6925 - Methods of test for determination of water soluble chlorides in concrete admixtures.</p> <p>8) IS 3535 - Methods of sampling Hydraulic Cement.</p> <p>2.4 <u>Material Storage</u></p> <p>1) IS:4082 - Recommendations on stacking and storing of construction materials at site.</p> <p>2.5 <u>Concrete Mix Design</u></p> <p>1) IS:10262 - Recommended guidelines for concrete mix design.</p> <p>2) SP:23 - Handbook on Concrete Mixes. (S&T)</p> <p>2.6 <u>Concrete Testing</u></p> <p>1) IS:1199 - Method of sampling and analysis of concrete.</p> <p>2) IS:516- Method of test for strength of concrete.</p> <p>3) IS:9013 - Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.</p>		
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<p>4) IS:8142 - Method of test for determining setting time of concrete by penetration resistance.</p> <p>5) IS:9284 - Method of test for abrasion resistance of concrete.</p> <p>6) IS:2770 - Methods of testing bond in reinforced concrete.</p> <p>2.7 <u>Equipment</u></p> <p>1) IS:1791 - Specification for batch type concrete mixers.</p> <p>2) IS:2438 - Specification for roller pan mixer.</p> <p>3) IS:4925 - Specification for concrete batching and mixing plant.</p> <p>4) IS:5892 - Specification for concrete transit mixer and agitator.</p> <p>5) IS:7242 - Specification for concrete spreaders.</p> <p>6) IS:2505 - General Requirements for concrete vibrators : Immersion type.</p> <p>7) IS:2506 - General Requirements for screed board concrete vibrators.</p> <p>8) IS:2514 - Specification for concrete vibrating tables.</p> <p>9) IS:3366 - Specification for pan vibrators.</p> <p>10) IS:4656 - Specification for form vibrators for concrete.</p> <p>11) IS:11993 - Code of practice for use of screed board concrete vibrators.</p> <p>12) IS:7251 - Specification for concrete finishers.</p>		
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<div> <div>13)</div> <div>IS:2722</div> <div>-</div> <div>Specification for portable swing weigh batchers for concrete (single and double bucket type).</div> </div> <div> <div>14)</div> <div>IS:2750</div> <div>-</div> <div>Specifications for steel scaffoldings.</div> </div> <div> <div>2.8</div> <div><u>Codes of Practice</u></div> <div> <div>1)</div> <div>IS:456</div> <div>-</div> <div>Code of practice for plain and reinforced concrete.</div> </div> <div> <div>2)</div> <div>IS:457</div> <div>-</div> <div>Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.</div> </div> <div> <div>3)</div> <div>IS:3370 (Parts 1 to 4)</div> <div>-</div> <div>Code of practice for concrete structures for storage of liquids.</div> </div> <div> <div>4)</div> <div>IS:3935</div> <div>-</div> <div>Code of practice for composite construction.</div> </div> <div> <div>5)</div> <div>IS:2204</div> <div>-</div> <div>Code of practice for construction of reinforced concrete shell roof.</div> </div> <div> <div>6)</div> <div>IS:2210</div> <div>-</div> <div>Criteria for the design of reinforced concrete shell structures and folded plates.</div> </div> <div> <div>7)</div> <div>IS:2502</div> <div>-</div> <div>Code of practice for bending and fixing of bars for concrete reinforcement.</div> </div> <div> <div>8)</div> <div>IS:5525</div> <div>-</div> <div>Recommendation for detailing of reinforcement in reinforced concrete works.</div> </div> <div> <div>9)</div> <div>IS:2751</div> <div>-</div> <div>Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.</div> </div> <div> <div>10)</div> <div>IS:9417</div> <div>-</div> <div>Specification for welding cold worked bars for reinforced concrete construction.</div> </div> </div>		
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<p>11) IS:3558 - Code of practice for use of immersion vibrators for consolidating concrete.</p> <p>12) IS:3414 - Code of practice for design and installation of joints in buildings.</p> <p>13) IS:4326 - Code of practice for earthquake resistant design and construction of buildings.</p> <p>14) IS:4014 - Code of practice for steel tubular scaffolding. (Parts1 & 2)</p> <p>15) IS:2571 - Code of practice for laying in-situ cement concrete flooring.</p> <p>16) IS:7861 - Code of practice for extreme weather concreting.</p> <p>Part -1 - Recommended practice for hot weather concreting</p> <p>Part-2 - Recommended practice for cold weather concreting</p> <p>2.9 <u>Construction Safety</u></p> <p>1) IS:3696 - Safety code for scaffolds and ladders. (Parts 1 & 2)</p> <p>2) IS:7969 - Safety code for handling and storage of building materials.</p> <p>3) IS:8989 - Safety code for erection of concrete framed structures.</p> <p>3.0 <u>GENERAL</u></p> <p>3.1 ENGINEER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment, and the quality control system. Such an inspection shall be arranged and ENGINEER's approval obtained, prior to starting of concrete work.</p>		
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This shall, however, not relieve CONTRACTOR of any of his responsibilities. All materials which do not conform to this specification shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the ENGINEER and after establishing their performance suitability based on previous data, experience or tests.

4.0 **MATERIALS FOR CONCRETE**



4.1 **Aggregates**

Aggregates shall comply with the requirements of IS: 383 "Coarse and Fine Aggregates for Concrete". They shall be hard, strong, dense, durable, clean and free from veins and adherent coating, vegetable matter and other deleterious substances; and shall be obtained from approved sources. Aggregates shall not contain any harmful material such as pyrites, coal, lignite, shale or similar laminated material, clay, alkali, soft fragments, seashells and organic impurities in such quantity as to affect the strength or durability of concrete. Aggregates, which are chemically reactive with alkalies of cement, shall not be used.

4.1.1 Aggregates, which are not sufficiently clean, shall be washed in clean fresh water to the satisfaction of the Engineer.

4.1.2 **Testing**

All aggregates shall be subject to inspection and testing. The Contractor shall submit- samples for testing as may be required by the Engineer. Sampling and testing shall be carried out in accordance with IS: 2386 "Methods of Test for Aggregates for concrete".

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4.1.3 **Grading**

The Contractor shall ensure that the full range of aggregate used for making concrete is graded in such a way as to ensure a dense workable mix. The delivery of aggregates will commence only when the Engineer has approved the samples and the quality and grade shall be maintained consistent and equal to the approved sample. Before construction commences, the Contractor shall carry out a series of tests on the aggregates and on the concrete made there from to determine the most suitable grading of the available aggregates. Once the most suitable grading has been found, the grading shall be adopted for the construction of the works and periodic tests shall be carried out to ensure that it is maintained.

4.1.3.1 **Size and grading of fine aggregates**



The grading shall conform to IS: 383 and shall be within the limits of Grading Zone-III. The maximum size of particle shall be 4.75mm and shall be graded down. Sand containing more than 10% of fine grains passing through 150 micron sieve or having the fineness modulus less than 2 shall not be used for concrete work.

4.2. **Size and grading of coarse aggregates**

The nominal maximum size of the aggregates for each mark of concrete or for each type of work shall be according to relevant clauses of IS: 456. The aggregates shall be well graded and the grading shall conform to relevant requirements of IS: 383 depending upon the maximum nominal size as specified or as required. The maximum size of coarse aggregate shall be as stated on the drawings, but in no case greater than 1/4 of the minimum thickness of the member. Plums 160 mm and above of a reasonable size may be used where directed. Plums shall not constitute more than 20% by volume of the concrete.

4.3 **Fine aggregate for mortar and grout**

The grading of fine aggregate for mortar and grout shall be within the limits of grading zone III and as defined in IS: 383.

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4.3.1 **Storage & stacking**

Care shall be taken in the storage to avoid intrusion of any foreign materials into the aggregates and where two types of aggregates are stored close to each other, they shall be separated by a wall or plate. In case of stockpiling, care shall be taken to avoid forming pyramids resulting in segregation of different sized materials. The height of the stacks shall be generally limited to 150 cm.

4.4 **Coarse Aggregates**

Types

The type of coarse aggregate viz., stone chips, gravel or broken brick shall be as specified. Unless otherwise specified, stone chips shall be used as coarse aggregate.



4.4.1 **Stone chips**

It shall be crushed or broken from hard stone obtained from approved quarries of igneous or metamorphic origin. The stone chips shall be hard, strong, dense, durable and angular in shape. It shall be free from soft, friable, thin, flat, elongated or laminated and flaky pieces and free from dirt, clay lumps, and other deleterious materials like coal, lignite, silt, soft fragments, and other foreign materials which may affect adversely the strength & durability Of concrete. The total amount of deleterious /foreign materials shall not exceed 5% by weight according to relevant clause of IS: 383-1970. If found necessary the stone chips shall be screened and washed before use.

4.5 **Fine Aggregates**

Unless specified otherwise it shall either be natural river sand or pit sand.

Sand shall be clean, sharp, strong, angular and composed of hard siliceous material. It shall not contain harmful organic impurities in such form or quantities as to affect adversely the strength and durability of concrete. Sand for reinforced concrete shall not contain any acidic or other impurities, which is likely to attack steel reinforcement. The percentage of all deleterious materials including silt, clay etc., shall not exceed 5% by weight. If directed sand shall be screened or washed

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before use to the satisfaction of Engineer. The fineness modulus of sand shall neither be less than 2.0 nor more than 3.2.

4.6 **Cement**

Ordinary Portland cement Portland slag cement complying with the requirements of IS: 8112 and IS: 455 respectively shall be used for making plain and reinforced concrete, cement grout and mortar.

4.6.1 Other types of cement may be used depending upon the requirements of certain jobs with the approval of the Engineer. These shall conform to the following standards:-

Portland Pozzolana Cement	.....	IS: 1489
Rapid Hardening Portland Cement	.....	IS: 8041
53 Grade Ordinary Portland Cement	.....	IS: 12269
Hydrophobic Portland Cement	.....	IS: 8043
High alumina cement for structural work	.....	IS: 6452
White portland cement	.....	IS: 8042
Sulphate Resisting Portland Cement	.....	IS: 12330



Only one type of cement shall be used in any one mix. The source of supply, type or brand of cement within the same structure or portion thereof shall not be changed without approval from ENGINEER.

4.7 **Testing of samples**

The sampling of cement for testing shall be according to IS: 3535. All tests shall be in accordance with the relevant clauses of IS: 4031 (Part-I to Part-15) & IS: 4032.

4.8 **Contractor's responsibility**

From the time a consignment of cement is delivered at site and tested and approved by the Engineer until such time as the cement is used on the works, the Contractor shall be responsible for keeping the same in sound and acceptable condition and at his expense and risk. Any cement which deteriorates while in the Contractor's charge and is

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rejected as unsuitable by the Engineer, shall be removed from the site to outside the limits of work at the cost of contractor within two days of ordering such removal by the Engineer.

4.9 **Stock of cement**

In order to ensure due progress, the Contractor shall at all times maintain on the site at least such stock of cement as the Engineer may from time to time consider necessary. No cement shall be used upon the works until it has been accepted as satisfactory by the Engineer.



4.10 **Storage of cement**

The cement shall be stored in such manner as to permit easy access for proper inspection and in a suitable weather-tight, well-ventilated building to protect it from dampness caused by ingress of moisture from any source. Different types of cement shall be stored separately. Cement bags shall be stacked at least 15 to 20 cm clear of the floor leaving a space of 60 cm around the exterior walls. The cement shall not be stacked more than 10 bags high. Each consignment of cement shall be stacked separately to permit easy access for inspection. Cement stored for more than 90 days shall be tested prior to use on work.

4.11 **Water**

Water used for both mixing and curing shall conform to IS:456. Potable waters are generally satisfactory.

Water used for mixing concrete and mortar and for curing shall be clean and free from injurious amounts of oil, acid, alkali, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel. The pH value of water shall generally be not less than '6'. Water has to meet the requirements as per IS: 456. Water shall be obtained from an approved source. Where it is obtained from a source other than a supply main, it shall be tested to establish its suitability. Water for construction purpose shall be stored in proper storage tanks to prevent any organic impurities getting mixed up with it. CONTRACTOR shall make his own arrangements for storing water at site in tanks to prevent contamination

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4.12 **Admixture for Concrete**



4.12.1 **Approval**

Admixtures to concrete shall not be used without the written consent of the Engineer. When permitted, the Contractor shall furnish full details from the manufacturer and shall carry out such test as the Engineer may require before any admixture is used in the work. Accelerating, retarding, water-reducing and air entraining admixtures shall conform to IS:9103 and integral water proofing admixture to IS:2645. Admixtures may be used in concrete as per manufacturer's instructions only with the approval of ENGINEER based upon evidence that with the passage of time neither the compressive strength nor its durability is reduced. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedments. Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

4.12.2 **Usage**

Admixtures may be used to modify one or more of the following properties of fresh concrete

- To increase workability without increasing water content or to decrease the water content at the same workability.
- To retard or accelerate both initial and final setting times.
- To reduce or prevent settlement.
- To create slight expansion in concrete and mortar.
- To modify the rate or capacity for bleeding or both.
- To reduce segregation of concrete, mortars and grouts.
- To improve penetration and/or pump ability of concrete, mortars and grouts.
- To reduce rate of slump loss.

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4.12..3 Admixtures may also be used to modify one or more of the following properties of HARDENED CONCRETE.

- a) To retard or reduce heat generation during early hardening.
- b) To accelerate the rate of strength development.
- c) To increase the strength of concrete or mortar (compressive, tensile or flexural).
- d) To increase the durability or resistance to severe conditions of exposure including the application de-icing salts.
- e) To decrease the capillary flow of water.
- f) To decrease the permeability to liquids.
- g) To control the expansion caused by the reaction of alkalis with certain aggregate constituents.
- h) To produce cellular concrete.
- i) To increase the bond of concrete to steel reinforcement.
- j) To increase the bond between old and new concrete.
- k) To improve impact resistance and abrasion resistance.
- l) To inhibit the corrosion of embedded metal.
- m) To produce coloured concrete or mortar.

While modifying any particular property, care shall be taken to ensure that other properties are not affected adversely.



4.13 Types

4.13.1 Integral water proofer

Admixtures used as integral waterproofer shall be free of chlorides and sulphates and shall conform to IS: 2645. The application and doses shall be as per manufacturer's specification.

4.13.2 Finely Divided mineral. admixtures

- 1) CEMENTITIOUS - Natural cements like hydraulic lime, slag cements (mixtures of blast furnace slag and lime) and granulated blast furnace slag.
- 2) POZZOLANIC - A siliceous or siliceous and aluminium material which in itself possesses little or no cementations value, but will in finely divided form and in presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds

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possessing cementations properties, e.g Fly ash, volcanic glass, diatomaceous earth and certain shale and clays either head treated or natural.

3) OTHER - Finely divided quartz, silica sands, dolomite and calcite limestone, marble, granite and other rocks, asbestos waste and hydrated lime.



These being extremely fine powders, their mineral admixtures will influence the fresh paste in a manner similar to cement. They can be used to augment the cement in mixtures deficient in fines. Many concretes contain large amount of Portland cement than necessary for strength requirements to provide workability or pumpability. A portion or all of this excess cement may be replaced with a suitable mineral admixture. They are usually used in the proportion of 15-35% by weight of the cement and in proportioning, the concrete should be considered as part of the cementing medium, provided they are uniformly blended with cement.



The placeability of concrete containing blast furnace slag is generally greater than indicated by static slump test or water/cement ratio. In medium or rich concretes, the increase in water requirements caused by their use may reduce strength. Pozzolanic admixture s usually increases the strength of concrete especially at later ages. The addition of fly-ash, natural pozzolana and granulated slag in sufficient quantities will increase the sulphate resistance of concrete.

4.13.3 **Accelerating admixtures**

Calcium Chlorides will also affect the following properties

- may increase drying, shrinkage and creep. The longer the concrete is allowed to cure, the less will be the effect on shrinkage and creep.
- may lower the resistance of concrete to freezing and thawing and to attack by sulphates and other injurious solutions.
- may increase the rate of temperature residue to the heat of hydration and in large sections may therefore increase the stresses caused by thermal contraction.

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<p>d) can cause corrosion of adequately embedded reinforcing steel in the concrete. Where large concentrations of stray currents are present, such as in concrete used in structures for electric railroads, power houses or electrolytic reduction plants.</p> <p>e) galvanized metal embedded in concrete containing calcium chloride may be expected to corrode at an accelerated rate.</p> <p>f) combinations of metals such as aluminium alloy, conduit and steel reinforcing should not be used in concrete containing calcium chloride as electrolytic corrosion may take place.</p> <p>For allowable limits of Calcium Chloride refer ACI Committee 201.</p> <p>1) Calcium Chloride will not increase the flexure strength of concrete to the same degree as the compressive strength and decreases in the flexure strength are generally obtained at or after 28 days. The total chloride content in the concrete should be limited as specified in IS: 456.</p> <p>2) Calcium aluminates cement blended with Portland cement:</p> <p>Strength will be reduced significantly, shrinkage and swelling on immersion will increase drastically and durability will be poor.</p> <p>4.13.4 <u>Air-entraining admixture</u></p> <p>a) The water reduction is possible due to entrained air. The volume of this water reduction is less than the volume of entrained air, therefore to compensate for the volume of entrained air, the fine aggregate volume must also be reduced.</p> <p>b) Despite reduction in the water/cement ratio usually obtained by the use of air entrainers, it may reduce strength, particularly, in concretes of high or moderate cement content.</p>		
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4.13.5 **Water reducing and set controlling admixtures**

Admixtures of the hydroxylated carboxylic acid type may tend to increase the bleeding rate and segregation in concrete deficient in fines (aggregate fines of cement). When prolonged retardation is employed care must be taken to prevent the drying of the concrete.

The water reducing admixture should be added at the same time in the mixing cycle, in order to obtain a uniform setting time among the batches.

Then admixtures in many cases will increase the slump loss.

Increases in the flexural strength of concrete containing water reducing admixtures are usually attained but they are not proportionately as great as the increase in the compressive strength.

4.14 **General**



Suitable remedial measures as recommended by the manufacturers and approved by the Engineer shall be taken to eliminate any disadvantages arising from the mix of admixtures.

While using the admixtures the maximum amount chloride expressed either in percentage of cement concrete shall not exceed the limit as specified I.S. 6925.

4.15 **Interval of Routine Test**

All materials used for the works shall be tested before use. Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by ENGINEER samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER at no extra cost to OWNER. CONTRACTOR shall furnish manufacturer's test certificates and technical literature for the admixture proposed to used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

The routine tests of materials, delivered at site shall be at the following intervals :

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Aggregates - Fortnightly or for every 200 M3 for each aggregate whichever is earlier and in other respects generally as per IS : 2386 (Part I to 8)

Cement - Fortnightly or for each consignment within 4 days of delivery and other respects generally as per IS 4031.

Water - Once in two months for each source supply and in other respects generally as per IS : 456.

Reinforcement- For each consignment within 4 days delivery in accordance with IS: 1786, IS: 1599 and IS :1608.

5.0 **STEEL**



5.1 **For Reinforcement**

Reinforcing bars for concrete shall be round steel bars of the following types as may be shown on drawing:

- i) Plain mild steel bars conforming to Grade-I of IS - 432 "Mild Steel & Medium Tensile Steel- for Concrete Reinforcement".
- ii) "High strength deformed steel bars conforming IS : 1786 for Concrete Reinforcement".
- iii) Reinforcement fabrics confirming to IS:1566.
"Hard Drawn Steel wire fabric reinforcement"
- iv) Thermo mechanically treated (TMT) high strength deformed bars.

All reinforcement bars shall be of uniform cross sectional area and be free from loose mill scales, dust, loose rust, coats of paint, oil or other coatings which may destroy or reduce bond. Unit weight of reinforcement bars conforming to I.S. 1786 is as given below.

Nominal Size (Dia) (mm)	Mass Per Metre Run (Kg)
6	0.222
8	0.395
10	0.617
12	0.888

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Nominal Size (Dia) (mm)	Mass Per Metre Run (Kg)
16	1.580
18	2.000
20	2.470
22	2.980
25	3.850
28	4.830
32	6.310

6.0 **STORING OF MATERIALS**

- 6.1 All material shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS:4082 shall be complied with..



WORKMANSHIP

7.0 **CONCRETE**

This chapter covers the workmanship, special requirements & regulations with which the contractor must comply to achieve the following two objectives:

- The provision, at all locations on the site of dense workable concrete, having the specified characteristic strength.
- The placing of concrete at all elevations, well compacted by vibrations, in well aligned and well fixed formwork ensuring the internal and external dimensions of structures as per drawings and maintaining the size, shape, number and locations of reinforcements, inserts etc., as specified in the drawings, providing the surface finish after stripping off the formwork to ensure structural configurations as per drawings as well as within the specified tolerance limits, curing and guaranteeing the characteristic strength, all as specified.

The mixing, placing, compacting, curing and finishing of concrete shall be done according to IS: 456 "Code of Practice for Plain and Reinforced Concrete".

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7.1 Grades of Concrete

The grades of concrete unless otherwise specified shall be in accordance with the following table. The grade of concrete to be used in each section of work will be shown in the drawings .

Grade of Concrete	Characteristic Strength, ie. compressive strength of 15 Cm.cubes at 28 days (N/mm ²)
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M-5	5
M-7.5	7.5
M-10	10
M-15	15
M-20	20
M-25	25
M-30	30
M-35	35
M-40	40



Unless otherwise specified in the drawings the maximum nominal size of coarse aggregates for different grades of concrete shall be as under:

- (a) For concreting in very narrow space or in very small thickness .12 mm.
- (b) For all PCC, Reinforced concrete20 mm.

7.2 Mix Design

7.1.1 General

At the commencement of the contract the Contractor shall make preliminary tests to determine the proportions by weight of cement, fine aggregates, coarse aggregates and water necessary to produce required grades of concrete. The mix proportions shall be selected to ensure that workability of the fresh concrete is suitable for the conditions of handling and placing and when concrete hardens, it shall have the required strength, durability and surface finish. The Contractor shall get approval of Engineer to proportions before he starts concreting. However such approval shall not relieve the Contractor of his responsibility to produce concrete having compressive strengths as laid down in the foregoing Table.



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No departure from the approved proportions will be permitted during the works unless and until the Engineer gives written permission for any change in proportion. The Engineer shall have authority at any time to check whether the mixing of concrete is carried out according to the approved proportions. For the all major and important R.C. works and for all special works, the design of mixes shall be made by the Contractor at his own cost, for each grade of concrete as well as for various workability. The design of mixes shall be made according to I.S. 10262 or any other approved standard methods. The concrete made by designing the mix is termed hereinafter as "Design Mix Concrete". The cement content for various grades of concrete shall be based on design mix. However, irrespective of requirement of cement found out from design mix, cement content of concrete shall not be reduced below the quantities specified as under except for the cases specifically approved by the Engineer.

Grade of concrete	Minimum cement content /cu.m of Finished concrete
M-15	290 kg
M-20	320 kg.
M-25	380 kg.
M-30	410 kg.
M-35	430 kg.
M-40	450 kg.

The minimum cement content stipulated above shall be adopted irrespective of whether the CONTRACTOR achieves the desired strength with less quantity of cement. The CONTRACTOR's quoted rates for concrete shall provide for the above eventuality and nothing extra shall become payable to the CONTRACTOR in this account. Even in the case where the quantity of cement required is higher than that specified above to achieve desired strength based on an approved mix design, nothing extra shall become payable to the CONTRACTOR.

The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456.

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Grade of Concrete	Minimum Compressive Strength N/Sq.mm at 7 days	Specified Characteristic compressive strength N/sq.mm at 28 days
-----	-----	-----
M15	10.0	15.0
M20	13.5	20.0
M25	17.0	25.0
M30	20.0	30.0
M35	23.5	35.0
M40	27.0	40.0



7.2.2 Water Cement Ratio

Where a particular water cement ratio is stipulated in the design or drawing along with the characteristic grade of concrete the design of mix shall be carried out by adjusting the other variable factors to obtain the characteristic strength of concrete with stipulated water cement ratio. In the structures where the impermeability and shrinkage of concrete have an important bearing on the durability and serviceability of the structures, such as water retaining structures, basements,, underground premises, tunnels, pumphouses, exposed structures near sea side or deserts, prestressed structure, thin precast members etc., the water cement ratio shall be kept low and preferably not exceeding 0.45. The water cement ratio, as achieved in the Mix Design or as specified in the drawings shall be adhered to strictly and shall not be varied without the permission of the Engineer.

7.2.3 Workability

The workability of fresh concrete shall be such that the concrete is just suitable for the conditions of handling & placing so that after compaction it becomes completely consistent and homogeneously surrounds all the reinforcement and completely fills the formwork.

The workability of fresh concrete at the place of batching/mixing shall be measured by compaction factor test and at the place of disposition by means of slump test. During the finalisation of Trial Mixes, the relationship between compaction factor and slump test shall be

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established for each grade of concrete as well as for various levels of workability. The workability tests shall be carried out in accordance with IS:1199.

Normally, in the condition of low water cement ratio as well as for medium/high workability, the workability shall be achieved by increasing the cement content, in consistent with added water.



In cases where the cement content is to be limited to reduce the heat of hydration, and the water cement ratio is also to be kept low to reduce the permeability or due to other requirements the desired workability may be achieved with use of limited doses of plasticiser or air entraining agent. In such cases the method of mixing and dosage of the plasticiser/ air entraining agent shall be according to the manufacturer's specification and with the approval of the Engineer.

The usual limits of consistency for various types of structures are given below :

7.2.4 **Limits of consistency**

Unless otherwise specified the limits of consistency shall be as follows

Degree of workability	Slump in mm with standard cone as suitable per IS : 1199		Use for which concrete is suitable
	Minimum	Maximum	
Very low	0.0	25.0	Large mass concrete structure with heavy compaction equipment, roads and the like.
Low	25.0	50.0	Uncongested wide and shallow R.C.C structures
Medium	25.0	75.0	Deep but wide R.C.C structures with congestion of reinforcement and inserts
High	75.0	125.0	Very narrow and deep R.C.C structures, with congestion due to

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			reinforcement and inserts
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Note :

Notwithstanding anything mentioned above, the slump to be obtained for work in progress shall be as per direction of the Engineer.

With the permission of the Engineer, for any grade of concrete, if the water has to be increased in special cases, cement shall also be increased proportionately to keep the ratio of water to cement same as adopted in trial mix design for each grade of concrete. No extra payment will be made for this additional cement.

7.2.5 Durability

The durability of concrete, depending on the exposure condition, is to be taken into account while designing the mix. For given aggregates the cement content should be sufficient to make sufficiently low water cement ratio .



7.3 Trial mixes

After approval of the Mix Design by the Engineer, the Contractor shall make in presence of Engineer the Trial Mixes for each grade of concrete as well as for required workability.

Before starting the trial mixes, necessary preparatory works like sieve analysis of the aggregates, determination of densities of different ingredients and moisture contents, in the aggregates, shall be completed according to the I.S.Codes 383 and 2386. Each trial mix shall be handled and compacted by method which the Contractor proposes to use for that mix in the works and the mixes shall not show tendency of inadequate compaction by the method proposed.

The compacting factor and the slump of each trial mix shall be determined immediately after mixing and the values shall not exceed the maximum value obtained by the mix design.

Six numbers of 150 mm test cubes shall be made from each trial mix. These shall be cured and tested in accordance with relevant I.S. codes. In order to have the specified characteristic strength in the field, the concrete mix as designed in the Design Mix shall have higher average compressive strength depending on the degree of quality

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control at site. If the size and special requirement of the work so warrants, the trial may be extended to cover larger ranges of mix proportions as well as other variables such as alternative source of aggregates, maximum size and grading of aggregates and different type and brands of cement.

- 7.4 Before commencement of the concreting works of particular grade of concrete, the Contractor must complete the work of trial mixes and subsequent testing of test cubes obtained therefrom the design of the approved Mix for that particular grade of concrete. The entire cost of all the trial mixes including all the preparatory works for trial mixes, preparation of test cubes and their testing shall be borne by the Contractor.

7.5 **Nominal Mix Concrete**

Nominal mix concrete may be used for all concrete of Grade M-10 and below. If design mix concrete cannot be used for any reason for Grade M-15 & M-20, nominal mix concrete may be used with the permission of Engineer. Nominal mix concrete shall not be used, in any case for Grade of concrete above M-20. Mix Design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS:456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per IS:456. However, it will be CONTRACTOR's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.



7.6 **Batching of Concrete**

7.6.1 **Cement**

Cement shall always be batched by weight. A separate weighing device shall be provided for weighing cement. Where the weight of cement is determined by accepting the weight per bag, number of bags shall be weighed separately to determine the average net weight of cement per bag and the same shall be checked regularly

7.6.2 **Aggregates**

For both Design Mix concrete and Nominal Mix concrete the aggregates (coarse and fine) shall be batched by weight.

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In particular cases, or where weigh-batching is not possible proportioning by volume batching may be allowed by the Engineer, provided the Contractor guarantees the uniformity of aggregates throughout the period of construction. For this purpose, the Contractor shall submit to the Engineer sufficient data indicating the weight/volume relationship of aggregates for different types of concrete and after such approval, periodic checks on the weight/volume relationship of the aggregates shall be made by the Contractor to the satisfaction of the Engineer.

Where aggregates are moist and volume batching is adopted, allowance shall be made for bulking in accordance with I.S. 2386 (Part-III).

Suitable adjustments shall be made for the variation in the weight of aggregates due to variation in moisture contents.



7.6.3 **Water**

Water may be measured either by weight or by volume. When measured by volume, it shall be by well calibrated conical shaped jar or vessel or from a calibrated tank fitted to the mixer.

7.6.4 Adjustment of water due to moisture contents in coarse & and fine aggregates

It is very important to maintain the water cement ratio constant at its correct value. For the correct determination of amount of water to be added in the concrete mix, to maintain the water cement ratio constant, the amount of moisture content in both coarse and fine aggregates shall be taken into consideration, be as frequently as possible, the frequency for a given job being determined by the Engineer according to weather conditions.

7.6.5 Determination of moisture content in the aggregates Determination of moisture content in the aggregates shall be according to I.S. 2386 (Part-III). Where tests are not conducted, the amount of surface water may be estimated from the following table:

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7.6.6 Surface water carried by Aggregates

Aggregates	% by weight	Lit/m3
Very wet sand	7.5	120
Moderately wet sand	5.0	80
Moist sand	2.5	40
Moist gravel & stone chips+	1.25 - 2.5	20-40

+Coarser the aggregate, less the water it will carry.

7.6.7 Admixtures

Any solid admixture, to be added, shall be measured by weight, but liquid or semi liquid admixture may be measured by weight or volume.

7.6.8 Accuracy of batching

The accuracy of batching shall be within the following tolerance:



Cement within plus or minus	2.00% by weight.
Aggregate within plus or minus	5.00% by weight.
Water within plus or minus	0.50% by weight.

7.7 Mixing & Transportation of concrete

7.7.1 Mixing of Concrete

7.7.1.1 Machine mixing

Concrete shall always be mixed in mechanical mixer. Water shall not, normally, be charged into the drum of the mixer until all other ingredients are already in the drum and mixed for at least one minute. Mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. The mixing time from the time of adding water shall be in accordance with IS: 1791 but in no case less than 2 minutes or at least 40 revolutions.

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7.7.1.2 **Hand mixing**

When hand mixing is permitted by the Engineer it 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. In case of hand mixing 10% extra cement shall be added to each batch at no extra cost to the Owner.

7.8 **Transportation of concrete**

Concrete shall be transported from the place of mixing to the place of placing concrete as rapidly as practicable by such means which will prevent the segregation or loss of any of the ingredients and maintain the required workability. No water shall be mixed with the concrete after it has left the mixer. Where concrete is transported over long distances, the Contractor shall provide suitable means by which different grades of concrete are readily identifiable at the place of final deposit.



7.9 **Actions before placement of concrete**

7.9.1 **Programme of works**

At the beginning of every fortnight, the contractor shall give his detailed concreting programme for that fortnight to the Engineer. Such programmes, shall specify all information such as the locations where concrete is to be poured., type/grade of concrete, volume of concrete to be poured, number and type of Vibrators proposed to be used as well as proposed to keep as standby, number of skilled technicians and supervisors proposed to be engaged, the proposed time and period of pouring etc.

7.9.2 **Checking & approval**

Before placement of concrete, the contractor shall get all the form works, reinforcements, inserts, conduits, openings, surface preparation etc., checked and approved by the Engineer. To facilitate such checking, the contractor shall complete all his works according to the drawings and specifications well in advance before placement of concrete at least 36 hours for all major/important/complicated works and 24 hours for all minor/ordinary/simple works. The checks are purely in the interest of the work and to draw the contractor's

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attention to his contractual obligations to execute the works according to the drawings/specification and do not relieve the contractor from his responsibility in getting the end results for the quality & strength of concrete and for maintaining the shape, level & dimensions of the finished concrete, as well as the inserts, openings, other features within the tolerance limits.

7.10 **Preparatory Works/Surface Preparation**

7.10.1 **For concrete directly on earth foundation**



Earth foundation on which direct placement of concrete is specified, shall be rammed and consolidated as directed by the Engineer such that it does not crumble and get mixed with concrete during or after placement. If the foundation is quite wet, the same shall be kept dry and then sufficiently consolidated, if necessary, a thin top layer of the wet soil shall be removed and replaced by sand or other suitable materials as directed by the Engineer without any extra cost to the Owner. Care shall also be taken that earth from the sides also does not get mixed with the concrete, during or after placement, before it has sufficiently set and hardened.

The earth foundation, over which concrete is to be placed direct, shall not be kept abandoned at the specified level and concrete shall be placed immediately following the final preparation of the formation otherwise suitable measures shall be taken, as directed by the Engineer without any extra cost to the Owner.

7.10.2 **For construction joints**

All such joints shall have continuous square bond grooves to produce a substantial and watertight key. Where the placement of concrete has to be resumed on a surface which has hardened, it shall be roughened, cleaned by wire or bristle brushing, compressed air, water jet etc., and thoroughly wetted.

For vertical construction joints neat cement slurry shall be applied on the surface immediate before the placement of concrete. For horizontal joints the surface shall be covered with a layer of freshly mixed mortar about 10 to 15 mm thick composed of cement and sand in the same proportion as the cement and sand in the concrete mix and applied immediately before placing of the concrete. On this

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surface (i.e. on the surface of joints) a layer of concrete not exceeding 150 mm in thickness shall first be placed and shall be well rammed against old work, particular attention being paid to corners and close spots. To ensure water tightness, care shall be taken to punn concrete properly against the old surface.

a) On vertical surfaces of masonry

When the concrete is placed on the vertical surface of masonry (as in the case of thin concrete fins projected from the vertical masonry surface), a groove of dimension as directed by the Engineer shall be cut in the masonry to ensure a proper bond and the surface shall be cleaned thoroughly. Before the placement of concrete, the surface shall be kept moist by spraying water at least for the period of 2 hours and a thick coat of cement slurry shall be applied immediately before the placement of concrete.

b) Over walls



Building paper over average 12mm thick cement sand bearing plaster of 1:3 mix with neat cement finish shall be provided at the bearings of slabs over walls as directed by the Engineer.

7.10.3 Inside the formwork (cleaning, surface preparation etc.)

The interior of the form works, where the concrete is to be placed, shall be thoroughly washed by high pressure water jet or air jet to completely clean the entire volume from all sort of dirt, grease/oil, foreign and deleterious materials etc. The reinforcement shall be completely clean and free from all sorts of dirt, grease/oil, rust, foreign/deleterious materials etc., Before placement of concrete, the form works coming in contact with concrete, shall be coated with form oil or raw linseed oil material or provided with any approved material to prevent adhesion of concrete to the form work, but utmost care shall be taken so that such oily material do not come in contact with the reinforcement.

7.11 Placing and Compaction of Concrete

7.11.1 The concrete shall be placed and compacted before setting commences & should not be subsequently disturbed. No water shall



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be mixed with the concrete after it has left the mixer. Method of placing should be such as to preclude segregation. Approved mechanical vibrator shall be used for compacting concrete, and concrete shall not be over vibrated or under vibrated. No concrete shall be placed until the place of deposit has been thoroughly inspected and approved by the Engineer. All inserts and embedments properly secured in position and checked and forms properly oiled. No concrete shall be placed in the absence of the Engineer. Concrete shall be placed on clean bed having the designed level. The bed shall be cleaned of all debris and other objectionable materials. Seepage water, if any, shall be controlled or diverted.

7.11.2 Concreting shall not be carried on during rains unless all precautions have been taken by the Contractor and necessary permission has been given by the Engineer. Suitable measures shall be taken to control the temperature of concrete.

7.11.3 Where plums are permitted in massive concrete, they shall be washed and carefully placed. No stone shall be closer than 30 cm to an exposed face, nor nearer than 15 cm to an adjacent stone.

7.11.4 Concrete shall not be dropped from a height of more than 2m except through a chute, the design and type of which shall be subject to approval of the Engineer. The concrete shall be placed, spread and compacted by approved mechanical vibrator. Vibrators shall not be used for pushing concrete to adjoining areas. For members involving vertical placing of concrete (eg. columns, walls etc.,) each lift shall be deposited in horizontal layer extending the full width between shuttering and of such depth that each layer can be easily and effectively vibrated and incorporated with the layer below by means of compaction. For member involving horizontal placing of concrete (e.g. slabs, beams etc.,) the concrete shall be placed along the line of starting point in such quantities as will allow members to be cast to their full depth along the full width between side shuttering and then gradually brought towards the finishing point along its entire front parallel to the starting line. Vibration and surface finish shall follow behind the placement as closely as possible. Utmost care shall be taken to avoid the displacement of reinforcements/embedded parts or movement of formwork or damage to faces of the formwork or transmission of any harmful vibration/shocks to the concrete, which has not yet hardened sufficiently.

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7.11.5 All members shall be concreted at such a rate that no cold joint is formed and fresh concrete is placed always against green concrete, which is still plastic and workable. Should any unforeseen occurrence results in a stoppage of concreting for one hour or such other time as might allow the concrete, already placed, to begin to set before the next batches can be placed, the Contractor shall make at his own cost, suitable tongue and groove construction joint, as approved by the Engineer. Any additional reinforcement required as directed by the Engineer shall also be provided by the Contractor at his own cost. Before placement of new batches of concrete over that construction joint, the surface preparation according to this specification, stipulated earlier, shall be done by the Contractor. The concrete shall be worked well up against whatever surface it adjoins and compacted to such a degree that it reaches its maximum density as a homogeneous mass, free from air and water holes and penetrates to all corners of moulds and shuttering and completely surround the reinforcement. All measures shall be taken to make the shape, size, and location of the finished concrete including its embedments, holes, openings etc., well within the accepted tolerance limit.



7.12 **Construction Joints & Cold Joints**



7.12.1 **Construction joints**



Normally, the construction joints including crank inducing joints shall be constructed as per locations and details indicated on the drawings. Where the location of the joint is not specified in the drawings, it shall be in accordance with the following guide lines :

(a) In Columns

- (i) In case of Projection from basement slab 300 mm from the top of base slab or 75 mm from the top of the haunches whichever is higher.
- (ii) In framing of beam at different elevation, 75 mm below the lowest soffit of the beam and in case of projection from beams and slabs 75 mm from the top surface of the beam/slab or at the top surface of beam/Slab whichever facilitates formwork.
- (iii) For columns under flat slabs, 75 mm below the lowest soffit of the slab.

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<p>(a) In walls (horizontal construction joints)</p> <p>Walls projecting from base slab 300 mm from top of base slab.</p> <p>Walls supporting the suspended slab 75 mm from the lowest soffit of the slab.</p> <p>Note: In the case of water retaining structures and structures under the influence of ground water, approved water bars of suitable size shall be provided to make the joint completely water tight.</p> <p>(c) In beams</p> <p>Beams shall be cast, as a rule, without a joint. But if provision of a joint is unavoidable, the joint for simply supported beam shall be vertical and at the middle of the span ; in continuous beam, the same shall be at the point of minimum shear force.</p> <p>(d) In suspended slabs</p> <p>(i) In slab of small span, there shall be no construction joints. (ii) In slabs of large span and continuous slabs, construction joint, if allowed by the Engineer shall be vertical at the middle of span and at the right angles to the principal reinforcement.</p> <p>(a) In walls (Vertical construction joint)</p> <p>As a rule, walls shall be cast monolithically without any vertical construction joint, unless specified in the drawing. However, for a long wall, the Engineer may allow vertical construction joint and the same shall be at the place of minimum shear force. In water retaining structures and in structures under the influence of ground water approved water bars of suitable size shall be provided to make the joints completely water tight.</p> <p>(f) In slabs resting on ground</p> <p>(i) For Plain concrete Concreting shall be done in alternate panels not exceeding 10 sq.m in area. The largest panel dimension shall be 5 m.</p>		
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<p>(ii) For nominally reinforced slab The area of pour shall not exceed 40 sq.m and the maximum panel dimension shall not exceed 8m.</p> <p>(iii) For the basement slabs which act as structural member There shall be no construction joint.</p> <p>(iv) In ribbed beam</p> <p>The beams shall be cast monolithically with the slab in one continuous operation.</p> <p>In all construction joints the reinforcements shall pass through as per drawings and the same shall not be disturbed in any way. The vertical construction joints shall be provided by insertion of board keeping provision for passage of reinforcement/ fixtures/embedments. All construction joints shall be made to form a tongue and groove joint.</p> <p>7.12.2 Cold joint</p> <p>An advancing face of a concrete pour, which could not be covered before expiry of initial setting time for unexpected reasons, is called a cold joint. The Contractor shall remain always vigilant to avoid cold joints. If however, a cold joint is formed due to unavoidable reasons, the following procedures shall be adopted for treating it:</p> <p>(a) If the concrete is so green that it can be removed manually and if vibrators can penetrate the surface without much effort, fresh concrete can be placed directly over the old surface and the fresh concrete along with the old concrete shall be vibrated systematically and thoroughly.</p> <p>(b) In case the concrete has hardened a bit more than (a), but can still be easily removed by a light hand pick, the surface shall be raked thoroughly and the loose concrete removed completely without disturbing the rest of the concrete in depth. Then a rich mortar layer of 12 mm thickness, shall be placed on the cold joint, and then the fresh concrete shall be placed on the mortar layer and vibrated thoroughly, penetrating deep in to the layer of concrete.</p>		
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- (b) In case the concrete at the joint has become so stiff that it cannot be remoulded and mortar or slurry does not rise inspite of extensive vibration, a tongue and groove joint shall be made by removing some of the older concrete and the joint shall be left to harden at least for 12-24 hours. It will then be treated as regular construction joint and the surface preparation of the same, before placement of concrete, shall be as described in the appropriate clauses of these specifications.

7.13 **Requirements for Concreting in Special cases**

7.13.1 **Concreting in deep lifts**

Placing of concrete in lifts exceeding 2 M in columns and walls is in the category of deep lifts. Before commencement of work, the contractor shall submit for the approval of the Engineer, the details of the methods he proposes to adopt for concreting. The placement of concrete shall preferably be by tremie, chute or any other approved method. In structures of heavy/complicated reinforcement or in complicated form works, the contractor shall provide sufficient number of windows in the form works as directed by the Engineer to check the placement and compaction of concrete in different stages. Such windows shall be closed as soon as the concreting reaches the bottom level of the same.

7.13.2 **Concreting under water**



When it is necessary to deposit concrete under water, the special requirements, over and above those of this specification shall be in accordance with IS: 456.

7.13.3 **Cold weather concreting**

When conditions are such that the ambient temperature may be expected to be 4.5 degree C or below during the placing and curing period, the work shall conform to IS: 7861 (Part-II).

7.13.4 **Hot weather concreting**

When concreting in very hot weather the Contractor shall take all precautions as stipulated in IS: 7861 (Part-I) and stagger the work to

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cooler parts of the day to ensure that the temperature of wet concrete used, specially in massive structure, does not exceed 38 degree 'C'. Positive temperature control by methods like pre-cooling, post cooling or cooling of concrete by circulating cold water through small embedded pipe lines inside concrete, if required, shall be specified and shall be undertaken.

7.13.5 Concreting during Inclement Weather

During windy weather, efficient protection is to be provided to prevent the cement from being blown away during the process of apportioning and mixing.

All special care shall be taken to protect new concrete from the harmful effects of drying winds.

During wet weather, the concrete shall be adequately protected as soon as it is in position.

No concreting shall be carried out during periods of continuous heavy rain unless it is completely covered during mixing, transporting and placing.



No concrete work shall be carried out during dust/sand storms.

7.13.6 Concreting in large pours (mass concrete)

The aim of controlling the concreting in large pours is to reduce cracking caused by shrinkage due to heat of hydration. The Contractor shall submit detailed proposal to the Engineer for approval about the method of pouring and the measures to reduce heat of hydration, which he proposes to adopt. The maximum height of lifts will depend on the type of cement used. The use of cement having low heat of hydration, could allow greater lifts.

The Contractor shall provide all the necessary arrangements like pre-cooling of aggregates, cooling of fresh concreting by passing cold water through pipes placed inside the concrete or such other measure at least 48 hours before the placement of concrete and also provide the facility for recording of temperature at least 24 hours prior to placement of concrete.

The minimum interval between concreting of successive lifts, separated by horizontal construction joint shall be six days or as directed by the Engineer. The minimum interval between the

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concreting of adjacent pours separated by vertical construction joints shall be three (3) days, or as directed by the Engineer.

7.14 **Finishes to Exposed Surfaces of Concrete**

This shall include, the provision of normal finishes in both formed & unformed surfaces as and where directed by the Engineer. Some common finishes are indicated below:

7.14.1 **Surface which do not require plastering**

Surface in contact with casings shall be brought to a fair and even surface by working the concrete smooth against casings with a steel trowel while it is being deposited and also by working over the surface with a trowel immediately after the removal of the casings or centrings, removing any irregularities and stopping air holes, etc. Use of mortar plaster is not permissible for correcting levels, removing unevenness etc. However, if, in the opinion of the Engineer, such plastering is unavoidable then the thickness of plaster shall in no case exceeds 5 mm and the plastering shall be in cement and sand mortar.(1:3).

7.14.2 **Exposed surfaces which need plastering**



Surfaces of beams/columns flushing with the brick work or other structures where intended to plaster, shall be hacked adequately as soon as the shuttering is stripped off so that proper bond with the plaster can develop.

7.14.3 **Surface for non-integral finish**

Where a non-integral finish such as floor finish is specified or required, the surface of the concrete shall be struck off at the specified levels and finished rough.

7.14.4 **For monolithic finish**

Where no more finishing course is to be applied as in the case of basement floor, industrial flooring or the screed concrete flooring etc, the concrete shall be completed and struck off at the specified levels and sloped with a screed, board and then floated with a wooden float. Steel trowelling is then started after the concrete has hardened enough to prevent the excess of fines and water to rise to the surface

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but not hard enough to prevent proper finishing. Trowelling shall be such that the surface is flat, smooth and neatly finished.

7.15 **Curing of Concrete**

7.15.1 **General**

The purpose of curing is to prevent loss of moisture from the concrete itself so that the cement inside the concrete is sufficiently hydrated which of course is slow and prolonged process. As soon as the concrete has hardened sufficiently the curing shall be started. To cure the concrete properly and sufficiently is also the sole responsibility of the contractor.

7.15.2 **Different methods of curing**

Any one of the following methods may be used for curing as approved by the Engineer:

- Curing by direct water.
- Curing by covering the concrete with absorbent material and kept damp.
- Covering the concrete with an impervious sheet
- Curing by providing protective membrane.
- Curing by chemical coating.

7.15.3 **Curing by direct water**



This is done either by ponding or spraying water.

(a) Ponding

Ponding is widely used for curing slab and pavements. Earth bunds are formed over the slabs and water is pumped or poured into them and the same is replenished at interval to make up for the loss of evaporation. As this type of curing is one of the best methods, 10 days of curing after final setting is sufficient.

(b) By spraying water

Curing is done by spraying water by suitable means at approved time, intervals. While spraying, it shall be ensured that the

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complete area is covered. In order to avoid cracking, cold water shall not be applied to massive members immediately after striking the form work, while the concrete is still warm. Alternate wetting and over drying shall be avoided. Curing by spraying water shall be continued at least for 18 days after final setting.

7.15.4 Curing of concrete with absorbent material kept damp

The entire concrete surface is covered either with hessian, burlap, sawdust, sand, canvas or similar material and kept wet continuously for at least 12 days after final setting.



7.15.5 Curing by covering concrete surface with an impervious sheet

This is achieved by covering the entire concrete surface with water proof paper or plastic sheets specially manufactured for this purpose. The waterproof papers are stuck together by adhesive compound and the plastic sheets can be welded at site. Such type of covering shall be kept at least for 24 days after the final setting. It is preferable to have sheet as white in appearance since the white colour will reflect hot sunrays and keep the concrete temperature at reasonable level.

7.15.6 Curing by providing protective membrane by applying a curing compound

This is achieved by applying a membrane forming compound (curing compound) over the concrete surface. Generally these are available in emulsion form, liquid. The application of the curing compound should be started, immediately after stripping off the shuttering in case of formed surface and after the surface has hardened in case of unformed surface.

The curing compound membrane forming emulsion dry up within 3 to 4 hours after application and forms a continuous coherent adhesive membrane over the concrete surface. Such membrane serves as a physical barrier to prevent the loss of moisture from the concrete itself. Membrane forming emulsions are generally coloured black. or white to improve visibility for ensuring uniform application. Black colour shall never be used for curing in very hot weather. In order to, prevent glare, a colouring pigment may be added to white compounds.

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- (a) Black curing compounds are either Bituminous or Asphaltic emulsions and shall be used to the surface, which are to be covered by back filling or on the floor, which is to be covered with tiles and linoleum.
- (b) White curing compound shall be used to the surfaces of tall structures under exposure of hot sun where other method of curing cannot be properly ensured.

7.15.7 Curing by chemical coating

For chemical curing sodium silicate or calcium chloride is used. The use of calcium chloride shall not be done without the approval of the Engineer. Normally the sodium silicate mixed with water is applied over concrete surface and when it dries up it forms a thin varnish like film, which fills up the pores and surface voids and prevents evaporation of water. This also acts like curing compound but only difference is that curing compounds are available in ready mixed emulsion forms while sodium silicate is to be mixed with water at site.



7.15.8 Limitation to use of different methods of curing

- (i) Curing by the processes as indicated in CI 7.15.3 & 7.15.4 give very good results normal warm climate for maturity of concrete.
- (ii) In cold weather, the process as indicated in CI 7.15.4 gives very good result for maturity of concrete.
- (iii) Where water cement ratio is less than 0.5 the methods indicated in CI 7.15.3 & 7.15.4 shall not be used.
- (iv) In warm climate also, where the methods of curing as indicated cannot be properly ensured, any suitable method of curing as indicated in 7.15.5 or as approved/directed by the Engineer shall be adopted.

7.16 Testing of Concrete

7.16.1 General

The Contractor shall carry out, entirely at his own cost, all sampling and testing in accordance with the relevant I.S. standards and as supplemented herein. The Contractor shall get all tests done in approved Laboratory and submit to the Engineer, the test result in triplicate within 3 days after completion of the test.

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7.16.2 **Consistency test (tests of fresh concrete)**

At the place of deposition/pouring of the concrete, to control the consistency, slump tests and/or compacting factor tests shall be carried out by the Contractor in accordance with I.S. 1199 as directed by the Engineer.

The results of the slump tests/compacting factor tests shall be recorded in a register for reference duly signed by both the Contractor and the Engineer. That register shall be considered as the property of the owner and shall be kept by the Contractor at site in safe custody.

The results of the slump tests/compacting factor tests shall tally, within accepted variation of plus or minus 12% with the results in the respective design mix, in case of mix design concrete and with the values indicated in IS: 456 in case of nominal mix concrete.

For any particular batch of concrete, if the results do not conform to the requirements as specified or do not conform to any requirement of this specification, the Engineer has the right to reject that batch and the Contractor shall remove the same immediately from the site, at no cost to the owner.



7.16.3 **Strength test of concrete**



While placing concrete, the Contractor shall make 6 nos. of 15 cm test cubes from particular batches of concrete as desired by the Engineer. The frequency of taking test cubes shall be according to IS: 456 or as directed by the Engineer.

The cubes shall be prepared, cured and tested according to IS: 516. Out of 6 nos. Of test cubes 3 shall be tested for compressive strength at 7 days after casting and the remaining 3 at 28 days after casting.

A register shall be maintained at site by the Contractor with the following details entered and signed both the Contractor and the Engineer. That register shall be considered as the property of the Owner.

Reference to the specific structural member
Mark on cubes

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<p>The grade of concrete The mix of concrete Date and time of casting Crushing strength at 7 days Crushing strength at 28 days Any other information directed by the Engineer.</p> <p>7.16.4 <u>Acceptance criteria for test cubes</u></p> <p>The acceptance criteria of concrete on strength requirement shall be in accordance with the stipulations under IS: 456.</p> <p>7.16.5 <u>Non-destructive tests on hardened concrete</u></p> <p>If there is doubt about the strength or quality of a particular work or the test results do not comply with the acceptance criteria as stipulated under IS: 456, non-destructive tests on hardened concrete like core test and/or load tests or other type of non destructive tests like ultrasonic impulse test etc. shall be carried out, as may be directed by the Engineer, by the Contractor at entirely his cost. The core tests and load tests shall comply with the requirements of IS: 456. In case of other types of special tests like ultrasonic impulse test etc., the relevant stipulation of clauses of IS: 456 shall be applicable.</p> <p>7.16.6 <u>Concrete below specified strength</u></p> <p>In case of failure of test cubes to meet the specified requirements the Engineer may take one of the following actions:-</p> <ol style="list-style-type: none"> 1) Instruct the Contractor to carryout additional test and/or works to ensure the soundness of the structure at contractor's expense. 2) Reject the work and instruct that section of the works to which the failed cubes relate shall be cut out and replaced at Contractor's expense and the resultant structures affected due to such rejection shall be made good at contractor's expense. 3) Modification/remedial measures if approved by the engineer to be carried out at contractor's expense. 4) Accept the work with reduction in the rate in appropriate item subject to the provisions of IS 456 provided it is technically acceptable. The reduction in the rate shall be as given below :- 		
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- i) When test strength of the sample is above 90% of the characteristic strength, payment shall be made 10% less than the contract rate.
- ii) When test strength of the sample is between 80-90% of the characteristic strength, payment shall be made 25% below than the contract rate.

7.16.7 Concrete failed in non-destruction tests

In case the test results of the core tests or load tests in a particular work do not comply with the requirements of clauses for load tests of IS: 456 the whole or part of the work concerned shall be dismantled and replaced by the Contractor as may be directed by the Engineer at no extra cost to the Owner and to the satisfaction of the Engineer. No payment for the dismantled concrete including relevant formwork, reinforcement, embedded fixtures etc. shall be made. In the course of dismantling if any damage occurs to the adjacent structure or embedded item, the same shall be made good, free of charge by the Contractor, to the satisfaction of the Engineer.

7.17 Steel Reinforcement

7.17.1 Material



The specifications of materials shall be as per clause 8.0 of section D4.6-C.

7.17.2 Storage

Steel reinforcement shall be stored in such a manner that they are not in direct contact with ground. Bars of different classifications and sizes shall be stored separately. In cases of long storage or in coastal areas, reinforcement shall be stacked above ground level by at least 15 cm, and a coat of cement wash shall be given to prevent scaling and rusting at no extra cost of the owner.



7.17.3 Bending and placing

Bending and placing of bars shall be in conformity with IS: 2502 "Code of Practice for Bending and Fixing of Bars for Concrete Reinforcement" and IS 456 "Code of Practice for Plain and Reinforced Concrete".

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7.17.4 **Lapping / Welding of Reinforcement**

- 7.17.4.1 Normally the lapping of reinforcement bars shall be by mechanical means satisfying the requirements of IS:456 . However, in case of congestion of reinforcement the welding of reinforcement may be adopted with approval of Engineer. The following procedure shall be adopted in case of welding of reinforcement.
- 7.17.4.2 Welding of mild steel reinforcement bars conforming to IS:432 (Part-I) and shall be done in accordance with IS: 2751"Code of Practice for Welding of Mild Steel Bars used for Reinforced Concrete construction" with additional precaution that for lap welded joints the throat thickness of weld beads shall be at least 3mm or 0.6 times the nominal size of weld (which is the radius of bar) whichever is more. Welding of cold worked high strength deformed bars conforming to IS: 1786 shall be done using electric arc welding process using low hydrogen electrodes (Ferro Weld- I or Ferro Weld-II or equivalent). Oxy-acetylene welding shall not be used.
- 7.17.4.3 Butt welding of bars upto 32 mm diameter for vertical splices shall be done either by single bevel groove weld or double bevel groove weld, with bevel angle 45 degree. But welding of bars upto 32 mm diameter for horizontal splices shall be done either by single Vee-groove weld or double Vee-groove weld with chamfered angle of 45 degree to 60 degree. The diameter of welded joint shall be 1.2 times the diameter of bar. Edge preparation for butt welding shall be done by shearing, machining and grinding. Oxy-acetylene flame shall not be used for cutting. Chamfered faces shall be smooth finished by hand file if required.
- 7.17.4.4 Lap welding of bars upto 20 mm diameter shall have a minimum bead length of 12 times the diameter of bar or 200 mm whichever is more arranged on one or both sides. The throat thickness of weld beads shall be 5 mm or 0.75 times the nominal size of weld (which is the radius of bar) whichever is more. In case of unsymmetrical lap weld with weld bead on one side only, the maximum length of each weld bead shall be 6 times the diameter of bar or 100 mm (whichever is more), separated by an equal length in between weld beads. Splice bars used in symmetrical weld joint shall have same diameter as the parent bars. Lap joint with single splice bars shall have weld beads on both sides. Lap welding of bars above 20 mm

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shall be done using splice plate or splice angle. Thickness of splice plate shall not be less than 0.65 times the diameter of bar and width shall not be less than twice the diameter of bar. The size of splice angle shall be such that its area of cross section is at least 1.62 times the area of bar being spliced.

7.17.4.5 More than one third of the bars shall not be welded at any one section and welded joints shall be staggered at a distance of 50 times the diameter of bars. Welding shall not be done at bends or curved parts of bars and it shall be located at least at a distance of 50 times the diameter of bar from bends.

7.17.5 **Tests**



Test pieces of welded bars shall be selected and tested in accordance with the provisions of IS: 2751. The number of tests will be as laid down in IS 2751 or such larger number as the Engineer may decide having regard to the circumstances.

7.17.6 **Cleaning**

All steel for reinforcement shall be free from loose scales, rust coatings, oil, grease, paint or other harmful matters immediately before placing the concrete. To ensure this, reinforcements with coatings shall be cleaned thoroughly before bending/placement of the same.

7.17.7 **Placing in position**

All reinforcements shall be accurately fixed and maintained in positions as shown on the drawings and by adequate means like mild steel chairs and/or concrete spacer blocks as required. Bars intended to be in contact at crossing points, shall be securely tied together at all such points by 20G annealed soft steel wire or by tack welding in case of bars larger than 25 mm dia, as may be directed by the Engineer. Binders shall tightly embrace the bars with which they are intended to be in contact and shall be securely held. The vertical distance between successive layer bars shall be maintained by provision of mild steel spacer bars. They should be spaced such that the main bars do not sag perceptibly between adjacent spacers. The binding wire shall be single strand for 16G, two strands for 18G and

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three strands for 20G . The binding wires shall be soft annealed black wire.

7.17.8 **Clear cover**



Clear cover shall be as specified in the drawings. If nothing is specified in the drawing the clear cover shall be in accordance with the relevant clause of IS 456.

7.17.9 **Light structural work and embedded metallic parts, conduits, Fabrication of metallic parts & light structural.**

Fabrication of all structural steel work shall be done in accordance with IS: 800 "Code of practice for use of Structural Steel in General Building Construction". Workmanship shall match to the best practice in modern structural shops. Greatest accuracy shall be observed in the manufacture of every part and all identical parts shall be strictly interchangeable. Steel work shall be shop fitted and shop assembled as far as practicable to minimise site work and to meet transport restrictions. All materials shall be straight and if necessary before being worked shall be straightened or flattened by pressure and shall be free from twists. Shearing or flame cutting may be used and the resulting edges shall be clean and straight. Flame cut edges shall be planed/cleaned by chipping or grinding. Sheared members shall be free from distortion at sheared edges. Welding and welded work shall conform to IS: 816 "Code of Practice for use of metal arc welding for General Construction in Mild Steel". Mild steel electrodes conforming to IS: 814 "Specification for covered electrodes for metal arc welding of mild steel" shall be-used.

7.17.10 **Transportation and Storages**

All pieces shall be properly identified and bundled for transportation to work site. Care shall be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials shall be kept free of dirt, grease and foreign matter and shall be stored properly on skids or any other suitable supports to avoid contact with ground, damage due to twisting, bending etc.

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7.17.11 Erection of light structural work



Erection of light structural work shall be carried out in accordance with the provisions of IS: 800. No component which is bend or twisted shall be put in place until the defects are corrected. Components seriously damaged during handling shall be replaced. No riveting, permanent bolting or welding shall be done until proper alignment has been completed. Whenever field welding is to be done it shall be in accordance with the requirements of shop fabrication. Shop paints shall be removed before field welding for a distance of at least 50 mm on either side of the joints.

7.17.12 Erection of embedded metallic parts, inserts, conduits

Bolts and inserts shall be securely fixed In position as shown in the drawings, before commencement of concreting. Bolts shall be checked for accuracy in alignment on both the axes. Limits of tolerance in alignment and level shall be as shown in the drawing or described elsewhere in these specifications. Where bolts are housed in sleeves, special care shall be taken after concreting is over and has partly set to ensure that the bolts move within the sleeves. The annular space of the sleeve shall be plugged suitable stoppers to prevent the ingress of grout, dust, rubbish or other foreign material into it, both during and after concreting. Opened conduits shall be plugged similarly. Where channels, irregular profiles or other similar inserts are required to be placed in concrete, special care shall be taken to keep the grooves of such profiles free from the ingress of concrete, slurry etc., by suitable packing material, if necessary. All threads for bolts and inserts shall be greased at intervals and kept covered to prevent damage.

Necessary templates, jigs, fixtures, supports shall be used as may be specified or required or directed by the Engineer . Templates shall invariably be supported such that the same is not disturbed due to vibration ,movement of labourers ,materials ,shuttering works ,reinforcement etc while concreting. Contractor will have to suitably bend ,cut or otherwise adjust the reinforcement in concrete at location of inserts as directed by Engineer.

The Contractor shall ensure proper protection of all bolts ,Inserts Etc from weather by greasing or other approved means such as applying white lead putty and wrapping them with gunny bags or canvas or by

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other means as directed by Engineer to avoid damage due to movement of labourers, materials equipment etc. Exposed surfaces of embedded materials shall be painted with one coat of anticorrosive paint or bituminous paint. If welding is to be done subsequently on the exposed surfaces of the embedded parts, the painting for a length of 50mm beyond each side of the weld line shall be cleaned off.

7.18 **Shuttering**

7.18.1 **General**

All shuttering, formwork, supports and staging shall be designed by the Contractor and be subject to approval by the Engineer. The Contractor shall submit drawings and calculations to the Engineer for scrutiny when called upon to do so. The shuttering shall be designed for a live load of 400 Kg/m² in addition to the weight of the green concrete, or such other load as the Engineer may specify. The Contractor shall be responsible for the correctness and strength of the formwork including its supports and centering and approval by the Engineer will not relieve him of responsibilities.



7.18.2 **Material**

The staging and supports may be of round or sawn timber or tubular or other shapes in steel. Round timber shall preferably extend over the full height in one piece. These shall be securely jointed or otherwise fastened and spaced at suitable intervals as the design may warrant and shall be suitably braced at regular intervals horizontally and diagonally.

The form work shall be of steel plate on steel frame, wooden boards with steel sheet lining, or plywood or seasoned timber board. Where ornamental and curved surfaces are required the material shall be very good seasoned timber or plywood, which can be shaped correctly.

7.18.3 **Fixing**

The shuttering shall conform to the shapes, lines, levels and dimensions shown in the drawing. It shall be fixed in perfect alignment and securely braced so as to be able to withstand, without appreciable

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displacement, deflection or movement of any kind, the weight of all construction, movement of persons and plant. It shall be so constructed as to remain rigid during the placing and compacting of concrete without shifting or yielding and shall be sufficiently water tight to prevent loss of slurry from the concrete.

All props shall be supported on sole plates and double wedges. At the time of removing props these wedges shall be gently eased and not knocked out. The formwork shall be so designed that the sides are independent of the soffits and the side forms can be removed easily without any damage or shock to the concrete.

7.18.4 **Wrought shuttering**

Wrought shuttering shall be such as to produce a first class fair face on the concrete free from board marks or any other disfigurements. This shall be used for exposed surfaces where specified or directed by the Engineer. It may be made of heavy quality plywood or steel sheets having smooth, plain surface.

The joints in shuttering shall be arranged in a regular pattern approved by the Engineer. Wrought shuttering shall be aligned within a tolerance of 3mm.

7.18.5 **Rough shuttering**



Rough shuttering shall be used for all surface of concrete walls, footings etc., which are not exposed in the finished work or which are to receive plaster and as directed by the Engineer. It may be made of timber, ordinary plywood or steel sheets.

7.18.6 **Slipform shuttering**

Slip forms, where used, shall provide a smooth, even surface true to dimensions and alignment. The concrete surface produced by such shuttering shall be free from lines, bulges and unseemly offsets. Slipforms shall have prior approval of the Engineer and the Contractor shall submit complete information required in this regard.

7.18.7 **Special provision**

Wherever concreting of narrow member is required to be carried out within shutters of considerable depth, temporary openings in the sides

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of the shutters shall if so directed by the Engineer, be provided to facilitate cleaning, pouring and consolidation of concrete.

In liquid retaining structures and structures below ground water level, through bolts for the purpose of securing and aligning the form work shall not be used. Forms shall be given an upward camber, if so desired by the Engineer, to ensure that long beams do not have any sag. The camber may be 1 in 250 or as the Engineer may direct. The joints in form work shall be sealed by adhesive tapes or by other means, to prevent any leakage of slurry or mortar if so directed by the engineer.

7.18.8 Preparation for concreting



Before any concreting is commenced the shuttering shall be carefully examined for dimensional accuracy and safety of construction. The space to be occupied by concrete shall be thoroughly cleaned out to remove rubbish, debris, shavings and saw dust. The surface in contact with concrete shall be coated with an approved substance such as mould oil or other non-staining mineral oil to prevent adhesion. Where necessary the surface shall be wetted to prevent absorption of moisture from concrete. Care shall be taken to avoid the reinforcements coming in contact with shutter oil.

7.18.9 Removing

Removal of forms shall never be started until the concrete has thoroughly set and aged to attain sufficient strength to carry twice its own weight plus the live load that is likely to come over it during construction. Removal of forms shall not entail chipping or disfiguring of the concrete surface. Shuttering shall be removed without shock or vibration and shall be eased off carefully in order to allow the structure to take up its load gradually.

Under normal circumstances (generally where temperatures are above 21 degree 'C'), and where ordinary portland cement is used shuttering may be struck after the expiry of the following periods :

- | | |
|------------------------------------|--|
| i) Walls, columns & vertical faces | : 24 to 48 hours as may be directed by the Engineer. |
| ii) Bottom of slab upto 4.5 m span | : 7 days |

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- iii) Bottom of slab above 4.5 m span and
bottom of beam and arch, rise upto 6 m span : 14 days
- iv) Bottom of beam and arch rise over 6 m span : 21 days

These periods may be increased at the discretion of the Engineer. Special care shall be taken while striking the shuttering of cantilevered slabs and beams, portal frames etc. Before removing the form work, the Contractor must notify the Engineer to enable him to inspect the condition of the finished concrete immediately after the removal of the form works.

7.18.10 **Contractor's responsibility**

Any damage resulting from faulty preparation premature or careless removal of shuttering shall be made good by the Contractor at his own expense.

7.18.11 **Irrecoverable shuttering**

In cases where the shuttering cannot be removed without damaging the structure itself or where removal of shuttering is rendered impossible due to the nature of construction or where the Engineer may so instruct, such shuttering shall be classified as irrecoverable shuttering. However, such abandoning of shuttering will be permitted only in situations where it will not remain exposed or otherwise cause damage of any kind.



7.18.12 **Metal Forms**

Where permanently left-in-place metal forms or deck are shown in drawings or otherwise ordered to be provided by the Engineer, they shall satisfy the requirements with regard to load carrying capacity. The metal forms shall be obtained from a reputed manufacturer whose performance guarantee shall be obtained and submitted to the Engineer. Designs and drawings giving full details shall be submitted to the Engineer in advance for approval.

7.19 **Damp Proof Course Concrete**

7.19.1 Thickness

It shall be as specified in the drawings .

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7.19.2 **Mix**

The grade of mix shall be as specified in the drawing. If nothing is specified, the mix shall be 1 part of cement: 1 1/2 part of coarse sand: 3 parts of stone chips. The stone chips shall be 12 mm down graded.

Approved water proofing admixture shall be mixed with cement as per manufacturer's specifications. The water cement ratio shall be as low as possible to increase the impermeability of concrete and in no case more than 0.5.

7.19.3 **Preparation of base surface**

The base surface shall be well roughened by chipping and brushing with steel brush and shall be cleaned of all dirt, dust, grease, oil and all other foreign & deleterious materials. Then the surface shall be well moistened with water.

7.19.4 **Placing and compaction**

Just prior to placement of D.P.C. Concrete, a thick coat of cement slurry shall be applied on the base surface. The placement shall be as specified for the concrete in beams. The concrete shall be well compacted to make it dense.

7.19.5 **Finishing**

When the concrete has set enough but remains still green, the top surface shall be marked in regular pattern by steel trowel so as to have proper bond with the future work.



7.19.6 **Curing**

The D.P. course shall be kept continuously moist at least 7 days.

7.20 **Grout**

7.20.1 **Scope**

The scope covers the grouting under base plates, grouting between the joints of precast concrete, grouting the pockets/holes/opening etc.

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7.20.2 **Grouting under base plates**

Grouting under base plates of equipments/structures shall be of cement mortar 1:2 for thickness upto 25mm. For thickness exceeding 25 mm, concrete of grade specified in the drawing or minimum M-20 grade using 10 mm down graded aggregates shall be used. The grout shall be placed in position well rammed until the whole space is completely filled with concrete. No vibrators shall be used. Quick setting cements shall be used in the preparation of mortar or concrete where so specified.

The grout shall either be "dry" concrete or mortar or "wet expanding" concrete or mortar as the Engineer may direct. A dry grout shall have a slump not exceeding 6 mm. It shall be rammed under the horizontal surface with the aid of suitable tools. A "wet expanding" grout shall have a slump of at least 125 mm but not exceeding 225 mm. To this shall be added an expanding admixture approved by the Engineer and in accordance to the Manufacturer's instructions.

7.20.3 **Grouting the joints of precast members**



The requirements are same as that described in 7.20.2 except that the slump shall be much less (the slump in this case shall be within 75 mm to 125 mm as per requirements) and in the case the thickness of joint is 30 mm or less the mix shall be 1 part of quick setting cement and 1 1/2 parts of coarse sand. Some times dry mortars i.e. mortar with slump less than 6 mm is used for grouting the joints of precast members.

7.20.4 **Grouting the pockets/holes in concrete**

Depending upon the size of the pockets/holes in concrete, the mix of the grout shall be either of concrete or of cement sand mortars. Normally the grade of such concrete/mortar shall be M-20 unless specified otherwise. In filling the holes of foundation bolts and expanding admixture of approved type shall be used as per manufacturer's specification.

7.20.5 **Workmanship**

The surface of the concrete over which grouting is to be applied shall be thoroughly prepared to provide a clean rough surface. If necessary,

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chipping shall be carried out on such surface to make it completely rough. Then the surface shall be wetted. Bolt pockets shall be cleaned immediately before the base plate is placed in position. Before grouting the surface shall be thoroughly cleaned with compressed air/water jet.

Before placement of grout, the surfaces (except in the case of bolt holes) shall be wetted with cement slurry. In case of bolt holes/pockets water from such pockets shall be thoroughly removed by some suitable means and no cement slurry shall be applied.

Hand mixing is not permitted and the grout shall always be machine mixed. If however in some special cases where the quantity of grout is so small that it cannot be machine mixed, hand mixing may be allowed but the same shall be done under the strict supervision of an experienced supervisor of the Contractor.

The grout shall be placed within 30 minutes of being mixed. The grout shall be poured And then worked into position by suitable means until the space is completely filled. The Contractor shall take all possible measures during grouting so that the grout fills the space completely and thoroughly. Where the gap is very small or unapproachable for the placement of concrete, the Contractor shall grout by pressure grouting and in that case the mix may be of cement sand mortar of the appropriate grade but in any case the water cement ratio shall be as low as possible. Neither "Dry" grout (having slump 6mm or less) nor expanding wet grout shall be grouted with any type of vibrating machine.



7.20.6 **Curing**

After 10 hours of grouting, the same shall be covered with wet gunny bags and the surface shall be kept continuously moist at least for 10 days.

7.21 **Concreting in Water Retaining Structures**

7.21.1 **General requirements**

The basic specifications as regards 'mix' design, placing, compacting, curing etc. shall conform to the requirements as specified hereinbefore in this chapter. Over and above the materials and workmanship shall conform to the stipulations of IS: 3370 (Part-I& II) to make dense and

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impervious concrete. As specified herein before all the construction joints shall be provided with approved water bars. The expansion and construction joints, if any, shall be provided with the requirements as specified in the drawing or as directed by the Engineer.

7.22 **Application of Live Load**

The designated live load shall be allowed on any structure only after 28 days, after proper curing is carried out, on the last concrete poured in structure.

8.0 **SPECIAL CONCRETES & STRUCTURES**

8.1 **Precast Concrete**

8.1.1 **General**



The following clauses shall be read in conjunction with the section relating to concrete and reinforced concrete.

8.1.2 **Precasting Yard**

The precast units shall be cast on, or their shutters supported from a suitably prepared casting yard or level, unyielding area/large enough to accommodate the largest item of work intended to be cast at a time. The yard shall be prepared at a convenient place sufficient material can be stored. Mixers can be installed and other facilities can be made available.

8.1.3 **Shutters**

Forms must ensure correct geometric outline, dimensions and surface finish of the members to be cast. They shall be designed such that they are strong and easy to assemble and dismantle and convenient for cleaning and oiling. They shall be strongly constructed, jointed and smooth to ensure true sharp arise and a perfect surface. The form may be of wood, steel lined on wood or steel. Ordinary steel form may be of welded channel frame with hinge mounted sides covered by 4 to 6 mm steel plate lugs may be provided for lifting the forms by crane or trolley, or wheels may be provided. The joints of the form should be such that it shall not permit any leakage of cement slurry.

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8.1.4 **Workmanship**

Workmanship shall conform to the clauses relating to concrete and reinforced concrete.

In the case of precast members having congested reinforcement at certain places a suitable mix design shall be done in advance, with aggregate, the maximum size which can pass through the gap between reinforcement at that place and this mix used at that place only. Slump tests shall be done each day at the beginning of the work. At least one set of cubes must be taken for all important items irrespective of quantity and time.

8.1.5 **Vibrating**

Extra care must be taken in vibrating the concrete. Only low or medium frequency vibrator of small needle, which can pass through the gap between reinforcement, shall be used. Where this cannot be used with ease, surface vibrators shall be used.



8.1.6 **Casting tolerance**

The casting tolerances, unless otherwise specified in the drawing, shall be as follows. These tolerances shall not come in the way of correct, assembly, performance and appearance of the structure. These permissible deviations for the units are consistent with the variation in the position of the adjoining components in the structure. The permissible deviations given below are a general guide and where closer values are necessary, they can be specified by the Engineer. For irregular, curved or specially shaped units, the necessary dimensions and permissible deviations shall be as defined/specified on the drawings, or as specified by the Engineer. Particular attention is drawn to the fact that tolerance can be cumulative.

8.1.7 **Size**

Permissible deviations shall be as specified below as plus or and minus value related to the work size of the member length

Upto 3m	plus or Minus 6mm
3m to 4.5m	---- do----- 9mm
4.5m to 6m	----do----- 12mm

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Additional for every subsequent 6m Cross Section (each direction)	-----do-----	6mm
Up to 500mm	-----do-----	6mm
500mm to 700mm	-----do-----	9mm
Additional for every subsequent 250mm	-----do-----	3mm
Straightness or bow (deviation from intended line)		
upto 3m	-----do-----	6mm
3m to 6m	-----do-----	9mm
6m to 12m	-----do-----	12mm
Additional for every subsequent 6m	-----do-----	6mm.

8.1.8 **Squareness**

When considering the squareness of a corner, the longer of the two adjacent sides being checked should be taken as the base line. The shorter side should not vary in its distance from a perpendicular so that the difference between the greatest and shortest dimensions exceeds Length of shorter sides:



8.1.9 **Length of shorter sides**

Upto and including 1.2m	.....	6 mm
Over 1.2 m but less than 1.8m	.....	9 mm
1.8m and over	.....	12 mm

For the purpose of this requirement any error due to lack of straightness should be ignored, squareness should be measured with respect to the straight lines which are most nearly parallel with the features being checked. When the nominal angle is other than 90 degree, the included angle between check lines should be varied accordingly.

8.1.10 **Twist**

Any corner should not be more than the deviation stated from the plane containing the other three corners:

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Upto 600mm wide and upto 6m in length 6mm
Over 600mm wide and for any length 12mm.

8.1.11 **Flatness:**

The maximum deviation from a 1.5m straight edge place in any position on a nominally plane surface should not exceed 6mm.

8.1.12 **Striking shutters**



The method and interval after casting of units, of striking the side shutters shall be subject to approval of the Engineer. The use of crowbars and sledgehammers is not permitted. In the event of any damage resulting from premature removal of shutters or from any other cause the unit or units concerned will be liable to rejection and replacement by the Contractor at his own cost.

8.1.13 **Curing**

The top and sides of all precast units shall be kept covered in a damp condition for at least 10 days after casting or for such periods as the Engineer may decide. Steam curing, which reduces considerably the production time, may be used subject to approval of the Engineer and must be carried out with strict observance of all pertinent variables e.g temperature, relative humidity (from 60 to 90%) preheating time, treatment at constant temperature, cooling off period and the time during which the concrete is left to harden under normal conditions before being sent to the curing chamber.

8.1.14 **Lifting and stacking**

Precast units shall not be lifted, transported or used in the work until they are properly hardened and sufficiently matured. The crushing tests on the test cubes will be used to assess the maturity of the units. The contractor shall satisfy the Engineer that the methods proposed for lifting transporting and setting precast units will not overstrain or damage the precast unit due to any cause whatsoever. Lifting and stacking of precast units shall be undertaken without causing shock, vibration, or undue stress to or in the units. Units damaged will be liable to rejection and if rejected shall be immediately broken up and removed from site. The contractor shall replace such rejected units at his own cost.

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The lifting and storage area must be equipped with adequate lifting machinery. Rows of stacked pieces must be separated by aisles, allowing through traffic, and convenient manoeuvring of vehicles and cranes. Identification tags must always face the aisles and lifting hooks on top. Spacing blocks are to be placed in between two elements and beneath the lowest member and all supports from top to bottom must be arranged strictly vertical. Stacking shall be done on a hard surfaced floor, preferably of concrete, with slope for drainage of rainwater.

8.1.15 **Marking**

The contractor shall ensure that all precast units are properly marked in clean and legible manner with the reference number and the date of casting and it shall be clearly visible where the units are stacked. Reinforced precast members shall be clearly marked to indicate the top face.



8.1.16 **Precast record**

Full and accurate records shall be maintained of all precast work. Every unit shall have a reference number, date of casting, date of removal from bed and the date and position of placing recorded together with test results.

8.1.17 **Erection**

The contractor shall prepare and submit to the Engineer for approval the sequence and scheme he proposes to adopt for erection of precast structural elements. The precast units shall be handled and erected with utmost care to prevent damage to them as well as to other adjoining constructions. All measures necessary for the safety of personnel shall be taken.

Erection of large and heavy pieces such as portable frames, columns, trusses, rafters and purlins shall be done using crane or derrick. The contractor shall employ skilled workers having adequate experience who will be under the supervision of a competent foreman. The contractor shall provide all tools, tackles, false work, staging, supports and equipment required for erection of precast concrete structure.

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8.1.18 Finishing

All exposed faces of precast articles shall be brought to a fair, even and smooth surface by suitable rendering. Precast units, which are intended to be plastered, shall be sufficiently rough to provide a good key to the plaster.

8.2 Foam Concrete

This shall be of average 50mm thickness or as specified or as shown on drawings. This may be laid in in-situ in suitable panels or in precast blocks. The insulating properties shall be such that the thermal conductivity shall not exceed 0.125 Kcl m/m²h/ degree C. The weight of the insulating material shall be from 0.5 to 0.75 gm/cm³, strength not less than 5Kg/sq.cm or (0.5N/sq.mm.). In general, the main ingredients of Foam Concrete are cement, fly ash and foaming agent and the work shall be carried on by specialised Agencies/Companies. Before starting the laying of foam concrete samples shall be prepared at site and got tested for approval of the Engineer.

The foam concrete laid shall be sufficiently strong to take the usual workloads and standard loads expected on the roof. Any damaged portion shall be, removed and replaced forthwith. Approval of the Engineer shall be taken before laying the water-proofing over the insulation. While laying the foam concrete, sample batches of mix shall be kept for test if so desired by the Engineer.



8.3 Light Weight Concrete

8.3.1 General Use

This type of concrete is used as inter layer concrete over the main structural concrete, in industrial buildings, to cater to space for concealed conduits and other types of service pipings. As such this also acts as subgrade for the floor finish.

8.3.2 Materials

The coarse aggregates shall be porous like broken brick bats or any other approved materials. The grading shall be as specified in the Concrete Chapter. The fine aggregates and cement shall be as specified in concrete in this series.



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8.3.3 Density

The density shall vary from 1.2 t/m³ to 1.7 t/m³.

8.3.4 Mixing, laying, compaction and curing

All the works shall conform to the specification concrete in this series.

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CONCRETE POUR CARD

CLIENT :

DATE :

POUR NO. :

PROJECT :

STRUCTURE :

LEVEL/ LOCATION :

CONTRACTOR :

MAX AGGREGATE SIZE

SLUMP : MM/ MM



DRG. NO. :

START/COMPLETION TIME :

CONCRETE GRADE/QUANTITY : M / M³

MIXING TIME :

SR. NO.	ITEM	CONTRACTOR'S REP. SIGNATURE	ENGINEER'S SIGNATURE	REMARKS
1.	CENTERLINES CHECKED			
2.	FORMWORK AND STAGING CHECKED			
3.	REINFORCEMENT CHECKED			
4.	COVER TO REINFORCEMENT CHECKED			
5.	VERIFIED TEST CERTIFICATE FOR CEMENT /STEEL	YES/NO	YES/NO	
	SLUMP			
6.	ADEQUACY OF MATERIALS/EQUIPMENT FOR POUR	YES/NO	YES/NO	
7.	EMBEDDED PARTS CHECKED (LOCATION & PLUMB)			
	CIVIL			
	MECHANICAL			
	ELECTRICAL			
POUR AUTHORISED SITE ENGINEER				
8.	SOFFIT(S) AND POUR TOP(T) LEVELS CHECKED BEFORE(B) AND AFTER(A) FORM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN & IMPORTANT STRUCTURES LIKE T.G. ETC.)	S(B) S(A)	T(B) T(A)	
9.	CONSTRUCTION JOINT LOCATION & TIME (IF NOT AS PER DRAWING)			



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10.	CEMENT CONSUMPTION IN KGS.		
11.	NUMBER OF CUBES AND IDENTIFICATION MARK		
12.	TEST CUBE RESULTS (7 DAYS/ 28 DAYS)	/ / /	
13.	CONCRETE CONDITION ON FORM REMOVAL	V.GOOD/GOOD/FAIR/POOR	

CONSULTANT SITE ENGINEER	SITE-IN-CHARGE
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NOTES:

1. EACH ITEM TO BE CHECKED & SIGNED BY THE RESPECTIVE ENGINEERS.
2. ITEMS 8 TO 13 (BOTH INCLUSIVE) TO BE FILLED BY SITE IN CHARGE
3. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE FOR REFERENCE OF OWNER ,CONSULTANT
4. REMARKS INDICATE DEVIATIONS FROM DWGS & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURENCES, SUCH AS FAILURE OF EQUIPMENT'S, SINKING OF SUPPORTS/PROPS, HEAVY RAINS AFFECTING CONCRETEING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATION ETC.

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PART E : STRUCTURAL STEEL WORKS

1.0 SCOPE OF WORK

1.1 The scope of work for steel structures will be as follows :

Preparation and Supply of shop detail drawings, erection drawings, shop material lists, site-bolt list, As Built drawings and despatch documents for the steel structures /sheetings/ glazing, etc.



Supply, fabrication, shop painting, Finish painting at site, transportation, delivery and storage of all steel structures and sheeting including site bolts, electrodes, sheeting fixtures etc. complete in all respects.

Erection (including tools, tackles, cranes and any staging or false work required for erection), handling, transport and rectification of damaged structures, fixing, bolting, welding, alignment, levelling etc of all steel structures, complete in all respects.

While designing and fabricating laced columns, lacing will not project outside the column faces.

1.2 Miscellaneous

- a) Bolt diameter will not be less than 16mm. except for bolts securing roof and wall sheetings, windows, doors and stitching of thin coverings. For bolted joints, min. two bolts will be used.
- b) The size of fillet welds will not be less than 5mm.
- c) Main structural elements will be welded continuously. Intermittent welds will be used only on secondary members, which are not exposed to weather or other corrosive influence.
- d) Connection and splices will be made by welding or bolting with high tensile turned and fitted bolts. Black bolts will be used in connections and attachments of secondary members such as purlins, wall girts, etc. Bolts will be prevented from loosening by means of lock nuts, single coil spring washers or similar devices.

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2.0 **STANDARDIZATION AND UNIFORMITY**

Every endeavour will be made to achieve standardization and uniformity amongst the steel structures of different units of the plant particularly in the following items:



- Uniform layout module to the extent possible.
- Uniform slopes of roofs matching with existing buildings, unless specifically required otherwise for any particular unit.
- Uniform adoption of clearances between structures and moving parts of the equipment.
- Provision of adequate natural ventilation by using louvers (canopy like structures) at appropriate locations.
- Standardized details for handrails, stairs, ladders etc.
- Procedure for installation of high strength bolts.
- Uniform painting Specification and colour schemes.

2.0 **IS CODES :**

Sl. No.	Description	IS Code
1	Code of practice for design loads for buildings and structures (5 parts)	IS:875
2	Use of structural steel in general building constn.	IS:800
3	Use of steel tubes in general building constn.	IS:806
4	Rolled steel beams, channels and angle sections.	IS:808
5	Glossary of terms relating to welding and cutting of metals.	IS:812
6	Scheme of symbols for welding.	IS:813
7	Covered electrodes for metal arc welding of structural steels.	IS:814
8	Covered electrodes for metal arc welding of mild steel and high strength low alloy steel.	IS:815
9	Use of metal arc welding for general construction in mild steel	IS:816
10	Black hexagonal bolts, nuts and lock nuts (6mm. diameter to 39mm. diameter) and black hexagonal screws 6mm. diameter to 39mm. diameter).	IS:1363
11	Precision and semi-precision hexagonal bolts, screws, nuts and lock-nuts 6mm. diameter to 39mm. diameter).	IS:1364

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Sl. No.	Description	IS Code
12	High tensile friction grip fasteners for structural engineering purposes.	IS:3757
13	Structural steel (fusion welding quality).	IS:2062
14	Structural steel (ordinary quality),	IS:1977
15	Hot rolled carbon steel sheet and strip.	IS:1079
16	Steel chequered plates	IS:3502
17	Expanded metal steel sheet for general purposes.	IS:412
18	Fixing and glazing of metal doors, windows and ventilators	IS:1081
19	Code of practice for glazing in buildings.	IS:3548
20	Steel doors, windows and ventilators.	IS:1038
21	Steel windows for industrial buildings.	IS: 1361
22	Criteria for earthquake resistant design of structures.	IS:1893
23	Design of steel chimneys (2 parts)	IS:6533
24	Steel tubes for structural purposes.	IS:1161
25	BIS handbook for structural engineers (Structural steel sections).	
26	Spirally welded pipes.	IS:5504
27	Stainless steel plates, sheets and strips.	IS:6911
28	Weldable structural steel (medium & high strength quality).	IS:8500
29	Use of welding in bridges and structures subjected to dynamic loading.	IS:1024
30	Inspection of welds.	IS:822
31	Radiographic examination of fusion welded butt joints in steel plants.	IS:1182
32	Ultrasonic testing of welds in ferritic steel.	IS:4260
33	Tolerance of fabricated steel structures	IS:7215
34	Tolerance for erection of steel structures	IS:12843
35	Magnetic flaw detection of welds.	IS:7743

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Sl. No.	Description	IS Code
36	Recommended design practice for- corrosion prevention of steel structures.	IS:9172
37	Technical supply conditions of threaded fasteners.	IS:1367
38	Code of practice for training and testing of metal arc welders	IS:817

4.0 **FABRICATION OF STEEL STRUCTURES**

4.1 **General**



This Specification will apply to steelwork in buildings and general structural work.

4.2 **Drawings**

The Contractor will prepare fabrication drawings, erection drawings, bill of materials, drawing office despatch lists/shipping documents, schedule of bolts and nuts and as built drawings. All drawing work will be in metric system and all writing work will be in English.

The fabrication drawings will show full length layout with all connecting members and connections marked thereon. The fabrication drawings will include all the necessary blown-up details required for the correct fabrication of the structures to meet the design requirements. These drawings will be made in conformity with the best modern practices and with due regard to speed and economy in fabrication and erection. Each erection piece will be clearly identified by an erection mark in these drawings.

The preparation/detailing of fabrication drawing will be complete in all respects. In the case of bolted connections, the bolt dia., the hole dia., the actual location of holes and the coordinating scheme with connecting/ matching elements will be clearly indicated. As far as possible, uniformity in the bolt dia will be maintained. Where HSFG bolts are used, method of surface preparation will be indicated. In case of welded constructions, the size and length of welds along the relevant weld lines should be distinctly marked. The length specified will be the effective length excluding end craters. For all butt welds, details of appropriate edge preparation will be indicated.

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Detailing of structural steel members subjected to dynamic loading will be so as to keep the stress concentration to a minimum. Cross welding will be avoided as far as practicable. Welding across tension flange of crane girders will not be permitted.

For bolted connections subject to dynamic loading, lock nuts or spring washers will be used in addition to plain washers.

Erection drawings will consist of line diagrams showing every detailed member in position with the respective erection mark. Erection marks will appear on the left end of the members as detailed. All steel members will be erected with marks in the same relative position as shown in plan or elevation. All loose members will either be given part marks or wired on to the main erection mark for despatch.

The erection clearances for cleated ends of members connecting steel to steel will preferably not be greater than 1.5mm. at each end. The erection clearance at ends of beams will not be more than 3mm. at each end but where for particular reasons greater clearance is necessary, suitably designed seatings will be given.

The fabrication drawings will be prepared in such a manner that structures are despatched with maximum transportable lengths and work involved at site is minimum. Steelwork will be shop-fitted and shop- assembled as far as practicable.



All edge preparations for weldings will conform to IS:9595.

4.3 **Material of Construction**

All steel and other materials used for steelwork and in association with steelwork will conform to appropriate Indian standards. Only tested materials will be used unless written authority is obtained for the use of untested materials for certain secondary structural members.

Unless otherwise specified in the drawings

- a) All rolled sections and plate will conform to Grade "A" as per IS : 2062.

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- b) Plated structures subjected to dynamic loading will conform to Grade "B" as per IS : 2062.

Steel sheets will conform to IS : 1079.

Steel tubes for structural purpose will conform to IS : 1161 (of Grade Yst 240)

Aluminium industrial troughed sheets conforming to IS : 1254 will be used as follows :

- i) In roof - 0.91mm thick
- ii) In side walls - 0.71mm thick

Translucent sheets will be fibreglass reinforced polyester sheets of matching profile as per appropriate standards.

Gutters will be of copper bearing steel conforming to Grade "A" as per IS :2062.

Crane rail will conform to IS : 3443.

All black hexagonal bolts, nuts and locknuts will conform to IS - 1363 and IS : 1364 (for precision and semi precision hexagonal bolts). Washers will conform to IS : 5369.



All HSFG bolts will conform to IS : 3757. Assembly of joints using HSFG bolts will conform to IS : 4000.

Covered electrodes for arc welding will conform to IS: 814. Coding of electrodes will be as follows :

- a) ER421 'C' X for mild steel of Grade 'A' and Grade 'B' as per IS : 2062
- b) EB 542 'C' H3X for Mild steel of Grade 'B' as per IS 2062 for dynamically loaded structures (arising out of crane, vibratory screen, equipments etc.) 'C' is the value of the current as recommended by the electrode manufacturer.

Certified mill test reports of materials used in the work will be made available for inspection by the Owner / Consultant upon request.

All materials will be straight and if necessary before being worked will be straightened and/or flattened by pressure including decoiling of

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plates unless required to be of curvilinear form and will be free from twists.

4.4 **Method of Construction**

The method of construction will be either by welding or by bolting limiting the site work to the minimum possible.

Method of splicing will be similar to the method of construction adopted for structures.

Roof and wall sheets will be fixed to purlins and wall girts by stainless steel top speed screws/galvanized J- hook bolts, each complete with neoprene and stainless steel /galvanized washers. The connection will ensure water leakproofness into the buildings. The spacing of these screws/bolts will be sufficient to prevent uplift of sheets by suction. The roof and wall sheets will be stitched together at their edges by using studs, rivets or screws. The overlaps of sheetings will be sufficient to prevent ingress of rainwater.

4.5 **Structural steel connection**



The Contractor will be responsible for the design and the detailing of all connections. The design of connections will provide for adequate strength for the transfer of force in the structural elements indicated on the design drawings. For purposes of detailing of connections, the allowable stresses in material, bolts and welds will be as per IS:800 and IS:816 or as specified in the design drawings.

For all full strength butt welding of plates and sections thicker than or equal to 10 mm, edge preparation will be done and got approved by the Owner / Consultant.

Two numbers of washers will be used for all bolted connections, one washer bearing against the head and other bearing against the nut.

The magnitude of forces shown on design drawings will be used at face values with no reductions for connections.

All penetration for piping, conduit, cable trays, etc., through grating or plate flooring will be cut and suitably banded in the field, except

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when such penetrations are dimensioned in the drawings in which case they will be shop cut and banded.

4.6 **Fabrication**

Fabrication of all structural steelwork will be in accordance with IS:800 or their equivalent foreign national standard of the country of origin of supply unless otherwise specified, and in conformity with various clauses of this Specification.



Wherever practicable and wherever perfect matching of parts is required at site, members will be shop assembled before despatch to minimise site work. Parts not completely assembled in the shop will be secured, to the extent possible, to prevent damage during despatch.

All pieces will be properly identified and bundled for transportation to work site. Care will be exercised in the delivery, handling and storage of material to ensure that material is not damaged in any manner. Materials will be kept free of dirt, grease and foreign matter and will be protected from corrosion. All materials will be stored properly on skids above the ground which will be kept clean and properly drained. Girders and beams will be placed upright and stored. Long members such as columns and chord members will be supported on skids placed near enough to prevent damage due to deflection.

Bolts will be furnished according to bolt lists showing the location of their use and additional bolts will be supplied to cover wastage.

All fabricated pieces will bear erection mark numbers painted/punched according to appropriate erection and shop drawings at a prominent location on the structure for easy identification.

All workmanship will be in accordance with the best practice in modern structural shops. Greatest accuracy will be achieved in the manufacture of every part of the work and all identical parts will be strictly interchangeable.

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Shearing or flame cutting may be used at the Contractor's option provided that a mechanically controlled cutting torch is used for flame cutting and that the resulting edges are clean and straight.

Unless clean square and true to shape all flame cut edges will be planed/cleaned by chipping or grinding. Where machine flame cutting is permitted for high tensile steel, special care will be taken to leave sufficient margin and all flame hardened material will be removed by machining/edge planing.

Wherever shearing is used for cutting to size, sheared members will be free from distortions at Sheared edge.



The ends of all girder stiffeners will be in contact with the compression flange and will be planed or ground to fit tightly against flange plates unless otherwise stated on the drawings. Care will be taken to ensure full bearing of the stiffeners at the supports by machining the contact surfaces of both bearing stiffeners and bearing plates. The ends will not be drawn or caulked.

Column splices and butt joints of struts and compression members depending on contact for stress transmission will be accurately machined and close butted over the whole section with a clearance not exceeding 0.1 mm locally at any place.

In column cap and bases, the ends of shafts together with the attached gussets, angles, channels, etc., after welding together, should be accurately machined so that the parts connected butt over the entire surfaces of contact. Care should be taken so that these connecting members are fixed with such accuracy that they are not reduced in thickness by machining by more than 1.0 mm. Where sufficient gussets and welds are provided to transmit the entire loading, the column ends need not be machined.

Bidder has to indicate clearly his option between machining and non-machining.

Holes for permanent black bolts will not be more than 1.5 mm larger than the nominal diameter of the black bolts unless specified otherwise. All holes for turned and fitted bolts will be sub punched or drilled and reamed at site under assembly of connected parts to a tolerance of +0.3 mm unless specified otherwise.

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Holes in purlins, side-sheeting runners, packing plates and lacing bars may be punched full size. Holes in light framing with the exception of joint holes, may be punched full size. All punching and sub-punching will be clean and accurate and all drilling free from burrs. In block/batch drilling, parts will be separated after drilling and the burrs removed. No hole will be made by gas cutting process.



The component parts will be so assembled that they are neither twisted nor otherwise damaged and specified cambers, if any, will be provided. No drifting of hole will be permitted except to draw the parts together. Drifts used will not be larger than the nominal diameter of the bolt. Drifting done during assembling will not distort the metal or enlarge the holes. Sufficient trial assembly will be carried out in the fabrication works to prove the accuracy of workmanship and the number of such trials required will be at inspector's discretion.

Where necessary, washers will be tapered or otherwise suitably shaped to give the heads and nuts of bolts a satisfactory bearing. The threaded portion of each bolt will project through the nut by at least one thread.

In all cases where the full bearing area of the bolt is to be developed, the bolt will be provided with a washer of sufficient thickness, under the nut so as to avoid any threaded portion of the bolt being within the thickness of the parts bolted together. Column bases and caps, if applicable, will be in one solid piece, and except when cut from plates with true surfaces, will be accurately machined over the bearing surfaces, and will be in effective contact over the whole area of the machine end of the stanchion.

Each piece will be distinctly marked before delivery, in accordance with an approved marking diagram and will bear such other marks as well to facilitate erection. For easy identification at site a small distinguishing mark for each building will be painted at each end of every member before despatch from fabrication shop. The fabricated steel work will be despatched in sequence as per agreed programme and for such portion as may be found convenient for erection or as ordered by the Owner / Consultant.

The Contractor will provide suitable packing wherever necessary to guard against damage during handling and transportation to site. All

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fabricated parts will be adequately braced to prevent damage during transit.

The tolerances for fabrication of steel structures will generally conform to IS:7215.



Any fabrication work which is considered not to be in keeping with the Technical Specification forming the Contract, or in absence of Technical Specification with recognized good practice, will be rectified /replaced /corrected at the Contractor's expense as directed by the Owner / Consultant. Site fabrication work will also conform to all specifications, stipulations, terms and conditions applicable for shop-welded structures as mentioned above.



4.7 **Erection of Steel Structures**

4.7.1 **Scope**

The scope of work under erection includes in addition to provision of erection and transport equipments, tools and tackles, consumables, materials, labour and supervision, the following:

- a) Storing and stacking at site of erection of all fabricated structural components/ units/assemblies till the time of erection.
- b) Transportation at site of structures.
- c) Receiving at site of structures including site handling /movement, unloading, storing and stacking at site of erection of technological structures such as bunkers and the related structures
- d) All minor rectification/modification such as :
 - i) Removal of bends, kinks, twists, etc. for parts damaged during transport and handling;
 - ii) Cutting chipping, filing, grinding, etc., if required, for preparation and finishing of site connections;
 - iii) Reaming for use of next higher size bolt for holes which do not register or which are damaged.

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<p>iv) Welding of connections in place of bolting for which holes are either not drilled at all or wrongly drilled during fabrication.</p> <p>e) Other rectification work such as</p> <p>i) Re-fabrication of parts, damaged beyond repair during transport and handling or incorrectly fabricated.</p> <p>ii) Fabrication of parts omitted during fabrication by oversight or subsequently found necessary.</p> <p>iii) Plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.</p> <p>iv) Drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.</p> <p>f) Fabrication of minor items/missing items or such important items as directed by the Owner Consultant.</p> <p>g) Assembly at site of steel structural components wherever required including temporary supports and staging.</p> <p>h) Making arrangements for and providing all facilities for conducting ultrasonic X-ray or gamma ray tests on welds; getting the tests conducted by reputed testing laboratories, making available test films/ graphs, reports and interpretation.</p> <p>i) Rectifying at site, damaged portions of shop primer by cleaning and touch-up paint.</p> <p>j) Erection of structures including making connections by bolts/high strength friction grip bolts/weldings.</p> <p>k) Alignment of all structures true to line, level plumb and dimensions within specified limits of tolerances as per IS code IS:12843 "Tolerance for Erection of Steel Structures".</p> <p>l) Application of second coat of primer paint and two coats of finishing paint at site after erection.</p> <p>m) Supply of labour in sufficient numbers, where necessary, as directed by the Owner /Consultant.</p> <p>n.) Conducting preliminary acceptance and final acceptance tests.</p>		
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- o) Preparation of as built drawings, preparing of sketches/drawings to suit availability of material, convenience of fabrication, transportation and erection and changes during fabrication and erection.

All such works are subjected to approval by the Owner / Consultant.

4.7.2 **Erection Drawings**

The approved erection drawings and any approved arrangement drawings, specifications or instructions accompanying them will be followed in erection of structures and miscellaneous connected items throughout the project.

If any dimension figured upon a drawing or plan differs from that obtained by scaling the drawing or plan, the dimension as figured upon the drawing or plan will be taken as correct. In case of discrepancy between large-scale details and small-scale drawings, the former will be followed. However, in such cases of discrepancies, the Contractor will get the same clarified by the Owner / Consultant.



4.7.3 **Storing and Handling**

The fabricated materials on receipt at site will be carefully unloaded, examined for defects, checked, stored out for each building and stacked securely on skids above level ground which will be kept clean and properly drained. Girders and beams will be placed upright and stored. Long members, such as columns and chord members, will be supported on skids placed near enough to prevent damage from deflection.

The fabricated materials will be verified with respect to markings on the marking plan or shipping list which will be supplied by the Contractor.

Any material found damaged or defective will be stacked separately and the damaged or defective portions will be painted in distinct colour for identification. Such materials will be dealt with as ordered by the Owner / Consultant.

The handling and storing of the component parts of a structure will involve the use of methods and appliances not likely to produce injury

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by twisting, bending or otherwise deforming the structures. No member slightly bent or twisted will be put in place until the defects are corrected. Members seriously damaged in handling will be rejected.

4.7.4 Defects in material & fabrication

All materials will be straight unless required to be curvilinear form and will be free from twist. All cold straightening will be done by pressure only.

During assembly and during erection the units to position, the Contractor will compare the structures with the drawings to ensure that there are no fabrication omissions or errors. Should any omission or defect be found the same will be brought to the notice of the Owner / Consultant who will issue necessary instructions for the rectification.



4.7.5 Setting out

The Contractor will prepare geodetic survey scheme of all embedded parts and holding down bolts and submit the same to Owner / Consultant. The Contractor will inform the Owner / Consultant about any discrepancy with approved design drawings well in advance of erection and if necessary will make necessary adjustments at site or during fabrication of structures.

The Contractor will assume, full responsibility for the free and correct setting out of all steel work and erection correctly in accordance with position, alignment, dimensions and levels shown on the approved drawings and plumbing vertical members. Particular care will be taken to ensure free expansion and contraction wherever provided. Notwithstanding any assistance rendered to the Contractor by the Owner / Consultant, if at any time during the progress of the work, any error should appear or arise therein, on being required to do so, the Contractor at his own cost will remove and amend the work to the satisfaction of the Owner / Consultant.

4.7.6 Assembly and Erection

Before starting erection, the Contractor will submit to the Owner / Consultant for his approval the method he proposes to follow and the number of types of equipments and temporary, works he proposes to use for the erection.



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The approval of drawings by the Owner / Consultant will not relieve the Contractor from the basic approach to design as regards the loads which the erection equipment and temporary work will be called upon to carry and support. Adequate allowance and provision will be made for lateral forces and wind loads.

If in the opinion of the Owner / Consultant, the tools, tackles plant and equipment instruments, apparatus, etc. arranged by the Contractor are not sufficient or are inadequate for the fulfilment of the contractual obligations of the Contractor within the stipulated period, the Owner / Consultant will have the right to order the Contractor and the Contractor will comply with the order to bring/arrange such additional tools, tackles, plant and equipment instruments, apparatus, etc. to the site and employ the same to complete the work in time. All charges in connection thereof will be borne by the Contractor.

Proper consideration will be given to the following items during erection.

- i) Frame of building to be true and plumb.
- ii) Temporary guying and bracing will be used to align the framing during erection, if required.
- iii) Temporary bracing may be required to sustain forces due to erection loads and equipments. Erected parts of the structures will be stable during all stages of erection. The stability of structures subjected to the action of wind, dead weight and erection forces will be obtained by observing specified sequence of erection of vertical and horizontal structural members and by installing permanent and temporary bracings.
- iv) Erection members will be held securely in place by bolts to take care of dead load, wind load and erection load.
- v) Free expansion and contraction wherever provided
- vi) No final bolting or welding of joints will be done until the structure has been properly aligned.
- vii) Erection tools and machinery will be of suitable capacity for handling the materials furnished and must be in safe operating conditions at all times to avoid danger to materials and personnel.
- viii) In positioning beams, columns or other steel members the use of steel sledges will not be permitted.

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- ix) The Contractor will report all failures of the fabricated Steel to fit together properly to the Owner / Consultant and will obtain approval prior to taking corrective measures.
- x) Steel members will not be allowed to fall or be subject to shock or impact due to other members being swung into position or for any other cause.

The erection will be carried out according to the best modern practices and as laid down in the IS : 800-1984 and other relevant standards referred to therein and according to this erection Specification together with approved erection drawings.



The Contractor will design, manufacture, erect and provide false work; staging, temporary supports, etc. required for safe and accurate erection of structural steelwork and will be fully responsible for the adequacy of the same.

The Contractor will, if so required by the Owner Consultant, get his drawings, erection schemes and designs for such false work, staging, etc. approved by the Owner / Consultant, but such approval by the Owner / Consultant will not relieve the Contractor of any of his responsibilities for the safety of such works. As far as possible, assemblies of structures will be made on the ground itself.

The Contractor will provide adequate supervision at all stages of the work and examine each portion of the work for accuracy before commencing the erection of the next structural member. The Contractor will also provide facilities such as adequate temporary access ladders, tools and tackles, instruments, etc. satisfactory to Owner Consultant for his inspection at any stage during erection.

Instrumental checking for correctness of initial setting out of structures, and adjustment of alignment will be carried out in sequence at different stages as determined by design as against checking and adjustment of alignment in one stage after completion of entire erection. The final levelling and alignment will be carried out immediately after completion of each section of a building or when called for by the Owner / Consultant.

All structural members will be erected with erection marks in the same relative position as shown' in the appropriate erection and shop drawings.

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4.7.7 **Field connections**

The holes of erection joints required to be machine bolted will be filled with temporary bolts and plugs after mounting the structures. The number of bolts and plugs will be determined by design but it will not be less than 50% of the total number of holes. In joints where the number of holes is equal to 5 or less, not less than 3 holes will be filled. The number of plugs will be about 20% of the holes filled.



The number of washers on permanent bolts will not be more than two (and not less than one) for nut and one for the bolt head. Wooden rams or mallet will be used in forcing members into position, in order to protect the metal from injury and shocks. Chipping of edges of plates will be done without breaking parent metal. Chipped edges will be finished with a file and all short corner and hammered rough faces will be rounded off. Chipping with the use of sledge hammer will only be permitted in exceptional cases and will be done without resulting in fractured edges.

Where bolting is specified on the drawings, the bolts will be tightened to the maximum limit. The threaded portion of each bolt will project through the nut by at least one thread. Tapered washers will be provided for all heads and nuts having bearing on bevelled surfaces. Use of special bolts, such as high strength friction grip bolts, will be according to the relevant Indian or other recognized standards And will be subject to the prior approval of the Owner / Consultant before use.

Spring washers or lock nuts will be provided as specified in the design/shop drawings. All machine fitted bolts will be perfectly tight and the ends will be checked to prevent nuts from becoming loose. No unfilled holes will be left in any part of the structures. All field assembly and welding will be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint will be removed before field welding, for a distance of at least 50mm on either side of the joints.

4.7.8 **Assembly by high strength friction grip bolts**

The mating surfaces will be absolutely free from grease, lubricant, dust, rust, etc. and will be thoroughly cleaned before assembly. The preparation of the mating surfaces will be done as specified in the design drawings.

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The nuts will be tightened upto the specified torque with the help of torque wrench or by half turn method with the help of pneumatic wrench lever. Torque value has to be specified in design / fabrication drawings itself. The direction of tightening of the nuts will be from the middle towards the periphery of the joint. The bolt head, nuts and edges of the mating surfaces will be sealed with a coat of paint to obviate entry of moisture. As far as possible, the diameter of bolts and mating surface preparation will be kept uniform to have specified unique torque.

4.7.9 **Bedding and grouting**

Base plates will be set to elevations shown in the drawings, supported and aligned using steel wedges and shims or any other approved method. The supply of wedges, shims and any other material for alignment will be the responsibility of the Contractor as part of this work. Plates will be levelled, properly positioned and the anchor bolts properly tightened. The bedding/grouting will not be carried out until a sufficient number of columns have been properly aligned, levelled and plumbed, and sufficient girders, beams, trusses and bracings are in position to the satisfaction of the Owner / Consultant.

The Contractor will inform the Owner/Consultant when the base plates are ready for grouting for their verification. The Contractor is responsible for final vertical and horizontal alignment of all the base plates.

4.7.10 **Painting after erection**



The painting will be as per painting specifications and instructions given on the drawings.

4.7.11 **Acceptance of work**

Acceptance of erected steel structures will be either after completion of erection of the whole building or in blocks.

Intermediate acceptance certificates will be given in the following cases

- i) Any steelwork or part thereof, embedded in concrete.

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- ii) Steel structures which are to be covered in the process of carrying out further work.

The following documents will be prepared and produced by the Contractor at the time of acceptance of erected steel structures :-

- i) Documents showing approved deviations made during execution of erection work.
- ii) Documents showing acceptance of embedded structural steelwork.
- iii) Certificates / documents on control checking and test of materials (if any) and welds.
- iv) Data and results of Geodetic measurements while checking the erection of structures.
- v) Copies of "As Built Drawings" showing thereon all additions and alterations.

4.8 **Welding Specifications**



4.8.1 **General**

The welding and welded work will conform to IS:816 and other relevant codes unless otherwise specified. Electrodes will conform to IS:814 and will be approved by the Owner / consultant.

Welding will be done by Electrical Arc Process. Automatic welding will be employed for important structures as specified in the drawings. Generally, submersed arc, Automatic & Semi-automatic welding will be employed. Only where it is not practicable, Manual Arc welding may be resorted to. In case of Manual Arc Welding, recommendations of electrode manufacturer are to be strictly followed.

Welding will not be done under such weather conditions which might adversely affect the efficiency of the welding and where necessary, effective protection and other safeguards will be provided.

Only qualified welders suitable for the job will be employed. The Owner / consultant at his discretion can order periodic tests in accordance with IS:817 of the welders and / or of the welds produced by them at no extra cost. Welds will be made using requisite jigs and fixtures to avoid distortions or damage to members during / after

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welding. Welds on exposed work will be finished uniformly smooth to present a neat appearance.

The layouts and sequence of operations will be arranged so as to eliminate distortion and shrinkage stress to the satisfaction of the Inspector. Welding work will be under constant supervision of competent welding supervisor and will be done in a properly organized manner with the approved quality welding sets and with automatic welding machines. Details of welding procedure shall be agreed upon with the Owner / consultant before the fabrication is commenced.

4.8.2 Welding procedure



Welding procedure will include the following

- i) Type and size of electrodes.
- ii) Current and arc voltage.(for automatic welding)
- iii) Length of run per electrode, or (for automatic welding) speed of travel.
- iv) Number and arrangement of runs in multi-run welds.
- v) Position of welding.
- vi) Preparation and set-up of parts.
- vii) Welding sequence.
- viii) Pre or, post-heating.
- ix) Any other relevant information.

The welding procedure will be arranged to suit the details of the joints as indicated in the drawings and the positions in which the welding is to be carried out. The welds will meet the requirements of quality specified.

All electrodes for use in the work to which the specification relates will be kept under dry conditions. Electrodes which are damaged by moisture will not be used unless it is certified by the manufacturer that when it is properly dried there will be no detrimental effect. Any electrode which has part of its flux coating broken away or is otherwise damaged will be discarded.

The Contractor will prepare the edges with an automatically controlled flame cutting torch followed by grinding correctly to the shape, size and dimensions of the groove, prescribed in the design

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and shop drawings. in case of U-groove joint, the edges will be prepared with an automatic flame cutting torch in two passes following a bevel cut with a gouging pass, or by machining.

The welding surfaces will be smooth, uniform and free from fins, tears, notches or any other defect, which may adversely affect welding. Welding surfaces or the surrounding surfaces within 50 mm of weld will be free from loose scale, slag, rust, grease, paint, moisture or any other foreign material. Pre-bending of plates for three plate welded sections will be done where found necessary.

Manipulators will be used where necessary and will be designed to facilitate welding and to ensure that all welds are easily accessible to the operators. Where full strength butt welds are specified run-on and run-off pieces will be used. The welding will be such that the face of weld deposit will at all places be proud of the surfaces of the parent metal by 1 to 1.5 mm. Where a flush surface is required, the surplus weld metal will be ground and dressed off.



After completing each run of weld, all slag will be thoroughly removed, and the surface cleaned before starting the next run of weld. The weld metal, as deposited (including tack welds if to be incorporated) will be free from cracks, slag, inclusions, gross porosity, cavities and other deposition faults. The weld metal will be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surfaces of the weld will have a uniform and consistence contour and uniform appearance.



All weld runs found defective will be cut by using either chipping hammer, gouging torch, or suitable grinding wheel in such a manner that adjacent material is not injured in any way. Peeling of the welds involving deformation of the weld surface either during de slagging or thereafter will not be allowed.

4.8.3 **Control in Welding**

The extent of quality control in respect of welds for structural elements for both statically and dynamically loaded structures will be as follows and will be conducted by the contractor at his own cost:-

- a) **Visual Examination** - All welds will be 100% visually inspected to check the following:

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<p>i) Presence of undercuts</p> <p>ii) Visually identifiable surface cracks in both welds and base metals.</p> <p>iii) Unfilled craters</p> <p>iv) Improper weld profile and size</p> <p>v) Excessive reinforcement in weld</p> <p>vi) Surface porosity</p> <p>Before inspection, the surface of weld metal will be cleaned of all slag, spatter matter, scales etc. by using wire brush or chisel.</p> <p>b) Dye Penetration Test (DPT) - This will be carried out for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following</p> <p>i) Surface cracks</p> <p>ii) Surface porosities</p> <p>Dye Penetration Test will be carried out in accordance with American National Standard ASTM E 165.</p> <p>c) Ultrasonic- testing: Ultrasonic test will be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by Owner, to detect the following</p> <p>i) Cracks</p> <p>ii) Lack of fusion</p> <p>iii) Slag inclusions</p> <p>iv) Gas porosity</p> <p>Ultrasonic testing will be carried out in accordance with American National Standard ANSI/AWS D1.92 Chapter - 6: Part C. Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. will be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface will be prepared to make it suitable for carrying out ultrasonic examination.</p> <p>d) Radiographic Testing (X-ray and Gamma-Ray Examination)</p>		
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This test will be limited to 2% of length of welds for welds made by manual or semi- automatic welding and 1% of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method will be decided by Owner to detect the following defects

- i) gas porosity
- ii) slag inclusions
- iii) lack of penetration
- iv) lack of fusion
- v) cracks

Radiographic testing will be conducted in accordance with American National Standard ANSI/AWSDI.1-92. Any surface irregularity like undercuts, craters pits etc. will be removed before conducting radiographic test. The length of weld to be tested will not be more than 0.75 x focal distance. The width of the radiographic film will be width of the welded joint plus 20 mm on either side of the weld.

- e) The Contractor will provide testing equipment for conducting non-destructive tests for confirming the integrity of welding wherever necessary as directed by the Owner / consultant.



4.8.4 **Acceptable Limits of Defects of Weld**

Limits of Acceptability of welding defects will be as follows:

- a) Visual inspection & Dye Penetration Test

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test will be in accordance with clauses 8.15.1 & clauses 9.25.3 of American National Standard ANSI/AWS DI.1-92 respectively, for statically and dynamically loaded structures.

- b) Ultrasonic Testing - The limits of acceptability of defects detected during ultrasonic testing will be in accordance with clause 8.15.4 & clause 9.25.3 of American National

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Standard ANSI/AWS D1.1-92 respectively for statically and dynamically loaded structures.

- c) Radiographic testing - The limits of acceptability of defects detected during Radiographic testing will be in accordance with clause 8.15.3 & 9.25.2 of American National Standard ANSI/AWS D1.1-92 respectively, for statically and dynamically loaded structures.

4.8.5 **Rectification of Defects in Welds**

In case of detection of defects in welds, the rectification of the same will be done as follows

- i) All craters in the weld and breaks in the weld run will be thoroughly filled with weld.
- ii) Undercuts, beyond acceptable limits, will be repaired with dressing so as to provide smooth transition of weld to parent metal.
- iii) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits will be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and will be re-welded. Defective weld will be removed by chipping hammer gouging torch or grinding wheel. Care will be taken not to damage the adjacent material.



4.9 **Painting of Building Steel Structures**

All steel structural work will be painted as follows unless otherwise stated in the drawings.

4.9.1 **Surface preparation**

The steel surface which is to be painted will be cleaned of dirt and grease, and the heavier layers of rust will be removed by chipping prior to actual surface preparation to a specified grade.

Following are the type and standards of surface preparation to be followed based on the requirement of a particular painting system or as specified in the design drawings.

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Manual/Power tool cleaning Manual/Power tool cleaning will be done as per Grade St-2 or St-3 of Swedish Standard institution SIS 05 5900 or cl. 6.2.1.1 & 6.2.1.2 of IS : 1477 (Part - I).

Grade St-2 :- Thorough scraping and wire brushing, machine brushing, grinding , etc - This grade of preparation will remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or clean brush. After preparation, the surface should have a faint metallic sheen. The appearance will correspond to the prints designated St-2.

Grade St-3 :- Very thorough scraping and wire brushing, machine brushing, grinding etc. The surface preparation is same as for St-2 but to be done much more thoroughly. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.



If no grade of surface preparation is specified, St-2 grade of preparation as per Swedish Standard will be followed.

4.9.2 Paint system

General service paint with intermediate coat for moderately humid condition, 10 to 15 km away from coast.

- i) Surface preparation : St-2
- ii) Primer paint: Two coats of zinc phosphate in phenolic alkyd medium 35 microns/coat).
- iii) Finishing paint: TWO coats of synthetic enamel (25 microns/coat) conforming to IS - 2932 .

All paints will be of approved and shade as per, Owner / Consultant's requirements. Joints to be site welded will have no paint applied within 100mm of the welding zone. Surfaces not in contact, but inaccessible after assembly, will receive two coats of primer paints before assembly.

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4.9.3 **Paint and painting** **General**

Manufacture of paints, mixing of paints, etc - will be generally according to the relevant IS codes of practice.

In the event of conflict between this Technical Specification for painting and the paint manufacturer's specification, this conflict will be immediately brought to the notice of the Owner / Consultant. Generally in cases of such conflicts, manufacturer's Specification/recommendation will prevail.

Generally compatibility between primer intermediate and finishing paint will be certified by the paint manufacturer supplying the paints. Before the Contractor buys the paint in bulk, it is recommended to obtain sample of paint and establish "Control Areas of Painting". On Control Area, surface preparation and painting will be carried out in the presence of the manufacturer of paint.



Control areas serve as specimen of painted surfaces, for observing and recording quality and performance of paint.

It is recommended to send samples of paint to recognized testing laboratories to establish quality of paint with respect to:

- i) Viscosity
- ii) Adhesion/bond of paint to steel surfaces
- iii) Adhesion/simulated salt spray test
- iv) Chemical analysis/percentage of solid by weight
- v) Normal wear resistance as encountered during handling and erection
- vi) Resistance against exposure to acid fumes, and such other tests as considered necessary by the Owner / Consultant.

Whole system of paint will be obtained from the same manufacturer.

Guarantee period will commence from the date of completion of finishing coat of paint on entire structures. The guarantee period will be indicated depending on the type of surface preparation and system of painting. To fulfill this obligations, the Contractor may obtain from the painting manufacturer, guarantee for the performance of paint/painted surfaces.

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The painting material as delivered to the Contractor/Appplier, must be in the manufacturer's original containers bearing thereon manufacturer's name, brand and description. Paint/painting material in the containers without labels or with illegible labels will be rejected, removed from the area and will not be used. Thinners wherever used will be those recommended by the paint manufacturer and will be obtained in the containers with manufacturer's name and brand name of the thinner legibly printed, failing which the thinner is liable to be rejected and will not be used.



Wherever shop primer painting is scratched, abraded or damaged, the surface will be thoroughly cleaned using emery paper and power driven wire brush wherever warranted or as directed by the Owner / Consultant, and touched up with corresponding primer. Touching up paint will be matched and blended to conspicuous marks. If more than 50% of the painting surface of an item requires repair, the entire item will be mechanically cleaned and new primer coats followed by finishing coats will be applied as per painting Specification.

All field welded areas on shop painted items will be mechanically cleaned including the weld area proper, adjacent to contaminated by weld spatter or fumes & areas where existing primer/intermediate/finish paint is burnt.

Subsequently, new primer and finishing coats of paint will be applied as per painting Specification.

Application of paint will be by spraying or brushing as per IS : 486 and IS . 487 and in uniform layers of 50% overlapping strokes by skilled painters. Painting will not be done when the temperature is less than 5 degree C or more than 45 degree C and relative humidity is more than 85%; unless manufacturer's recommendations permit. Also painting will not be done in foggy weather. During application, paint agitation must be provided where such agitation is recommended by the manufacturer.

Painting will be applied at painting manufacturer's recommended rates. The number of coats will be such that minimum dry film thickness specified is achieved. The dry film thickness (DFT) of painted surfaces will be checked with ELCOMETER or measuring gauges to ensure specified DFT.

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The inside surfaces of gutter which come in contact with rain water will be provided with 2 finishing coats of water resistant, bitumastic paint of minimum DFT 75 microns, in addition to the primer coats of red oxide zinc, phosphate in phenolic alkyde medium or 2 primer coats of epoxy based red oxide zinc chromate/epoxy based zinc phosphate of minimum DFT 25 microns per coat, as given in Specification and drawings. Other structures will be painted as per painting system mentioned .

All structures will receive one coat of primer paint at shop after fabrication before despatch after surface preparation has been done as per requirements. Unless otherwise specified all structures after erection will be given one coat of primer and two coats of finishing paint of approved colour and quality. The under coat will have different tint to distinguish the same from the finishing coat. Edges, corners, crevices, depressions, joints and welds will receive special attention to ensure that they receive painting coats of required thickness.

Machine-finished surface will be coated with white lead and tallow before shipment or before being put out into the open air. Part of steel structures embedded in concrete, will be given a protective coat of portland cement slurry immediately after fabrication after this part is thoroughly cleaned from grease, rust, mill scales etc. No paint will be applied on this part.



Zinc-rich primer paints, which have been exposed several months before finishing coat is applied, will be washed down thoroughly to remove soluble zinc salt deposits. In similar circumstances, the surface of paint based on epoxy resin should be abraded or lightly blast cleaned to ensure adhesion of next coat.

The proposed make, quality and shade of paint will have the approval of Owner / Consultant.

5.0 **General requirements**

5.1 **Programme**

The Contractor will prepare a programme showing the date of supply of steel to his work, and the fabrication and erection of each section of the structure or structures. The erection dates will be the dates for completion of all the follow-up work in addition to main erection

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keeping overall completion of project in view. The programme will include quantum of different activities of work planned month wise to complete the work.

5.2 **Drawings**

The Contractor will prepare steel structural arrangement drawings and design drawings along with design calculation of major elements and take their approval by Owner / Consultant with in the time schedule as per contract. Necessary number of prints of drawings and documents; as per contract will be submitted for approval. Bill of materials will form part of the fabrication drawings and will be included in the body of the drawing or prepared separately.



Even if the drawings are approved/Commented by the Owner / Consultant, the Contractor will not be relieved of the responsibilities for the accuracy of the detailed dimensions shown in the drawings and the safety of all structural connections.

Notes on specifications shown on design drawings will be considered as superseding or overriding the specifications with which they conflict. On all drawings, dimensions shown in figures will be acted on. Erection drawings in requisite number of sets will be submitted to the Owner / Consultant showing thereon all authorized additions and alterations in the process of erection. These drawings will show the "As-Built Installations".

Supply and distribution of fabrication drawings. and other documents like bolt list etc. for the contractors own use or for the use of his subcontractors will be the responsibility of the Contractor.

- 5.3 The Contractor will assume full responsibility for the correct setting out of all steel works and erecting correctly in accordance with alignment and levels shown on the approved drawings and plumbing of vertical members. Notwithstanding any assistance rendered to the Contractor by the Owner / Consultant, if at any time during the progress of the work, any error should appear or arise therein, on being required to do so, the Contractor at his own cost will remove and amend the work to the satisfaction of the Owner / Consultant.

The Contractor will provide his own measuring instruments for setting out, levelling and aligning work at his own expense.

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5.4 **Co-ordination with other Contractors**

The structures will have to be erected suitably detailed with erection of equipment or construction of civil works. The Contractor will ensure spirit of co- operation with other contractors and strict adherence to the schedule so that erection schedules of the other parties are not affected.

5.5 **Staging**

Any staging necessary for the pre assembly work of structures will be provided by the Contractor.

5.6 **Rules and regulations of safety, electricity boards, factory etc.**



The Contractor will at all times comply with such rules and regulations as stipulated in relevant factory acts, electricity rules, safety regulations, etc.

6.0 **Gratings**

- 6.1 The MS/GI gratings shall be electro forged and shall be of approved brand and manufacturer .The type of grating selected shall be based on the loading in the area in which the grating is provided and shall be subject to approval of Engineer.

7.0 **Deviations**

- 7.1 Should the contractor wish to deviate from any specifications or approved drawings and /or technical specifications ,he will obtain the Owner/Consultant's written authority before proceeding with the deviations.

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PART F: FABRICATION OF GALVANISED STEEL SWITCHYARD STRUCTURES

1.0 SCOPE

- 1.1. This specification covers provisions relating to preparations of shop and erection drawings based on design drawings, fabrication, inspection, galvanising, packing requirements and delivery at destination specified, of self supporting steel lattice Transmission line towers, and Substation / Switchyard structures.



2. APPLICABLE CODES AND SPECIFICATIONS



The following specifications, standards and codes are made a part of this specification. All standards, specifications, codes of practice referred to herein shall be the latest edition including all applicable official amendments and revisions.



In case of discrepancy between this specification and those referred to herein, this specification shall govern.

- 1) IS : 209 - Zinc Ingot for galvanising
- 2) IS : 800 - Code of Practice for General Construction in steel.
- 3) IS : 802 - Code of practice for use of Structural Steel in
(Part I, Part 1/ Overhead Transmission line towers.
Sec1 & Sec 2,
Part II , III)
- 4) IS : 808 - Dimensions for Hot Rolled Steel Beams, Column Channel and Angle sections.
- 5) IS : 816 - Code of Practice for use of Metal Arc Welding for General Construction in Mild Steel.
- 6) IS : 961 - Structural Steel (High Tensile)

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<p>7) IS : 1367 - Technical Supply Conditions for Threaded Steel Fasteners.</p> <p>8) IS : 1852 - Specification for Rolling and Cutting Tolerance for Hot Rolled Steel Products.</p> <p>9) IS : 2016 - Plain Washers.</p> <p>10) IS : 2062 - Steel for General Structural purposes - Specification.</p> <p>11) IS : 2551 - Danger, Notice Plates.</p> <p>12) IS : 2629 - Recommended Practice for Hot Dip Galvanising of Iron and Steel.</p> <p>13) IS : 2633 - Methods of Testing Uniformity of Coating of Zinc coated Articles.</p> <p>14) IS : 3063 - Single coil rectangular section spring washers for fasteners.</p> <p>15) IS : 4759 - Hot dip zinc coatings on structural steel and other allied products.</p> <p>16) IS : 5613 - Code of Practice for design, installation and maintenance of over head power lines.</p> <p>17) IS : 6639 - Hexagonal bolts for steel structures.</p> <p>18) IS : 8500 : Structural steel – Microalloyed (Medium & high strength quantities)</p> <p>19) IS : 9595 - Recommendations for Metal-arc welding of carbon and carbon manganese steels.</p> <p>20) IS :10238 - Step bolts for steel structures (Ammendments 3)</p> <p>3. <u>DRAWINGS BY ENGINEER</u></p> <p>3.1. Bid / preliminary drawings represent only typical structural arrangements of the proposed structures, and are for information</p>		
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<p>only. Final design drawings and all subsequent revisions when completed and issued, shall form a part of this specification.</p> <p>3.2. Engineer shall furnish to fabricator final design drawings giving all Dimensions, sizes of members, forces in members and all other pertinent details. Fabrication drawings shall be prepared by fabricator / other experienced detailers only from these drawings and shall be reviewed and stamped by Engineer as “ APPROVED FOR FABRICATION ”.</p> <p>4. <u>SUBSTITUTION / MODIFICATION</u></p> <p>No deviations and /or substitutions of section shall be made by Fabricator, unless authorised in writing by Engineer.</p> <p>5. <u>DRAWINGS BY FABRICATOR</u></p> <p>5.1. Plans and drawings shall be prepared according to IS : 696 and IS : 962.</p> <p>5.2. Fabricator / Detailor shall prepare fabrication and erection drawings in metric units as specified under “Scope”. These drawings shall clearly show member sizes, length and marks, hole positions, gauge lines, bend lines, edge distance, amount of chipping, notching, etc. in complete details. All connections and splices shall be designed and detailed by fabricator / detailer and clearly shown on the drawings. Bill of materials for each type of tower / structure shall be prepared separately. This shall show grade of steel, mark numbers, section sizes, member lengths their calculated weights and assembly mark on each type of member and shall include all bolts, nuts, washers, other accessories and their sizes, total quantities required complete for one structure. No reduction in weight due to drilling, punching of bolts holes, screw cuts, clipping, notching, chamfering, etc. shall be made while computing calculated weight of members.</p> <p>5.3. Fabricator shall submit for information design calculations in support of the connection details proposed by him.</p> <p>5.4. Fabricator shall check erection clearances and ensure that detailing of connection is carefully planned for easy erection.</p>		
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<p>5.5. Erection drawings shall show each individual member with its identification mark, location and position of the outstanding leg of angles, number and length of connection bolts and their diameter. These drawings shall also show location and details of splicing, bottom of base plate, levels and locations of all cross connections. All drawings shall be of one standard size. The main views like plan and elevation of towers shall be drawn to a scale not smaller than 1:15. All connection details shall be drawn to a scale of not smaller than 1:5. Separate erection drawings to a convenient scale shall be prepared for facility of use in the field. Any special erection techniques proposed / required in erection of the structure shall be shown on the erection drawings.</p> <p>5.6. Engineer shall furnish separate footing or foundation drawings if such drawings are considered necessary for fabricator's work. These drawings will show details in respect of stubs or foundation anchor bolts and any other details that may be required.</p> <p>5.7. Fabricator shall submit atleast three copies of all drawings to the Engineer for review. Engineer will return one copy each of the drawings marked with his approval / comments. Fabricator shall submit to Purchaser and Engineer with requisite nos. of prints of all approval final drawings as per work order for field use and record purpose. Contractor shall also submit to Purchaser as well as Engineer with two direct reading reproducible of each drawing. These reproducible shall incorporate all modifications, field changes, substitutions etc. effected and reflect the status "As Built". All these drawings will remain property of Purchaser.</p> <p>Purchaser reserve the right to use them in any manner whatsoever.</p> <p>6. <u>MATERIALS AND WORKMANSHIP</u></p> <p>6.1. <u>GENERAL</u></p> <p>Materials used for fabrication shall conform to the material specification furnished in design drawings and in accordance with good practice pertinent to the fabrication of structural steel. All material supplied by fabricator shall be of recent manufacture,</p>		
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free from defects, mill scales, slag intrusions, laminations, pitting, flake rusts etc.

6.2. MATERIALS

Unless otherwise stated, materials shall be new and in accordance with the following:

6.2.1. ROLLED SECTIONS AND PLATES



Rolled section and plates shall conform to any of the grade, as appropriate of IS : 2062 / 961 / 8500. Medium / High strength structural steel with known properties conforming to other national and international standards may also be used subject to approval of Purchaser.

6.2.2. Certified mill test reports, properly correlated to the materials, shall be made available to Engineer to constitute evidence of conformity with the above specification.

6.2.3. BOLTS, NUTS AND WASHERS

Bolts for tower connections shall conform to IS : 12427 or of property class 4.6 conforming to IS : 6399. High strength bolts, if used (only with structural steel of IS : 8500) shall conform to property class 8.8 of IS : 3757. Foundation bolts shall conform to IS : 5624.

Step bolts shall conform to IS : 10328.

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Nuts shall conform to IS : 1363 (Part 3). Its' mechanical properties shall conform to property class 4 or 5 as the case may be as specified in IS : 1376

(Part 6) except that Proof Stress for nuts of property class 5 shall be as specified in IS : 12427.

Nuts for High strength bolts shall conform to IS : 6623.

Washers / Heavy washers / Spring washers shall conform to IS : 2016 / 6610 / type B of 3063 respectively.

Washers to be used with High strength bolts & nuts shall conform to IS:6649.

6.2.4. ZINC



Zinc required for galvanising will have to be arranged for by fabricator. Quality of zinc shall confirm to IS : 209.



6.2.5. Castings shall not be used except where specifically approved by Engineer.



6.3. FABRICATION AND WORKMANSHIP

6.3.1. All workmanship and finish shall be first class and conform to the best modern practice for the work in view. Ease of assembling the structures in the field is of utmost importance.

6.3.2. All materials shall be reasonably straight before fabrication. Raw materials slightly bent in transit or stacking shall be thoroughly straightened and or flattened by pressure, unless required to be of curvilinear and shall be free from twists in the shop by methods which will not impair its specified strength in any manner before being laid out or worked on in anyway. Materials damaged or badly bent in transit or otherwise shall not be used.

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<p>6.3.3. Cutting may be effected by shearing, punching, flame cutting or sawing done accurately. Surface so cut shall be clean, smooth, reasonably square and free from distortion and such that members of the structure may be assembled without mismatch /reaming of holes.</p> <p>Shearing shall be done by gauge and no variation in length shall be allowed except where otherwise noted on shop detail drawings. All bend cutting shall be accurate and variation of more than 1.5 mm shall be cause for rejection.</p> <p>6.3.4. Punching shall be done by gauge or by other methods acceptable to Engineer to ensure the accuracy required for this class of work. No variation shall be allowed in a group of holes and the centre to centre distance between the end holes of a piece shall not vary more than 1.0 mm. The diameter of holes shall not exceed the diameter of the bolts by more than 1.5 mm. However, holes for embedded anchor bolts where so specified shall be 5 mm larger than the bolt diameter. Holes may be punched full size as indicated below:</p> <p>For Mild Steel : Member thickness not to exceed hole diameter minus 1.6 mm subject to a maximum of 12 mm.</p> <p>For High Tensile Steel : Member thickness not to exceed hole diameter minus 4.7 mm subject to a maximum of 12 mm.</p> <p>Sub-punching may be permitted before assembly, provided the holes are punched 3 mm smaller in diameter than the required size and reamed before assembly to the full diameter. The thickness of material punched in such cases shall not exceed 16 mm.</p> <p>6.3.5. Holes in members thicker than 12 mm shall be formed by drilling.</p> <p>6.3.6. Holes shall not be formed by flame cutting process.</p> <p>6.3.7. All holes shall be truly cylindrical. Oval holes are not acceptable. Holes shall be perpendicular to the surface of plates or angle.</p> <p>6.3.8. Holes near the bend line of a bent member, on both sides of bend line shall be punched / drilled after bending and relative position of these holes shall be maintained with use of proper template / jigs</p>		
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<p>and fixtures. Bending shall be moderately sharp and true to the detail shown on shop drawings. Bends may be done either hot or cold. Angles upto and including 100 mm leg width and 6 mm thickness up to a bend angle of 10° shall be bent cold. All angles section larger than 100 mm leg width and 6 mm thickness and also for bend angle more than 10° shall be bent hot. All plates up to 12-mm thickness shall be bent cold up to a maximum bend angle of 15°. Greater bends and larger thickness shall be bent hot.</p> <p>6.3.9. The maximum length of members shall normally be restricted to 6.5 metres or the length that can be accommodated in the size at the galvanising bath available and in no case shall exceed 8.0 metres. Where lap splices are used, the back of the inside angle shall be chamfered / ground to clear the fillet of the outside angle. Leg splices shall be located near strut connections, but clear of the strut.</p> <p>6.3.10. All identical pieces bearing the same erection number must be interchangeable with each other and interchangeable in their relative position in all towers or structures of which they form a part.</p> <p>6.3.11. All burrs and irregular edges will be ground smooth before galvanising.</p> <p>6.3.12. Holes required for various attachments, accessories, connections, extensions etc. shall be drilled as shown / required before galvanising.</p> <p>6.3.13. Joints shall be so detailed to avoid eccentricity as far as possible. Gusset plates and spacer plates shall be used in conformity with the best modern practice. Pockets or depressions shall have drain holes.</p> <p>6.3.14. Bolts at a joint shall be so staggered that nuts may be tightened with spanners without fouling.</p> <p>6.3.15. Leg ends, bearing on each other or resting on bases, shall be ground smooth true to bear and to ensure good bearing and perfect alignment. Base plates shall have their surfaces milled true and square.</p> <p>6.3.16. No machine or shopwork, diework, punching, welding, and grinding, machining etc. will be permitted after galvanising.</p>		
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- 6.3.17. After approval of drawings, unless specifically waived in writing by Engineer, Fabricator, in the presence of Inspector, shall completely assemble at his works, one tower/structure of each type, including extensions before undertaking mass fabrication work. The cost of such assembly and dismantling shall be borne by Fabricator.

Any errors in the shop detail drawings or shopwork shown by this assembling shall be immediately rectified.

7. CONNECTIONS



All field connections shall be made with hexagonal headed bolts with spring washers of positive lock type, specified thickness and hexagonal nuts. Lock nuts shall be provided, if specified. All bolts shall extend full size completely through the connected members. All bolts, nuts and washers shall be hot dip galvanised. Readily available GI nuts, bolts and washers may also be used. Nuts shall be retapped after galvanising. Bevelled washers shall be furnished for all bolts in sloping flanges.



- 7.1. Preferably all bolts for a particular tower shall be of same diameter.
- 7.2. The connections shall be designed in such a way to minimise use of gussets.
- 7.3. The length of the bolt shall be such that the threaded portion does not lie in the plane of contact of members.
- 7.4. It shall also be ensured that the threaded portion of bolt protrudes not less than 3 mm and not more than 8 mm over the nut after it is fully tightened.
- 7.5. The gap between ends of angle members in case of butt splice shall not exceed 6 mm.



8. WELDING



8.1. GENERAL



Welding shall be kept to a minimum but where necessary, it shall be carried out before galvanising and shall conform to Indian Standard

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<p>Specifications. Welding shall be continuous unless otherwise shown. Caution shall be exercised to obtain full penetration of weld when welding light members to heavy members. If minor site welding is proposed and erection is not a part of the total scope of Fabricator's work, electrodes 10% in excess of net requirement shall be supplied. Fabricator shall also in such a case supply sufficient quantity of Zinc rich paint.</p> <p>9. <u>TOLERANCES</u></p> <p>9.1. The weight and dimensional tolerances for rolled shapes and sections shall not exceed the limit specified by IS : 808 and IS : 1852.</p> <p>9.2. Finished members shall not have lateral variations greater than 1/1000 of the axial length between points of lateral supports.</p> <p>9.3. Finished members without ends finished for contact bearing shall have a tolerance ± 1 mm for members up to 3 m in length. For members over 3 m long an additional 1 mm for every 3 m length may be allowed but in no case will a tolerance more than 3 mm be allowed for any member.</p> <p>9.4. The maximum allowable difference in diameter of the holes on the two sides of plate or angle shall be 0.8mm, that is the allowable taper in a punched hole shall not exceed 0.8mm on diameter.</p> <p>9.5. Tolerance cumulative and between consecutive holes shall be within ± 0.5 mm.</p> <p>9.6. Tolerance on overall length of a member shall be within ± 1.6mm.</p> <p>9.7. Tolerance on gauge distance shall be within ± 0.5mm.</p> <p>10. <u>GALVANISING</u></p> <p>10.1. After all shop work is complete, all structural materials shall be punched with the erection mark and be hot-dip galvanised. Members embedded in concrete shall be galvanised from the top to a point atleast 300 mm below the proposed elevation of the concrete foundation. Earth grillage members including stubs shall be fully galvanised. Before galvanising, the steel section shall be thoroughly</p>		
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<p>cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process or with the quality and durability of the zinc coating. Pickling shall be very carefully done and shall be proper.</p> <p>10.2. The mass of zinc coating unless specified otherwise shall be at least 0.610 kg/m² of total surface area for normal and rural atmosphere. In case of special atmosphere like Marine and Industrial atmosphere, minimum mass of coating shall be increased as agreed to between galvanizer and purchaser. Stub members and members for grillage type footings shall have heavier zinc coating not less than 0.80 kg/m²</p> <p>10.3. The galvanised surface shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth, and shall be free from imperfections as flux, ash and black spots pimples, lumpinch runs, rust stains, balky white deposits and blisters. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.</p> <p>10.4. There shall be no flaking or loosening when struck squarely with a chisel faced hammer. The galvanised steel member shall withstand minimum four one minute dips in copper sulphate solution as per IS : 2633.</p> <p>10.5. Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However, in case of members over 7.5 m long, fabricator shall take prior approval of Engineer for double dipping. When the steel section is removed from the galvanising kettle, excess spelter shall be removed by bumping. The process known as 'wiping' or 'scraping' shall not be used for this purpose.</p> <p>10.6. Threaded fasteners shall be galvanised to conform to requirements of IS : 1367 (Part 13). Spring washers shall be hot dip galvanised as per service grade 4 of IS : 4759 or Electro-galvanised as per service grade 3 of IS :1573 as specified by purchaser. Readily available GI nuts, bolts and washers may also be used. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Rechasing of bolt threads, after galvanising, shall not be permitted. Nuts however may be tapped, but not to cause appreciable rocking of the nuts on the bolts.</p>		
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<p>10.7. Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications, or lack of quality control in any manner in the galvanising plant, shall render the entire production in the relevant shift liable to rejection.</p> <p>10.8. If called for in Engineer's drawings or in section C, all towers and accessories shall be treated with Sodium Dichromate or an approved equivalent solution after galvanising, so as to prevent white storage stains.</p> <p>10.9. Approval shall be secured from the Owner / Engineer if galvanising is done outside Fabricator's plant.</p> <p>10.10. Fabricator shall furnish sufficient quantity of appropriate paint, free of cost, for repairing galvanised surfaces, damaged in transit.</p> <p>11. <u>ACCESSORIES</u></p> <p>11.1. <u>STEP BOLTS</u></p> <p>Galvanised step bolts shall conform to IS : 10238 and shall be spaced 400mm centre to centre on tower legs as shown on the drawing and shall be provided up to the topmost conductor. The step bolt shall be 16 mm diameter and 165 mm long, with a 50 mm diameter button head. Each step bolt shall be provided with two nuts and shall be capable of withstanding a vertical load of not less than 150 kgs.</p> <p>11.2. <u>LADDER</u></p> <p>A galvanised steel ladder shall be provided if indicated in scope of supply. It shall generally be built of flats / angles spaced 450 mm apart clear with rungs of minimum 16□ □ round bars at spacing not exceeding 300 mm.</p> <p>11.3. <u>DANGER, NUMBER AND PHASE PLATES</u></p> <p>11.3.1. These plates shall be made from 16 gauge steel sheets and shall have enamelled finish. The sizes and markings to be painted on these plates shall be as detailed in Engineer's drawings. Phase</p>		
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<p>plates shall be in sets of three plates. Each tower shall be provided with suitable additional members and provided with drilled holes in a suitable position for fixing the danger, number and phase plates. The danger plate shall be fixed on the longitudinal face and phase and number plates on the transverse face.</p> <p>11.3.2. In addition, where specified, for facilitating tower identification during aerial- patrolling, tower number-plates shall be provided on the top of towers at intervals of one kilometre. These shall be made from 16 gauge steel sheets, with flexible baked enamel finish, and shall be as detailed in Engineer's drawings.</p> <p>11.4. Where called for, galvanised, spiked anti-climbing device shall be provided an each tower. Height of such a device shall be not less than 2.75 M and not greater than 3.75 M from ground level at tower positions. Spikes shall be of 12 mm dia and shall project atleast 300 mm from the face of the tower measured horizontally. Such spikes shall be inclined to the horizontal by 45⁰ and point downwards.</p> <p>11.5. Approved type of galvanised bird guards of cone design made of 16 gauge steel sheets shall be provided, as shown on the drawings.</p> <p>11.6. Galvanised U-bolts, shackles, hangers, clamps etc. shall be supplied as required.</p> <p>12. <u>MARKING</u></p> <p>12.1. Each individual tower member shall be marked with its respective identification mark given to it on the erection drawings. The marking shall be stamped with a metal die before galvanising with figure at least 2 cms high, in such a manner and to such optimum depth as to be clearly visible after galvanising.</p> <p>12.2. The markings shall be on the outer surface of all angle sections and near one end but clear of bolt holes. For other members such as channels, flats, gusset plates etc. the markings shall be so stamped that they are easily discernible when sorting out members.</p> <p>12.3. Marking on like pieces shall be in identical locations. Members having lengths 3 metres or more shall be stamped at each end.</p>		
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- 12.4. After galvanising, marks shall be circled or bracketed with black paint.



13. **ERRORS**

Any error in shop work, which prevents proper assembling and fittings up of parts in the field by moderate use of drift pins, will be classified defective workmanship. If erection is excluded from the scope of work, all charges incurred in rectification of defective workmanship will be deducted from the amount due to the Fabricator, when final payment is made. In case material is rejected, the cost of all handling and transport of the material to Fabricator shall be entirely to Fabricator's account. All replacement material shall be supplied free and the cost of handling, transport and delivery will be borne by Fabricator.

14. **INSPECTION**



- 14.1. The work and materials covered by this specification shall be subject to inspection by inspector. Inspection shall also include the stacking of finished material in fabricator's works and loading into cars or wagons, for shipment or despatch to the consignee.
- 14.2. Inspector shall have free access at all reasonable times to those parts of the fabricator's works which are connected with fabrication of steelwork and shall be afforded all reasonable facilities for inspection and tests. All gauges and templates, equipments and instruments required for routine inspection shall be furnished by fabricator. To ascertain correct grade and quality of steel used, the inspector at his discretion may get the material tested at a suitable or approved laboratory.
- 14.3. Inspection by Inspector or waiving of inspection and release of material shall not relieve Fabricator from the responsibility of furnishing materials to conform to the requirements of this specification, nor invalidate any claims which may be made because of defective or unsatisfactory material, workmanship and galvanising.
- 14.4. Any material that is rejected by Inspector shall be promptly replaced and or defects which may appear during fabrication shall be made good by Fabricator with consent of and according to procedure laid done by Inspector and without extra cost. The fact that certain

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<p>material has been accepted at Fabricator's works shall not prevent final rejection at site if it fails to meet specification requirements or if fabrication inaccuracies prevent proper assembly.</p> <p>15. <u>PACKING AND DELIVERY</u></p> <p>15.1. Angle sections shall be wire bundled or despatched loose as may be mutually agreed upon.</p> <p>15.2. All similar parts of the same tower structure shall be bundled together before despatch, except such parts as would make too heavy a bundle for convenience in handling, gross weight of each bundle shall not exceed approximately 600 kgs. The bundles shall be securely tied at the two ends with galvanised steel binding wire straps of adequate strength to withstand transit handling. Long members shall be similarly securely fastened at one or more intermediate points.</p> <p>15.3. Cleat angles, brackets, gusset plates and similar small pieces shall be nested, securely wired together through bolt holes and wrapped with galvanised steel wire of adequate strength to ensure against part falling during transit. Gross weight of such a bundle shall not exceed 50 kg.</p> <p>15.4. Bolts, nuts, washers and other attachments for one tower / structure shall be packed in double gunny bags accurately tagged. The various sizes of bolts shall be kept separate in sacks.</p> <p>15.5. Any loss or damage arising out of insufficient or defective packing shall be borne by fabricator. Bills of materials shall be furnished to Engineer for each consignment despatched.</p> <p>15.6. Complete tower / structure with bolts, nuts, attachments, etc. shall be included in each consignment. If so required, fabricator shall despatch stub members with necessary bolts, nuts etc. in advance of the super-structure, with associated templates for setting. Deliveries should be in a phased manner to that erection work could proceed simultaneously.</p> <p>15.7. Each bundle or package shall have the following details marked on it properly stencilled in indelible ink on the top members in the bundle</p>		
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of tower steel and on wooden boxes or bags carrying smaller components.

- a) The name or designation and address of consignee.
- b) The ultimate destination and the port of discharge.
- c) The relevant mark of structure members, bolts and nuts, gussets or other attachments for easy identification.

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PART G : GALVANISING OF STRUCTURAL STEEL



1. SCOPE



This specification covers the general requirement of Hot dipped galvanising, Electroplated, Sheardized and Sprayed Zinc coating of the structural steelwork. It covers the supply of all materials, labour, tools, plant, equipment, necessary to galvanise the structures in accordance with specifications.

2. APPLICABLE CODES AND SPECIFICATIONS

2.1 The following Specifications and Codes of Practice are made a part of this specification. All Specifications and Codes of Practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this Specification shall govern.



- 1) IS : 1367 - Hot-dip Galvanised Coatings on Threaded Fasteners.
(Part-13)
- 2) IS : 1573 - Electroplated Coatings of Zinc on Iron and Steel.
- 3) IS : 2629 - Recommended Practice for Hot-dip Galvanising on Iron and Steel.
- 4) IS : 2633 - Methods of Testing Uniformity of Coating on Zinc Coated Articles.
- 5) IS : 4736 - Hot-dip Zinc Coatings on Mild Steel Tubes.
- 6) IS : 4759 - Hot-dip Zinc Coatings on Structural Steel and Other Allied Products.
- 7) IS : 5905 - Sprayed Aluminium and Zinc Coatings on Iron and Steel.
- 8) IS : 6158 - Recommended Practice for Safeguarding Against Embrittlement of Hot-dipped Galvanised Iron and Steel Products.

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<p>9) IS : 6159 - Recommended Practice for Design and Fabrication of Material Prior to Galvanising.</p> <p>10) IS : 6745 - Method for Determination of Mass of Zinc Coating on Zinc Coated Iron and Steel Articles.</p> <p>3. GALVANISING PLANT</p> <p>3.1 The BIDDER shall indicate in his bid the galvanising plant where galvanising work will be carried out. Prior approval shall be obtained from OWNER/ ENGINEER if galvanising proposed to be carried out outside Contractor's plant.</p> <p>4. WORKMANSHIP</p> <p>4.1 After all shop work is complete, all structural material shall be punched with the erection mark to be hot-dip galvanised. Before galvanising, the steel shall be thoroughly cleaned of any paint, grease, rust, scale, acid or alkali or such other foreign matters as are likely to interfere with the galvanising process or with the quality and durability of the zinc coating as specified in clause 4 of IS : 2629. Pickling followed by Rinsing shall be carefully and properly done as specified in IS: 2629.</p> <p>4.2 Zinc conforming to any grade specified in IS : 209 shall be used for galvanising. Mass of zinc coating under specified otherwise shall be at least 0.610 kg/sq. m. of total surface area for normal or rural atmosphere. In case of industrial atmosphere, minimum mass of coating shall be increased as agreed to between the Galvanizer and Purchaser. Stub members and members for grillage type footing shall have heavier zinc coating of not less than 0.80 kg/sq. m. Where required by Purchaser, Post Treatment such as Chromating or Phosphating may be applied to reduce risk of wet storage staining or to assist subsequent painting, respectively.</p> <p>4.3 The galvanised surface shall consist of continuous & uniformly thick coating of zinc, firmly adhering to the surface of steel. The finished surface be cleaned & smooth & be free from imperfections as flux, ash and bare patches, black spots, pimples, lumpinches, runs, mist stains, bulky white deposits and blisters. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable for rejection. Sampling and nos. of test for coating</p>		
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characteristics shall be as specified in IS : 4759. Mass of zinc coating may be determined in accordance with IS : 6745.

- 4.4 There shall be no flanking or loosening when struck squarely with a chisel faced hammer. The galvanised steel member shall withstand minimum four no of one minute successive dips in copper sulphate solution kept at temp. of $18 \pm 2^{\circ}\text{C}$ as per IS : 2633 unless specified otherwise. If at anytime during the test, there is any doubt as to presence of exposed base metal as determined by visual inspection, one or more of supplementary tests as specified in Cl.6.1 or 6.2 of IS: 2633 should be performed. Where practicable, uniformity of galvanised coating shall be determined by Preece test as described in IS : 2633 Use of Preece test should be agreed to between Purchaser and Galvanizer. For Hot dipped galvanised steel members, coating shall withstand the Pirotted hammer and Knife tests as prescribed in IS: 2633 for testing adhesion of zinc coating on fabricated steel and hardware respectively.
- 4.5 All galvanised members shall be treated with Sodium Dichromate solution or an approved equivalent after galvanising, so as to prevent white storage stains.
- 4.6 Galvanising of each member shall be carried out in one complete immersion. Double dipping shall not be permitted. However in case of members over 7.5m long, the Contractor shall take prior approval of Engineer for double dipping. When the steel section is removed from the galvanising kettle, excess spelter shall be removed only by 'bumping'.
- 4.7 Whenever galvanised bolts, nuts, locknuts, washers, accessories etc. are specified, these shall be hot-dip galvanised. Spring washers shall be electro-galvanised. Excess spelter from bolts, nuts, etc. shall be removed by centrifugal spinning. Rechasing of bolt threads after galvanising shall not be permitted. Nuts however may be tapped, but not to cause appreciable rocking of the nuts on the bolts. Readily available GI nuts, bolts and washers conforming to galvanising requirements may also be used.
- 4.8 Defects in certain members indicating presence of impurities in the galvanising bath in quantities larger than that permitted by the specifications or lack of quality control in any manner in the

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galvanising plant, shall render the entire production in the relevant shift liable to rejection.

- 4.9 Sufficient care should be exercised while storing, packing and handling. Contractor shall ensure that galvanising is not damaged in transit. While storing and transporting, adequate ventilation should be provided as otherwise 'White rust' or 'Wet storage stain' may result with humidity and atmospheric gases. In the event of occurrence of any damage, contractor shall at its own cost adopt scrapping & regalanizing the member to satisfy the specific requirements. In many cases, it will be advisable to give a Post-treatment like Chromatting to minimise chances for formation of white rust.

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PART F : GENERAL BUILDING WORKS

1.0 SCOPE



This specification covers the general requirements for building works comprising brick and stone masonry, flooring, doors, windows, ventilators, wood/aluminium work, water- proofing, plastering, painting and such other related works forming a part of this job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, and everything necessary for carrying out the work.



2.0 APPLICABLE CODES AND SPECIFICATIONS



The following codes, standards and specifications are made a part of this specification. All standards, specifications, codes of practice referred to herein shall be the **latest editions including all applicable official amendments and revisions.**



In case of discrepancy between this specification and those referred to herein, this specification shall govern.



- IS:110 - Ready mixed paint, brushing, grey filler, for enamels for use over primers.
- IS:269 - Specification for 33 grade ordinary portland cement.
- IS:280 - Specification for mild steel wire for general engineering purposes.
- IS:287 - Recommendations for maximum permissible moisture content of timber used for different purposes.
- IS:337 - Varnish, finishing interior.
- IS:348 - French polish.
- IS:383 - Specification for coarse and fine aggregates from natural sources for concrete.



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	TECHNICAL SPECIFICATIONS FOR CIVIL WORKS PART F- GENERAL BUILDING WORKS																																							
<table><tr><td>IS:412</td><td>- Expanded metal steel sheets for general purposes.</td></tr><tr><td>IS:419</td><td>- Specification for putty for use on window frames.</td></tr><tr><td>IS:428</td><td>- Distemper, oil emulsion, colour as required.</td></tr><tr><td>IS:702</td><td>- Specification for industrial bitumen.</td></tr><tr><td>IS:710</td><td>- Specification for marine plywood.</td></tr><tr><td>IS:712</td><td>- Specification for building limes.</td></tr><tr><td>IS:733</td><td>- Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes.</td></tr><tr><td>IS:777</td><td>- Specification for glazed earthenware tiles.</td></tr><tr><td>IS:1003</td><td>- Specification for timber panelled and glazed shutters (Part 1)</td></tr><tr><td>IS:1003</td><td>- -DO- (Part 2)</td></tr><tr><td>IS:1038</td><td>- Specification for steel doors, windows and ventilators.</td></tr><tr><td>IS:1077</td><td>- Specification for common burnt clay building bricks.</td></tr><tr><td>IS:1081</td><td>- Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.</td></tr><tr><td>IS:1124</td><td>- Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.</td></tr><tr><td>IS:1237</td><td>- Specification for cement concrete flooring tiles.</td></tr><tr><td>IS:1322</td><td>- Bitumen felts for water- proofing and damp proofing.</td></tr><tr><td>IS:1346</td><td>- Code of practice for water-proofing of roofs with bitumen felts.</td></tr><tr><td>IS:1361</td><td>- Specification for steel windows for industrial buildings.</td></tr><tr><td>IS:1397</td><td>- Specification for kraft paper.</td></tr></table>			IS:412	- Expanded metal steel sheets for general purposes.	IS:419	- Specification for putty for use on window frames.	IS:428	- Distemper, oil emulsion, colour as required.	IS:702	- Specification for industrial bitumen.	IS:710	- Specification for marine plywood.	IS:712	- Specification for building limes.	IS:733	- Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes.	IS:777	- Specification for glazed earthenware tiles.	IS:1003	- Specification for timber panelled and glazed shutters (Part 1)	IS:1003	- -DO- (Part 2)	IS:1038	- Specification for steel doors, windows and ventilators.	IS:1077	- Specification for common burnt clay building bricks.	IS:1081	- Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators.	IS:1124	- Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones.	IS:1237	- Specification for cement concrete flooring tiles.	IS:1322	- Bitumen felts for water- proofing and damp proofing.	IS:1346	- Code of practice for water-proofing of roofs with bitumen felts.	IS:1361	- Specification for steel windows for industrial buildings.	IS:1397	- Specification for kraft paper.
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<div> <div>IS:2750</div> <div>- Specification for steel scaffoldings.</div> </div> <div> <div>IS:2835</div> <div>- Flat transparent sheet glass.</div> </div> <div> <div>IS:2932</div> <div>- Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing.</div> </div> <div> <div>IS:3036</div> <div>- Code of practice for laying lime concrete for a water-proofed roof finish.</div> </div> <div> <div>IS:3067</div> <div>- Code of practice of general design details and preparatory work for damp-proofing and water-proofing of buildings.</div> </div> <div> <div>IS:3068</div> <div>- Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete.</div> </div> <div> <div>IS:3384</div> <div>- Specification for bitumen primer for use in water-proofing and damp-proofing.</div> </div> <div> <div>IS:3461</div> <div>- Specification for PVC-asbestos floor tiles.</div> </div> <div> <div>IS:3462</div> <div>- Specification for unbacked flexible PVC flooring.</div> </div> <div> <div>IS:3495</div> <div>- Method of test for burnt clay building bricks : Part 1 to 4.</div> </div> <div> <div>IS:3536</div> <div>- Specification for ready mixed paint, brushing, wood primer, pink.</div> </div> <div> <div>IS:3564</div> <div>- Specification for door closers (hydraulically regulated.)</div> </div> <div> <div>IS:3696</div> <div>- Safety code of scaffolds and ladders (Part 1).</div> </div> <div> <div>IS:3696</div> <div>- -DO- (Part 2).</div> </div> <div> <div>IS:4020</div> <div>- Methods of test for wooden flush door (Part 1 to 16).</div> </div> <div> <div>IS:4021</div> <div>- Specification for timber door, window and ventilator frames.</div> </div> <div> <div>IS:4351</div> <div>- Specification for steel door frames</div> </div>		
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<p>IS:7452 - Specification for hot rolled steel sections for doors, windows and ventilators.</p> <p>IS:8042 - Specification for white portland cement.</p> <p>IS:8543 - Methods of testing plastics (Part 1/Section 1)</p> <p>IS:8543 - Methods of testing plastics (Part 1/Section 2)</p> <p>IS:8543 - Methods of testing plastics (Part 2/Section 1)</p> <p>IS:8543 - Methods of testing plastics (Part 2/Section 2)</p> <p>IS:8543 - Methods of testing plastics (Part 2/Section 3)</p> <p>IS:8543 - Methods of testing plastics (Part 3/Section 1)</p> <p>IS:8543 - Methods of testing plastics (Part 3/Section 2)</p> <p>IS:8543 - Methods of testing plastics (Part 4/Section 1)</p> <p>IS:8543 - Methods of testing plastics (Part 13/Section 1)</p> <p>IS:9197 - Specification for epoxy resin, hardeners and epoxy resin composites for floor topping.</p> <p>IS:9862 - Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting.</p> <p>IS:12200 - Code of practice for provision of water-stops at transverse contraction joints in masonry and concrete dams.</p> <p>3.0 <u>BRICKWORK</u></p> <p>3.1 <u>Materials</u></p> <p>3.1.1 Bricks used in the works shall conform to the requirements laid down in IS:1077. The class of the bricks shall be as specified</p>		
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<p>3.1.2 The nominal size of the traditional bricks is 230mm x 110mm x 70mm with tolerance upto <u>+3</u> mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively. However, where the size of bricks in the conventional type are not commonly available in the area the sizes shall be subject to approval of Engineer and the overall thickness including the interior / external plaster shall be maintained.</p> <p>3.1.3 Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have an average (as per IS) crushing strength of 5N/sq.mm unless otherwise specified in the item.</p> <p>3.1.4 The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.</p> <p>3.1.5 Sample bricks shall be submitted to the ENGINEER for approval and bricks supplied shall conform to approved samples. If demanded by ENGINEER, brick samples shall be got tested as per IS: 3495 by CONTRACTOR at no extra cost to OWNER. Bricks rejected by ENGINEER shall be removed from the site of works within 24 hours.</p> <p>3.1.6 Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS:2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below. Sand for masonry mortar shall conform to IS:2116. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER. If so directed by the ENGINEER, sand shall be screened and washed till it satisfies the limits of deleterious materials.</p> <p>3.1.7 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall</p>		
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<p>be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the ENGINEER. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.</p> <p>3.1.8 The CONTRACTOR shall arrange for test on mortar samples if so directed by the ENGINEER.</p> <p>3.2 <u>Workmanship</u></p> <p>3.2.1 Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work. Brick work 230mm thick and over shall be laid in English Bond unless otherwise specified. 115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only to make up required wall length or for bonding. Bricks shall be laid with frogs uppermost.</p> <p>3.2.2 All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, atleast one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45°. But in no case</p>		
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the level difference between adjoining walls shall exceed one metre. Brick-work shall not be raised more than one metre per day.

- 3.2.3 Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.
- 3.2.4 During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.
- 3.2.5 Brickwork shall be kept constantly moist on all the faces for at least seven days. The arrangement for curing shall be got approved from the ENGINEER.
- 3.2.6 Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part 1). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the ENGINEER. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/painting.
- 3.2.7 In the event of usage of traditional bricks of size 230 mmx110mmx70mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor or slabs and at the top of the parapet shall be laid with bricks on edge.
- 3.2.8 All brickwork shall be built tightly against columns, floor slabs or other structural members.

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3.2.9 To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.

3.2.9.1 For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

3.2.9.2 RCC/steel beams resting on masonry wall shall be provided with plain or reinforced concrete bed blocks of dimensions as indicated in the drawings duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.



3.2.10 Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

3.2.11 For half brick partition walls (CM1:4) two bars of minimum 6mm diameter MS bars shall be provided in every sixth layer. For one brick wall above 9 meters level reinforcement bars shall be provided in every sixth layer as above.

3.2.12 Where structural steel sections are to be encased in brickwork, the brick masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

3.2.13 Facing bricks of the type specified conforming to IS:2691 shall be laid in the positions indicated on the drawings and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

3.2.14 Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of painting to be carried out shall be as specified in the item of work. The pattern of laying the bricks shall be as specifically indicated in the drawings.

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3.2.15 For facing brickwork, double scaffolding shall be used.

3.2.16 Faced works shall be kept clean and free from damage, discoloration etc., at all times.

4.0 **DAMP - PROOF COURSE**

4.1 **Materials and Workmanship**



4.1.1 Where specified, all the walls in a building shall be provided with damp-proof course to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:1.5:3 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 12 mm down graded coarse aggregates.

4.1.2 The surface of brick masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.

4.1.3 Damp-proof course shall be cured properly for at least seven days after which it shall be allowed to dry for taking up further work.

5.0 **MISCELLANEOUS INSERTS, BOLTS ETC.**

5.1 All the miscellaneous inserts such as bolts, pipes, plate embedments etc. to be supplied by the CONTRACTOR shall be accurately installed in the building works at the correct locations and levels, all as detailed in the drawings. CONTRACTOR shall prepare and use templates for this purpose, if so directed by the ENGINEER. In the event, any of the inserts are improperly installed, CONTRACTOR shall make necessary arrangements to remove and re-install at the correct locations/levels, all as directed by the ENGINEER without any extra cost to the OWNER.

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6.0 **FITTINGS FOR DOORS, WINDOWS, ETC.**

- 6.1 Fittings shall be of iron, brass, aluminium or as specified. These shall be well made, reasonably smooth and free from sharp edges, corners,, flaws and other defects. Screw holes shall be countersunk to suit the head of specified wood screws. All hinge pins shall be of steel and their riveted heads shall be-well formed.

Iron fittings shall be furnished bright or black enamelled or copper oxidized or- painted as specified. Brass fittings shall be furnished bright, oxidized or chromium plated and aluminium fittings shall be furnished bright or anodized as specified. Fittings shall be got approved by the Engineer before fixing. Screws used for fittings shall be of the same metal and finish as the fittings. However, anodized cadmium / chromium plated M.S. screws of approved quality shall be used for fixing aluminium fittings.

6.2 **Hinges**

6.2.1 **Butt hinges**



These shall be mild steel but hinge (medium), brass butt hinges, and extruded aluminium alloy butt hinges or as specified. Type (light/medium/heavy weight) and size shall be as specified /approved by Engineer. Brass/Aluminium and M.S butt hinges shall conform to Indian Standard Specification for butt hinges IS: 205 and IS: 1341 respectively. Hinges shall be furnished bright or satin polished or anodized.

6.2.2 **Parliament hinges**

These shall be of mild steel or cast brass or as specified and shall generally conform to IS: 362. Hinges shall be furnished bright or satin polished or anodized.

6.2.3 **Spring hinges**

These shall be made of iron or brass casing with steel spring and shall conform generally to IS: 453. Hinges shall work smoothly and hold the door shutters truly vertical in closed position. The size of spring hinge shall be taken as length of its plate and shall be single or double acting as specified. The iron spring hinges shall be furnished stove enamelled

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black and brass hinges shall be furnished bright or satin nickel-plated or copper oxidized.

6.2.4 Continuous or Piano hinges

These shall conform to IS: 3818 and shall be made of mild steel or aluminium alloy sheets. Mild steel hinges shall be furnished with anticorrosive treatment or plating of brass or nickel as specified. Piano hinges shall be fixed in the entire length of the cupboard shutters. These are in two sizes of breadth 30 & 40mm, pin dia 2mm and flap thickness 0.8mm minimum and 1mm maximum.

6.2.5 Tee and strap hinges

These shall be made of MS sheets and furnished bright or stove enamelled black. They shall conform to IS 206. Type (light/medium/heavy weight) and size shall be as specified in the drawing.



6.3 Sliding Door Bolts

Mild steel sliding door bolts shall conform to IS 281 and are of 2 types, plate type and clip or bolt type. Plate type bolts shall have plates and straps stove enamelled black with hasp and bolt finished bright or copper oxidized or nickel/chromium plated. Clip or bolt type are copper Oxidized or plated. All screw holes in the M.S bolts shall be Countersunk. Diameter of bolt for plate type is 12mm and for clip type is 16mm.

Non ferrous metal sliding doors are of brass or aluminium alloy and shall conform to IS-2681. Brass sliding bolts are of 150 to 450mm size with bolt dia being 16mm for 150 to 300mm and 18mm for 375 and 450 size. Aluminium alloy sliding bolts are of size 200 to 450mm with 16mm bolt dia. Brass quality is furnished satin, polished or plated and aluminium alloy bolts are anodized. For both ferrous and non-ferrous metal bolts the size of the sliding bolt is determined by the length of the bolt.

6.4 Door Rim Latch

This shall be of Mild steel, brass, aluminium alloy or as specified and of sizes 75, 100, 125 and 150 mm denoted by overall length of the body

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measured from outside face of the fore end to the rear end. These are of type 1 and type 2 and shall conform IS:1019.

6.5 **Tower Bolts**

Tower bolts may be of one of the following types and shall conform to IS:204 (Part I and 2).

6.5.1 **Barrel tower bolts**

These shall be of bright furnished/stove enamelled/ black painted mild steel tower bolts, brass barrel tower bolts with cast brass barrel and rolled or drawn brass bolt/brass barrel tower bolts with barrel of extruded sections of brass and rolled or drawn brass bolt/brass barrel tower bolts with brass sheet barrel and rolled or drawn brass bolt. Aluminium barrel tower bolts with barrel and bolt of extruded section of aluminium alloy-bolts and barrel anodized.

6.5.2 **Semi-barrel tower bolts**

These shall be mild steel semi barrel tower bolts full cover/open type with mild steel sheet pressed barrel and cast iron/mild steel bolt. Bolt bright furnished other parts stove enamelled black.

6.5.3 **Riveted or spot welded tower bolts**



These shall be mild steel tower bolts riveted type with black flat and mild steel/cast iron bolt and open staple.

6.5.4 **Skeleton tower bolts**

These shall be of bright furnished/stove enameled/black painted mild steel or brass bright furnished skeleton tower bolts with cast brass/extruded sections and rolled' or drawn brass bolt or Alumininum skeleton tower bolts with plates staples and bolt or extruded sections Of Aluminium-alloy plate and staple anodized.

6.6 **Door Handles**

Door handles shall conform to IS:208-1987 and shall be of 4 types. Type1 is cast Iron/Brass/Aluminium or zinc alloy die casting and available in 75,100,125 150mm sizes. Type 2 is mild steel pressed oval

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in 75,100,115 and 135mm sizes. Type 3 is mild steel present half oval in 75, 90 and 100mm sizes.

Type 4 is fabricated (brass/aluminium alloy) in 75,100 and 125mm sizes. The size of the handle shall be determined by inside (grip) size overall size and internal depth of the handles shall be as detailed in IS:208.



Finish for type I shall be satin/nickel plating, copper oxidizing and bronze finish for cast-brass and zinc die cast handles and stove enamelled black or copper oxidized for cast iron handles. Aluminium handles shall be anodized. Type 2 and 3 handles shall be stove enamelled black. For type 4 it shall be satin finish, nickel plating, copper oxidized and bronze finish for brass handles and anodizing for aluminium handles.

6.7 **Mortise Lock and Rebated Mortise lock**

Mortise lock with latch and pair of lever handles shall have body of steel, Aluminium alloy or brass and shall be right or left handed as shown in the drawing or as directed by the Engineer. It shall be of the best Indian make of approved quality and shall conform to IS: 2209 / 6607. The shape and pattern shall be approved by the Engineer. The size of the lock shall be determined by its length. The lock for single leaf door shall have plain face and that for double leaf door a rebated face. Lever handles with springs shall be mounted on plates and shall weigh not less than 0.5 kg per pair. These shall be of brass finished, bright chromium plated or oxidized. The locks shall be of 65, 75 and 100 mm sizes.

6.8 **Floor Door Stopper**

These are for the use of the door shutters of 30, 35, 40 & 45mm thickness. It is made of aluminium alloy/ brass with springs of phosphor bronze or hard drawn steel wire and tongue of aluminium/brass/nylon/plastic. The floor door stoppers shall conform to IS:1823 and shall be best Indian make of approved quality. Width of cover plate is 40mm but its overall length is 140mm for 30 and 35mm thick shutters & 150mm for 40 and 45mm shutters. The body shall be cast in one piece and fixed to cover plate by brass or M. S screws. On the extreme end there shall be rubber cushion to absorb shocks.

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The extension of the door stopper shall be in flush with floor and be finished bright/satin/chromium plated or anodized.

6.9 Hooks and Eyes

These shall be of mild steel or hard drawn brass and shall generally conform to IS: 207.

6.10 Casement Window Handles

These shall be made of cast brass, steel protected against rusting, aluminium, pressed brass or as specified. Casement handles for single leaf window shutter shall be left or right handed and shall weigh as specified.

6.11 Casement Peg Stays

These shall be made of cast brass, steel protected against rusting, aluminium, cast alloy or as specified. The stay shall be made from a channel section and shall be 300mm long with steel peg and locking bracket. The peg stay shall have three holes to open the window in three different angles. The shape and pattern of stays shall be approved by the Engineer. The peg stay shall be minimum 2mm thickness in case of brass and aluminium and 1.25 mm in case of steel.



6.12 Quadrant Stays

These shall be made of cast brass, aluminium alloy, CP iron or as specified. The shape and pattern shall be approved by the Engineer. It shall weigh as specified.

6.13 Fan Light Pivots

These shall be made of mild steel, cast brass or aluminium alloy or as specified and shall generally conform to IS: 1837.

The pattern and the shape of the catch shall be as approved by the Engineer and size and finish shall be as specified.

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6.14 **Fan light catch**

These shall be made of mild steel, cast brass, aluminium alloy or as specified and shall generally conform to IS : 364. Steel springs of the catch shall be 0.90 mm dia, 6 coils, 12 mm internal diameter and 20 mm long. The pattern and the shape of the catch shall be as approved by the Engineer.

6.15 **Ventilator chain**

This shall be made of mild steel or aluminium alloy welded or twisted as specified and shall conform generally to IS: 3328. One end of the chain shall be provided with an eye and the other end with a staple. The minimum thickness of plates shall be 2.5 mm and the chain shall be 300mm long made from minimum 1.8 mm hard drawn wire.

6.16 **Hasp & staple**



The Hasp and staple shall conform to IS:363 and are of two types, safety type and wire type. For safety type material may be mild steel/brass/aluminium alloy but wire type are only of mild steel. Hinge shall be of mild steel in case of mild steel hasp & staple and of mild steel or brass in case of brass/aluminium type. Screw holes shall be counter sunk. Sizes and width of hasp & staple shall be detailed in IS:363. The size of hasp & staple shall be determined by the length of the hasp. Mild steel hasp & staple shall be stove enamelled black aluminium anodized and brass oxidized or polished.

6.17 **Cupboard Lock**

These shall be made of mild steel, cast brass, aluminium alloy or as specified conforming to IS- 729 and shall be of the best Indian make. The lock shall be easy in working, having duplicate keys and are of heavy type (Grade I) and light type (Grade II) in 48, 50, 65 and 75mm sizes as specified.

6.18 **Door Closers (Hydraulically regulated)**

Exposed type hydraulically regulated door closers for vertical hinge type doors, opening to one side only shall conform to IS:3564. These are available in three nominal sizes 1, 2 and 3. Size 1 is for door shutter of width upto 700mm and weight upto 35kg, Size 2 for door width 701 to

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850mm and weight 36 to 60 Kg and Size 3 for door width 851 to 1000mm and weight 61 kg to 80 Kg. Nonporous body is made of cast iron/aluminium alloy/zinc alloy 'and Main arm of cast iron/steel/zinc alloy. Each closer shall be supplied with one fitting key etc. for adjusting the spring valve and regulating screw. Hydraulic oil filling shall work satisfactorily between 49 degree and (-) 10 degree C. Doors closer when open through 90 degree, the door shall swing back to 20+/-5 degree with normal speed but thereafter speed should get retarded. IS:3564 does not cover requirement for concealed type, pneumatic or mechanical type door Closers.

6.19 **Steel Frames**

These shall conform to IS: 4351. The frames shall be manufactured from commercial mild steel sheets of 1.25mm thickness and are suitable for door shutters 30 to 40mm thick. The door frames are designated as per profile A, B and C.

Profile A	Size 105x60mm	rebated for one set of shutters
Profile B	Size 125x60mm	rebated for one set of shutters
Profile C	size 165x60mm	rebated for two sets of shutters

6.20 **Miscellaneous Items**

6.20.1 **Magic eye**



These shall be of approved type and made of .C.P. Iron/brass, or aluminium as specified.

6.20.2 **Coat Hooks**

These shall be made of Mild Steel/ brass/aluminium alloy or as specified and shall conform to IS-9899. These shall be in one piece with two unequal hooks and back plate. The minimum size shall be 50x30mm.

6.20.3 **Putty**

The material shall be homogeneous paste and shall be free from dust and other visible impurities. Putty shall-conform to I.S. 419 for wood work.

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6.20.4 **Flush Bolts**

The body, plate and bolt shall be made of brass/aluminium alloy but the spring of phosphor bronze or of steel strip. Flush bolts shall conform to IS:5187 and shall be of Type 1 and 2. The rod of the flush bolt shall be retained in its maximum bolting position by the spring and shall have smooth and easy working. Brass bolts shall be copper oxidized/nickel or chromium plated or satin or bright furnished. Aluminium flush bolts shall be anodized. Flush bolts shall be of best Indian make of approved quality.

6.20.5 **Mortise Night Latch**



Nominal size shall be denoted by length of face over the body in mm and are termed as "Left hand" "Right hand". The latches shall have the casing, body, face/striking plate made of mild steel/brass/aluminium alloy. Depth of body should not exceed 15mm locking bolt section not less than 8x25mm and number of levers not less than two. Finishing for aluminium shall be anodizing, for brass it shall be bright/satin or chromium plating. The steel body shall have protective coating. The mortise night latch shall conform to IS:3847 and of best Indian make of approved quality.

6.20.6 **Indicating Bolt**

Indicating bolt shall conform to IS:4621 and of best Indian make of approved quality. Operation of the bolt may be achieved either by gear work or by displacement. The bolts are normally made in sizes, size 1 and size 2 with length and breadth of the indicating bolt being 75mmx45mm and 85mmx50 mm respectively, dia of disc being same 70mm in both sizes. Material used for the bolts is Aluminium alloy/brass/zinc base alloy Finish shall be satin or bright finish or anodized aluminium.

6.20.7 **Door closer (Pneumatically Regulated)**

These shall conform to IS-6343 and shall be suitable for doors weighing upto 40 Kg only. These shall be of right, left or universal pattern as specified and shall work satisfactory from 10 degree C to 50 degree C. Main cylinder, brackets and fittings shall be of brass, mild steel or Aluminium item/zinc alloy. The closers shall be painted,

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polished or anodized. The door closer shall be of dimensions as agreed.

6.20.8 **Ball Catches**

Ball catches shall conform to IS:8756 . The shape and design of ball catches as given in the above code is only illustrative. Ball catches when assembled,, shall have smooth and easy working. The ball and the spring shall be made of steel and the body of brass. The body and the striking plate shall be satin or brass polished. The sizes of ball catches shall be 6, 7.5, 9.5 and 12.5mm, which shall be the external diameter of the cylinder.

6.20.9 **Floor Spring (without oil check)**

It shall conform to IS:7197 with materials for the manufacture of various part as specified in Table-1.

The door springs shall be suitable for fixing to doors weighing upto 125 Kg. These shall be covered by brass or aluminium sheet, which only shall be flush with the floor.



7.0 **GLAZING**

7.1 **General**

Plain, ground, frosted or rough cast wired glass shall be used as shown on the drawing . It shall be procured from a reputed source of manufacture and be of the best quality. All glass panes shall be free from flaws, specks, bubbles etc. Glass panes shall be of thickness 3mm or more as required. Weight of 3mm thick glass pane shall not be less than 7.5 Kg/m².The tolerance of glass panes, except wired glasses, in length and width shall be plus or minus 2 mm for 3 to 6.3 mm glass sheets. Tolerance in thickness of glass sheets shall be +/- 0.2mm for 3mm and 4mm thick glasses and +/- 0.3mm for 4.8, 5.5 and 6.3mm thick glasses.

7.2 **Plain Transparent Glass**

Plain transparent glass for glazing and framing shall conform to IS: 2835.It shall be free from flaws, specks, bubbles or distortions.

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7.3 **Ground and Frosted Glass**

Glare reducing or heat absorbing glass shall be "Calorex" or approved equivalent and special care shall be taken to grind smooth and round off the edges before fixing.

7.4 **Wired Glass**

Wired glass shall be thick rolled glass with centrally embedded steel wire mesh of Georgian type. This may be clear or coloured, as shown in drawings and conform to IS:5437.

7.5 **Obscure Glass**

Obscure Glass shall have a cast surface on one side.

7.6 **Coloured Glass**

Coloured glass and figured glass shall be as per sample approved.

7.7 **Thickness**

Glass shall have the following thickness, unless otherwise stated in the drawings

Upto 60 cms x 60 cms	3 mm
Larger size	4 mm and 4.8mm
Sheet glass for doors	5.5 mm
Rough cast wired	6.4 +/- 0.4 mm



7.8 **Inspection**

All glasses shall be subject to inspection on the site. Glass found to suffer from defects shall be rejected. Samples submitted for inspection shall be selected so as to be representative of the consignment.

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7.9 **General**

Glazing shall be done with plain, frosted, ground glass or wired cast glass, laminated safety glass or toughened glass etc. as shown on

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drawings or as approved by the Engineer. The method of glazing adopted shall, be such that movement of the structure, to which the securing is done, does not transmit strain to windows, doors or ventilators as the case may be. The work shall generally conform to IS:1081 "Code of Practice for Fixing and Glazing of Metal Doors, Windows & Ventilators". The material for putty shall consist of whiting and linseed oil, raw mixed in such proportion as to form a paste conforming to IS:419.



7.10 **Doors, Windows and Ventilators**

Windows and ventilators shall be designed for putty glazing fixed from outside and glazed doors for fixing from inside. In addition, spring type glazing clips shall be provided at intervals of 30 cm, or as specified otherwise on drawings . These shall be inserted into holes drilled in the shutters or frame as the case may be.

All glazing shall be puttied to the shutters of frames with good quality putty in addition to glazing clips. Glass panes shall not be placed directly against the metal/timber. A thin layer of putty shall be even spread over the glazing rebate and the glass pressed firmly against it. It shall be secured in position by means of teak wood beads for wooden shutters. Glass panes shall be set without springing & shall be bedded in putty and back puttied, except where moulding or gasket are specified. Putty etc., shall be smoothly finished to even lines. Figured glass shall be set with smooth side out. After completion of glazing work, all dirt stains, excess putty etc., shall be removed and the glass panes shall be left in perfectly acceptable condition. All broken, cracked or damaged glass shall be replaced by new ones at the Contractor's cost.

7.11 **Northlight Glazing**

This shall consist of aluminium or steel glazing bars as shown on drawings and subject to approval of Engineer. The glazing parts shall be securely fixed in their frame and shall be whether proof. All glazing shall be flashed to the surrounding so as to be weather proof. Glass shall be fixed to the astragals with glazing clips and putty.

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8.0 **WOOD WORK IN DOORS, WINDOWS, VENTILATORS & PARTITIONS**

8.1 **Materials**

All timber used for carpentry and joinery works shall be new. It shall be well seasoned by a suitable process conforming to IS: 1141 before being planed to the required sizes. It shall be sound, straight, free from sap, radial cracks, decay, fungal growth, boxed heart, pitch pockets, borer holes, splits, loose knots, flaws or any other defects and shall show a clean surface when cut. Timber shall conform to the requirements of IS: 1003 (Part - 1&2). The furnished components shall be given suitable preservative treatment wherever necessary.

8.2 **Teak wood/Sal/Bija sal/Deodar/Kail and other varieties of timber.**

8.2.1 **Teak wood**



The timber shall be of good quality and well seasoned. It shall be of fairly uniform colour and shall be free from defects such as cracks, dead knots, shakes etc. No individual hard and sound knot shall be more than 15 sq.cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. Wood shall be generally free from sap wood but traces of the same shall be allowed. The timber shall be fairly grained having not less than 2 growth per cm width in cross section.

8.2.2 **Sal/Bijasal wood**

Timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 6 sq.cm. in size and aggregate area of all such knots shall not exceed 2 % of the area of the piece. There shall not be less than 5 growth rings per 2 cm of the width.

8.2.3 **Deodar wood**

The timber shall be of good quality and well seasoned. It shall have fairly uniform colour, reasonable straight grains and shall be free from all defects as mentioned in previous clauses. No individual hard and sound knot shall be more than 15 sq.cm in size and aggregate area of

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all such knots shall not exceed 2% of the area of the piece. There shall be at least 3 growth rings per Cm width in cross section.

8.2.4 **Kail wood**

The timber shall be generally as specified in clause 8.2.3 for Deodar wood. However, there shall not less than 2 growth rings per cm width in cross section.

8.2.5 **Other varieties of timber**

The timber as named in the item of work shall be used. It shall be well-seasoned and generally free from defects such as dead knots, cracks, shakes, sapwood etc. However, traces of sapwood shall be allowed and sound and hard knots up to 2% of the area of the Piece shall be allowed.

8.3 **Storage and Inspection**

Timber shall be carefully stored and subject to inspection on site, piece by piece. The Engineer may reject such pieces as are considered by him not of the quality or meeting the requirements specified herein.

8.3.1 **Moisture Content**



Timber shall be accepted as well seasoned if its moisture content does not exceed the permissible limit as per IS : 287.

8.3.2 **Tolerances for Timber**

For timber allowance as specified in the IS: 1003 (Part 1&2) shall be applicable.

8.4 **Flush Door Shutters, Shelves**

Flush door shutters, shall be wooden, solid core or cellular and hollow core type, as may be shown in drawing or as directed by Engineer. They shall be obtained from an approved source of manufacture, covered on face with commercial ply, wood veneer or other finish as may be necessary. Solid core shutters shall conform to IS: 2202 (Part 1&2) and cellular or hollow core shutters to IS: 2191 (Part 1&2). The

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resin used shall be phenol formaldehyde. A full size sample door shall be offered for inspection and approval.

8.5 **Wood Particles Boards**

Particle boards for general purposes shall be of medium density conforming to IS:3087. These are of four types, Flat pressed single layer board (FPSI), Flat pressed three layer board (FPTH), Extrusion pressed solid board (XPSO) and Extrusion pressed tubular core (XPTU). Adhesive shall be BWR, WWR or unexpended CWR type. High-density wood particleboard shall conform to IS: 3478 and are in flat sheets or moulded forms. These shall be of type I (BWR type of resin) or Type 2 (WWR or CWR type of resin). Both types of boards shall be of Grade A (resin content 20 to 50 percent) and Grade :B (resin content 8-12 percent).



8.6 **Veneered Particle Board**

These shall conform to IS: 3097 and shall be of two grades. Exterior (grade-I with BWP or BWR type adhesive) & interior (grade-II with WWR or CWR type adhesive). Each grade of boards shall be of 4 types, solid core general purpose, solid core decorative, Tubular core general purpose and Tubular core decorative and accordingly designated.

8.7 **Plywood for General Purpose**

Plywood for general purpose shall conform to IS:303. Depending on type of adhesive used for bonding veneers, it is of 4 grades, BWP (boiling water proof), B.W.R (boiling water resistant), WWR (warm water resistant) and CWR (Cold Water resistant). Any species of timber may be used for plywood manufacture. However list of species, for the manufacture of plywood given in Annexure (B) of the IS:303 for guidance.

Plywood IS classified in 10 different types as per appearance of the surface. These are AA,AB, AC,AD,BB,BC,BD,CC,CD and DD as detailed in IS:303. It IS available from 3 ply to 11-ply thickness from 3mm to 25mm.

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8.8 **Veneered Decorative Plywood**

This quality of plywood shall conform to IS:1328. These plywood shall be of two types Type 1 and Type 2 as per details given in IS:1328. Species of timber for decorative face commonly used are given Table 1 of IS:1328 but the Owner shall specify the particular veneer to be used. Timber for cores and backs shall be either class I or II specified in IS: 303. Adhesive used shall be BWR or WWR synthetic resin.

8.9 **Workmanship**

8.9.1 The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. CONTRACTOR shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.



8.9.2 All works shall be executed as per the detailed drawings and/or as directed by the ENGINEER.

8.9.3 Woodwork shall be neatly and truly finished to exact dimensions and details as per drawings, without patching or plugging of any kind. Rebates, roundings and mouldings as shown in drawings shall be made before assembling. Exposed work shall be finished smooth with well planed faces.

All assembly of shutters of doors, windows, ventilators and frames thereof shall be exactly at right angles. In the case of frames, the right angle shall be checked from the inside surfaces of the respective members. All door and window frames shall be clamped together so as to be square and flat at the time of delivery. Doorframes without sills shall be fitted with temporary stretchers.

Horns of frames and other parts that go into or butt against the masonry shall be protected against moisture and decay with two coats of coal tar or other approved protective material.

All surfaces of the door, window and ventilator frames and shutters, which are required to be painted ultimately, shall be covered evenly by brush with a priming coat of approved primer. In the case of doors to be polished or varnished, a priming coat of approved Polish or varnish shall be given before delivery. No primer shall be applied to the wood work until it has been inspected and passed by the Engineer.



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All heads, posts, transoms and mullions etc., of doors, windows and ventilators shall be made out of single pieces of timber only. The heads and post shall be through tenoned into the mortices of the jamb posts to the full width of the latter and the thickness of the tenon shall be not less than 1.25 cm. The tenons shall be close fitting into the mortices and pinned with corrosion resisting metal pins not less than 8 mm diameter or with wood dowels not less than 10 mm diameter. The depth of rebate in frames for housing the shutters shall in all cases be 1.25 cm and the rebate in shutters for closing in double shutter doors or windows shall be not less than 2 cm. Unless otherwise specified, all joints shall be mortice and tenon joints with the ends of the tenons exposed to view. Joints shall fit truly and fully without fillings. The contact surfaces of tenons and mortices shall be treated, before putting together, with an approved adhesive conforming to I.S.:848 and 851.

The arrangement joining and fixing of all joinery work shall be such that shrinkage in any part and in any direction shall not impair the strength and appearance of the finished work. The tolerance on overall dimensions shall be within the limits prescribed in IS: 1003 (Part 1 & 2).

8.9.4 **Fixing**

Door and window frames shall generally be built in at the time the walls are constructed. Alternatively, where permitted by the Engineer, the frames may be subsequently fixed into prepared openings for which purpose holes to accommodate the holdfasts shall be left at the time of construction. Where the frames are subsequently fixed into prepared openings in the wall such openings should be 25 mm more than the overall width of the door, window or ventilator frame to allow minimum 12mm plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door care shall be taken to see that at least 6 mm space is left between the door and the finished floor. The M.S. clamps fixed to the frame shall be inserted in the holes and jammed in cement concrete M-15 or (1:2:4 mix) with 20 mm down graded stone chips after holding the frame in proper position to the line, level and plumb. The size of the concrete block shall be 250 x 125 x 85mm unless otherwise specified.

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8.9.5 Tarring

Timber in contact with earth, concrete, plaster or masonry shall be treated with boiling coal tar or 2 coats of wood preservative treatment like hot solingnum, or creosote oil etc. before fixing the frame in position.

8.9.6 Fittings

Unless otherwise specified, three holdfasts shall be fixed on each side of a doorframe, one at the centre point, and the other two at 30 cm from the top and the bottom of the doorframes. In the case of windows and ventilators, a pair on each side shall be fixed at quarter points of the frames. Unless otherwise specified the holdfasts shall be of mild steel plate 40 x 3 x 225 mm long, fish tailed at one end and screwed to the frame in the formed rebates.



Generally, each door shutter shall be fixed to the frame, with three hinges of approved manufacture, one at the centre and the other two approximately 24 cm from the top and bottom of the shutter. Each window shutter shall be fixed to its frame with two hinges at the quarter points.

Locks, handles, door closers, stoppers etc., shall be fitted as shown in drawings/as directed by Engineer.

8.9.7 Doors, Windows & Ventilators

Dimensions of the various components of doors, windows and ventilators shall be in accordance with IS : 1003 (Part 1&2) Table-III or as shown on the drawings. The work shall be carried out as per detailed drawing. The wooden members shall be planed smooth and accurate. They shall be cut to the exact, shape and size without patching or plugging of any kind. Mouldings, rebates, curves and roundings etc. shall be done as shown in the drawing before the pieces are assembled into the shutter.

The thickness of stiles and rails etc shall be as per IS: 1003 (Part 1&2) unless otherwise specified in the item of works. These shall be properly and accurately mortised and tenoned. Rails, which are more than 180mm in width, shall have 2 tenons. Stiles and rails shall be made out of single piece upto 200mm in width. In case more than one piece of timber is used for members exceeding 200mm width they

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shall be joined with a continuous tongued and grooved joint, glued together and reinforced with rust proof metal dowels or headless pins.

The tenons shall pass clear through stiles. The stiles and rails shall have a 12mm groove, unless otherwise shown in the drawing, to receive the panel. In case of double shutters the rebate at the closing junction of the two shutters shall be as per clause 5.5 of IS: 1003 or as shown in drawing. Primer coat shall not be put before shutters are passed by the engineer.

8.9.8 **Panelled Shutters**

These shall conform to IS: 1003 (Part I). Timber panelled shutters shall be constructed in the form of timber frame work of stiles and rails with panel inserts of timber, plywood, block board, veneered particle board, hard board or asbestos cement board. Stiles, rails and panels in door shutters shall be of the same species of wood.



Timber Panels shall be of minimum width of 150 mm. When made from more than one piece, the pieces shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. No single panel shall exceed 0.5 m² in area. Timber panels shall be fixed only with grooves but additional beadings may be provided either on one side or both sides.

Unless otherwise specified thickness of panel for 35mm thick shutter shall be 15mm and for 40mm and above thick shutter, it shall be 20mm. For 25mm thick shutter, panel thickness shall be 12mm.

Apart from timber panels other materials like plywood, block board, particle board, hard board and Asbestos cement may also be used for panelling purpose and shall be fixed with grooves or beading or both as per provisions made in IS:1003 (Part-I). Timber suitable for manufacture of door shutter have been grouped under class a, b, c & d in Table I of IS: 1003 (Part-I).

8.9.9 **Glazed Shutters**

The openings for glazed shutters shall be rebated and moulded out of solid timber. Plain sheet glass for panels shall be of approved quality as specified. Wherever specified, ground glass or frosted glass of approved quality shall be used in place of plain sheet glass. Unless otherwise specified glass panes shall be fixed by means of moulded

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beads and suitable MS panel pins. A thin layer of putty shall be applied between glass panes and sash bars and also between glass panes & beading.

8.9.10 **Flush Door Shutters**

Unless otherwise specified, flush door shutters shall have a solid/cellular core, a teak wood frame, and shall be faced with approved quality of plywood on both faces. The core and stock, shall be made from well seasoned approved timber and treated with approved preservatives. The plywood faces shall be glued on into the solid/cellular core with waterproof glue under pressure and heat. The construction of flush doors shall be such that no difficulty should arise in fixing mortice locks, hydraulic door closers etc. The shutters shall be rebated in the case of the double leaf doors. Where specified flush doors shall be provided with vision panels, rectangular/ round or louvered.

If specified so, the flush door shall be solid block board core or solid particle board core construction. The workmanship and overall finish shall be of very high standard and shall conform to IS:2191 (Part 1&2) & 2202 (Part 1&2). The shutters shall be procured from approved manufacturer BIS certification mark only.



8.10 **Other types of shutters**

8.10.1 **Ledged and braced shutters**

Door shutters will have battens secured to three ledges with 2 braces between the ledges. Window shutters will have 2 ledges and 1 brace. Battens shall have rebated joints. Each batten shall be fixed by means of 2 screws with each ledge and brace. The width of the battens shall not be less than 150mm or as shown in the drawing. Unless otherwise mentioned the thickness of the battens, ledge and brace shall be 20mm in case of 35mm thick shutters. The width of the ledges and braces shall be as per drg. "T" hinges shall be used to hang shutters.

8.10.2 **Louvered shutters**

The Venetians (louvers) shall be 12mm thick unless otherwise specified. The Venetian blades shall slope down towards the outside at an angle of 45 degrees or as shown in the drawing and shall be

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fixed to the stiles by making grooves in it of minimum 1.25cm depth to receive the ends of Venetians. Beading shall be fixed all round the panel opening if so shown in the drawing after fixing the Venetians.

8.10.3 Wire gauze shutters

The work shall be carried out as per drawing. Rebates shall be made in stiles and rails to receive the wire gauze, which shall form the panel. Wire gauze shall be of IS sieve designation 1.4 or 1.18 with wire dia 0.71mm and 0.56mm respectively, unless otherwise specified. Aperture size of I.S. Sieve Designation 1.4mm and 1.18 mm shall be 1.4mm and 1.18mm respectively. The wire mesh shall be double folded at the edges and securely housed in the rebate by giving a right angled bend. Over this a moulded wooden beading, made of same wood as that of shutter shall be fixed to cover the rebate fully by means of screws and nails. The space in between beading and rebate shall be filled with putty to give a neat finish. All wire gauge panels shall be in one piece.



8.11 Handrails

8.11.1 Wooden hand rails

Wooden hand rails shall be of approved quality teak wood fixed to concrete or metal balustrade with concealed steel or metal lugs and bolts as per drawing. Joints will be made with concealed screws and dowels. All bends, mitres, coves, moulds etc. will be strictly to proper profile and finally smoothened by sand paper. The handrail shall be finished with wax or french polish or painting as per direction of the engineer.

8.11.2 PVC Covers for Handrails

The top rail of the hand rail shall be covered with PVC hand rail covers of Kaliplast or equivalent. The fixing of the cap shall be strictly as per manufacturers instructions and the colour of the cap shall be as approved by Engineer. The covers shall be stored properly as per manufacturers instructions before installation.

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8.12 **Panelling to walls**



Unless otherwise mentioned, panelling to walls shall be done with teak faced decorative block board panels, groups matched and laid in patterns as shown in the drawing. The panels shall be 25mm or 20mm thick as specified in the drawings/specifications and shall be obtained from approved manufacturers.

The block board panels shall be fixed on teak batten framing with concealed brass screws. The joints between the panel shall be glued tight to each other and be "V" shaped. The battens on which the boards are fixed shall be 25mm x 35mm wrought to skew shape and fixed at 60mm centre to centre both ways. The battens will be fixed on the wall with iron screws in dove tailed teak lugs embedded in wall in cement concrete 1:2:4 with stone chips.

Teak woodwork in battens and the invisible face of the block board panels will be given 2 coats of wood preservative treatment. The visible face of the block board panels shall be polished with wax or french polish. Moulded skirting of approved quality teak wood is to be fixed and finished in the same manner.

8.13 **Panelled and glazed partitions**

Unless otherwise mentioned, the partition shall be partly panelled and partly glazed. The framing members of the partitions shall be of approved quality teak wood and of sizes and spacing as per drawing. These shall be fixed to the floor by means of iron clamps rigidly fixed to the floor slab and teak woodwork. The lower portion upto a height of 1m shall be either in teak wood panels 20mm thick and 25mm wide or covered over with tempered masonite or similar approved hard board 6mm thick on both sides as per design. In case of teak wood panels the joints shall be glued tight to each other and shall be "V" shaped. The upper portion shall be glazed with pinhead 'morocco glass' or wired glass or 5mm thick plain sheet glass. The glazing shall be fixed in rebates in the framing by means of teak moulded beads with brass screws. All exposed faces of the wood work and facing sheets shall be polished with wax or french polish. The work shall be executed in strict conformity with the drawings and shall be of high standard and must be approved by the Engineer.

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8.14 **Hardware fittings for door, windows & ventilators**

All mortice or rim locks, latches, cabinet and ward robe locks, hydraulic door closers, floor springs etc shall be of Godrej, Everite make or of similar approved make. The rate shall include for all necessary screws, other adjuncts, fixing in position and is for the completed work. The finish shall be as specified in drawings. Door, window and ventilator fittings shall be as per specifications already described.

8.15 **Inspection**

The Contractor shall provide all facilities to the Engineer for the inspection of the goods at his premises. No primer shall be applied until the wood work has been inspected and passed by the Engineer. The Engineer shall have the option of rejecting any article or asking for replacement of any article found to be defective or not complying with the requirements of this specification .

9.0 **STEEL DOORS. WINDOWS AND VENTILATORS**



9.1 **Materials**

Hot rolled steel sections for the fabrication of steel doors, windows and ventilators shall conform to IS:7452, which are suitable. for single glazing.

Pressed steel door frames for steel flush doors shall be out of 1.25 mm thick mild steel sheets of profiles as per IS:4351.

M.S. bolts, nuts, screws, washers, peg stays and other mild steel fittings shall be treated for corrosion. Putty for glazing shall conform to IS: 419. Glass panes and glazing shall conform to the specification detailed under this series.

Engineer. All hardware fixtures shall be able to withstand repeated use. Door closers shall be suitable for doors weighing 61-80 kg, unless otherwise stated. Each closer shall be guaranteed against manufacturing defect for one year and any defect found within this period shall be rectified or the closer replaced free of charge. Concealed door closers shall be either floor mounted or transom mounted, suitable for installation with metal doors.

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It shall conform to the performance requirements and endurance test stated in IS: 3564 Appendix-A.

The mastic for caulking shall be of best quality from a manufacturer approved by the Engineer. In general the mastic for fixing of metal frames shall conform to IS: 1081 and / or as approved by the Engineer.

9.2 **Workmanship**

All steel doors, windows and ventilator's shall be of the type and of sizes as indicated in the drawings.



9.3 **General**

Doors, windows and ventilators etc., shall be truly square and flat, i.e. free from twist and warp. The general fabrication shall conform to IS: 1038 & IS: 1361 as applicable.

Frames shall be constructed of sections, which have been cut to length and mitred. They shall be morticed, reinforced, drilled and tapped for hinges and lock and bolt strikes. Where necessary, frames shall be reinforced for door closers. Flash butt welding or any other suitable method, which gives the desired requirement, with mitred corners, shall be used. Rubber door silencers shall be furnished for the striking jamb. Loose "T" masonry anchors shall be provided. Frames shall finish flush with floor and adjustable floor anchors shall be supplied. Frames shall be brought to site with floor ties/weather bars installed in place. All frames shall be square and flat. Door thresholds shall be provided as shown on drawing. Doors without threshold shall have bottom tie of approved type.

The Contractor shall first submit for the approval of the Engineer, the name and address of the manufacturer whose metal casements and doors and windows he intends to use, together with typical drawings and specifications, describing the details of construction for each type of door/window/ventilator etc.

All steel doors, windows and ventilators shall be either galvanised or painted. All steel surface shall first be thoroughly cleaned free of rust, scale or dirt and mill scale by picking or similar process and then shall be painted with one coat of an approved primer conforming to IS: 102

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before dispatch. Alternatively they may be galvanised by the "Hot Dip" zinc spray or electro- galvanizing process as described in IS: I361.

9.4 **Fixing**

Doors, windows and ventilators shall not be built in at the time the walls are constructed but shall be subsequently fixed into prepared openings, as laid down in IS : 1031. Holes to accommodate the fixing lugs are to be left or cut, and the casements fixed after all the rough masonry and plaster work have been finalised. The lugs of the casement shall be jammed in cement concrete (M15) after holding the casement in proper position, line & and level.



The width of the clear unfinished opening in the wall should be 25 mm more than the overall width of the door frame to allow for plaster on each jamb. The height of the unfinished opening shall depend upon whether a threshold is required or not. While fixing the door, care shall be taken to see that at least 6mm space is left between the door and the finished floor.

9.5 **Fittings**

Hardware shall be fixed as late as possible, preferably just before the final coat of paint is applied. It shall be fitted in a workmanlike manner, so that it may not work loose and in such a way that screws and pins are not marked and mutilated by hammers and screw drivers. It shall be tested for correct operation. Where specified, doors shall be fitted with a three way bolting device which can be operated from out side as well as inside, and a locking system, which similarly be operated from either side. Solid steel bolt handles shall be provided, one on the outside one on the inside of each shutter. In case of doors provided with a service door, the lock shall be fitted on the service door. All materials shall be the best procurable and shall be approved by the Engineer.

9.6 **Normal Steel Plate Doors**

Steel doors may be of the hinged type or sliding/folding type, single shutter or double shutter, and of single walled or double walled construction, as specified on the drawings . All doors shall be provided with a sturdy frame and holdfasts for fixing into the wall. Unless otherwise specified, the frame shall be prepared from mild steel angles

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of size not less than 65 x 65 x 6 mm electrically welded at the corners and the shutter shall be made from flat steel sheet of 18 gauge or 1.25mm thickness with a frame of mild steel angles not less than 50 x 50 x 6 mm all round, suitably braced. The whole shutter shall be of welded construction and shall be hung at the sides by means of three or four hinges as specified.

9.7 **Double Plate flush door shutters**

Door shutters shall be 45 mm thick, completely flush design and shall comprise of two outer sheets or 18G or 1.25mm thick steel sheets, rigidly connected and reinforced inside with continuous vertical 20G or 0.99mm thick stiffeners, spot welded in position at not more than 150 mm on centres. Both edges of doors shall be joined and reinforced full height by steel channels placed immediately inside and welded to the door faces. Top and bottom of doors shall be reinforced horizontally by steel channels running full width of door. Doors shall not have more than 2.5 mm clearance at jambs and head, shall have proper level on lock stiles and rails and shall be reinforced at corners to prevent sagging or twisting. Pairs of double doors shall have meeting style edges bevelled or rebated. Where shown on drawing, the doors shall be sound deadened by filling the inside voids with mineral wool or other suitable approved materials. Doors shall be mortised, reinforced, drilled and tapped in shop for hinges, locks and bolts. They shall also be reinforced for closers, push-plates and other surface hardware where necessary. Any drilling and tapering required for surface hardware shall be done at site. Where shown in drawing, provisions shall be made for fixing glazing, vision panels, louvers etc. Glazing mouldings shall be of 18G or 1.25mm thick steel or extruded aluminium sections with profiles shown in drawing and suitable for fixing 6 mm glass. Louver blades shall be V or Z shaped sections.

9.8 **Single sheet door shutters**

Single sheet doors shall be made from best quality 18g/ 1.25mm mild steel sheets, and shall present a flush surface on the outside. The inside shall be stiffened with a semi tubular edge and central stiffening rail, which shall convey the lock and other fixture. The frames shall be made from best quality steel sections. Wherever required or shown on drawings, provision for fixing glass panes, louvers etc., shall be made. The manufacturing shall be done as specified in "Double Plate Flush Door Shutters".

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9.9 **Sliding Doors**

Shall be either double plate or single plate construction as shown in drawings and made out of 18 gauge or 1.25mm thick steel sheets with adequate stiffeners. The Contractor shall specify the weight of the door in his shop drawing and submit the manufacturer's catalogue of the sliding gear he proposes to use. Where shown in drawings, the Contractor shall make provision for openings in the door for mono rail beams. Doors when closed shall effectively exclude rainwater from seeping in. Sliding doors shall withstand specified wind loads without buckling or jamming. The door shall slide freely under all ambient conditions.



9.10 **Pressed Steel Doors**

All pressed steel doors shall be obtained from an approved manufacturer. The frame and shutters shall be fabricated from cold rolled or pressed steel sections. Unless otherwise specified, the thickness of all sheets used for frames shall be not less than 5 mm. The shutters shall be made of sheet steel of 2mm thickness for single shutter doors and double shutter doors with or without service door. The plates shall be adequately stiffened with suitably placed stiffeners.

The double-walled door shutter shall consist of two plates each 2.5 mm thick, separated by a gap of 33 mm in between making an overall thickness of 38 mm or as shown in drawing. The plates shall be adequately stiffened by means of suitably spaced horizontal steel stiffeners.

9.11 **Steel Windows, Sashes, Ventilators, etc.**

These shall conform to IS : 1038 and IS : 1361 as appropriate and as shown in drawings. The details as called for in the above codes shall be applicable for coupling mullions, transoms, weather bars, pivot arrangements for ventilators, etc. Where composite unit openings are shown in drawings, the individual window units shall be joined together with requisite transoms and mullions. Where aluminium glazing beads are specified, they shall be extruded aluminium channel 9.5 mm x 1.6 mm (Indal Section No. 2209) unless otherwise shown in drawings. All welds at the corner of casement shall be done by flash butt welding process or any other suitable method, which gives the desired requirement and dressed flush on all exposed and contact surfaces.

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9.12 **Special Doors (Steel)**

9.12.1 **General**

Special doors comprising Dust Proof, Air-tight and Fire Resistant and Fire-Proof types shall be double plate or single sheet and shall be constructed of normal steel sheet or pressed steel as specified on the drawings. Fire Resistant and Fire-Proof doors shall conform to LPA. The doors shall conform to the following additional special requirements.

9.12.2 **Dust proof doors**

When dust-proof door and windows are specified, sponge Rubber sealing strips shall be provided along all the four sides and along the vertical mating joint in the case of double shutters. This rubber strip shall be housed in a channel or other suitable section in such a way that when the shutters are closed, the strip will press against the frames and threshold plates.

10.0 **ALUMINIUM DOORS, WINDOWS, VENTILATORS & PARTITIONS**

10.1 **Materials**



10.1.1 Aluminium alloy used in the. manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS:733.

10.1.2 Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.

10.1.3 Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

10.2 **Workmanship**

10.2.1 All aluminium doors, windows, ventilators and partitions shall be of the type as specified and of sizes as indicated in the drawings.

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10.2.2 Aluminium Doors, Windows, Frames

Anodised tubular aluminium doors shall be of approved make and shall be of size and design as per relevant drawing. Unless otherwise specified, the door frame shall be of 101.4mm x 44.6mm and shutter of 50mm tubular extrusions, 3mm thick. The opening arrangement shall be single action or double action as shown in drawing with spring hinges in floor. The glazing shall be 5.5mm thick plain glass panes fixed with necessary gaskets and aluminium beading strip. The door shall be provided with one security lock. The shutters shall be provided with 1.6mm thick 300x150mm push plates and 1.6mm thick 300mm wide kick plate of anodised aluminium for full width of door inside and outside.



The doorframes shall be polished and anodized with approved colour. The average thickness of anodic coating shall not be less than 15 microns as per IS: 1868. Doorframe shall be provided with approved anchors @ 90 cm c/c maximum for fixing.

10.2.3 Aluminium windows

Aluminium hinged windows and ventilators shall conform to IS: 1948 or equivalent as approved by the Engineer. Fixed frame shall be manufactured from aluminium alloy conforming to ISS-HE-9 WP. The fixtures like handles, stoppers, stays, etc., shall also be anodized aluminium and shall be of approved make. Glazing shall be 4mm thick plain glass and shall be fixed with glazing clips and metal putty. It shall conform to IS:1081. Average anodizing coating to windows, ventilators and fixtures shall not be less than 15 microns as per IS 1868.

All work shall be fitted and shop assembled to a first job, and ready for erection. Shop joints shall be made to hair lines and then welded or braced by such methods as will produce a uniform colour throughout the work. Wherever possible, joints shall be made in concealed locations and on edges of doors.

Field connections of all work may be made with concealed screws or other approved type of fasteners. Glazing beads shall be shape fit type without visible screws and shall be of sizes, to accommodate glazing. All work shall be adequately braced and reinforced as necessary for strength and rigidity.

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10.2.4 **Aluminium partitions**



The fully glazed aluminium frame work shall consist of posts /rails of size 101.4mm x 44.6mm unfilled with timber. The vertical posts shall be spaced approximately at 1000mm centres. Horizontal rails shall be provided as per the approved partition drawings proposed. The frame work of the partitions shall be rigidly fixed to the floor and roof. Preformed rubber lining and aluminium beading shall be provided as necessary and the glazing shall be 5.5 thick plate glass as per specifications under glazing items.

11.0 **STEEL ROLLING SHUTTERS**

11.1 **Materials and Workmanship**

11.1.1 Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS:6248.

11.1.2 The type of rolling shutter will be. self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation. For electrically operated rolling shutters Power unit shall be suitable for 3 phase, 50 cycle, 400 volt A.C. power supply and shall be either floor or wall mounted unit. The motor shall be of sufficient capacity to move the shutter in either direction at a speed of about 0.3 metres per second. In addition to the gear motor, each standard power unit shall include a magnetic brake, reversing starter with built-in over-load protection, a geared limit switch and one push button station located inside the building. The bottom bar of motor operated doors shall be provided with a sensitive edge, electrically connected to stop the travel of the door on meeting an obstruction. Operating chains shall be of tested quality, heavily galvanised and with all ends rounded to assure smooth operation and hand protection. Reduction gears shall be of high strength grey cast iron, machine moulded from machined out patterns.

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11.1.3 Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the drawings.

11.1.4 Shutters shall be built-up of interlocking laths 75mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50m width and not less than 1.25 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

11.1.5 The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS:6248 for various clear width of the shutters.

11.1.6 Hood covers shall be of mild steel sheets not less than 0.90mm thick and of approved shape.

11.1.7 Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.



11.1.8 All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of red oxide zinc chrome primer conforming to IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified. Painting shall be carried out as per specification.

11.1.9 Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

12.0 **TERRAZZO AND PLAIN CEMENT TILING WORK**

12.1 **Materials**

12.1.1 Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS:1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14N/mm².

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12.1.2 The type, quality, size, thickness colour etc, of the tiles for flooring/dado/ skirting shall be as per specifications and as approved by Engineer.

12.1.3 The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

12.1.4 The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm upto 6mm or from 1mm upto 12mm. This shall be 6mm for tiles with chips varying from 1mm upto 25mm. The minimum thickness of wearing layer of cement/coloured cement tiles shall be 5mm. This shall be 6mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix.



12.2 Workmanship

12.2.1 Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS:1443.

12.2.2 Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.

12.2.3 The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

12.2.4 A layer of 25mm average thickness of cement mortar consisting of one part of cement to 3 parts of sand shall be provided as bedding for the

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tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS:2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles.



12.2.5 Neat cement slurry using 4.4 kg of cement per one sq.m of floor area shall be spread over the hardened mortar bedding over such an area at

a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the Joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade on the colour of the matrix of the tile. For this purpose white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.

12.2.6 About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those laid earlier, it is necessary that the CONTRACTOR shall procure sufficient quantity of extra tiles to meet this contingency.

12.2.7 Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

12.2.8 Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand

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mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish.

12.2.9 Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

12.2.10 Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

12.2.11 Machine grinding and polishing shall be commenced only after a gap of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS:1443.



12.2.12 Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localised deviation of $\pm 3\text{mm}$ in any 3m length is acceptable in a nominally flat floor.

12.3 In-Situ Terrazzo Work

12.3.1 Materials

12.3.2 The requirements of marble aggregates for terrazzo topping shall be as per clause 12.1.3.

12.3.3 Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement

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working to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

12.4 **Workmanship**

12.4.1 The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado skirting shall be as per specifications and as approved by Engineer. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS: 2114.



12.4.2 In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The under layer shall be of cement concrete of mix 1:2:4 using 10mm down graded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

12.4.3 The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than 10mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

12.4.4 Both the under layer and later the topping shall be divided into panels not exceeding 2 Sq.m. for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividing strips are not provided, the bays shall be laid alternately, allowing an interval of atleast 24 hours between laying adjacent bays.

12.4.5 Dividing strips shall be either of aluminium, brass or other material as indicated in the item of work. Aluminium strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work.

12.4.6 Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified

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thickness of terrazzo finish. Before spreading the under layer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips shall be fixed on the base and levelled to the correct height to suit the thickness of the finish. Just before spreading the under layer the surface shall be smeared with cement slurry at 2.75 Kg/sq.m. Over this slurry, the under layer shall be spread and levelled with a screeding board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

12.4.7 Terrazzo topping shall be laid while the under layer is still plastic and normally between 18 to 24 hours after the under layer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of trowelling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.



12.4.8 The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

12.4.9 Machine grinding and polishing shall be commenced only after a gap of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborandum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS: 2114.

13.0 **SHAHABAD/TANDUR/KOTA STONE SLAB WORK**

13.1 **Materials**

13.1.1 The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS:1124.

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13.1.2 The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100 mm shall be $\pm 5\text{mm}$. This shall be $\pm 2\text{mm}$ on dimensions less than 100mm.

13.1.3 Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

13.2 Workmanship

13.2.1 The type, size, thickness and colour/shade etc. of the slabs for flooring/dado/ skirting shall be as per specifications /approved by the Engineer.

13.2.2 Preparation of the concrete base, laying and curing shall be as per clause 12.2.3 to clause 12.2.5.



13.2.3 Dado/skirting work shall be as per clause. 12.2.8. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is 12mm from the surface of the wall. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

13.2.4 Grinding and polishing shall be as per clause 12.2.11 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

14.0 CARBORUNDUM TILE FINISH

14.1 Materials

14.1.1 Carborundum tiles shall generally conform in all respects to the standards stipulated in IS:1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm^2 .

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14.1.2 The topping shall be uniform and of thickness not less than 6mm. The quantity of carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60mm mesh.

14.1.3 The size, thickness, colour and plain or chequered etc. of the tiles for flooring/skirting shall be as specifications/approved by the Engineer.

14.2 WORKMANSHIP

14.2.1 Requirements as detailed for terrazzo/cement tile finish under clause 12.2 shall be applicable for carborundum tile flooring.

15.0 GLAZED TILE FINISH

15.1 Materials



15.1.1 Glazed earthenware tiles shall conform to the requirements of IS:777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

15.2 Workmanship

15.2.1 The size, thickness, colour, with or without designs etc of the tiles for flooring/dado/skirting shall be as per specifications /approved by the Engineer.

15.2.2 The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

15.2.3 The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modules of 1.5.

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15.2.4 Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

15.2.5 Coloured tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

15.2.6 Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

15.2.7 Neat cement slurry using 3.3 kg cement per one sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1 mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

15.2.8 All the joints shall be cleaned of grey cement with wire brush to a depth of at least 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

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15.2.9 Specials consisting of caves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

15.3 Ceramic Tiles Flooring

15.3.1 The sampling and basis for acceptance of tiles shall be as per IS:13711 and definition, classification and characteristics shall conform to IS:13712.

15.3.2 The workmanship shall be as defined under clause 15.2.

16.0 IN-SITU CEMENT CONCRETE FLOOR TOPPING

16.1 Materials

16.1.1 The mix proportion for the in-situ concrete floor topping shall be 1:2^{1/2}:3^{1/2} (one part cement : two and half parts sand : three and half parts coarse aggregates) by volume.

16.1.2 The aggregates shall conform for the requirements of IS:383.

16.1.3 Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS:2571.



16.1.4 Grading of the sand shall be within the limits indicated in IS:2571.

16.2 Workmanship

16.2.1 The thickness of the floor topping shall be as per specifications. The minimum thickness of the floor topping shall be 25mm.

16.2.2 Preparation of base concrete/structural slab before laying the topping shall be as per clause 12.2.3. The surface shall be rough to provide adequate bond for the topping.

16.2.3 Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for

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laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.



16.2.4 Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of atleast one day. Construction joints shall be plain vertical butt joints.

16.2.5 Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities from that specified in the drawings and these shall be made good immediately.

16.2.6 Finishing of the surface by trowelling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be retrowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

16.2.7 Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

16.2.8 It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerance, is achievable in practice, owing to its greater thickness. Further, as this would be laid

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after all other building operations are over, there will be no risk of any damages or discoloration to the floor finish which are difficult to repair satisfactorily.

17.0 **IN-SITU GRANOLITHIC CONCRETE FLOOR TOPPING**

17.1 **Materials and Workmanship**

17.1.1 The requirements of materials and workmanship shall be all as per clause 16.0 for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement:sand:coarse-aggregates) by volume.

17.1.2 The thickness of the floor topping shall be as per specifications. The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

18.0 **FLOOR HARDENER TOPPING**



18.1 **Materials & Workmanship**

18.1.1 Floor hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid monolithically with the concrete/granolithic floor finish on top of hardened concrete base.

18.1.2 Floor hardener of the metallic or non-metallic type as per manufacturer's specifications suitable for the performance of normal/medium/heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as per specifications.

18.1.3 For monolithic application with the floor finish/slab, the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid and it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screeded and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 16.2.6. After the surface has hardened sufficiently, it shall be kept continuously moist for atleast 10 days.

18.1.4 The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

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18.1.5 Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

19.0 **PVC SHEET/TILE FLOORING**

19.1 **Materials**

19.1.1 PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS:3462 or homogeneous PVC asbestos tiles conforming to IS:3461.

19.1.2 The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS codes. CONTRACTOR shall submit the test certificates, if so desired by the ENGINEER.

19.1.3 Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark and batch number.



19.1.4 The adhesive to be used for laying the PVC flooring shall be rubber based and of the make on recommended and approved by the manufacturer of PVC sheets/tiles.

19.1.5 The type, size, thickness, colour, plain or mottled and the pattern shall be as specified /approved by Engineer.

19.2 **Workmanship**

19.2.1 PVC floor covering shall be provided over an underbed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the under bed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS:5318.

19.2.2 The surface of the under bed shall have trowelled finish without any irregularities which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

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19.2.3 PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the under bed until the A/C units have been in operation for atleast 7 days. During this period, the temperature range shall be between 20⁰C and 30⁰C and this shall be maintained during the laying operations and also for 48 hours thereafter.



19.2.4 Layout of the PVC flooring shall be marked with guidelines on the under bed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout.

19.2.5 The adhesive shall be applied by using a notched trowel to the surface of the under bed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

19.2.6 PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

19.2.7 Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slid on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

19.2.8 Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

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19.2.9 A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

19.2.10 Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

19.2.11 Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the Joints shall be carried out, using special equipment as per manufacturer's instructions.

20.0 **ACID RESISTING TILING WORK**

20.1 **Materials**

20.1.1 The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS:4457.

20.1.2 The finished tile when fractured shall appear fine grained in texture, dense and homogeneous. Tile shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in the dimensions shall be within the limits specified in the respective IS Code.



20.1.3 The tiles shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS:4832 (Part II). Method of usage shall generally be as per the requirements of IS:4443.

20.2 **Workmanship**

20.2.1 The size and thickness of tiles for use in the flooring/skirting/dado shall be as specified /approved by Engineer.

20.2.2 The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

20.2.3 The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS:3384. The primed surface shall then be applied with a uniform

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coat of bitumen conforming to IS:1530. Tiles shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

20.2.4 Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

20.2.5 For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/. Two adjacent sides of the tile shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.



20.2.6 The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

20.2.7 Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively if heat treatment is given with infrared lamp.

21.0 **EPOXY LINING WORK**

21.1 **Materials**

21.1.1 The epoxy resin and hardener formulation for laying of Pointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS:9197.

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21.1.2 The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

- a) Hydrochloric acid upto 30% concentration
- b) Sodium hydroxide upto 50% concentration
- c) Liquid temperature upto 60 degree C
- d) Ultraviolet radiation
- e) Alternate wetting and drying

21.1.3 Sand shall conform to grading zone III or IV of IS:383.

21.1.4 The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

21.1.5 CONTRACTOR shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the ENGINEER.



21.2 WORKMANSHIP



21.2.1 The minimum thickness of epoxy lining shall be 4 mm. The thickness and areas of application shall be as specified . It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

21.2.2 The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

21.2.3 The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

21.2.4 Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

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<p>21.2.5 Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.</p> <p>21.2.6 Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.</p> <p>22.0 <u>WATERSTOPS</u></p> <p>22.1 <u>Material</u></p> <p>22.1.1 The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS:8543.</p> <table><tr><td>a)</td><td>Tensile strength</td><td>:</td><td>11.6 N/mm² minimum</td></tr><tr><td>b)</td><td>Ultimate elongation</td><td>:</td><td>300% minimum</td></tr><tr><td>c)</td><td>Tear resistance</td><td>:</td><td>4.9 N/mm² minimum</td></tr><tr><td>d)</td><td>Stiffness in flexure</td><td>:</td><td>2.46 N/mm² minimum</td></tr><tr><td>e)</td><td>Accelerated extraction</td><td>:</td><td></td></tr><tr><td></td><td>i) Tensile strength</td><td>:</td><td>10.50 N/mm² minimum</td></tr><tr><td></td><td>ii) Ultimate elongation</td><td>:</td><td>250% minimum</td></tr><tr><td>f)</td><td>Effect of Alkali</td><td>:</td><td>7 days</td></tr><tr><td>i)</td><td>Weight increase</td><td>:</td><td>0.1% maximum</td></tr><tr><td>ii)</td><td>Height decrease</td><td>:</td><td>0.10% maximum</td></tr><tr><td>iii)</td><td>Hardness change</td><td>:</td><td>± 5 points</td></tr><tr><td>g)</td><td>Effect of Alkali</td><td>:</td><td>28 days</td></tr><tr><td>i)</td><td>Weight increase</td><td>:</td><td>0.40% maximum</td></tr><tr><td>ii)</td><td>Weight decrease</td><td>:</td><td>0.30% maximum</td></tr><tr><td>iii)</td><td>Dimension change</td><td>:</td><td>± 1%</td></tr></table>			a)	Tensile strength	:	11.6 N/mm ² minimum	b)	Ultimate elongation	:	300% minimum	c)	Tear resistance	:	4.9 N/mm ² minimum	d)	Stiffness in flexure	:	2.46 N/mm ² minimum	e)	Accelerated extraction	:			i) Tensile strength	:	10.50 N/mm ² minimum		ii) Ultimate elongation	:	250% minimum	f)	Effect of Alkali	:	7 days	i)	Weight increase	:	0.1% maximum	ii)	Height decrease	:	0.10% maximum	iii)	Hardness change	:	± 5 points	g)	Effect of Alkali	:	28 days	i)	Weight increase	:	0.40% maximum	ii)	Weight decrease	:	0.30% maximum	iii)	Dimension change	:	± 1%
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22.1.2 PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use. The width, type, minimum thickness and safe hydraulic head requirements shall be as per specifications/drawings.

22.1.3 PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the ENGINEER before procurement for incorporation in the works.

22.2 Workmanship



22.2.1 Waterstops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

22.2.2 Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

22.2.3 Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/concrete coating before resuming further concreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregate shall be used for concreting in this region also.

23.0 PREFORMED FILLERS AND JOINT SEALING COMPOUND

23.1 Materials

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23.1.1 Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS:1838 (Part I).

23.1.2 Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS:702. Bitumen primer shall conform to IS:3384.

23.1.3 Chemical sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS:1834.



23.2 Workmanship

23.2.1 The work man ship shall be as per manufacturers specifications .The thickness of the preformed bitumen filler shall be as specified in the approved drawings. CONTRACTOR shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

23.2.2 The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot, the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

23.2.3 Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS:3384 in order to improve the adhesive quality of the sealing compound.

23.2.4 Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be

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provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

24.0 **WATER-PROOFING OF ROOFS WITH ELASTOMERIC MEMBRANE**

24.1 **Waterproofing Material**

The Waterproofing Membrane shall be ISOTHANE EMA or approved equivalent product.

24.2 **General**

The concrete surface to receive the membrane shall be dry, even and smooth and free from dust, oil and loose materials. All sharp projections, high spots and local depressions should be removed to give a smooth surface.



The membrane when meeting against the parapet or the upturn, shall turn up for at least 300 mm high from finished level and with top edge tucked in groove formed on wall or upturn and filled with an approved mastic filler material.

24.3 **Application Procedures**

Primer the surface with Isothane Special Primer or approved equivalent at 6 - 10 m²/litre or as per manufacturer's recommendations. Apply one coat of Isothane EMA of 0.5 mm thick waterproofing membrane or approved equivalent. Apply second coat of Isothane EMA of 0.5 mm thick or approved equivalent. The first coat shall be touch dry in 12 - 48 hrs. and second coat shall be applied within 24 hrs. of this stage or as per manufacturer's recommendations. Lay 25 mm thick cement screed (1:3) with waterproofing compound as protective layer immediately after the installed membrane has passed the water test.

24.4 In order to avoid damage to water-proofing treatment additional surface treatment by provision of machine made burnt clay flat terracing tiles conforming to IS:2690 (Part 1) shall be made

24.5 Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before

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laying. Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction of run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by atleast 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instructions. Curing shall be carried out for a minimum period of seven days.

25.0 **CEMENT PLASTERING WORK**



25.1 **Materials**

25.1.1 The proportions of the cement mortar for plastering shall be 1:4 (one part of cement to four parts of sand) . Cement and sand shall be mixed thoroughly in dry condition and then water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS. The quality and grading of sand for plastering shall conform to IS:1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. If so desired by the ENGINEER sand shall be screened and washed to meet the specification requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

25.2 **Workmanship**

25.2.1 Preparation of surfaces and application of plaster finishes shall generally confirm to the requirements specified in IS:1661 and IS:2402.

25.2.2 Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/window panels, pipes, conduits etc. are completed.

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25.2.3 All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean-water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

25.2.4 **Interior plain faced plaster** - This plaster shall be laid in a single coat of 12mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the ENGINEER.

25.2.5 **Plain Faced Ceiling plaster** - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in clause 25.2.4.

25.2.6 **Exterior plain faced plaster** - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 12 mm thick. The rendering coat shall be applied as stipulated in clause 25.2.4 except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for atleast two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for atleast 7 days.

25.2.7 Interior plain faced plaster 18mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be

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executed in 2 coats similar to the procedure stipulated in clause 25.2.6.

25.2.8 Exterior Sand Faced Plaster - This plaster shall be applied in 2 coats. The first coat shall be 12mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated in clause 25.2.6. However, only approved quality shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified .



25.2.9 Wherever more than 18mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the ENGINEER duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.



25.2.10 In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the ENGINEER.



25.2.11 Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the drawings.



25.2.12 Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for atleast 7 days.



25.2.13 When the specification of work calls for waterproofing plaster the CONTRACTOR shall provide the waterproofing compound as specified while preparing the cement mortar.



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<p>25.2.14 For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.</p> <p>25.2.15 Double scaffolding to be used shall be as specified under brick work.</p> <p>25.2.16 The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.</p> <p>25.2.17 To overcome the possibility of development of cracks in the plastering work following measures shall be adapted.</p> <p>25.2.17.1 Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.</p> <p>25.2.17.2 At the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement grooves of 5mm wide and 5mm deep shall be provided as directed by Engineer</p> <p>25.2.17.3 Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.</p> <p>26.0 <u>CEMENT POINTING</u></p> <p>26.1 <u>Materials</u></p> <p>26.1.1 The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand) . Sand shall conform to IS:1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by ENGINEER and if so directed it shall be washed/screened to meet specification requirements.</p>		
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<p>26.2 <u>Workmanship</u></p> <p>26.2.1 Where pointing of joints in masonry work is specified on drawings, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.</p> <p>26.2.2 Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified .No false joints shall be allowed.</p> <p>26.2.3 The work shall be kept moist for atleast 7 days after the pointing is completed. Whenever coloured pointing is to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the ENGINEER.</p> <p>27.0 <u>METAL LATH & WIRE FABRIC</u></p> <p>27.1 <u>Materials</u></p> <p>27.1.1 Welded steel wire fabric shall conform to IS:4948</p> <p>27.1.2 Expanded metal shall conform to IS:412</p> <p>27.1.3 Galvanised wire mesh shall be of approved quality.</p> <p>27.2 <u>Workmanship</u></p> <p>27.2.1 The type and details of the steel material to be used for metal lath plastering work and at the junctions of brick masonry/concrete before wall plastering shall be as specified /approved by Engineer.</p> <p>27.2.2 For metal lath plastering work, the weight of steel material shall be not less than 1.6 kg/sq m.</p>		
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<p>27.2.3 Steel material for use at the Junction of brick masonry/ concrete shall have the mesh dimensions not greater than 50 mm.</p> <p>27.2.4 Steel material shall be obtained in maximum lengths as manufactured to restrict joints to the minimum. Overlap at the joints shall be minimum 25 mm which shall be securely tied with wires of diameter not less than 1.25 mm at spacing not more than 100 mm for lath plastering work. Nailing to wall shall be at spacing not exceeding 200 mm. The material shall be straightened, cut and bent to shape if required for fixing as per the details indicated in the drawings.</p> <p>28.0 <u>WATER-PROOFING ADMIXTURE</u></p> <p>28.1 Water-proofing admixture shall conform to the requirements of IS:2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the Engineer.</p> <p>29.0 <u>PAINTING OF CONCRETE MASONRY & PLASTERED SURFACES</u></p> <p>29.1 <u>Materials</u></p> <p>29.1.1 Oil bound distemper shall conform to IS:428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.</p> <p>29.1.2 Exterior emulsion shall conform to IS:5410. The primer shall be a thinned coat of exterior emulsion.</p> <p>29.1.3 Acrylic emulsion paint shall be of an approved manufacture.</p> <p>29.1.4 Plastic emulsion paint shall conform to IS:5411.</p> <p>29.1.5 Lead free acid, alkali and chlorine resisting paint shall conform to IS:9862.</p> <p>29.1.6 White wash shall be made from good quality fat lime conforming to IS:712. It shall be slaked at site and mixed with water in the proportion of 5 litres of water to 1 kg of unslaked lime stirred well to make a thin cream. This shall be allowed to stand for a</p>		
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<p>minimum period of one day and strained through a clean coarse cloth. Four kg of gum dissolved in hot water shall be added to each cu.m of cream. 1.30 kg of sodium chloride dissolved in hot water shall then be added per 10 kg of lime used for the white wash to be ready for application.</p> <p>29.1.7 Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the ENGINEER.</p> <p>29.1.8 All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.</p> <p>29.2 <u>Workmanship</u></p> <p>29.2.1 CONTRACTOR shall obtain the approval of the ENGINEER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.</p> <p>29.2.2 Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub-strata.</p> <p>29.2.3 The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS:2395.</p> <p>29.2.4 Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.</p> <p>29.3 <u>White Wash</u></p> <p>The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries.</p>		
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<p>Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied. The dry surface shall present a uniform finish without any brush marks.</p>		
29.4	<u>Colour Wash</u> Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.	
29.5	<u>Exterior Emulsion Paint</u> The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. The paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water- proofing in addition to decoration. The paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 2 coats of the same colour shall be applied. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for atleast 2 days after the application of final coat.	
29.6	<u>Oil Bound Distemper</u> The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for atleast 48 hours. A minimum of two coats of oil bound distemper shall be applied. The first coat shall be of a lighter tint. Atleast 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double	
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<p>bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed in 29.3.</p>		
29.7	<u>Plastic Emulsion Paint</u>	
<p>The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. Un evenness in the plaster shall be made good by applying plaster of paris putty mixed with distemper of the colour to be used on the entire surface including filling up the undulations. The paint shall be laid an 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 for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied.</p> <p>Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.</p>		
29.8	<u>Acrylic Emulsion Paint</u>	
<p>Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided.</p>		
29.9	<u>Acid, Alkali Resisting Paint</u>	
<p>A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.</p>		
30.0	<u>PAINTING & POLISHING OF WOOD WORK</u>	
30.1	<u>Materials</u>	
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<p>30.1.1 Wood primer shall conform to IS:3536.</p> <p>30.1.2 Filler shall conform to IS:110.</p> <p>30.1.3 Varnish shall conform to IS:337.</p> <p>30.1.4 French polish shall conform to IS:348.</p> <p>30.1.5 Synthetic enamel paint shall conform to IS:2932.</p> <p>30.1.6 All the materials shall be of the best quality from an approved manufacturer. CONTRACTOR shall obtain prior approval of the ENGINEER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.</p> <p>30.2 <u>Workmanship</u></p> <p>30.2.1 The type of finish to be provided for woodwork of either painting or polishing, the number of coats, etc. shall be as specified /approved by Engineer.</p> <p>30.2.2 Primer and finish paint shall be compatible with each other to avoid, cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.</p> <p>30.2.3 Painting shall be either by brushing or spraying. CONTRACTOR shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS:2338 (Part I).</p> <p>30.2.4 All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified/approved by Engineer .Any slight irregularities of the surface shall then be made up by applying an optimum coat of filler conforming to IS:110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly</p>		
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<p>and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the ENGINEER. The number of coats of paint to be applied shall be as specified in the drawings/as approved by Engineer.</p> <p>30.2.5 All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off.</p> <p>Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS:337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the ENGINEER. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flatting varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified /Approved by Engineer. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woollen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as per drawings/as approved by Engineer.</p>		
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<p>31.0 <u>FLASHING</u></p> <p>31.1 <u>Materials</u></p> <p>31.1.1 Anodised aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.</p> <p>31.1.2 Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.</p> <p>31.2 <u>Workmanship</u></p> <p>31.2.1 The type of the flashing and method of fixing shall be as specified.</p> <p>31.2.2 Flashing shall be of the correct shape and size as indicated in the construction drawings and they shall be properly fixed to ensure their effectiveness.</p> <p>31.2.3 Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.</p> <p>31.2.4 Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide X 65 mm deep in masonry/concrete along with cement mortar 1:4 filletting as indicated in the drawings. Curing of the mortar shall be carried out for a minimum period of 4 days.</p> <p>32.0 <u>THERMAL INSULATION FOR CEILING .</u></p> <p>The insulation shall be provided wherever shown on the drawings and as directed by the OWNER.</p> <p>The material for insulation shall conform to IS 8183 and shall be resin bonded slabs and rolls or equivalent. Rolls shall have a density of 48kg/cum and shall be 50 mm thick with 0.03 mm aluminium foil facing on one side.</p> <p>The Contractor shall submit test certificate regarding thermal conductivity from the manufacturer and samples of the thermal insulation material he proposes to incorporate in the works and get the approval in writing from the Engineer before procuring the</p>		
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<p>material. All the insulation material used in the works shall strictly conform to the sample approved.</p> <p>The material shall be stored at site under a covered shed properly packed as supplied by manufacturer on firm and dry floor and shall be handled with care before being finally installed in the works.</p> <p>32.1 <u>Fixing</u></p> <p>Timber pegs 50x50 mm and thickness as specified by the Engineer or slotted angles shall be fixed to the underside of the slab at 600mm centres both ways with wood screws, rawl plugs, dash fastners. etc. of suitable length.</p> <p>Insulation slabs / rolls shall then be stuck to the slab with a suitable adhesive recommended by the manufacturer of the slabs / rolls and secured in position by 14SWG lacing wires tied across the pegs diagonally with galvanised nails.</p> <p>The slabs / rolls shall then be covered with GI wire mesh netting 24 SWG , mesh size 25mm, nailed to the timber pegs / tied to the slotted angle. The joints of the wire netting shall be butted and lightly laid down with G.I wire. The joints shall then be covered with bitumen / polythene faced hessian cloth, scrim cloth, canvas , or aluminium foil as shown in the drawing and as directed by the Engineer.</p> <p>Alternatively, if the Contractor proposes his own arrangement for installing the insulation, he may submit his scheme for the approval of the Engineer and on the Engineer's specific approval the arrangement may be used.</p> <p>33.0 <u>RUBBLE SUB-BASE</u></p> <p>33.1 <u>Materials</u></p> <p>33.1.1 Stones used for rubble packing under floors on grade foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stone shall generally conform to the requirements stipulated in IS:1597(part I).</p>		
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- 33.1.2.1 Stones shall be as regular as can be obtained from quarries. Istones shall be of height equal to the thickness of packing proposed with a tolerance of $\pm 10\text{mm}$. Stone shall not have a base area less than 250 sq.cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stone shall be subject to the approval of the ENGINEER.

33.2 **Workmanship**

- 33.2.1 Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with the height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely.
- 33.2.2 The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.


34.0 **BASE CONCRETE**

- 34.1 The thickness and grade of concrete and reinforcement shall be as specified in the technical specifications.
- 34.2 Before placing the blinding concrete of M15 mix , 50/75 mm thick as per the item of work, the sub base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms thoroughly tamped and surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

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35.0 **CHAIN LINK FENCING**

- 35.1 The chain link fencing shall be 2400 mm high with PVC coated chain link fencing fixed on to 80 mm dia GI medium type pipe spaced at 2500 mm centres with suitable concrete foundation for the posts. The mesh size of the chain link shall be 50 mm square of minimum 3.1 mm thickness. The chain link shall be reinforced with three nos tie wires of 4mm thickness at top ,bottom and middle. The fencing GI pipes shall be reinforced with two GI pipes at every fourth span and at all bend locations. A brick kerb wall projecting 300 mm above grade /Ground level shall be provided all along the fence with drainage pipe at intervals in the kerb wall.The total finished height of the fencing shall be 2700 mm including the brick kerb wall. All the other related works shall be carried out as per the directions of the Engineer.

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PART G : WATER SUPPLY & SANITARY WORKS

1.0 **SCOPE**

1.1 This specification covers the general requirements for supplying and laying of water supply pipe line with necessary fittings and fixtures for buildings/structures tapping off from potable water supply distribution system, supplying and laying sewage pipe line with disposal works including provision of all fittings and fixtures of sanitary works and such other related items of work forming a part of the job, which may be required to be carried out though not specifically mentioned above. The work under this specification shall consist of furnishing of all tools, plants, labour, materials, and any and everything necessary for satisfactorily carrying out the work.

2.0 **APPLICABLE CODES**


2.1 The following standards and codes are made a part of this specification. All standards, codes of practice referred to herein shall be **the latest version on the date of offer** made by the Bidder.


1. IS.458 : Concrete Pipes (with and without reinforcement).
2. IS.554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
3. IS.651 : Salt glazed stoneware pipes and fittings.
4. IS.774 : Flushing Cisterns for water closets and urinals (valveless siphonic type)
5. IS.775 : Cast iron brackets and supports for wash basins and sinks.
6. IS.781 : Sand-cast brass screw-down bib taps and stop taps for water services.

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<p>7. IS.783 : Code of practice for laying of concrete pipes.</p> <p>8. IS.1068 : Electroplated coatings of nickel and chromium on iron and steel.</p> <p>9. IS.1239 : Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II).</p> <p>10. IS.1536 : Centrifugally cast (spun) iron pressurepipes for water, gas and sewage.</p> <p>11. IS.1626 : Asbestos cement building pipes, gutters and fittings (spigot and socket types).</p> <p>12. IS.1703 : Ball valves (horizontal plunger type) including floats for water supply purposes.</p> <p>13. IS.1726 : Cast iron manhole covers and frames.</p> <p>14. IS.1726 : Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.</p> <p>15. IS.1742 : Code of practice for buildings drainage.</p> <p>16. IS.2326 : Automatic flushing cisterns for urinals.</p> <p>17. IS.2470 : Code of practice for design and construction of septic tanks.</p> <p>18. IS.2556 : Vitreous sanitary appliances (Part I to Part XV)</p> <p>19. IS.2963 : Non-ferrous waster fittings for wash basins and sinks.</p> <p>20. IS.3311 : Waste plug and its accessories for sinks and wash basins.</p> <p>21. IS.5329 : Code of practice for sanitary pipe work above ground for buildings.</p>		
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22. IS.5434 : Non-ferrous alloy bottle traps for marine use.

3.0

DRAWINGS

3.1

CONTRACTOR shall submit to OWNER/ENGINEER for his approval, detailed working drawings showing layout of water supply and sanitary works with necessary fittings and fixtures before the actual construction is undertaken.

4.0

SANITARY IN STALLATION

4.1

The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Owner/ Engineer.

4.2

Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor

4.3

All sanitary and plumbing work shall be carried out by licensed plumbers.

4.4

On completion of the work, the site shall be cleaned and disposed of all debris as directed by the Engineer.

4.5

All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of size, and design as specified in the item of work and as per sample approved by the Engineer.

4.6

All sanitary fittings and fixtures shall be acceptable to the Owner/Engineer and if there are any variations, they shall satisfy the permissible tolerances in dimensions/slope/ contour as specified in relevant IS codes/ standards.


4.7

All colour glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, `P' trap etc. shall have hard durable glazed finish. They shall be free from cracks, indentations, or other glazing defects. No chipped porcelain fixtures shall be used. Joints between iron and earthenware pipes

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shall be made perfectly air and water tight by caulking with neat cement mortar.

4.8 **Indian Type Water Closet** (Orissa Pattern)

This shall be the long pan pattern made of colour glazed earthenware, colour glazed vitreous china or of colour glazed fire clay. The general requirements shall conform to IS.2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap 'P' or 'S' type with a minimum 50 mm water seal and 50 mm diameter vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1 part lime mortar to 2 parts brick bats with lime mortar of 1 part lime to 2 parts of sand) or cement-sand admixture as specified in the drawings.


4.9 **European Type Water Closet** (W.C)

Water closets shall be either of colour glazed earthenware, colour glazed vitreous china or colour glazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one piece construction with approved plastic/bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole 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 water closets shall have an anti siphonage 50 mm dia. vent horn on the outlet side of the trap. The inside surface of water closets and traps shall be uniform and smooth in order to ensure

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smooth flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

4.10 Urinals

Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of colour glazed earthenware, colour glazed vitreous china or colour glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the outlet pipe. The inside surface of the urinal shall be uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

4.11 Wash Basins

- a) Wash basins shall be of coloured glazed earthenware, coloured glazed vitreous china or coloured glazed fire clay as specified and conforming to IS.2556

Type

Size


Flat Back

630 x 450 mm

Flat Back

550 x 400 mm

- b) Wash basins shall be of one piece construction, including a combined overflow. All internal angles shall be designed

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so as to facilitate cleaning. Each basin shall have a rim sloping inside towards the bowl on all sides except sides on contact with the walls and shall have skirting at the back. Basins shall be provided with single or double tap holes as specified. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or bevelled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with a non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the under side of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 sq.cm. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The specifications for waste plug, chain and stay shall be the same as given for sinks.

(c) All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

4.12 **Sinks**

a) The sinks shall be of colour glazed earthenware, colour glazed vitreous china or colour glazed fire clay as specified conforming to IS.2556 (Part V) and shall be of the following sizes :


450 x 300 x 150 mm
600 x 450 x 200 mm

b) They shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be

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suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS.2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS.1068.

4 13 **Flushing Cisterns**

The flushing cisterns shall be of PVC, automatic or manually operated, high level or low level, as specified. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. The W.C. pan shall be connected to the cistern by G.I. 32mm dia or 40mm (O.D) high density Polythene flush pipe with holder clamp and brass coupling.


4.14 **Mirror Frames:**

Mirror frame where specified shall be of fibre glass of approved shape, size, colour and make. Mirror shall be of superior glass with edges rounded off or levelled as specified. It shall be free from flaws, specks or bubble and its thickness shall not be less than 5.0 mm. The glass for the mirror shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint.

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4.15 **Toilet Shelf**

Glass shelf unit shall consist of an assembly of glass shelf, anodized aluminium/CP brass guardrail and supporting brackets. The shelf shall be of glass of best quality with edges rounded off and shall be free from flaws, specks, bubbles and of thickness not less than 5.0 mm. The shelf shall have guardrail, resting on rubber washers on glass plate.

Ceramics shelf shall be of shape, size and design as specified in the drawings/approved by Engineer.

4.16 **Towel Rail**

Towel rail shall be of CP brass/anodized aluminium with two brackets of same material, diameter and length as specified.

4.17 **Toilet Paper Holder**

Toilet paper holder shall be of CP brass, PVC with CP brass brackets or ceramic of approved make and design.

4.18 **Soap Container**

Soap container shall be of C.P. brass, PVC with CP brass brackets of approved make and design.

4.19 **CP Flush Valves for EWC**

The CP flush valve for EWC shall be of "Jaquar" brand of Jaquar & Co. 'ACCO' brand of Asia Continental Metallwaren Fabric or equivalent quality.

4.20 **CP Flush Valve for Urinals**

CP flush valve for urinal shall be of "Jaquar" brand of Jaquar & Co., 'ACCO' brand of Asian Continental Metallwaren Fabric or of equivalent quality.

4.21 **Gully Trap**


Each gully trap shall have one C.I. grating 150 mm x 150 mm and one water tight precast R.C. cover 300 x 300 x 40 mm thick with

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1:1 1/2:3 mix concrete (one cement: one and half sand: 3 stone chips 20 mm down) including neat cement finish.

4.22 Fibre Glass Sink

Fibre glass sink where specified shall be of heavy duty (4 ply) of approved manufacturer, shape and size. The pipes and other appurtenances shall be of the description mentioned for the glazed vitreous sinks.

4.23 Stainless Steel Sink

It shall be of required shape and size, with or without drain board as provided in the schedule item. Sinks shall be made from stainless steel sheets of approved make and quality and properly polished. Thickness of the sheet shall be 1 mm or more as per the requirement.

4.24 Plastic Seats & Covers for Water Closets

These shall conform to IS : 2548 (Part 1&2) and shall be either of thermoset or of thermoplastic quality.

Thermo-set Seats and Covers are moulded from phenolic plastics (Type A) or Urea Formaldehyde (Type B) Thermo plastic Seats and Covers are also of Type A, moulded from Polystyrene or Type B, moulded from Polypropylene.


Underside of the seats may be either flat or recessed and colour shall be as agreed. Table Dimensions of the seats and covers shall be as per Table-I of the Code (both Part 1&2). Hinging device may be either of the following materials:

- Bronze or Brass with Nickel Chromium Plating.
- Mild Steel with Nickel Chromium Plating
- Aluminium alloy with anodic coating
- Suitable plastic with reinforcement.

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5.0 Polyethylene and UPVC Pipes

High Density Polyethylene Pipe

These are used for potable water supplies, sewage and industrial effluents and shall conform to IS :4984 - 1987. High density polyethylene (HDPE) used for the manufacture of pipes shall conform to designation HDPE 52 PB of IS : 7328 - 1992.

The pipes shall be classified by pressure ratings (working pressure) at 27 degree 'C' as follows :

Class of pipe	Working pressure
Class - 1	2.0 kg/cm ² (0.2 Mpa)
Class - 2	2.5 kg/cm ² (0.25 Mpa)
Class - 3	4.0 kg/cm ² (0.4 Mpa)
Class - 4	6.0 kg/cm ² (0.6 Mpa)
Class - 5	10.0 kg/cm ² (1.0Mpa)

The outside diameter of the pipe and their wall thickness shall be as given in the table of IS:4984 - 1987.


Each pipe shall be clearly and indelibly marked at intervals of not more than 5 metres in colour and also may be marked with, BIS mark. The marking shall show manufacturer's name or trade mark. Marking in colour shall be as follows :

Colour

Class - 1	Orange
Class - 2	Red
Class - 3	Blue
Class - 4	Green
Class - 5	Yellow

5.1 Unplasticized PVC Pipes for Potable Water Supplies

The plain as well as socket end pipes, made of unplasticized polyvinyl chloride, are used for potable water supplies and not suitable for use in suction and delivery lines of agricultural pumps and casing pipes in tube-well. These shall conform to IS : 4985 -

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1988. The pipes other than those meant for plumbing shall be classified by pressure ratings (working pressure) at 27 degree 'C' as follows:

Class of pipe	Working pressure
Class - 1	2.5 kg/cm ² (0.25 Mpa)
Class - 2	4.0 kg/cm ² (0.4 Mpa)
Class - 3	6.0 kg/cm ² (0.6 Mpa)
Class - 4	10.0 kg/cm ² (1.0 Mpa)

The outside diameter of the pipe and Wall thickness shall be as per IS : 4985 The nominal outside diameter of plain end pipes plumbing works shall be 20,25,32,40& 50mm. Each pipe shall be clearly and indelibly marked at intervals of not more than 3 metres in colour and shall also be marked with the standard mark.. The marking shall show Manufacturer's name or trade mark, outside diameter, class of pipe and pressure rating, batch number word "Plumbing" in the case of plumbing pipes.

Marking in Colour except plumbing pipes which shall be marked in Pink shall be as follows:


Class - 1	Red
Class - 2	Blue
Class - 3	Green
Class - 4	Yellow

5.2 **Low Density Polyethylene pipes for Potable Water Supplies**

These low-density black polyethylene pipes conforming to IS: 3076 - 1985 are used up to 140 mm outside diameters for potable water supplies and material used for manufacture shall conform to Type WA of IS : 3395 1984.The pipes shall be classified by pressure rating (working pressure at 27 degree -C) as follows :

Class of pipe	Working pressure
Class - 1	2.5 kg/cm ² (0.25 Mpa)
Class - 2	4.0 kg/cm ² (0.4 Mpa)
Class - 3	6.0 kg/cm ² (0.6 Mpa)
Class - 4	10.0 kg/cm ² (1.0 Mpa)

The outside diameter and the thickness of the pipes shall be as

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per IS : 3076 - 1985.Each pipe shall be clearly and indelibly marked at intervals of not more than 5 metres in colour and also may be marked with BIS mark. The marking shall show manufacturer's name or trade mark, outside diameter, class of pipe and batch number.
Marking in colour shall be as follows

Class - 1	Red
Class - 2	Blue
Class - 3	Green
Class - 4	Yellow

5.3 **Fittings for Polyethylene /Un plasticized PVC Pipes**

Unless otherwise specified, fittings shall be injection moulded and/or fabricated type and shall conform to IS: 7834 (Part 1 to 8) - 1987, IS : 8008 (Part 1 to 7) 1976 & IS : 8360 (Part 1 to 3) - 1977.

6.0 **G.I. PIPES**

6.1 The pipes shall be galvanised mild steel welded pipes screwed pipes conforming to the requirements of IS:1239, heavy class for piping works. They shall of the diameter (nominal bore) specified in the description of the item. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tubes / pipes.


6.2 All screwed tubes / pipes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes / pipes shall have taper threads while the sockets shall have parallel threads. The screwed joints shall be sealed suitably with PTFE tape.

6.3 The fittings shall be of malleable mild steel tubes / pipes complying with all the appropriate requirements as specified for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to

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the requirements of IS.554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

6.4 a) The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded the ends shall be carefully filed out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening bend and damaged screw threads and shall not be used for turning of the threads so as to make them slack, water tight joint. The screw-thread of pipes and fittings shall be protected from damage until they are fitted.

b) The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.


c) Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

6.5 a) For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of

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recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. where directed by the Engineer, a M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion/contraction and other movements/maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as directed by the Engineer.

b) G.I. pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS:3114.

6.6 a) The work of excavation and backfilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches for pipes laid underground.


b) The pipes shall be laid on a layer of 7.5 cm sand and filled upto 15 cm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. when excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

6.7 The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as specified by the Engineer and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped, the section of the pipeline shall maintain the test pressure for at least half an hour. Any

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joints or pipes found leaking shall be removed and replaced by the Contractor.

6.8 The G.I. pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe, G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

6.9 The galvanised pipes, valves and fittings shall be as per list of approved brands /manufacturers list.

6.10 The portable water system shall be hydrostatic tested at site for 10kg/cm².

7.0 **STONEWARE PIPES AND FITTINGS**


7.1 All pipes with spigot and socket ends shall conform to IS.651 and shall be of grade 'A' as specified. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer. There shall be no broken blisters. The pipe shall be handled with sufficient care to avoid damage to them.

7.2 Pipes shall be laid to the correct grade and alignment shown in the plan/sections with their sockets up the gradient. Laying and jointing shall conform to the general requirements specified in IS.651.

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7.3

Stoneware pipes used for sewers shall be subjected to a test pressure of 1.5 m head of water at the highest point of the section under test. The test shall be carried out suitably by plugging the low end of the drain and the ends of the connection if any and filling the system with water. A buckle bend shall be temporarily jointed in at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head or the top may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. Where leakage will be visible the defective part of the work shall be removed and made good.

8.0

STOP COCK AND BIB COCK

8.1

A bibcock (bibtap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. In finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, roughness and shall not be stained or discoloured.

8.2

These fittings shall be of brass heavy class, chromium plated (C.P) and of approved manufacture and pattern with screwed or flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be got approved from the Engineer and all supplies made according to the approved samples.


8.3

All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean,

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smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

8.4 The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workmanlike manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test specified by the Engineer and the defective fittings and joints shall be replaced or redone.

.9.0 **MANHOLES**

9.1 Manholes of types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer. The size specified indicate the inside dimensions of the manhole.

9.2 Excavation and backfilling shall be as per respective specifications.

9.3 Manhole shall be built on a bed of cement concrete 1:4:8 (1 cement : 4 sand : 8 graded stone aggregate of 40 mm nominal size). The thickness of the bed concrete shall be 23 cm unless otherwise specified or directed by the Engineer. In bad ground special foundation as suitable shall be provided.


9.4 Brick work shall be with first class country bricks in cement mortar 1:4 (1 cement : 4 sand). The external joints of the brick masonry shall be finished smooth. The joints of the pipes with the masonry shall be made perfectly leak-proof.

9.5 The brick walls of manholes shall be plastered inside with 13 mm thick cement plaster 1:2 (1 cement : 2 sand) finished smooth with a floating coat of neat cement.

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9.6 Channels and benching shall be in cement concrete 1:2:4 (1 cement : 2 sand : 4 graded stone aggregate).


9.7 The depth of channels and benching shall be as indicated in the table given below :

Size of drain mm	Top of channel at the centre above bed concrete mm	Depth of benching at side wall above bed concrete mm
100	150	200
150	200	300
200	250	350
250	300	400
300	350	450
350	400	500
400	450	550
450	500	600

9.8 All manholes deeper than 0.8 m shall be provided with staggered M.S. rungs as specified in drawings. Rungs shall be painted with coal tar, the portion embedded in cement concrete block being painted with thick cement slurry before fixing.

9.9 C.I. manhole covers and frames shall conform to IS 1726. The covers and frames shall be neatly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All casting shall be free from voids whether due to shrinkage or other causes. Cover shall have a raised chequered design on the top surface to provide an adequate non-slip grip. The cover shall be capable of easy opening and closing and it shall be correctly fitted in the frame. The cover shall be gas tight and water tight. The cover shall be coated with black bituminous composition. It shall not flow when exposed to a temperature of 63⁰C and shall not be brittle as to chip off at temperature of 0⁰C.

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<p>9.10 The frame of the manhole cover shall be firmly embedded to correct alignment and levels in plain cement concrete 1:2:4 (1 cement : 2 sand : 4 graded stone aggregate) on top of the brick masonry. After completion of the work, manhole covers shall be smeared with thick grease.</p> <p>9.11 Manhole cover and frame shall conform to "Medium Duty", 500 mm internal diameter and shall weigh not less than 116 kg. (weight of cover 58 kg. and weight of frame 58 kg.).</p> <p>9.12 The depth of the manholes shall be reckoned from top level of C.I cover to the invert level of channel. The depth shall be measured correct to centimetres.</p> <p>9.13 Inspection chambers shall be constructed similar to manholes as detailed in working drawings.</p> <p>9.14 Sewers of unequal sectional area shall not be jointed at the same invert level in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3 the diameter of the main, above the invert of the main. The branch sewer should deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in the main is not impeded. No drains from house fittings e.g. gully trap or soil pipe etc. to manhole shall normally exceed a length of 6 meters unless it is unavoidable.</p> <p>10.0 <u>DROP CONNECTION</u></p> <p>10.1 In cases where branch sewer enters the manholes of main pipe sewer at a higher level than the main sewer, a drop connection should be provided. Pipes and specials conforming to IS 1729 shall be of the same size as the branch pipe sewer.</p> <p>10.2 For 150 mm and 250 mm main line, if the difference in level between the water line (peak flow level) and the invert level of branch line is less than 600 mm a drop connection may be provided within the manhole by giving a suitable ramp. If the difference in level is more than 600 mm the drop should be provided externally.</p> <p>10.3 The excavation shall be done for the drop connection at the place</p>		
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where the branch line meets the manhole. The excavation shall be carried up to the bed concrete of the manholes and to the full width of the branch line. Excavation and backfilling shall be done as per respective specifications.

10.4 At the end of branch sewer line C.I. tee shall be fixed to the line which shall be extended through the wall of manhole by a horizontal piece of C.I. pipe to form an inspection or cleaning eye. The C.I. drop pipe shall be connected to the tee at the top and to the C.I. bend at the bottom. The bend shall be extended through the wall of the manhole by a piece of pipe which shall discharge into the channel. Necessary channel shall be made with cement concrete of grade M15 and finished smooth to connect the main channel. The joint between C.I. pipe and fittings shall be lead caulked. The joint between C.I. tee and S.W. branch line shall be made with cement mortar 1:1 (1 cement : 1 fine sand). The exposed portion of the drop connection shall be encased around with minimum 150 mm. thick concrete 1:5:10 (1 cement : 5 coarse sand : 10 graded stone aggregate 40 mm nominal size) and cured. For encasing the concrete around the drop connection, necessary centering and shuttering shall be provided. The holes made in the walls of the manhole shall be made good with brick work in cement mortar 1:4 (1 cement : 4 coarse sand) and plastered with cement mortar 1:2 (1 cement : 2 fine sand) on the inside of the manhole wall. The excavated earth shall be back filled in the trench in level with the original ground level. Drop connection shall be measured in numbers.

11.0 **ROAD GULLY CHAMBERS**


11.1 The chamber shall be of brick masonry/RCC and shall have a C.I. grating with frame fixed in 150 mm thick cement concrete of grade M15 at the top. The size of the chamber shall be taken as clear internal dimensions of the C.I. frame. The chamber shall have a S.W. connection pipe, the length of which between road gully chamber and the point of discharge to drain or to open ground shall be measured separately. The chamber shall be built at the locations indicated in drawings.

11.2 Bed concrete, brick work, plastering, RCC work, excavation, backfilling, etc. shall be as per details given on the drawing and in compliance with the requirements laid down in the specifications

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<p>for the respective items.</p> <p>11.3 The gully grating cover shall be hinged to the frame to facilitate its opening for cleaning and repairs. The weight of grating shall be 75 kg. minimum.</p> <p>11.4 After completion of the work, the exposed surfaces of the grating and the frame shall be painted with a thick coat of coal tar.</p>		
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