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## SPECIFICATIONS FOR CIVIL WORKS

### 6.1 General

This part of the specification covers the design loads to be considered, specifications of material and workmanship for the civil works. Material used and workmanship for the civil works of campus development, repair/new works of buildings, civil works associated with pipeline lying etc. to be done under the contract will adhere to the provisions laid down in this chapter.

For materials used other than those specified, the material must conform to the requirement of respective Indian Standards/International Standard and/or good engineering practices. The contractor shall get prior approval of the materials proposed to be used under the contract as per the provisions of Special Conditions of Contract, from the Engineer-in-Charge.

#### 6.1.1 Design Considerations:

##### 6.1.1.1. *Design Submissions*

The contractor shall be responsible for the safety of structures, correctness of design and drawings, even after the approval of the same by Engineer-in-Charge.

Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to the Engineer-in-charge. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by the Engineer-in-charge.

The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed.

##### 6.1.1.2. *Design Standards*

All designs shall be based on the latest Indian Standard (I.S.) Specifications or Codes of Practice unless otherwise specified. The design standards adopted shall follow the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language is being supplied to and got approved by the Engineer-in-charge. In case of any variation or contradiction between the provisions of the I.S. Standards or Codes and the specifications given in the tender document, the provision given in this specification shall be followed.

##### 6.1.1.3. *Design Life*

The design life of all structures and buildings shall be 60 years.

##### 6.1.1.4. *Design Loading*

All buildings and structures shall be designed to resist the worst combination of the following loads/ stresses under test and working conditions; these include dead load, live load, wind load, seismic load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads:

##### a) Dead Load

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This shall comprises all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipments and other items of machinery. In estimating the loads of process equipment all fixtures and attached piping shall be included.

b) Live Load

Live loads shall be in general as per I.S. 875. However, the following minimum loads shall be considered in the design of structures:

- i) Live load on roofs : 2.00 kN/m<sup>2</sup>
- ii) Live load on floors supporting equipment such as pumps, blowers, compressors, valves etc. : 10.00 kN/m<sup>2</sup>
- iii) Live load on all other floors walkways, stairways and platforms : 5.00 kN/m<sup>2</sup>

In the absence of any suitable provisions for live loads in I.S. Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of the Engineer-in-charge prior to starting the design work. Apart from the specified live loads or any other load due to material stored, any other equipment load or possible overloading during maintenance or erection/ construction shall be considered and shall be partial or full whichever causes the most critical condition.

c) Wind Load

Wind loads shall be as per I.S. 875. Part 3

d) Earthquake Load

This shall be computed as per I.S. 1893 taking into consideration soil foundation system, importance factor appropriate to the type of structure, basic horizontal seismic coefficient/ seismic zone factor & average acceleration coefficient.

e) Dynamic Load

Dynamic loads due to working of plant items such as pumps, blowers, compressors, switch gears, travelling cranes, etc. shall be considered in the design of structures

6.1.1.5. *Joints*

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be designed to suit the structure. However contraction joints in buildings shall be provided at specified locations spaced not more than 7.5 m in both right angle directions for walls and rafts.

Expansion joints of suitable gap at suitable intervals not more than 40 m shall be provided in walls, floors and roof slabs of water retaining structures, as per IS-3370.

The positions of construction joints should be specified by the designer & indicated on the drawings. If there is a need on site to revise any specified position or to have additional joints, the proposed positions should be agreed with the designer.

The concrete at the joint should be bounded with that subsequently placed against it, without provision for relative movement between the two concrete should not be allowed to run to a feather edge & vertical joints should be formed against stop edges.

Expansion joints for non liquid retaining structures shall be provided as per IS 3414.

6.1.1.6. *Design Conditions for Underground or Partly Underground Liquid Retaining Structures*

All underground or partly underground liquid containing structures shall be designed for the following conditions :

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- a) liquid depth up to full height of wall : no relief due to soil pressure from outside to be considered;
  - b) structure empty (i.e. empty of liquid, any material, etc.) : earth pressure and surcharge pressure wherever applicable, to be considered as per site conditions;
  - c) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall;
  - d) partition wall between two compartments : to be designed as one compartment empty and other full;
  - e) structures shall be designed for uplift in empty conditions with the water table due care should be taken for seasonal variation on higher side. The possible flooding levels due to local drainage system shall be accounted while designing the structures.
  - f) walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;
  - g) underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The design shall be such that the minimum gravity weight exceeds the uplift pressure at least by 20%.

#### 6.1.1.7. Foundations

- (i) The minimum depth of foundations for all structures, equipments, buildings and frame foundations and load bearing walls shall be as per IS 1904.
- (ii) Bearing capacity of soil shall be determined as per IS : 6403.
- (iii) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by the Employer.
- (iv) A structure subjected to groundwater pressure shall be designed to resist floatation. The dead weight of empty structure shall provide a factor of safety of 1.2 against uplift during construction and service.
- (v) Where there is level difference between the natural ground level and the foundations of structure or floorslabs, this difference shall be filled up in the following ways.
  - a) In case of non-liquid retaining structures the natural top soil shall be removed till a firm strata is reached (minimum depth of soil removed shall be 500 mm) and the level difference shall be made up by compacted backfill as per specifications. However the thickness of each layer shall not exceed 150 mm. The area of backfilling for floor slabs shall be confined to prevent soil from slipping out during compaction.
  - b) In case of liquid retaining structures, the natural top soil shall be removed as described above and the level difference shall be made up with Plain Cement Concrete not weaker than M 10.
- (vi) If pile foundations are used, the contractor shall conduct the initial routine

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test as per IS 2911 at his own cost, to determine the safe load bearing capacity of piles.

## **6.2 Requirements for Construction of RCC Reservoirs**

### **6.2.1 General**

The RCC reservoirs are to be constructed as per the type and size detailed in the “Scope of Work” defined in the BOQ of tender document. The conceptual drawing of CWR / OHSR is given in the tender document which are for general understanding of department requirements but shall have no bearing on the submissions for approval, the requirements as given in this document are required to be fulfilled. The facilities and general arrangements of the reservoirs shall be as shown in the drawing.

The contractor shall submit detailed general arrangement drawings, structural drawings and design of each structure after getting these checked and approved from the Malviya National Institute, Jaipur. The designs shall adhere to the provisions given in this chapter. The contractor shall bear the charges for proof consultancy directly. The contractor may perform test at site. The contractor shall bear the charges for S.B.C test at site of work. The contractor shall submit the design & drawings duly approved by MNIT in three copies to the Engineer-in-Charge.

The OHSRs shall be of Intze type shape, supported on raft foundation. The arrangements for lightening arrestor, conductors and earthing system shall be made by the contractor.

The construction of reservoirs shall be carried out in accordance with the specifications mentioned herein and relevant IS amended upto date. The general arrangement drawings of the piping system and other drawings like layout plan of site, structural drawings and designs, working drawings, etc shall be submitted by the contractor for approval of the department prior to start of work. In cases where the specifications given below are silent about any aspects in respect of any item, the work shall be carried out as per the relevant IS code of practice in the latest version and/or as per sound engineering practice after approval of Engineer-in-Charge.

### **6.2.2 Preparatory Works**

The Contractor shall provide and maintain a benchmark with a level at a location approved by the Engineer in Charge at each reservoir construction sites. All levels shall be deemed to refer to that benchmark. The Contractor may establish other secondary benchmarks on the site.

### **6.2.3 Soil & Geo Technical Investigation**

SBC tests shall be got done through an approved agency wherever the strata on which foundation is to be laid is not rocky. For foundations to be laid on sandy strata, the structural design and reinforcement drawings shall be prepared assuming maximum SBC of soil as 10 T/Sqm even if the SBC testing is found to be 10 T/Sqm or more at foundation depth. If the SBC testing is found to be less than 10 T/Sqm at foundation depth, the structure shall be designed on the basis of actual SBC found on testing for which no extra payment will be made to contractor.

For foundations to be laid on rocky strata, with firm rocks the SBC shall be taken as 18 T/Sqm.

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## 6.2.4 Material of Construction

The building/construction material to be used shall be as per the specifications given in this chapter. The pipes & specials to be used shall be as per the specifications given in Chapter 3 for Pipes. The valves and instruments shall be as per the specifications given in this volume II containing specifications for Valves and Instrumentation respectively.

## 6.3 Design Considerations for Reservoirs

### 6.3.1 GENERAL PRINCIPLES:

- Maximum height of live storage in water reservoirs shall be 4.0 meters.
- Height of dome shall be  $1/5^{\text{th}}$  to  $1/6^{\text{th}}$  of span of dome.
- Minimum Free board shall be kept as 0.3 meters.
- Staging in case of overhead reservoirs is defined as the difference of levels between the finished ground level and bottom of the water retaining structure (top of the bottom ring beam of bottom dome).

#### 6.3.1.1. Considerations for CWR -

- All underground or partly underground liquid containing structures shall be designed for the following conditions :
- liquid depth up to full height of wall : no relief due to soil pressure from outside to be considered;
- structure empty (i.e. empty of liquid, any material, etc.) : earth pressure and surcharge pressure wherever applicable, to be considered as per site conditions;
- partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall;
- partition wall between two compartments : to be designed as one compartment empty and other full;
- structures shall be designed for uplift in empty conditions with the water table as per site conditions considering due variation on higher side. The possible flooding levels due to local drainage system shall be accounted while designing the structures.
- walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads;
- underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. The design shall be such that the minimum gravity weight exceeds the uplift pressure at least by 20%.

### 6.3.2 Design Requirements

The following are the design requirements for all reinforced or plain concrete structures.

- a) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade M10 unless otherwise specified.
- b) Liquid Retaining Structures:

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All structural reinforced concrete shall be of a minimum M30 grade with a maximum 40 mm aggregate size for footings and base slabs and with a maximum 20 mm aggregate size for all other structural members.

- c) The reinforced concrete for water retaining structures shall have a minimum cement content of 300 kg/m<sup>3</sup> with a maximum 20 mm size aggregate and 330 kg/m<sup>3</sup> with a maximum 40 mm size aggregate.
- d) The minimum reinforcement in walls, floors and roofs in each of two directions of right angles within each surface zone shall be as per 7.1 of IS: 3370 part 2.
- e) The nominal cover of concrete for all steel, including stirrups, links, sheathing and spacers shall be as per 7.2 of IS : 3370 Part 2 for liquid retaining structures and as per IS:457 for other structures.
- f) Suitable admixtures may be used with the approval of engineer in charge.
- g) Construction of floors and walls of Liquid Retaining structures shall be as per IS: 3370 Part 1.

Design requirement of RCC liquid retaining structures / grade of concrete / minimum cement content and for other provisions, these shall be governed by the provisions of latest IS 456 and IS 3370 amended upto date, whichever is more stringent.

### **6.3.3 Loads**

All loads shall be considered as per the provisions of IS 875 and other references as defined in this chapter. The design shall be suitable for the worst possible conditions of loading during construction and operation.

### **6.3.4 Concrete Grade, cover, minimum cement content and thickness**

Grade of concrete to be used for the reservoirs shall be as per the provisions of IS 456 for moderate environmental exposure conditions. The minimum cement content for reservoir members shall be 360 Kg/cum. For other works such as plinth protection etc., the minimum cement content shall be as per the respective codes. Minimum cover as prescribed in IS 456 shall be provided. The minimum thickness of reservoir members shall be in accordance to the provisions of IS 456 and IS 3370. However the following minimum thicknesses shall be provided for different reinforced concrete members, irrespective of design thicknesses as follows:

Walls for liquid retaining structures	150 mm
Spherical Dome/Flat roof slab of RCC reservoirs	100 mm
Bottom slabs of CWRs	150 mm
Floor slabs including roof slabs, walkways, canopy slabs	150 mm
Wall of cables/ pipe trenches, underground pits etc.	125 mm
Wall of cables/ pipe trenches, underground pits etc.	125 mm
Column footings	150 mm

Parapets, Chajja	75 mm
Pre-Cast trench cover	50 mm
Free board depth to be provided	300mm
Dead storage depth	100mm
Thickness of lean concrete below foundation	100mm
Depth of foundation for OHSR	2000mm or on solid rock.
Age factor shall not be more than	1(one)

### 6.3.5 Final Finishing

The contractor will ensure that the entire structure along with all its installations are in a finished and in new and fully operative condition when handed over, after the O & M period is over. He shall have repaired and removed all signs of damage that might have been done during the course of installation and fixing of equipment. He shall also see that all the exterior has been finished properly and the entire site is cleared of all extra construction material, debris and excavated soil. This shall have to be done to the satisfaction of the Engineer in Charge.

## 6.4 Miscellaneous Items of Reservoirs

### 6.4.1 Puddle collars

Puddle collars shall be used for connecting the inlet, outlet, overflow & washout pipes to the reservoir. All puddles shall be fixed at right angle to the RCC wall during casting of wall. All puddle collars shall be of C.I. The minimum length shall be at least 100 mm more than the total finished thickness of the walls and size of the puddle collars shall be equal to the size of the respective pipe.

### 6.4.2 Float Valve System

The float valve system shall be installed at the end of inlet pipe in each OHSR.

The float valves for OHSR shall comprises of two float valves i.e. main float valves and the auxiliary float valve. The different materials of construction for the components are as under.

Part no	Name of part	Material	Specification
1.	Body	Cast iron	IS 210,FG 200
2.	Valve	Cast iron	IS 210,FG 200
3.	Bottom plate	Cast iron	IS 210,FG 200
4.	Washer plate	Gun metal	IS 318
5.	Seat ring	Gun metal	IS 318
6.	Link	Gun metal	IS 318
7.	Liner	Brass	--
8.	Eye bolt for valve	Brass	--
9.	Lever fork	Mild steel	
10.	Valve face	Synthetic rubber	--

The float ball is to be suspended in a cylindrical vessel fabricated from 4mm MS sheet hot dip galvanized, So that free upward/ downward movement is available to the ball as the water level rises/falls in the cylindrical vessel. The valve shall ensure tight closing.

The auxiliary float valve shall be installed at the bottom of the vessel. It shall be of copper alloy, Croydon pattern with rough body and screwed male ends. The material of ball shall be copper and shall be installed at the bottom of the vessel. The size of the float and the length of the lever must ensure a tight closing at a pressure of 6 kg/cm<sup>2</sup>. The valve design must be made with view to a permanent withdrawal at pressures reaching 6 kg/cm<sup>2</sup>. This relates to cavitation of the seat, the piston and the washers. The size of the valve is 25mm.

The different materials of construction for the components are as under:

Part no	Name of part	Material	Specification
1	Float Ball	Copper	-
2	Ball Cap	Gun metal	BS 1400 LG 2
3	Lever	Brass rod	BS 2872 or 2874 CZ 114
4	Split Pin	Brass	-
5	Piston	Gun metal	BS 1400 LG 2
6	Piston Cap	Gun metal	
7	Washer	Nitrile rubber	-
8	Body	Gun metal	BS 1400 LG 2

The above valves shall be tested for the following hydrostatic pressure. The lever and its connection to the ball must be designed for heavy duty conditions.

- Body of valve : 10 kg/cm<sup>2</sup>
- Seat of valve : 6 kg/cm<sup>2</sup>

#### 6.4.3 Ladder

M.S. ladder 450 mm wide, made up of 50mm x 50mm x 6mm M.S. angle iron and 25mm M.S. bars welded at 300mm c/c shall be provided outside from the balcony to top dome in OHSR. MS cage shall also be provided on this ladder. Similarly MS ladder/RCC Staircase shall be provided at CWR for access to the top dome. M.S. ladder with all its components should be suitably painted as per approval of EIC.

The ladders in all type of reservoirs (i.e. CWR & OHSR) from top dome roof to inside platform and from platform to bottom dome in the container shall be of aluminium. Its drawing shall be got approved from EIC before dispatch.

#### 6.4.4 Railing

Hand railing shall be provided along the stairs of OHSR and on the top dome of OHSR. Hand railing around the platforms, Balcony, stairs and landings shall be consisting of 25 mm diameter medium B class GI pipes in two rows (one at the top and other at middle level) and 750mm high vertical post 50x50x6 mm angle iron @ > 750mm centre to centre properly embedded in the concrete (At least two vertical angles are to be provided wherever distance is less) with all accessories like elbows, tees etc. including welding, threading and embedding in cement concrete floor. Railing shall be protected against corrosion after welding. The pipe shall pass through hole in the vertical angle.

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#### **6.4.5 Water level indicator**

Water level indicator shall be provided for each reservoir to be constructed in this contract. Water level indicator consisting of an approved float and an iron counter weight connected to a flexible stainless steel wire 4mm thick passing over pulley 70mm diameter. The pulleys shall be properly fixed with structure and should have a guide so that the wire does not slip from the pulley.

The scale shall be calibrated in centimeters and should consist of M.S. sheet 20 gauge fixed over wooden plank with an M.S. angle iron frame of 35mm x 35mm x 5mm and painted with white enamel base, letters in black and red. The scale shall be located and fixed with RCC vertical wall of OHSR/CWR.

#### **6.4.6 Ventilator**

Ventilators shall be provided for all reservoirs. The size of ventilator shall be approved by EIC in consideration to the tank size and shall be of CI cowl and a bend of 300 mm high with mosquito proof jali of stainless steel shall be fixed at the opening. It shall be well painted and properly fixed in concrete. Thickness in case of MS shall be not less than 3 mm.

For smaller reservoirs CI vent pipes of dia as per approval of EIC shall be provided.

#### **6.4.7 Lightning arrester**

Lightning arrester shall be of copper bar of 25mm dia and 2m long to be provided at the top of OHSR. This is to be connected by a GI strip 25 mm wide & 3mm thick. This conductor strip shall be connected to a 450 mm x 450mm x 3mm thick copper plate to be embedded below the average ground level by digging a pit. The earthing system shall comply with Indian Electricity Rules and shall conform to IS 3043. The pit shall be refilled by alternate layers of salt and coke and balance shall be filled with loose soil. The 40 mm dia GI watering pipe shall be provided in the pit. Care shall be taken that earth pit does not sink.

#### **6.4.8 Plinth Protection**

Plinth protection works for OHSR and CWR is to be provided all around each reservoir in a 1 m circular strip. It shall consist of laying lean concrete 100 mm thick in M10, over compacted soil. Over the lean concrete brick on edge flooring or RR stone flooring in 1:4 cement sand mortar shall be provided. Along this plinth protection provision of toe wall of M15 grade cement concrete 150 mm wide over the base of lean concrete of M10 shall be provided. Side slope of plinth protection shall be 1 in 50 outward & peripheral slope should be 1 in 500.

Plinth protection works to be constructed below the OH Service Reservoir, shall be extended up to 1m from fall of balcony or edge of raft slab, whichever is more, all around service reservoir. It shall consist of laying lean concrete 100 mm thick in M10, over compacted soil.

The minimum free space between plinth protection and the first bracing of the OHSR shall be 1.60 meters.

#### **6.4.9 Slogan and logo**

The contractor shall paint on the vertical wall of the tank portion by using 3 coats of plastic emulsion paint of shade as approved by engineer in charge to form a base for writing the slogan. The Size & shade for painting the slogan will be approved and directed by Engineer in Charge. The logo should indicate the name of the project, name of the

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village and the capacity of the reservoir. The slogan shall be as directed by the Engineer-in-charge.

#### **6.4.10 Pipe Clamp**

At least two clamp on one staging shall be provided of 6mm thick 50mm wide MS flat fixed on pipe & column.

#### **6.4.11 Man Hole Cover**

Square manhole cover 600X600 mm shall be provided. The cover shall be made of 5 mm thick MS flat. The frame shall be made of MS angle 50\*50\*6. The cover shall be connected to this frame by using two nos. strung hinges. Locking arrangement shall be provided.

#### **6.4.12 Treatment of Joints in continuous portion**

Two hours after pouring the concrete, the slurry would be washed with high pressure water jet & air jet. Before pouring the next layer of concrete the old surface shall be brushed, painted with approved joining compound.

Water bar of G.I. sheet 150 mm wide 20 gauge shall be provided as per IS 3370 Part-I 1965 as construction joints in vertical wall. Overlaps in sheets shall be 300 mm. Alternatively water stopper of PVC can be used.

### **6.5 Testing for water tightness**

The contractor shall carry out a water tightness test as per IS: 3370 for the maximum water head condition i.e. with the water standing at full supply level. All cost of testing shall be borne by the contractor. This test shall be carried out in accordance with the procedure given below

- For water tightness test, before the filling operations are started, the reservoirs shall be jointly inspected by the Engineer in Charge and the representative of the Contractor and condition of surfaces of wall, construction joints etc. shall be inspected and noted and it shall be ensured that jointing material filled in the joints is in position and all openings are closed. The contractor shall make necessary arrangement for ventilation and lighting of reservoir by way of flood lights, circulators etc. for carrying out proper inspection of surfaces and internal conditions if so desired by the Engineer in Charge.

- The water retaining structures shall be filled with water gradually at the rate not exceeding 30 cm. rise in water level per hour and shall extend for a period of 72 hours. Records of leakages starting at different level of water in the reservoirs, if any, shall be kept.

- The reservoirs once filled shall be allowed to remain filled for a period of 7 days before any readings or drop in water level is recorded again at 7 days. The total drop in surface level over a period of 7 days shall be taken as indication of the water tightness of the reservoir, which for all practical purposes shall not exceed 40mm. There shall be no indication of leakages around the puddle collars or on the wall and bottom of the reservoir.

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- If the structure does not satisfy the test requirements, and the daily drop in water level is decreasing, the period of test may be extended for further seven days and if the specified limit is not exceeded, the structure may be considered as satisfactory.

- In case the drop in water level exceeds the permissible limit with the stipulated period of test, the Contractor shall carry out such additional works and adopt such measures as may be directed by the Engineer in charge to reduce the leakage in the permissible limit. The entire rectification work that shall be carried out in this connection shall be at Contractor's cost.

If the test results are unsatisfactory, the Contractor shall ascertain the cause and make all necessary repairs and repeat the water retaining structures test procedures, at his own cost. Should the re-test results still be unsatisfactory after the repairs, the structure will be condemned and the Contractor will dismantle and reconstruct the structure, to the original specification, at his own cost.

## **6.6 Materials & Standards**

The term "materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.

Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.

All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.

Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.

Where the relevant standard provides for the furnishing of a certificate to the Engineer-in-charge, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificates and forward it to the Engineer-in-charge.

The specifications, standards and codes listed below are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

In case of discrepancy between two standards the provisions more stringent shall be followed. In case of discrepancy between the Bid Specification and the Standards referred to herein, the Bid Specification shall govern.

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<b>IS No.</b>	<b>Title</b>
<b>CONSTRUCTION PLANNING AND STORAGE OF MATERIALS</b>	
4082 :	Recommendation on stacking and storage of construction materials at site (first revision)

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<b>IS No.</b>	<b>Title</b>
7969 :	Safety code for handling and storage of building materials

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## **EARTHWORK**

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3764: 1992	Excavation work - Code of safety (first revision)
4081	Safety code for blasting and related drilling operations

**FOUNDATIONS**

269 :	33 grade ordinary Portland cement.
432 (Part 1)	Mild steel and medium tensile steel bars and hard-drawn steel wire for concrete reinforcement : Part 1 Mild steel and medium tensile steel bars (third revision)
456	Code of practice for plain and reinforced concrete (Reaffirmed 1991)
2974 (Part 1)	Code of practice for design and construction of machine foundations : Part 1 Foundations for reciprocating type machines
2974 (Part 2)	Code of practice for design and construction of machine foundations : Part 2 Foundations for impact type machines (hammer foundations)
2974 (Part 3)	Design and construction of machine foundations - Code of practice : Part 3 Foundations for rotary type machines (medium and high frequency)
2974 (Part 4)	Code of practice for design and construction of machine foundations : Part 4 Foundations for rotary type machines of low frequency
2974 (Part 5)	Code of practice for design and construction of machine foundations : Part 5 Foundation for impact machines other than hammers (forging and stamping press, pig breakers, drop crusher and jolter)
6403	Code of practice for determination of bearing capacity of shallow foundations.

**PLAIN AND REINFORCED CONCRETE**

269	33 grade ordinary Portland cement
383	Coarse and fine aggregates from natural resources for concrete
456	Code of practice for plain and reinforced concrete
516	Method of test for strength of concrete
875 (Part 1)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 1 Dead loads -Unit weights of building material and stored materials
875 (Part 2)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 2 Imposed loads
875 (Part 3)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 3 Wind loads
875 (Part 4)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 4 Snow loads
875 (Part 5)	Code of practice for design loads (other than earthquake) for buildings and structures : Part 5 Special loads and load combinations
650	Standard sand for testing of cement
1199	Methods of sampling and analysis of concrete
1786	High strength deformed steel bars and wires for concrete

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	reinforcement
2502	Code of practice for bending and fixing of bars for concrete reinforcement
2505	Concrete vibrators - Immersion type - General requirements
4926	Ready mixed concrete
8112	43 grade ordinary Portland cement
9012	Recommended practice for Concreting
9103	Admixtures for concrete
10262	Recommended guidelines for concrete mix design
12269	53 Grade ordinary Portland Cement

#### **STEEL CONSTRUCTION**

104	Ready mixed paint, brushing, zinc chrome, priming
123	Ready mixed paint, brushing, finishing, semi-gloss, for general purposes to Indian Standard Colours No.445, 446, 448, 449, 451, 473 and red oxide
800	Code of practice for general construction in steel
7205	Safety code for erection of structural steel work

#### **FLOORS AND FLOOR COVERINGS**

1237	Cement concrete flooring tiles
1443	Code of practice for laying and finishing of cement concrete flooring tiles
8042	White Portland cement

#### **WHITE WASHING, COLOUR WASHING AND PAINTING OF MASONRY, CONCRETE AND PLASTER SURFACES (CALCAREOUS SURFACES)**

44	Iron oxide pigments for paints
109	Ready mixed paint, brushing, priming, plaster, to Indian Standard Colour No. 361 and 631 White and off white
133	Enamel, interior : (a) undercoating, (b) finishing
158	Ready mixed paint, brushing, bituminous, black lead-free, acid alkali and heat resisting
168	Ready mixed paint, air drying, for general purpose
427	Distemper, dry, colour as required
428	Distemper, oil emulsion, colour as required
2395 (Part 1)	Code of practice for painting concrete masonry and plaster surfaces : Part 1 Operation and workmanship
2395 (Part 2)	Code of practice for painting concrete masonry and plaster surfaces : Part 2 Schedule
5410	Cement paint
6278	Code of practice for whitewashing and colour washing

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9862 Ready mixed paint, brushing, bituminous, black lead-free, acid alkali, water and chlorine resisting

### **6.6.1 Samples and Tests of Materials**

The Contractor shall submit samples of such materials as may be required by the Engineer-in-charge and shall carry out the specified tests directed by the Engineer-in-charge at the Site, at the supplier's premises or at a laboratory approved by the Engineer-in-charge.

Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by the Engineer-in-charge.

Approval by the Engineer-in-charge as to the placing of orders for materials or as to samples or tests shall not prejudice to any of the Employer's powers under the Contract.

### **6.6.2 Standards**

Materials and workmanship shall comply with the relevant Indian Standards (with amendments upto date).

Where the relevant standard provides for the furnishing of a certificate to the Engineer-in-charge, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificates and forward it to the Engineer-in-charge.

The specifications, standards and codes listed in this chapter are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

## **6.7 Earthwork For Buildings/Reservoirs**

### **6.7.1 General**

The Contractor shall furnish all tools, plant 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 work in accordance with the Department's Requirements.

The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8 m in case of buildings and 30 m in case of roads and pipe lines works intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

The excavation shall be carried out 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.

Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Engineer-in-charge. 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.

Topsoil shall be stock piled separately for later re-use.

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### **6.7.2 Clearing**

The area to be excavated/filled shall be cleared of fences, trees, plants, logs, stumps, bush, vegetation, rubbish, slush, etc. and other objectionable matter. If any roots or stumps of trees are encountered during excavation, they shall also be removed. The material so removed shall be disposed off as approved by the Engineer-in-charge. Where earthfill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter / materials before fill commences.

### **6.7.3 Excavation**

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the approved drawings or such other lines and grades as may be agreed with the Engineer-in-charge. Rough excavation shall be carried out to a depth of 150 mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with material as approved by the Engineer-in-charge. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the approved drawings or as agreed with the Engineer-in-charge. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with material as approved by EIC upto the required elevation at no cost to the department.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Engineer-in-charge shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, 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 slipped material shall be removed and the slope dressed to a modified stable slope.

### **6.7.4 Rock**

#### **6.7.5 Stripping Loose Rock**

All loose boulders, detached rocks partially and other loose material 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 Engineer-in-charge, to fall or otherwise endanger the workmen, equipment, the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe portion, which was originally sound and safe.

Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Engineer-in-charge, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

#### **6.7.6 Fill, Backfilling and Site Grading**

##### *6.7.6.1. General*

All fill material shall be subject to the Engineer-in-charge's approval. If any material is rejected by Engineer-in-charge, the Contractor shall remove the same forthwith from the site. Surplus fill material shall be deposited/disposed off as directed by Engineer-in-charge after the fill work is completed.

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#### 6.7.6.2. *Material*

To the extent available, selected surplus soil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed unless otherwise stated. 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 murrum or earth to fill the voids and the mixture used for filling.

If fill material is required to be imported, the Contractor shall make arrangements to bring such material from outside borrow pits. The material and source shall be subject to the prior approval of the Engineer-in-charge. The approved borrow pit areas shall be cleared of all bushes, roots of trees, plants, rubbish, etc. Top soil containing foreign material shall be removed. The materials so removed shall be disposed of as directed by Engineer-in-charge. The Contractor shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

#### 6.7.6.3. *Filling in pits and trenches around foundations of structures, walls, etc.*

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 and properly consolidated to the satisfaction of Engineer-in-charge. Earth shall be rammed with approved compaction mechanism. Usually no manual compaction shall be allowed unless the Engineer-in-Charge is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Engineer-in-charge.

The filling shall be done after the concrete or masonry is fully set and done in such a manner as not to cause undue thrust on any part of the structure.

#### 6.7.6.4. *Plinth Filling*

Plinth filling shall be carried out with approved material such as soil, sand or murum as in layers not exceeding 15 cm, watered and compacted with approved compaction mechanism. 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 settlement at a later stage. The finished level of the filling shall be trimmed to the level/slope specified.

Compaction of large areas be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. 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-in-charge. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

The thickness of each unconsolidated fill layer can in this be upto a maximum of 300 mm. The Contractor will determine the thickness of the layers in which fill has to be consolidated depending on the fill material and equipment used and the approval of the Engineer-in-charge obtained prior to commencing filling.

The process of filling in the plinth, watering and compaction shall be carried out by the contractor in such a way as not to endanger the foundation columns, plinth walls etc. already built up. Under no circumstances Black cotton soil shall be used for plinth in filling.

For mechanical compaction rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of Engineer-in-charge, 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

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and uniform gradient. All soft spots shall be excavated, then filled and consolidated.

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.

#### **6.7.6.5. Sand Filling in Plinth and Other Places**

Where backfilling is required to be carried out with local sand it 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. 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-in-charge has inspected and approved the fill.

#### **6.7.7 General Site Grading**

Site grading shall be carried out as indicated in the approved drawings. Excavation shall be carried out as specified in the Department's Requirements. Filling and compaction shall be carried out as specified elsewhere unless otherwise specifications indicated below.

If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 200 mm and levelled uniformly and compacted as indicated above before the next layer is deposited.

To ensure that the fill has been compacted as specified, field and laboratory tests shall be carried out by the Contractor.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

The Contractor shall protect the earth fill from being washed away by rain or damaged in any other way. Should any slip occur, the Contractor shall remove the affected material and make good the slip.

#### **6.7.8 Fill Density**

Unless otherwise specified the compaction, where so called for, shall comply with minimum 90% compaction by Standard Proctor at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained.

#### **6.7.9 Timber Shoring**

The provisions of relevant ISS shall apply.

#### **6.7.10 Dewatering**

The Contractor shall ensure at his cost that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/ rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/ trenches required for further work. The method of pumping shall be approved by Engineer-in-charge, 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. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure

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that no damage to the structure results on stopping of dewatering.

The Contractor shall study the sub-soil conditions carefully and shall conduct any test necessary at the site with the approval of the Engineer-in-charge to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

The scheme for dewatering and disposal of water shall be approved by the Engineer-in-charge. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a build up of water in the opinion of the Engineer-in-charge obstructs the progress of the work, leads to unsanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Engineer-in-charge, to be large, a well point system-single stage or multistage, shall be adopted. The Contractor shall submit to the Engineer-in-charge, details of his well point system including the stages, the spacing number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

If any foundation pits are filled due to accumulation of surface flow during the progress of work or during rainy season, or due to any other cause all pumping required for dewatering the pits & removing silt shall be done without extra cost.

#### **6.7.11 Rain Water Drainage**

Grading in the vicinity of excavation shall be such as to exclude rain/ surface water draining into excavated areas. Excavation shall be kept clean of rain and such water as the Contractor may be using for his work by suitably pumping out the same. The scheme for pumping and discharge of such water shall be approved by the Engineer-in-charge.

### **6.8 Concrete**

#### **6.8.1 General**

The Engineer-in-Charge 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 the *Engineer-in-Charge's* approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials which do not conform to the Specifications 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-in-Charge and after establishing their performance suitability based on previous data, experience or tests.

#### **6.8.2 Materials**

##### *6.8.2.1. Cement*

Unless otherwise called for by the Engineer-in-charge, cement shall be ordinary Portland cement (Grade 43) conforming to IS : 2697, IS : 8112 or IS : 12269. Super Sulphated cement conforming to IS 6909 or super resistant Portland cement conforming to IS 12330.

**Sulphate resistant cement conforming to IS 12330 shall be used for all cement concrete works below ground level if the soil resistivity is less than 2000 ohm-cm.**

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 the Engineer-In-Charge.

Cement which is not used within 90 days from its date of manufacture shall be tested at a laboratory approved by the Engineer-In-Charge and until the results of such tests are found satisfactory, it shall not be used in any work.

**6.8.2.2. Aggregates (General)**

It shall comply with requirement of IS 383 and as specified in IS 456-2000. Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/slit/organic impurities/deleterious materials such as iron pyrites, cod, mica, slate, clay alkali, soft fragments, sea shells and conform to IS : 383. Aggregates such as slag, crushed over burnt bricks, bloated clay aggregates, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the Engineer-in-Charge.

Aggregates containing reactive silica shall not be used.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than ¼ of the minimum thickness of the member.

Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed. Plums shall not constitute more than 20% by volume of the concrete when specifically permitted. The plums shall be distributed evenly and shall not be closer than 160 mm from the surface. For heavily reinforced concrete members as in the case of ribs of main beams the nominal maximum size of aggregate shall be restricted to 5 mm less than minimum clear distance between the main bars or 5 mm less than the minimum cover to reinforcement whichever is smaller. Coarse and fine aggregates shall preferably batched separately, specially for design mix concrete.

The largest possible size, properly graded should be used in order to reduce water demand.

Graded aggregate shall confirm to requirements in Table 1, 2, 3 & 4. All in aggregate shall confirm to requirements in Table 5.

Table 1

Graded Aggregate

IS Sieve Designation	Percentage Passing for Normal size of Aggregate			
	40 mm	20 mm	16 mm	12.5 mm
Mm	40 mm	20 mm	16 mm	12.5 mm
80	100	-	-	-
40	95-100	100	-	-
20	30-70	95-100	100	100
16	-	-	90-100	-
12.5	-	-	-	90-100
10	10-35	25-55	30-70	40-85
4.75	0-5	0-10	0-10	0-10
2.36	-	-	-	-

Table 2

## Single Sized Aggregate (Ungraded)

IS Sieve Designation	Percentage Passing for Normal size of Aggregate					
	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
Mm	63 mm	40 mm	20 mm	16 mm	12.5 mm	10 mm
80	100	-	-	-	-	-
63	85-100	100	-	-	-	-
40	0-30	85-100	100	-	-	-
20	0-5	0-20	85-100	100	-	-
16	-	-	-	85-100	100	-
12.5	-	-	-	-	85-100	100
10	0-5	0-5	0-20	0-30	0-45	85-100
4.75	-	-	0-5	0-5	0-10	0-20
2.36	-	-	-	-	-	0-5

Table 3

## Making Single Sized to Graded Aggregate

Cement Concrete Mix	Nominal size of Graded Aggregate Required	Part of Single Size Aggregate to be Mixed to Get Graded Aggregate (by Volume)				
		50 mm	40 mm	20 mm	12.5 mm	10 mm
1:6:12	63	9	-	3	-	-
	40	-	9	3	-	-
1:5:10	63	7.5	-	2.5	-	-
	40	-	7.5	2.5	-	-
1:4:8	63	6	-	2	-	-
	40	-	6	2	-	-
1:3:6	63	4.5	-	1.5	-	-
	40	-	4.5	1.5	-	-
	20	-	-	4.5	-	1.5
1:2:4	40	-	2.5	1	-	0.5
	20	-	-	3	-	1
	12.5	-	-	-	3	1
1:1.5:3	20	-	-	2	-	1

**Note** : Proportions indicated are by volume. If single sized aggregate specified is not available, the volume of single sized aggregates shall be varied with a view to obtain the graded aggregate.

Table 4

## Grading of Fine Aggregates

IS Sieve Designation	Percentage Passing for				
	Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV	Grading Zone
10 mm	100	100	100	100	
4.75 mm	90-100	90-100	90-100	90-100	

2.36 mm	60-95	75-100	85-100	95-100
1.18 mm	30-70	55-90	75-100	90-100
600 micron	15-34	35-59	60-79	80-100
300 micron	5-20	8-30	12-40	15-50
150 micron	0-10	0-10	0-10	0-15

**Note : For crushed stone sands, the possible limit on 150 micron IS sieve is increased to 20 percent. This does not affect 5 percent allowance permitted to other sieves.**

Table 5

All-in-Aggregate Grading

IS Sieve Designation	Percentage Passing All-in-Aggregate Grading of	
	40 mm Nominal Size	16 mm Nominal Size
Mm		
80	100	-
40	95-100	95-100
20	45-75	95-100
4.75 mm	25-45	30-50
600 micron	8-30	10-35
150 micron	0-6	0-6

Fine aggregates are divided into 4 zones. Typical good sand falls in Zone II grading, however, finer or coarse sand may be used with suitable adjustment in the ratio of quantities of coarse to fine aggregates.

Very fine sands as included in Zone IV grading should not be used except when the concrete is closely controlled by design mixes.

6.8.2.3. *Water*

Water used for both mixing and curing shall conform to IS : 456-2000 and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials that may be deleterious to concrete or steel. The pH value of water shall not be less than 6.

6.8.2.4. *Reinforcement*

Reinforcement shall be any of the following :

- (i) High strength deformed bars and wires to IS 1786.
- (ii) Rolled steel Grade A made from structural steel to IS 2062.

All reinforcement shall be free from loose mill scales, loose rust and coats of paints, oil, mud or other coatings which may destroy or reduce bond.

6.8.2.5. *Admixtures*

Accelerating, retarding, water reducing and air entraining admixtures shall conform to IS : 9103 and integral water proofing admixtures to IS : 2645.

Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the Engineer-in-Charge. 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

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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.

### **6.8.3 Samples and Tests**

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 the Engineer samples shall also be got tested by the Contractor in a laboratory approved by the Engineer-in-Charge.

Sampling and testing shall be as per IS : 2386 under the supervision of the Engineer-in-Charge.

Water to be used shall be tested to comply with requirements of IS : 456.

The Contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested at an approved laboratory at no extra cost.

### **6.8.4 Concrete**

#### *6.8.4.1. General*

Concrete grade shall be as designated on approved drawings. In concrete grade M15, M20 etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq. mm as per IS: 456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5, M10, and M15 shall be NOMINAL MIX CONCRETE. Grade M20 can be nominal or design mix as per the requirement whereas all other grades, above M20 necessarily be DESIGN MIX CONCRETE.

#### *6.8.4.2. Design Mix Concrete*

The mix design shall produce concrete having reduced workability (consistency) and strength not less than approximate values given in table below. Workability shall be controlled by direct measurement of water content and checking it at frequent intervals by method prescribed in IS 1199.

##### a) Mix Design and Testing

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS: 456. The design mix shall be cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For liquid retaining structures, the mix shall also result in watertight concrete. The Contractor shall exercise great care while designing the concrete mix and executing the works to achieve the desired result.

The minimum cement content for Design Mix Concrete shall be as per IS: 456.

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.

It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish mix design to the Engineer-in-Charge well in advance of the concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS : 516 shall comply with the requirements of IS : 456.

<u>Grade of Concrete</u>	<b>Minimum Compressive Strength N/sq.mm at 7 days</b>	<b>Specified Characteristic Compressive Strength N/sq. mm at 28 days</b>
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

Grades lower than M20 shall not be used for reinforced concrete (general). Grading lower than M25 shall not be used for reinforced concrete in liquid retaining structures.

A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the Engineer-in-Charge is given below:

<b>Structure / Member</b>	<b>Slump in millimeters</b>	
	<b>Maximum</b>	<b>Minimum</b>
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	100	25
Slabs, Beams and reinforced walls	75	25
Pump & miscellaneous Equipment Foundations	100	25
Building columns	50	25
Pavements	50	25
Heavy mass construction	50	25

**b) Batching & Mixing of Concrete**

Proportions of aggregates and cement, as decided by the concrete mix design, shall be by weight. These proportions shall be maintained during subsequent concrete batching by means of weigh batchers capable of controlling the weights within one percent of the desired value.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water-cement ratio specified for use by the Engineer-in-Charge shall be maintained. Each time the work stops, the mixer shall be cleaned out and while recommencing, the first batch shall have 10% additional cement to allow for sticking in the drum.

Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the Engineer-in-Charge. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS : 516 and IS : 456.

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#### 6.8.4.3. Nominal Mix Concrete

##### a) Mix Design & Testing

Mix Designing 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 Table 9 of IS : 456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

##### b) Batching & Mixing of Concrete

The Proportions of materials used for concrete of grades shall be as given below :

Proportions for Nominal Mix of Concrete

Grade of Concrete	Total Quantity for Dry Aggregate by Mass per 50 kg of Cement (as Sum of Fine and Coarse Aggregates), in kg, Max	Proportion of Fine Aggregate to Coarse Aggregate (by Mass)	Quantity of Water per 50 kg of Cement, Max in Litres
M 5	800	Generally 1:2 Subject to an upper limit of 1:1.5 and a lower limit of 1:2.5	60
M 7.5	625	-do-	45
M 10	480	-do-	34
M 15	350	-do-	32
M 20	250	-do-	30

##### NOTES

- The proportions of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of the fine aggregates becomes finer and maximum size of coarse aggregate becomes larger. Graded coarse aggregate (see Table 5.1) shall be used.
- Example: For an average grading of fine aggregate (that is, Zone II of IS 383 :1970, Table 4) the proportions shall be 1:1.5, 1:2 and 1:2.5 for maximum size of aggregates 10 mm, 20 mm and 40 mm respectively.
- This table envisages batching by weight,. Volume batching when done the nominal mixes would roughly be 1:3:6, 1:2:4 and 1:1.5:3 for M 10, M 15 and M 20 respectively.
- For underwater concreting the quantity of coarse aggregate, either by volume or mass, shall not be less than 1.5 times nor more than twice that of the fine aggregate.

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##### c) Mixing

Concrete shall be mixed in a mechanical mixer conforming to IS 1791. The mixing shall be continued until there is uniform distribution of materials and the mass is uniform in colour and consistency. If there is segregation after unloading, the concrete should be remixed.

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### 6.8.5 Formwork

Formwork shall be all inclusive and shall consist of but not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the Engineer-in-Charge, the drawings and calculations for the design of the formwork shall be submitted to the Engineer-in-Charge for the approval.

Formwork shall be designed to fulfill the following requirements:

- (i) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.
- (ii) Made of suitable materials.
- (iii) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- (iv) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.
- (v) Capable of easy striking out without shock, disturbance or damage to the concrete.
- (vi) Soffit forms capable of imparting a camber if required
- (vii) Soffit forms and supports capable of being left in position if required
- (viii) Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.

The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer-in-Charge. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the Engineer-in-Charge. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.

Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.

Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left in-situ shall not impair the desired appearance or durability of the structure by causing spalling, rust

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staining or allowing the passage of moisture.

For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.

Where specified all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of the Engineer-in-Charge, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the Engineer-in-Charge, than that required as per drawing to compensate for irregularities in excavation.

The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.

The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0 m or as approved by the Engineer-in-Charge. The Contractor shall temporarily and securely fix items to be cast (embedments/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.

#### **6.8.6 Preparation Prior to Concrete Placement**

Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.

All arrangements- formwork, equipment and proposed procedure, shall be approved by the Engineer-in-Charge. Contractor shall maintain separate Pour Card for each pour as per the approved format.

#### **6.8.7 Check for Reinforcement and concreting**

All reinforcement shall be checked and recorded prior to pouring of concrete by an authorised representative of the engineer in Charge. Similarly the entire concrete pouring work shall be done in the presence of authorised representative. The contractor shall therefore give a notice of a minimum three days to the engineer in Charge or his representative such that the works can be checked by him or his authorised representative.

#### **6.8.8 Transporting, Placing and Compacting Concrete**

Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water. During hot or cold weather, concrete shall be transported in deep containers or by other suitable measures to reduce loss of water by evaporation and heat loss in cold weather may also be adopted.

In all cases concrete shall be deposited as nearly as practicable directly in its final

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position to avoid rehandling. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms, Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0 m. Care shall be taken to avoid displacement of reinforcement or formwork.

Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.

While placing concrete the Contractor shall proceed as specified below and also ensure the following:

- (i) Continuously between construction joints and pre-determined abutments.
- (ii) Without disturbance to forms or reinforcement
- (iii) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
- (iv) Without dropping in a manner that could cause segregation or shock.
- (v) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
- (vi) Do not place if the workability is such that full compaction cannot be achieved
- (vii) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary in supported excavations, withdraw the linings progressively as concrete is placed.
- (viii) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
- (ix) Ensure that there is no damage or displacement to sheet membranes.
- (x) Record the time and location of placing structural concrete.

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration shall be avoided; under vibration is likewise harmful.

The vibrator should penetrate rapidly to the bottom of the layer and at least 15 cm into the preceding layer if there is any. It should be held generally 5 to 15 sec. until the compaction is considered adequate and then withdrawn slowly at thereof about 8 cm/s.

Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the Engineer-in-Charge. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be

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taken to avoid stoppages in work once pumping has started.

Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the Engineer-in-Charge. Concrete shall be protected against damage until final acceptance.

#### **6.8.9 Mass Concrete Works**

Sequence of pouring for mass concrete works shall be as approved by the Engineer-in-Charge. The Contractor shall exercise great care to prevent shrinkage cracks and shall monitor the temperature of the placed concrete if directed.

#### **6.8.10 Curing**

Curing and protection shall start immediately after the compaction of the concrete to protect it from

- a) Premature drying out, particularly by solar radiation and wind;
  - leaching out by rain and flowing water;
  - rapid cooling during the first few days after placing;
  - high internal thermal gradient;
  - low temperature of frost;
  - vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement
  - After the concrete has begun to harden i.e. 1 to 2 hr. after laying curing shall be started.
  - All concrete, unless approved otherwise by the Engineer-in-Charge, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 10 days. The quality of curing water shall be the same as that used for mixing.
  - Where a curing membrane is approved to be used by the Engineer-in-Charge, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the Engineer-in-Charge before use and shall be applied with spraying equipment capable of a smooth, even textured coat.
  - When concrete is used as subgrade for flooring, the flooring may be commenced before the curing period of subgrade is over, but curing of subgrade shall be continued along with the top layer of flooring for a minimum period of 10 days.
  - Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

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### **6.8.11 Construction Joints and Keys**

The position and arrangement of construction joints shall be as indicated by the contractor in his working drawings dually approved by the department. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the Engineer-in-Charge.

Dowels for concrete work, not likely to be taken up in the near future, shall be coated with cement slurry and encased in lean concrete as indicated on the drawings or as approved by the Engineer-in-Charge.

Before resuming concreting on a surface which has hardened all laitance and loose stone shall be thoroughly removed by wire brushing/hacking and surface washed with high pressure water jet and treated with thin layer of cement slurry for vertical joints and horizontal layers.

When concreting is to be resumed on a surface, which has not fully hardened, all laitance shall be removed by wire brushing, the surface wetted, free water removed and a coat of cement slurry applied. On this, a layer of concrete not exceeding 150 mm thickness shall be placed and well rammed against the old work. Thereafter work shall proceed in the normal way.

For horizontal joints, the surface shall be covered with a layer of mortar about 10-15 mm thick composed of cement and sand in the concrete mix. This cement slurry or mortar shall be freshly mixed and applied immediately before placing concrete.

### **6.8.12 Foundation Bedding**

All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the Engineer-in-Charge. The surfaces of absorptive soils shall be moistened.

Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

Excavation, in clay or other soils that are likely to be affected by exposure to atmosphere, shall be concreted as soon as they are dry. Alternatively, unless otherwise mentioned the bottom of the excavation shall be protected immediately by 8 cm thick layer of cement concrete not leaner than M10 or in order to obtain a dry hard bottom, the last stretch of excavation of about 10 cm shall be removed just before concreting.

### **6.8.13 Repair and Replacement of Unsatisfactory Concrete**

Immediately after the shuttering is removed, all defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc, shall be inspected by the Engineer-in-Charge who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the Contractor at no additional cost to the Employer.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the Engineer-in-Charge.

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Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Engineer-in-Charge as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the Engineer-in-Charge.

#### **6.8.14 Hot Weather Requirements**

Concreting during hot weather shall be carried out as per IS 7861 (Part I).

Adequate provision shall be made to lower concrete temperatures which shall not exceed 40 deg C at time of placement of fresh concrete.

Where directed by the Engineer-in-Charge, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

#### **6.8.15 Cold Weather Requirements**

Concreting during cold weather shall be carried out as per IS: 7861(Part II).

The ambient temperature during placement and upto final set shall not fall below 5 deg. C. Approved antifreeze/accelerating additives shall be used where directed.

For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

#### **6.8.16 Liquid Retaining Structures**

The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.

The Contractor shall make all arrangements for hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.

The Contractor shall also make all temporary arrangements that may have to be made to ensure stability of the structures during construction.

Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the engineer-in-charge. All such rectification shall be done by the contractor to the entire satisfaction of the engineer-in-charge at no extra cost to the department.

#### **6.8.17 Water stops**

##### *6.8.17.1. Material*

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.

- |    |                      |   |                                |
|----|----------------------|---|--------------------------------|
| a) | Tensile strength     | : | 3.6 N/mm <sup>2</sup> minimum  |
| b) | Ultimate elongation  | : | 300% minimum                   |
| c) | Tear resistance      | : | 4.9 N/mm <sup>2</sup> minimum  |
| d) | Stiffness in flexure | : | 2.46 N/mm <sup>2</sup> minimum |

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- e) Accelerated extraction
    - i) Tensile strength : 10.50 N/mm<sup>2</sup> minimum
    - ii) Ultimate elongation : 250% minimum
  - f) Effect of Alkali : 7 days
    - i) Weight increase : 0.10% maximum
    - ii) Weight 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%

**PVC waterstops 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.**

PVC waterstops shall be of approved manufacture. Samples and the test certificate shall be got approved by the Engineer-in-Charge before procurement for incorporation in the works.

#### 6.8.17.2. Workmanship

Water stops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.

Water stops 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 water stops shall not be permitted. All jointing shall be of fusion-welded type as per manufacturer's instructions.

Water stops 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 water stops embedded in concrete shall be thoroughly cleaned of all mortar/concrete coating before resuming further concreting operations. The projecting water stops 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 aggregates shall be used for concreting in this region also.

### 6.8.18 Preformed Fillers and Joint Sealing Compound

#### 6.8.18.1. Materials

Preformed filler for expansion / isolation joints shall be non-extruding and resilient type of bitumen impregnated fibers conforming to IS : 1838 Part I or IS 1838 Part 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.

Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS:1834.

Other organic solvents such as polysulphate based joint sealants to IS:1433 Part 1 or IS 12118 Part 1 may be used with the approval of Engineer-In-Charge.

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## 6.9 Structural Steel Work

### 6.9.1 Fabrication

#### 6.9.1.1. General

As much fabrication work as is reasonably practicable work shall be completed in shops, where steel work is fabricated.

All workmanship and finish shall be of the best quality and shall conform to the best-approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Tolerances for fabrication of steel structures conform IS 7215. Tolerances for erection of steel structures shall conform to IS 12843.

#### 6.9.1.2. Minimum thickness of metal - Corrosion Protection

Unless, otherwise specified, the thickness of steel section shall be governed as below:

a) Steel work exposed to weather

Where steel work is directly exposed to weather and is fully accessible for clearing and repairing the thickness shall not be less than 6 mm; and where steel is exposed to weather and is not accessible for cleaning and painting, the thickness shall not be less than 8 mm. This shall not apply for hot rolled sections covered by Indian Standards.

b) Steel work not directly exposed to weather

The thickness of steel work not directly exposed to the weather shall be not less than 6 mm. The thickness of steel in secondary members shall be not less than 4.5 mm. For hot rolled sections to Indian Standards, the mean thickness of flange be considered and not the web thickness.

c) The requirements (a) and (b) above does not apply to light structural work or sealed box section or to steel work in which special provision against corrosion has been made and also in case of steel work exposed to highly corrosive fumes or vapour in which case the thickness shall be as approved by the Engineer-In-Charge.

#### 6.9.1.3. Drawings prepared by the CONTRACTOR

The contractor shall prepare all fabrication working and erection drawings for the entire work. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

All fabrication drawings shall be submitted to the Engineer-In-Charge for approval.

No fabrication drawings will be accepted for Engineer-In-Charge's approval unless checked and approved by the contractor's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.

Fabrication shall be started by the contractor only after Engineer-In-Charge's approval of fabrication drawings. Approval by the Engineer-In-Charge of any of the drawing shall not relieve the contractor from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon.

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The drawings prepared by the contractor and all subsequent revisions etc. shall be at the cost of the contractor for which no separate payment will be made.

#### 6.9.1.4. *Welding*

Welding shall be in accordance with IS 816, IS 819, IS 1024, IS 1261, IS 1323 and IS 9595 as appropriate.

Welding procedure shall be submitted to the Engineer-in-Charge for approval. Welding shall be entrusted to qualified and experienced welders who shall be tested periodically and graded as per IS 817, IS :7310 (Part 1) and IS :7318 (Part 1).

For welding any particular type of joints, welders shall give evidence acceptable to Engineer-In-Charge of having satisfactorily completed appropriate tests as per IS 817 Part 1, IS 1393, IS 7307, IS 7310 Part 1 and IS 7318 Part 1 as appropriate.

While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled off welding, these welds shall be ground flush prior to assembly.

Approval of the welding procedure by the Engineer-in-Charge shall not relieve the Contractor of his responsibility for correct and sound welding without undue distortion in the finished structure.

No welding shall be done when the surface of the members is wet nor during period of high wind.

Each layer of a multiple layer weld except root and surfaces runs may be moderately panned with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening.

No welding shall be done on base metal at a temperature below -5 Deg. C. Base metal shall be preheated to the temperature as per relevant IS codes.

Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above.

All welds shall be inspected for flaws

The correction of defective welds shall be carried out in a manner approved by the Engineer-in-Charge without damaging the parent metal.

#### **6.9.2 Painting**

All fabricated steel material, except those galvanised shall receive protective paint coating as prescribed in IS 1477 Parts 1 & 2.

All surfaces to be painted, oiled or otherwise treated shall be dry thoroughly cleaned to remove all loose scale and loose rust.

Shop contact surfaces need not be painted unless otherwise specified.

Surfaces not in contact but inaccessible after shop assembly shall receive full specified protective treatment before assembly. This does not apply to interior of hollow seatings.

Chequered plates shall be painted after the details of painting are approved by the Engineer-In-Charge.

In case of surfaces to be welded, steel shall not be painted within a suitable distance of any edges to be welded if paint would be harmful to the welder or impair the quality of welds.

Welds and adjacent parent metal shall not be painted prior to slugging, inspection and

approved.

Parts to be encased in concrete shall not be painted or oiled.

#### 6.9.2.1. Surface Treatment

All the surfaces of steel work to be painted shall be thoroughly cleaned of all loose mill scale, rust, grease, dirt and other foreign matter. The type of surface treatment shall be as specified in the respective item of work. The workmanship shall generally conform to the requirements of IS 1477- Part I.

#### 6.9.2.2. Painting of Ferrous Surface

Unless and otherwise mentioned, all MS fabricated items used in the project shall be painted with any of the three options given for interior or external works. The specifications adopted for every component must be got approved from the Engineer-in-Charge, before use.

Sr. No.	Final Finish Required	Primer	Undercoat	Finishing Coat	Number and Thickness of Coating
(1)	(2)	(3)	(4)	(5)	(6)
<b>A. FOR INTERIORS</b>					
(i)	Full gloss (enamel gloss)	IS 102:1962 (see Note)  IS 207:1964	IS 133:1993 (B)1  IS 2933:1975 (B, S)1)	IS 133:1993 (B)1  IS 2933:1975 (B, S)1)	For optimum results, two coats of primer, one undercoat, and two finishing coats are recommended. The total film thickness shall be not less than 100 microns.
(ii)	Oil gloss	Same as for (i)	IS 133:1993 (B)  OR  IS 144:1950 (S)		Same as for (i)
(iii)	Metallic finishes	Same as for (i)	-	IS 2339:1963 (B)  IS 2339:1963 (S)  OR  Bituminous aluminium paints	One coat of primer and two finishing coats; if bituminous aluminium paint is used, three coats will be necessary.
(iv)	Bitumen	Same as for (i)	-	IS 158:1981	Three coats of bitumen shall be used.
<b>B. FOR EXTERIORS</b>					
(v)	Full gloss	IS 102:1962 (see Note)	IS 2933:19751)	IS 2933:19751)	For optimum results, two coats of primer, one undercoat, and two finishing coats are recommended. The total film thickness shall be not less than 100 micron.
(vi)	Oil gloss	Same as for (v)	-	IS 117:1964  OR  IS 128:1962	Same as for (vii)
(vii)	Metallic	Same	-	IS 2339:1963	One coat of primer and two

Sr. No.	Final Finish Required	Primer	Undercoat	Finishing Coat	Number and Thickness of Coating
(1)	(2)	(3)	(4)	(5)	(6)
	finishes	as for (v)		OR Bituminous aluminium paint	finishing coats; if bituminous aluminium paint is used, three coats will be necessary.

**NOTE – Paint primer conforming to IS 102:1962 may be used only where special precautions for drying of the primer coat taken and where satisfactory drying conditions is ensured before application of further coats.**

1) Each of these Indian Standards cover both undercoating and finishing paints, and paints appropriate for the function shall be used.

**(B) in brushing.**

**(S) is spraying.**

#### 6.9.2.3. *Materials*

- 1) All the materials shall be of the best quality from an approved manufacturer. contractor shall obtain prior approval of the engineer-in-charge for the brand of manufacturer and the colour/shade prior to procurement for usage in the works.
- 2) Primer and finish paints shall be compatible with each other to avoid cracking and wrinkling. As such it is recommended that the primer and finish paint shall be from the same manufacturer.
- 3) The colour and shade shall conform to IS Standards referred to in Appendix 'D' of IS 1477-Part II. To facilitate choosing the correct shade/number from the alternatives available, contractor shall adopt trial painting in small patches in consultation with and as directed by the engineer-in-charge.
- 4) All paint delivered to the fabrication shop/site shall be ready mixed, in original sealed containers, as packed by the manufacturer. Thinner shall not be permitted for usage unless specifically directed by the engineer-in-charge.
- 5) Paints shall be stirred thoroughly to keep the pigment in suspension.
- 6) Contractor shall at his own cost arrange for testing of paints as per relevant Indian Standard laboratory whenever engineer-in-charge wants the tests to be carried out for each batch of paints. Test results shall be submitted to the engineer-in-charge for obtaining approval.

#### 6.9.2.4. *Workmanship*

- 1) The type and the number of coats of the primer paint and finish paint shall be as specified in the respective items of work.
- 2) Painting shall be carried out only on thoroughly dry surfaces.

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- 3) No painting shall be done in frosty/foggy weather or when the humidity is high enough to cause condensation on the surface to be painted. Paint shall not be applied when the temperature of the surface to be painted is at 50<sup>0</sup> C or lower.
  - 4) Primers shall adhere to the surface firmly and offer a key to the subsequent coats.
  - 5) The application of paint film serve the twin purpose of protecting the steel from corrosion and giving the decorative appearance. A paint which gives the steel adequate protection over a long period together with good appearance shall therefore be adopted.
  - 6) Workmanship shall generally conform to requirements specified in IS 1477-Part-II.
  - 7) It is essential to ensure that immediately after preparation of the surfaces, the first coat of primer paint shall be applied by brushing and working it well to ensure a continuous film without "holidays". After the first coat becomes hard dry a second coat of primer shall be applied by brushing to obtain a film free from holidays.
  - 8) Structural steel surfaces shall be given the first coat of primer at shop and the second coat after it is erected in position. Further, any abraded surfaces of the first coat during transport from shop to site and during erection shall be provided with a touch up coat of the primer.
  - 9) The dry film thickness of each coat of primer shall be not less than 25 microns.
  - 10) Application of finishing paints shall be carried out within the shortest possible time interval after primer since the primer coats are too thin to give adequate corrosion protection to the steel surface over a long duration.
  - 11) Filler coats shall be applied to fill dents and to obtain a smooth finish wherever necessary. Only factory prepared filler suitable for steel work shall be used. Filler prepared by whiting and linseed oil by craftsmen at site shall never be used as such fillers may be unbalanced and incompatible with primer and finishing coats. Application of filler shall be done with good putty knife and necessary skill. Filler applied shall be just sufficient to fill the depression or unevenness and it shall be restricted to the minimum. It shall be applied in thin layers. In filling depression or unevenness, due as many coats as are necessary may be applied allowing each layer to dry hard. The hardened coat shall be cut down by wet rubbing before the subsequent coat is applied. Where necessary, filler coats shall be applied over the undercoats also.
  - 12) Painting shall be carried out either by brushing or by spraying. contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer.
  - 13) After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of paint of optimum thickness shall be applied

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by brushing/spraying with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

- 14) The first finishing coat of paint shall be applied by brushing or by spraying and allowed to hard dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing or by spraying.
- 15) 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-in-charge.
- 16) Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Minimum dry film thickness of other finish paints shall be as specified in the respective item of work.
- 17) Epoxy primer and epoxy paint shall be applied within the specified pot life all as per recommendations of the manufacturer.
- 18) Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly.
- 19) Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.
- 20) Portion of steel members embedded to be encased in concrete shall not be painted. Joints to be site welded shall have no shop paint for atleast 50 mm from the welding zone. Similarly, the steel surfaces shall not be painted in areas where connection is by use of friction grip bolts. On completion of the joint, the surfaces shall receive the painting as specified.
- 21) Maintenance painting of steel structures will become necessary if the painting already carried out shows signs of chalking, hairline cracking, deep checking, fine checking, peeling, blistering and rusting. The breakdown of a paint film is progressive from the top finish paint to the primer coat and the object of maintenance painting is to renovate periodically to effectively check the breakdown and protect the steel surfaces from corrosion. It is essential that same quality of paint as specified earlier need be adopted to ensure compatibility. The general workmanship for maintenance painting shall conform as per Clause 7 of IS 1477 - Part II.
- 22) Contractor shall provide suitable protection as necessary to prevent paint finishes from splashing on equipment, floors, walls etc.

## **6.10 Civil Works Details**

### **6.10.1 Brickwork**

#### *6.10.1.1. Materials*

Bricks used in the works shall conform to the requirements laid down in IS : 1077, IS 2180, IS 2222, IS 2691, IS 3952, IS 6165. The class of the bricks shall be as specifically

indicated in the respective items of work prepared by the Contractor.

Bricks shall have following dimensions :

	<b>Length Mm</b>	<b>Width mm</b>	<b>Height mm</b>
Non Modular Bricks	230	110	70
	230	110	30

Common burnt clay bricks are classified on the basis of compressive strength as given below:

Class designation	10	7.5	5	3.5
Avg. compressive strength N/ mm <sup>2</sup>	10	7.5	5	3.5

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 and shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be uniform in colour, tolerance of brick dimension shall be  $\pm 3\%$  for designation 10 & above and  $\pm 8\%$  for lower designation. 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.

6.10.1.2. *The sample size for all the tests shall be as follows :*

<b>Brick</b>	<b>Lot size</b>	<b>Sample Size</b>
Class 10	more than 50000 bricks	20 bricks
7.5, 5, 3.5	more than 100000 bricks	20 bricks

The sampling shall be at random & samples shall be stored in a dry place until tests are done.

6.10.1.3. *Compressive strength :*

Five bricks shall be tested. The average compressive strength shall be as per class designation. The compressive strength of individual brick shall not be less than 20 % of the specified value.

6.10.1.4. *Water absorption :*

Five bricks shall be tested for water absorption and shall not exceed 20 % by weight upto class 12.5 & 15% by weight for higher classes.

6.10.1.5. *Efflorescence:*

Five bricks shall be tested for efflorescence. The efflorescence shall be 'nil' to 'moderate'

Sample bricks shall be submitted to the Engineer-in-Charge for approval and bricks supplied shall conform to approved samples. If demanded by Engineer-in-Charge, brick samples shall be got tested as per IS : 3495 by Contractor. Bricks rejected by Engineer-in-Charge shall be removed from the site of works within 24 hours.

Mortar for brick masonry shall consist of cement and sand.

Mortar leaner than 1.5 and richer than 1:3 shall not be used.

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6.10.1.6. *Preparation of mortar*

a) Materials

1) Water :

Water used shall be clean and reasonably free from injurious or deleterious materials such as oils, acids, alkalis, salts. The pH value of water shall not be less than 6.

2) Cement :

Cement shall conform to any of the following :

33 Grade	Ordinary	Portland	Cement	IS : 2697
	y			
43 Grade	Ordinary	Portland	Cement	IS : 8112
	y			
53 Grade	Ordinary	Portland	Cement	IS : 12269
	y			

3) Sand :

Sand for masonry mortars shall conform to IS 2116

6.10.1.7. *Preparation of mortars :*

Mortars shall be prepared and tested as per IS 2250. Mixing of cement mortar shall be done in a mechanical mixers.

6.10.1.8. *Workmanship*

Workmanship of brick work shall conform to IS : 2212. All bricks shall be thoroughly soaked in clear 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 prepared by the Contractor. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/ 115 mm 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.

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 on e 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 on e 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 be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one meter. Brick work shall not be raised more than one metre per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10 mm/ 15 mm by raking tools during the progress of work when the

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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.

During harsh weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.

Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the Engineer-in-Charge.

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 - I). 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-in-Charge. 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/ pointing.

In the event of usage of traditional bricks of size 230 mm x 115 mm x 75 mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/ floor slabs and at the top of the parapet shall be laid with bricks on edge.

All brickwork shall be built tightly against columns, floor slabs or other structural members.

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

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 layer of 50 micron thick polyethylene sheets.

RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 150 mm thickness, projecting 150mm on either sides of the beam, duly finished on top with 2 layer of Kraft paper Grade 1 as per IS : 1397 or 2 layers of 50 micron thick polyethylene sheets.

Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.

Bricks for partition walls shall be stacked adjacent to the structural member to predeflect 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.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction Drawings to be prepared by the Contractor are generally required to be provided in the half brick partition walls.

Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20 mm thick cement-sand mortar 1:4 over all the steel

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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.

## **6.10.2 Uncaused Random Rubble Masonry, in Foundation Plinth and Superstructure**

### *6.10.2.1. Materials*

Stones for the works shall be of the specified variety which are hard, durable, fine grained and uniform in colour (for superstructure work) free from defects like cracks, sand holes, patterns of soft / loose materials veins, other defects. Quality and work shall conform to the requirements specified in IS : 1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the Engineer-in-Charge for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be as per IS 2250.

### *6.10.2.2. Scaffolding*

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 - I). 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-in-Charge. 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/ pointing.

### *6.10.2.3. Workmanship*

For all works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dress stones for the facing.

For all R.R. masonry in superstructure the masonry shall be well bounded, faced with hammer dressed stones with squared quoins at corners. The bushing on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depression more than 10mm from the average wall surface.

Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be upto a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall

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be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in wall upto 600 mm thick and in case of wall above 600mm thickness, a set of two or more bond stones overlapping each other by at least 150mm shall be provided in a line from face to back. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45 deg. Masonry work shall not be raised by more than one metre per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.

### **6.10.3 Damp - proof Course**

#### *6.10.3.1. Materials and Workmanship*

All the walls in a building shall be provided with damp-proof course covering plinth 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 opening. Damp-proof course shall consist of minimum 50mm thick cement concrete of 1:2:4 nominal mix with nominal reinforcement and approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10mm down graded coarse aggregates.

The surface of brick work/stone 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. 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.

### **6.10.4 Miscellaneous Inserts, Bolts etc.**

All the miscellaneous inserts such as bolts, pipes, plate embedments etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the construction Drawing to be prepared by the Contractor. Contractor shall prepare and use templates for this purpose, if so directed by the Engineer-in-Charge. In the event, of any of the inserts are improperly installed, contractor shall make necessary arrangement to remove and reinstall at the correct locations/levels all as directed by the Engineer-in-Charge.

### **6.10.5 Base Concrete**

The thickness and grade of concrete and reinforcement shall be as specified in items of works prepared by the Contractor.

Before placing the blinding concrete, 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

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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.

### **6.10.6 Cement Plastering Work**

#### *6.10.6.1. Materials*

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 just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. 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-in-Charge. If so desired by the Engineer-in-Charge sand shall be screened and washed to meet the Specifications. 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 restoring 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.

#### *6.10.6.2. Workmanship*

Preparation of surfaces and application of plaster finishes shall generally conform to the requirements specified in IS: 1661 and IS: 2402.

Plastering operations shall not be commenced until installation of all fittings and fixtures such as door/ window panels, pipes, conduits etc. are completed.

All joints in masonry shall be raked as the work proceeds to a depth of 10 mm / 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 only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

#### a) Interior plain faced plaster

This plaster shall be laid in a single coat of 12 mm 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-in-Charge.

#### b) Plain Faced Ceiling plaster

This shall be applied in a single coat of 6 mm thickness. Application of mortar shall be as stipulated in above paragraph.

#### c) Exterior plain faced plaster

This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14 mm thick. The rendering coat shall be

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applied as stipulated above 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 6mm 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.

Interior plain faced plaster 20 mm thick if specified for uneven faces of brick walls or for random/ coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.

For external plaster, the plastering operation 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.

Double scaffolding to be used shall be as specified in clause 6.6.1.8.

The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2 m length placed against the surface.

To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.

- a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.
- b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/ thermal movement.
- c) 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.

### **6.10.7 Cement Pointing**

#### *6.10.7.1. Materials*

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-in-Charge and if so directed it shall be washed/ screened to meet specification requirements.

#### *6.10.7.2. Workmanship*

Where pointing of joints in masonry work is specified, the joints shall be raked at least 15 mm/ 20 mm deep in brick/ stone masonry respectively as the work proceeds when the mortar is still green.

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 joint shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be

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regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.

The work shall be kept moist for atleast 7 days after the pointing is completed. Wherever coloured pointing has 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-in-Charge.

#### **6.10.8 Water-Proofing Admixtures**

Water-proofing admixtures 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-in-Charge.

### **6.11 Miscellaneous requirements**

#### **6.11.1 Nameplates, signboards, nomenclature**

Each item of the plant shall have permanently attached to it in a conspicuous position a nameplate, on which shall be engraved or stamped the manufacturer's name, type and serial number, year of manufacture, details of the design capacity etc. Such labels shall be of non-hygroscopic material to be approved by the Engineer in Charge.

Near by or on each item of the plant, shall be fixed a plate with the name and nomenclature (code) of the item according to the project nomenclature. It shall be visible from a distance of several metres.

The Bidder shall also provide bilingual signboards and instruction tables of durable material, throughout the plant, for the purposes of operation, maintenance and security:

- Danger and caution signs (English and local language)
- Preventive maintenance schedules (local language)
- Operating instructions (local language)
- Unit names (English and local language)
- Nameplates at the doors to the units (English and local language)

Signboards and plates shall be appropriately sized in relation to the relevant item and its surroundings. Details of the proposed inscription, size, material and colours shall be submitted to the Engineer in Charge for approval before any signboards or plates are manufactured. They shall be compatible with the instructions in the operation manual.

All cables shall be provided with clip-on identification numbers on both ends and at all terminations in between, for identification. The nomenclature shall correspond to the electrical as-built drawings.

The nomenclature and labelling of the plant shall be decided in close co-operation with the Engineer in Charge.

#### **6.11.2 Fire extinguishers**

The Bidder shall provide 4 nos. dry powder type CO<sub>2</sub> fire extinguishers (10 kg) for the each pumping station and switchyards at the following locations after consultation with the Engineer in Charge:

- at transformer site (1 nos. at each P.S.)
- indoor electrical room (1 Nos. at each P.S)

- 
- pump rooms (maintenance bay) ( 1 Nos. at each P.S)
  - control room (1 No at each P.S)

### **6.11.3 First aid kits**

Complete first aid kits at all the sites shall be provided for the maintenance bays of the pump houses. The first aid kit shall consist of all materials, medicines necessary for treatment of cuts, wounds, burns bad effects of inhalation of chlorine, bad effects on skin due to contact of chemicals acids etc. Following materials in general in sufficient quantities shall be provided.

- Medical cotton, sterile cotton pads
- Cotton Bandages, elastic bandages
- Pair of scissors, packet of new shaving blades
- Sticking plaster for medical use.
- Band aid stripes

Following chemicals/medicines shall be provided in sufficient quantities :

- Tinctures iodine and mercury chrome
- Burnol ointment
- Bottles of spirit and of Dettol / Savlon
- Toilet soaps

To be procured under medical advice

- Skin lotions and ointments for burns, acid effects
- Eye drops for soothing effects

Fire extinguisher and first aid kits shall be provided for the end of the commissioning period only. They shall not be used before and shall be complete.