

RFP No. HML / INFRA / 01 / 2021

**REQUEST FOR PROPOSAL (RFP)
FOR SELECTION OF
DESIGN & BUILD CONTRACTOR
FOR DEVELOPMENT OF PHYSICAL INFRASTRUCTURE AND
CONSTRUCTION OF ADMINISTRATIVE BLOCK AT
MEDIPARK IN CHENGALPATTU DISTRICT, TAMIL NADU**

**VOLUME IV
SCHEDULE OF WORKS**

**SCHEDULE 4
WATER SUPPLY STORAGE AND DISTRIBUTION SYSTEM**



**HLL Medipark Limited
(A Govt. of India Enterprise)
2nd Floor, HLL Bhavan
No: 26/4, Tambaram – Velachery Road
Pallikaranai, Chennai – 600100
info@hllmedipark.com || Phone: 044 – 29813732**

Contents

SCHEDULE 4: Water Supply Storage and Distribution System	3
1. Design Brief	3
2. Water supply and distribution scheme	4
3. Design parameters	5
4. Water treatment plant	8
5. Scope of work & general conditions & technical specifications	11
6. Technical specification for civil and finishing works	39
7. List of Approved Makes	100
8. Testing	103
9. Intent Diagram.....	105
Appendix 1: Additional specification for quality of materials and tests to be conducted (as applicable)	108

SCHEDULE 4: Water Supply Storage and Distribution System**1. Design Brief**

- The contractor shall be responsible for designing, engineering, vetting, providing, construction, testing & commissioning of water supply network system at Medipark.
- The scope of work includes design, drawings, obtaining operational approvals from statutory bodies, coordinating across the infrastructure works in the Park for execution, erection of equipment with necessary foundations, installation, testing and commissioning of all equipment, and obtaining results as committed.
- The water storage services should be designed with the capacity of;
 - Raw water sump - 900,000 liters
 - Filtered water sump - 300,000 liters
 - Overhead tank - 300,000 liters
- Water treatment plant (WTP) should be designed with capacity of 300 KLD
- The contractor shall be responsible to provide underground sump tank with all required pumps & accessories as per details
- The contractor shall also be responsible for providing, supplying, laying, testing and commissioning of the water supply network. The details of the specification are provided in below section.
- The Contractor is also required to operate and maintain the WTP till the period specified in the Special Conditions of Contract (Volume 3 of RFP)
- The Contractor shall be required to design and execute every such items of work which are considered required or necessary for the satisfactory completion and functioning of the entire work and operation and maintenance of the project. Even if such items of work are not specified in the bid document but are essential to complete the project.
- The Contractor must conduct Soil Investigation survey at the location where the civil structures are proposed, and suitably consider the findings of the survey before designing and constructing the structure.

2. Water supply and distribution scheme

- Raw water from Palar River/ tanker of supply shall be collected to raw water storage sump.
- OHT proposed with a capacity to store half-day requirement of water Capacity 300KLD
- All the pumps would work automatically with the help of level switches installed both at ground level and terrace level tanks.
- Water shall be distributed to all proposed individual plots/ blocks, pressure reducing valve shall be fitted to maintain adequate pressure at the lower level.
- Each header main line will be provided with a control valve from the ring main at the connecting junction level for easy maintenance and isolation.
- Also, each entry road level shall be provided with an individual control valve for the isolation of respective toilet for easy maintenance.
- Minimum pressure of 2-5kg/sq. cm shall be maintained.
- The sizing of the entire distribution network is based on the simultaneous use of fixture unit's demand. A shut off valve will be provided within the battery limit of each block, which serves for the purpose of maintenance of any utility. Individual toilets will be provided with main control valve for isolation and maintenance of the same.
- Air release valves and water hammer arrestors shall be provided as per requirement of the design.
- Arriving at the quantities and items are sole responsibility of contractor which should be based on their detail design

3. Design parameters

The Project Facilities to be provided as per enclosed drawings/ details after proper designing as per standards and execution of the same, shall include the following:

3.1 Under Ground Sump Tank with Pump room.

To collect 9 lakh liters of raw water and 3 lakh liters of treated water and with all required pumps & accessories and water treatment plant as required, all as per enclosed drawing/ details.

- a) Outer dimensions (overall) – 24.6m x 20m
- b) Internal dimensions (Raw water) – 18.0m x 19.60m, Height – 2.8m (Including Free board)
- c) Internal dimensions (Treated water) – 6.0m x 19.60m, Height – 2.8m (Including Free board)
- d) Pump room (above ground) – 8m x 10m, Height – 2.8m
- e) Total Plinth Area (Pump room) – 87.36 Sqm.
- f) Total Carpet Area (Pump room) – 80.0 Sqm.
- g) Total Roof Area (Pump room) – 87.36 Sqm.

3.2 Over Head Water Tank with staging

To design & execute circular overhead water tank with staging to collect 3 lakh liters of water and with all required pumps & accessories as required, all as per enclosed drawing/ details.

- a) Outer dimensions (overall) – 10.8m dia.
- b) Internal dimensions (Raw water) – 10.0m dia., Height – 4.10m (including free board)
- c) Total staging height (from Plinth to OHT bottom) – 11.60m
- d) Total staging height (from Plinth to OHT top slab) – 16.20m
- e) Total Plinth Area – 91.56 Sqm.

3.3 Water supply lines

The minimum parameters to be considered for detailed designing from the contractor as mentioned below;

1	Supply delivery of CI D/F pipes and specials of various length both standard and nonstandard as per IS specification No.7181 / 86 and IS 1538/76 and as amended from time to time including all	<ul style="list-style-type: none"> a) 80 mm X 1.00 m CI/D / F PIPE b) 80 mm X 0.30 m CI/D / F PIPE c) 80 mm X 0.50 m CI/D / F PIPE d) 80 mm X 1.00 m CI/D / F Slotted
---	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

	other taxes, duties, loading, unloading, freight, insurance charges etc. complete and stacking them at site of work for pipe inlet & outlet connection works.	e) 80 mm X 90* CI/D/F Duck foot Bend f) 80 mm X 90* CI/D/F Bend g) 80 mm CI flgd / skt tail piece
2	Construction of Masonry valve pit for fixing the following sizes of all valves as per the type design. With all complete inlet and outlet connections	a) Inlet 100mm dia b) Outlet 150mm dia c) By-pass 100mm dia
3	Supplying fixing, testing and commissioning of brass 'Y' / pot strainer screw type tested to 15 kg / sq.cm.	150mm dia – 3 Nos
4	Supply and Delivery of Tamper proof DI single chamber air release valves with pressure range from PN 1.0 to 2.5 with body and cover made of Ductile Iron of Grade GGG 40 or equivalent grade conforming to IS 1865 with Food Grade Epoxy Powder coating (EP-P)	a) 50mm dia – 3 Nos b) 80mm dia – 3 Nos c) 100mm dia - 1 Nos d) 150 mm dia – 1 Nos e) 200 mm dia – 1 Nos
5	Providing and fixing of uPVC pipes confirming to ASTM D-2467 standard including all uPVC fittings like tees, elbows, bends, unions, coupling, reducer tees, collars etc.	a) 32 mm Pipe-500 Mtrs b) 50 mm pipe-650 Mtrs c) 65 mm Pipe-420 Mtrs d) 80 mm pipe-580 Mtrs e) 100 mm pipe - 550 Mtrs f) 150 mm pipe-3000 Mtrs
6)	Supply and Delivery of DI D/F Gate Valves (soft seated) resilient seated soft sealing gate valves (sluice valves)	a) 50mm dia – 3 Nos b) 80mm dia – 3 Nos c) 100mm dia - 2 Nos d) 150 mm dia –1 Nos e) 200 mm dia – 1 Nos
7	Supply and delivery of the following sizes of OHT flow control valve with female BSP treaded ends	100 mm (20LPM to 2000 LPM)- 2 Nos
8	Water meters confirming to ISO 4064 part I, II, III class B or IS 779 and IS 2373 with life cycle test certificate from FCRI/ NABL accredited lab.	a) 50mm dia – 3 Nos b) 80mm dia – 2 Nos c) 100mm dia – 1 Nos d) 150 mm dia – 1 Nos e) 200 mm dia – 1 Nos
9	Every Plot Water Meter chamber of 900 x 900 including all etc.	35 Nos
10	Tilting Disc Swing Check Valve in single piece body and closed eye disc construction.	200mm – 1Nos.

11	Every plot Woltman model with removal mechanism water meters confirming to ISO 4064 part I, II, III class B or IS 779 and IS 2373 with life cycle test certificate from FCRI/ NABL accredited lab	a) 40mm dia – 50 Nos. b) 80mm dia -- 03 Nos. c) 100mm dia – 03 Nos
12	Pumps from Filter water sump to OHT -	1 Working & 1 Standby- 35 mtr Head. From UG sump to OHT 25000lts/hr.
13	Three phase panel board-star delta with two level guard and auto start	1 number as per the Electrical details
14	Electrical panel feeder to provide for Pump room	1 number as per the Electrical details
15	Near OHT provision of water tap points to be provided	4 number as per the site condition
16	Master control valve with chamber to provide near the OHT for easy maintenance	1 number as per the site condition
17	Automatic level controller with complete works from UG sump to OHT	Proposed near the sump - 3 number
18	Electromagnetic Flow Meter conforming to ISO 17025 Standard shall be a velocity sensing Electromagnetic type, microprocessor-based signal converter, sealed housing, flanged tube meter for 1.0 MPA working pressure	1 number to be provided as per the requirement
19	Proper Electrical conduits for all inlet and out points	To be Provided
20	Supporting materials and items to be considered.	To be Provided

4. Water treatment plant

It is assumed that water from the Palaar river will be the primary source and would be available and if the need arises, tanker water or bore well water will supplement in future. The quality of the secondary sources of water is not known and it is proposed to have a water treatment plant of 300KLD plant primarily consisting of

- Pressure filters
- Softeners
- Activated Carbon Filters.
- Chlorine dosing for disinfection.
- All water is purified to attain standards as per **IS 10500-1991**

Providing and fixing of uPVC pipes confirming to ASTM D-2467 standard including all uPVC fittings like tees, elbows, bends, unions, coupling, reducer tees, collars etc.

4.1 Physical Tests

Sl. No.	Substance or Characteristic	Result parameters	Permissible Limit in the Absence of Alternate source
(1)	(2)	(3)	(4)
1.	Color, Hazen units	0.5	25
2.	Odor	Unobjectionable	-
3.	Turbidity, NTU	5	10
4.	pH	7.9	No Relaxation
5.	Total dissolved solids, mg/l	314	600

4.2 Chemical Tests

Sl. No.	Substance or Characteristic	Result parameters	Permissible Limit in the Absence of Alternate source
(1)	(2)	(3)	(4)
1.	Chlorides (as Cl)	53	100
2.	Total Hardness (as CaCO ₃)	300	600
3.	Iron (as Fe)	0.223	0.3
4.	Fluoride (as F)	1.0	1.5

4.3 Treatment scheme

The treatment scheme will comprise the following components:

Sr. No.	Description								
1	Pressure Sand Filter								
2	Activated Carbon Filter								
3	Anti scaling Dosing System (for more than 2000 ppm TDS)								
4	Cartridge Filter Housing <table border="1"> <tr> <td>Flow rate</td><td>20 M³/hr.</td></tr> <tr> <td>MOC</td><td>FRP</td></tr> <tr> <td>No. of Cartridge Housing</td><td>2 Nos.</td></tr> <tr> <td>Make</td><td>Ametek, USA</td></tr> </table>	Flow rate	20 M ³ /hr.	MOC	FRP	No. of Cartridge Housing	2 Nos.	Make	Ametek, USA
Flow rate	20 M ³ /hr.								
MOC	FRP								
No. of Cartridge Housing	2 Nos.								
Make	Ametek, USA								
5	Micron Cartridge Filter (20 Micron & 5 Micron) Flow Rate: 15 M ³ /hr								
6	High pressure Pump Make: Grundfoss / ITT/C.R.I./ LUBI preferred								
7	Pressure Tube								

4.4 Instrumentation

A	Digital Conductivity or TDS Meter	
	Quantity	One Nos.
	Indication	4 Digit 1 Line LED
	Conductivity Meter	0-200 μ S/Cm
	Maximum Temperature	40 Degree Centigrade
	Location	RO Permeate
B	Flow Indicators	
	Quantity	2 Nos.
	Type	Float Type Panel Mounted
	Maximum Op. Temp.	40 Degree Centigrade
	Location	1) RO Product Water Flow 2) RO Reject Water Flow
C	Pressure Gauges	
	Quantity	2 Nos.
	Range	0-20 Kg / Cm ²
	Location	1) RO Module Inlet

		2) RO Module Reject Flow
	Make	ALLOT, H GURU, FIEBIG
D	High Pressure Switch and Low-Pressure Switch	
	Quantity	One Nos.
	Location	Before & After High Pressure Pump
E	Pressure Control Valve	
	Location	Reject Water Line
	Numbers	1 Nos.
	Make	Spring System, USA
F	Electronic Control Panel with a meter, Voltmeter m indicators, On off Switch	
G	Auto Flushing Switch with Solenoid Valve	

5. Scope of work & general conditions & technical specifications

5.1 Scope of work

The scope of work of the Contractor shall broadly include supply, installation, testing & commissioning of the following services:

- a. Internal and external water supply distribution network,
- b. Above ground drainage system,
- c. Landscape irrigation system,
- d. Underground drainage system including construction of manholes and all other related appurtenances,
- e. Inlet and outlet connections, over-flows and drain connections in the water storage tanks using puddle flanges,

All works shall be carried out as per statutory requirements/regulations laid down in codes.

5.2 Details of Civil and finishing works

5.2.1 Underground sump tank with pump room (Civil Works)

- a) Clearing the site of light jungle/ Scrub jungle
- b) Earthwork excavation for UG sump, to required size and depth, in all types of soil/ soft rock/ hard rock including depositing away from the excavation area with all lead & lift, trimming the bottom and sides, all as per standard practice and structural requirement.
- c) Plain cement concrete of grade M-10 for bed concrete with necessary form work.
- d) Filling to sides of footings/ foundations and inside plinth either with available earth or with borrowed earth as per requirement including consolidation and having 100mm thick PCC M10 bed concrete on top.
- e) Machine batched and machine mixed design mix M-25 grade cement concrete for RCC works, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of Authority Engineer.
- f) Centering and shuttering including strutting, propping etc. and removal of form for
 - Foundations, footings, bases of columns, etc. for mass concrete
 - Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
 - Suspended floors, roofs, landings, balconies and access platform
 - Lintels, Beams, Plinth beams, Girders, Bressumers and cantilevers

- Columns, Pillars, Piers, Abutments, Posts and Struts
 - Weather shade, chajjas, corbels etc. including edges
- g) Reinforcement to all RCC works as per structural design/ drawings/ details using thermo mechanically treated bars of grade FE-500D or more
- h) Masonry work for walls, piers and architectural features, in CM 1:6 for super-structure using solid concrete blocks of approved quality, size and of grade D(3.5) blocks as per IS: 2185 (Part I) - 1979 including necessary scaffolding, raking of joints, finishing, curing etc., complete with all lead & lift for all materials & labor and as directed (with minimum compressive strength of blocks should be 35 kgs./ sqcm.).
- i) Flagging concrete around the building to a width of 600mm with PCC 1:3:6 concrete including finished the top surface with 15mm thick cement plaster 1:4 and with a floating coat of neat cement.

5.2.2 Underground sump tank with pump room (Finishing Works)

- a) 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix: 2 graded stone aggregate 6 mm nominal size)
- b) **Pump room** – with 1 mm thick MS sheet door with frame of 40x 40x 6mm angle iron and 3mm MS gusset plates at the junctions and corners, MS angles of 40x 40x 6mm for diagonal braces, all necessary fittings complete including applying a coat of approved steel primer after pre-treatment of the surface. Finishing surfaces with synthetic enamel paint (two or more coats) of approved brand and manufacture of required color over an under coat of suitable shade with ordinary paint of approved brand and manufacture.
- c) **Pump room** – Factory made ISI marked steel glazed doors/ windows/ ventilators (weighing 15 kg./ sqm.), side/ top/ center hung, with beading and all members such as F7D, F4B, K11B and K12B etc. complete of standard rolled steel sections, providing & fixing 4mm thick glass panes with putty and glazing clips, hinges, pivots etc., including providing and applying a coat of approved steel primer, all as per approved design including fixing of steel frames with 15x 3mm lugs and 10 cm long embedded in cement concrete block of 15x 10x 10 cm of PCC 1:3:6. Finishing surfaces with synthetic enamel paint (two or more coats) of approved brand and manufacture of required color over an under coat of suitable shade with ordinary paint of approved brand and manufacture
- d) Providing and fixing MS grills (weighing 15 kg./ sqm.) of required pattern in frames of windows etc. with MS flats, square or round bars etc. including priming coat with approved steel primer and finishing with synthetic enamel paint (two or more coats) of approved brand and manufacture of required color over an under coat of suitable shade with ordinary paint of approved brand and manufacture

- e) Water proofing treatment on roofs of slabs by applying cement slurry mixed with water proofing cement compound consisting of applying a) after surface preparation, first layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/sqm. b) laying second layer of Fiber glass cloth when the first layer is still green. Overlaps of joints of fiber cloth should not be less than 10 cm. c) third layer of 1.5 mm thickness consisting of slurry of cement @ 1.289 kg/sqm mixed with water proofing cement compound @ 0.670 kg/sqm and coarse sand @ 1.289 kg/sqm. This will be allowed to air cure for 4 hours followed by water curing for 48 hours. The entire treatment will be taken up to 30 cm on parapet wall and tucked into groove in parapet all around. d) fourth and final layer of brick tiling with cement mortar (which will be paid for separately).
- f) Providing and laying integral cement-based water proofing treatment with average thickness of 120 mm and minimum thickness at khurra as 65 mm including preparation of surface as required for treatment of roofs, balconies, terraces etc.
- g) Pressed clay tiles (as per approved pattern 20 mm nominal thickness of approved size) on roofs jointed with cement mortar 1:4 mixed with 2% integral water proofing compound, laid over a bed of 20 mm thick cement mortar 1:4 and finished neat complete.
- h) Providing gola 75x75 mm in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 10 mm and down gauge), including finishing with cement mortar 1:3, as per standard design
- i) Making khurras 45x45 cm with average minimum thickness of 5 cm cement concrete 1:2:4, over PVC sheet 1 m x 1 m x 400 microns, finished with 12 mm cement plaster 1:3 and a coat of neat cement, rounding the edges and making and finishing the outlet complete.
- j) All internal concrete/ masonry surfaces plastered with CM and finished with lime rendering/ cement rendering. All external concrete/ masonry surfaces plastered with CM and sponge finished.
- k) All cement mortar used for plastering, should be mixed with waterproofing compound in proportion recommended by the manufacturers.
- l) All internal plastered surfaces finished with distempering in two or more coats with 1st quality acrylic distemper (ready mixed) having VOC content less than 50 gms/ liter, of approved manufacture and of required shade & color, over plaster of paris putty of 2 mm thickness and one coat of water thinnable cement primer of approved brand and manufacture.
- m) All external plastered surfaces finished with Premium Acrylic Smooth exterior paint with Silicone additives of required shade (Two or more coats) including priming coat of exterior primer.

5.2.3 Overhead water tank (Civil Works)

- a) Clearing the site of light jungle/ Scrub jungle. The site has to be clear up to Overhead tank for easy access.

- b) Earthwork excavation for column footings (isolated/ combined)/ foundations for overhead water tank, to required size and depth, in all types of soil/ soft rock/ hard rock including depositing away from the excavation area with all lead & lift, trimming the bottom and sides, all as per standard practice and structural requirement.
- c) Plain cement concrete of grade M-10 for bed concrete with necessary form work.
- d) Filling to sides of footings/ foundations and inside plinth either with available earth or with borrowed earth as per requirement including consolidation and having 100mm thick PCC M10 bed concrete on top.
- e) Machine batched and machine mixed design mix M-25 grade cement concrete for RCC works, using cement content as per approved design mix, including pumping of concrete to site of laying but excluding the cost of centering, shuttering, finishing and reinforcement, including admixtures in recommended proportions as per IS: 9103 to accelerate, retard setting of concrete, improve workability without impairing strength and durability as per direction of The Authority Engineer.
- f) Centering and shuttering including strutting, propping etc. and removal of form for
 - Foundations, footings, bases of columns, etc. for mass concrete
 - Walls (any thickness) including attached pilasters, buttresses, plinth and string courses etc.
 - Suspended floors, roofs, landings, balconies and access platform
 - Lintels, Beams, Plinth beams, Girders, Bressumers and cantilevers
 - Columns, Pillars, Piers, Abutments, Posts and Struts
- g) Reinforcement to all RCC works as per design/ drawings/ details using thermo mechanically treated bars of grade FE-500D or more
- h) Wall foundation as per structural requirement to required width and depth using solid concrete blocks of 200mm width or as specified in CM 1:6, with necessary earthwork excavation, PCC bed concrete, Plinth course in PCC M-10 concrete with necessary formwork.
- i) Flagging concrete around the building to a width of 1500mm with PCC 1:3:6 concrete including finishing the top surface with 15mm thick cement plaster 1:4 and with a floating coat of neat cement.

5.2.4 Overhead water tank (Finishing Works)

- a) 52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix: 2 graded stone aggregate 6 mm nominal size)
- b) Pump room – with 1 mm thick MS sheet door with frame of 40x 40x 6mm angle iron and 3mm MS gusset plates at the junctions and corners, MS angles of 40x 40x 6mm for diagonal braces, all necessary fittings complete including applying a coat of approved steel primer after pre-treatment of the surface. Finishing surfaces with synthetic enamel paint (two or more coats)

- of approved brand and manufacture of required color over an under coat of suitable shade with ordinary paint of approved brand and manufacture.
- c) Pump room – Factory made ISI marked steel glazed doors/ windows/ ventilators (weighing 15 kg./ sqm.), side/ top/ center hung, with beading and all members such as F7D, F4B, K11B and K12B etc. complete of standard rolled steel sections, providing & fixing 4mm thick glass panes with putty and glazing clips, hinges, pivots etc., including providing and applying a coat of approved steel primer, all as per approved design including fixing of steel frames with 15x 3mm lugs and 10 cm long embedded in cement concrete block of 15x 10x 10 cm of PCC 1:3:6. Finishing surfaces with synthetic enamel paint (two or more coats) of approved brand and manufacture of required color over an under coat of suitable shade with ordinary paint of approved brand and manufacture
 - d) Providing and fixing MS grills (weighing 15 kg./ sqm.) of required pattern in frames of windows etc. with MS flats, square or round bars etc. including priming coat with approved steel primer and finishing with synthetic enamel paint (two or more coats) of approved brand and manufacture of required color over an under coat of suitable shade with ordinary paint of approved brand and manufacture
 - e) Water proofing treatment on roofs of slabs by applying cement slurry mixed with water proofing cement compound consisting of applying a) after surface preparation, first layer of slurry of cement @ 0.488 kg/sqm mixed with water proofing cement compound @ 0.253 kg/sqm. b) laying second layer of Fiber glass cloth when the first layer is still green. Overlaps of joints of fiber cloth should not be less than 10 cm. c) third layer of 1.5 mm thickness consisting of slurry of cement @ 1.289 kg/sqm mixed with water proofing cement compound @ 0.670 kg/sqm and coarse sand @ 1.289 kg/sqm. This will be allowed to air cure for 4 hours followed by water curing for 48 hours. The entire treatment will be taken up to 30 cm on parapet wall and tucked into groove in parapet all around. d) fourth and final layer of brick tiling with cement mortar (which will be paid for separately).
 - f) Providing gola 75x75 mm in cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 10 mm and down gauge), including finishing with cement mortar 1:3, as per standard design
 - g) MS Ladder of 45cm clear wide made out of 50mm x 50mm x 6mm MS angle for sides and steps in 16 mm MS plain rods fixed at 30cm C/C welded jointed etc. providing with suitable side supports, clamps and locking arrangements provided with two coats of approved enamel paint over one coat of red oxide paint, for providing access to roof top of OHT of suitable inclined length, including bottom anchorage and transportation and as directed by Authority Engineer. The rate includes concrete bed block in CC 1:1.5:3 using 20mm HBGS at top and bottom of suitable size with necessary anchor bolts.
 - h) RCC inner access ladder in RCC 1:1-1/2:3, using 20mm HBG stone for OHT including cost of reinforcement, placing grill in position, centering, shuttering charges, mixing concrete, curing

- etc. to required height and clear width of 45 cm consisting of 2 nos. of vertical post of 10 cm x 15 cm and step slab of 25mm x 25mm etc. complete and as directed by Authority Engineer.
- i) Handrails over the Standing Platform by using 10 mm GI Pipe with 40mm x 6mm MS Flat and fixed with 12mm dia. Fastener Bolt 75mm long and as directed by Authority Engineer.
 - j) Providing 110mm PVC vent cowl arrangements mosquito proof nylon net and as directed by Authority Engineer.
 - k) Supply and fixing of cut stone of size 0.30m x 0.30m x 0.15m in CM 1;3, below inlet pipe for Service Reservoir as directed by Authority Engineer.
 - l) Watertight Manhole frame and cover (Medium type) of size 0.60m x 0.60m in RCC 1:11/2:3 with suitable reinforcement and 50 x 50 x 6mm MS angle fixed along edges and as directed by the Authority Engineer.
 - m) Construction of Rainwater harvesting for OHT etc., complete and as directed by Authority Engineer.
 - n) All internal concrete/ masonry surfaces plastered with CM and finished with lime rendering/ cement rendering. All external concrete/ masonry surfaces plastered with CM and sponge finished.
 - o) All cement mortar used for plastering, should be mixed with waterproofing compound in proportion recommended by the manufacturers.
 - p) All internal plastered surfaces finished with distemping in two or more coats with 1st quality acrylic distemper (ready mixed) having VOC content less than 50 gms/ liter, of approved manufacture and of required shade & color, over plaster of paris putty of 2 mm thickness and one coat of water thinnable cement primer of approved brand and manufacture.
 - q) All external plastered surfaces finished with Premium Acrylic Smooth exterior paint with Silicone additives of required shade (Two or more coats) including priming coat of exterior primer.

5.3 Structural details

Conventional reinforced concrete with RC Column/ Wall/ Beam/ Slab frame structure has been considered as the basic structural system for the UG sump/ OHT/ STP.

Analysis and detailed design have been carried out in accordance with relevant BIS codes as described in the following paragraphs.

5.3.1 Loading and other considerations

The building shall be designed for the following loads:

a) Dead Load

Self-Weight (slab) – $t \times 25 \text{ KN/m}^2$

Superimposed Dead Load – Wall thickness x 20 kn/m²

Floor Finishes – 1.5 KN/m²

b) Imposed Load

Live Load – 4.0 KN/m²

c) Wind Load

Basic wind speed at Chennai is 50m/s. Design wind pressure is calculated in accordance with clause-5 of IS:875 (Part-3).

$V_b = 50$ m/sec.

Risk coefficient = $k_1 = 1.00$ (Design life of the structure=50 years)

Terrain, height and structure size factor= $k_2 = 0.97$

Topography factor = $k_3 = 1.0$

Importance Factor for Cyclonic region $k_4 = 1.0$

Design wind speed= $V_z = V_b \times k_1 \times k_2 \times k_3 \times k_4 = 48.50$ m/sec

Design wind pressure= $0.6 V_z^2 = 1411.35$ N/m² (height 12m)

d) Seismic Load

The seismic force shall be calculated in accordance with IS:1893 (Part-I). Chennai comes under seismic zone –III. Accordingly, the following parameters are considered in calculating seismic load.

Response Reduction Factor R : 3.0

Soil Type : Medium

Importance factor I : 1.5

Seismic zone factor Z : 0.16

e) Load Combination considered for Design

Load combination considered is as per Clause 36.4.1 of IS: 456-2000

- | | | |
|-------|--------------------|----------------------------|
| i) | DL+LL | DL=DEAD LOAD |
| ii) | 1.5 (DL + LL) | LL=LIVE LOAD |
| iii) | 1.5 (DL + EQX) | EQX=SEISMIC LOAD IN X-AXIS |
| iv) | 1.5 (DL - EQX) | EQZ=SEISMIC LOAD IN Z-AXIS |
| v) | 1.5 (DL + EQZ) | WL X=WIND LOAD IN X-AXIS |
| vi) | 1.5 (DL - EQZ) | WL Z=WIND LOAD IN Z-AXIS |
| vii) | (0.9 DL + 1.5EQX) | |
| viii) | (0.9 DL - 1.5EQX) | |
| ix) | (0.9 DL + 1.5 EQZ) | |
| x) | 1.2 (DL+LL-EQX) | |
| xi) | 1.2 (DL+LL+EQZ) | |

- xii) 1.2 (DL+LL-EQZ)
- xiii) 1.5 (DL+WLX)
- xiv) 1.5 (DL-WLX)
- xv) 1.5 (DL+WLZ)
- xvi) 1.5 (DL-WLZ)
- xvii) (0.9 DL+1.5 WLX)
- xviii) (0.9 DL-1.5 WLX)
- xix) (0.9DL+1.5WLZ)
- xx) 1.2 (DL + LL - WLX)
- xxi) 1.2 (DL + LL + WLZ)
- xxii) 1.2 (DL + LL - WLZ)

The most critical of the above combinations has been considered for design.

5.3.2 Structural analysis

- a) Analysis for Dead Load, Imposed Load and lateral load due to wind.

Building frames have been analyzed as three-dimensional space frame structure using software.

- b) Seismic Analysis

The building is in seismic zone-III. This analysis has been carried out using software by 3-D model with columns fixed at foundation.

5.3.3 Structural design

All the structural elements have been designed as per limit state method as given in IS:456-2000. Slab and beam elements have been checked for limit state of serviceability such as deflection and cracking as outlined in IS:456-2000.

However, foundations are designed by working stress method.

5.3.4 Soil report

Soil consists of medium dense soils with SBC – 250 KN/m²

5.3.5 Foundation system

Foundation system shall be consisting of isolated footing. Founding level will be 1.5m from the natural ground level as per Soil report.

5.3.6 Construction materials

Controlled concrete shall be used for all reinforced concrete structures as follows:

- i) Concrete Grade – M-25 grade concrete
- ii) Reinforcement – High yield strength deformed TMT bars of grade Fe 500 conforming to IS:1786-1985

5.3.7 Cover

Minimum clear cover to all main reinforcement shall be as follows:

For Foundation	:	50 mm
For Columns	:	40 mm
For beams	:	30 mm
For slabs	:	20 mm

5.3.8 Reference codes:

- a) IS 456-2000 – Plain and reinforced concrete- code of practice
- b) IS 1893 (Part I)-2016 – Criteria for earthquake resistant design of structures.

- c) IS 875 (Part I)-1987 edition 3.1 (1997-12) – Code of practice for design loads (other than earthquake) for buildings and structures- Dead loads
 - d) IS 875 (Part-II)-1987-(reaffirmed 1997) – Code of practice for design loads (other than earthquake) for buildings and structures - Imposed loads
 - e) IS 875 – (Part – III) – 2015 - Code of practice for design loads (other than earthquake) for buildings and structures. - Wind loads
 - f) IS 875 – (Part – V) -1987- reaffirmed 1997) Code of practice for design loads (other than earthquake) for buildings and structures. - special loads and load combinations.
- IS 13920 – 2016 - Ductile detailing of reinforced concrete structures subjected to seismic forces- code of practice

5.4 Site conditions

It is assumed that before tendering the Contractor would have visited the site and familiarized himself with all the local conditions and means of transportation and communications. No claim of whatsoever nature would be entertained at a later date on account of the Contractor's ignorance of the local conditions.

5.5 Standard and codes of practice

The work shall be carried out as per the enclosed Specifications of Work and the construction drawings to be issued from time to time. These specifications shall be read in conjunction with CPWD specifications 2002 (with up-to-date correction slips), National Building Code 2005, relevant Codes of Practice and Standards as issued by Bureau of Indian Standards (B.I.S. - all with the latest amendments) wherever applicable.

5.6 Workmanship

All the work shall be carried out in a workmanship like manner and as per the best practices of the trade.

5.7 Wings and documents

5.7.1 General

- i) The Drawings provided with the Specification shall be treated as confidential documents and must not be copied or loaned to any other party without the express permission of the Authority Engineer.
- ii) The Drawings are intended as a guide to the firms tendering and give approximate positions of pipes, conduits, cable runs and/or equipment only and in measuring from these drawings, the Tenderer must make due and proper allowance for all necessary diversions from the straight

line, rises or falls as may be required for the proper execution of the works.

Detail drawings in all cases shall be worked to in preference to those of a more general nature and figured dimensions where indicated shall be followed in preference to scale.

Where necessary, the exact positions of plant and/or equipment will be decided by the issue of further drawings, but no claim for extra payment due to insufficient information on this scope will be entertained.

In any case of doubt as to the interpretation of either Drawings and/or Specification, the Contractor must refer the matter to the Authority Engineer prior to the submission of his Tender.

- iii) It is to be clearly understood that this Tender is to be absolutely inclusive for the proper completion of the whole of the works specified to the true intent and meaning of the specification and/or Drawings and the description therein contained shall be read conjointly and together and no error, inconsistency, discrepancy in the Drawings and/or Specification will relieve the Contractor of his obligations to include for an hand-over the work in the true meaning and intent of the Specification and/or Drawings, complete in every respect.

Should any portion of the works which would reasonably and obviously be inferred as necessary for the installation as a whole not be expressly specified, the Contractor shall provide and execute such work as part of the Contract and shall not be entitled to any extra payment of that account.

- iv) The Contract Drawings and such other drawings as may be furnished to the Contractor during the progress of the Works shall be considered as illustrating between the Drawings and the Specification, the Contractor shall execute the work in accordance with the decision of the Authority Engineer. If modifications are necessary, the Contractor shall submit modifications to the Authority Engineer for approval before such modifications are executed.
- v) All Drawings and Specification are the property of the Authority Engineer.
- vi) The Contractor will be required to give and obtain all necessary site and other particulars and to agree such details with the Authority Engineer. The Contractor must also obtain details of any other Contractor's work affected by his work and shall work in close co-operation with all such firms or persons concerned.

- vii) The Contractor shall be responsible for any damage caused to buildings and contents and works by reason of, arising out of, or incidental to, or in connection with the execution of any work in the Contract Documents.

The Contractor shall permit nothing to be done which may injure the stability of the Works, or existing buildings and no cutting through floors or walls will be allowed other than where required by the Drawings, without the sanction of the Authority Engineer.

- viii) The Contractor shall submit to the Authority Engineer for approval, before the work is commenced, a copy of all working details and installation drawings and shall also supply sufficient copies for the use of the Authority Engineer.

These drawings must be submitted by the Contractor as soon as possible after the order is placed to give ample time for all parties concerned to study and comment thereon.

- ix) The work described on any working drawings submitted shall be carefully checked by the Contractor for all clearance, field conditions, maintenance of architectural conditions and proper co-ordination with all trades on the job. To this end, the Contractor, during the construction drawing stage, shall ensure that he co-ordinates drawings of all other trades that might interfere with the proper installation of his work. No payment shall be made for any variations or alterations on site due to lack of knowledge of other trades. Any unresolved conflict between various trades shall be referred to the Authority Engineer.

The equipment layout is to be detailed on the drawings, showing the exact method of installing and clearly illustrating components to be used in making all connections.

- x) Pipework drawings must be fully detailed, showing all pipework in double line and indicating the precise size of fittings, valves and equipment, position of hanger supports with reference numbers must be indicated and a large-scale detail must be given, showing the type and method of installation of each type of hanger. A schedule is to be included on each drawing, showing details of the type of hanger fixings and reference number for each type.

All general layout drawings shall be drawn 1/50 scale, unless agreed otherwise with the Authority Engineer. Toilet piping layouts, details and hangers, cleanouts, methods of fixing of all fittings and fixtures including pipes, detailed cross sections of service ducts, etc., are to be drawn to 1/10 scale.

- xi) The Contractor shall provide a detailed programme incorporating working drawing production

which can be read in conjunction with the building construction programme.

- xii) The Contractor shall prepare schedules and drawings showing precise details of holes in concrete, block works etc., base frames or support required and the like. The schedules shall show in detail the builder's work required to be performed by all other trades for the mechanical and electrical installations. These drawings and schedules, in an approved form, must be submitted to a properly approved by the Architect before any structural work requiring holes or other modifications is constructed.
- xiii) The Contractor shall submit all drawings as prescribed hereunder. All drawings shall be supplied in the form of a second negative and signed by a principal of the Contractor. After approval from the Authority Engineer, the negative will be signed by the Authority Engineer and returned to the Contractor. The Authority Engineer will take as many prints from this negative as he requires for his own use.

Signed and approved drawings will not be departed from unless a signed variation or omission certificate is issued in writing by the Authority Engineer. Drawings returned to the Contractor for alteration or amendment shall be re-submitted to the Authority Engineer for approval.

Amended or altered drawings shall show the nature of the amendment or alteration in a revision block on the drawing, together with the revision number or letter and the date of the revision.

5.7.2 Manufacturers' Data

- i) Manufacturers' performance data, certified factory drawings of apparatus, giving full information as to capacity, dimensions, materials and all information pertinent to the adequacy of the submitted equipment shall be submitted to the Authority Engineer for approval.

Manufacturer names, sizes, catalogue numbers and/or samples of all materials shall be submitted to the Authority Engineer for approval.

Submittals and working drawings should, as far as possible be complementary so that drawings and submittals can be cross checked.

- ii) Order of equipment submitted to the Authority Engineer for approval must be accompanied by relevant drawings, technical data, catalogues and samples, Where data, certified drawings or other required information is not available until after orders have been placed, the Authority Engineer will give provisional approval until all requested drawings and information have been

supplied to the Authority Engineer and approved by him. It is the Contractor's responsibility to ensure that all necessary information is supplied to the Authority Engineer in accordance with the progress of the work.

5.7.3 Operating and Maintenance Manual

- i) The Contractor shall furnish six copies in bound form of an instruction manual containing all information applicable to this section of the Works. This manual is to be similar in design and content to those to be provided under other services.

The manual shall contain a comprehensive written description of the Works, outlining the operation of the systems and maintenance procedures.

5.7.4 "As Installed " Drawings

- i) The Contractor shall arrange to keep on Site a full set of drawings showing the progress of the Works, which must be kept up to date.

The Contractor shall keep a record as the work proceeds of any work installed not in accordance with the drawings. On completion of the Works the Contractor shall supply three clear colored prints of each applicable drawing, showing the exact position of all apparatus, pipelines, services, control valves, switchgear, etc., together with diagrams, schedules, etc.

The word "AS INSTALLED DRAWINGS" shall be clearly indicated on all drawings adjacent to the title block.

5.8 Work and time schedule

The Contractor shall prepare a work and time schedule in a format as approved by the Authority Engineer. The schedule shall be submitted to the Authority Engineer within ten days of the award of the Contract. It shall indicate the expected date of commencement and completion of each item of work. The chart shall also indicate the Scheduling of samples, shop drawings and approvals from the Authority Engineer. In addition to this, the Contractor shall also furnish to the Authority Engineer fortnightly progress reports indicating percentage completion of each item of work.

5.9 Rates

The rates quoted for any particular item by the Contractor shall be inclusive of the cost of material, erection, connection, testing, labor, supervision, tools, plant, transportation, excise

duties and taxes, contingencies, breakage, wastage and all other sundries.

The rate shall also be inclusive of cutting holes, making chases in RCC and making good the same. No claim for extra would be entertained on this account.

5.10 Plumbing drawings

The plumbing drawings issued from time to time to the Contractor are diagrammatic but shall be following as closely as actual construction work will permit. Any deviation from the drawings required to conform to the building construction shall be made by the Contractor at his own expenses. The architectural drawings shall take precedence over the services drawings as far as the Civil and other trades works are concerned.

5.11 Discrepancies in the drawings

Should there be any discrepancy due to in-complete description, ambiguity or omission in the drawings and other documents relating to this Contract found by the Contractor either before starting the work or during execution or after completion, the same shall be immediately brought to the attention of the Authority and his decision would be final and binding on the Contractor.

5.12 Materials

All materials to be supplied by the Contractor shall be new. All packed items shall arrive at site in original packing only. Any items found defective or damaged shall be replaced by the Contractor at his own expenses. The Contractor shall get the `seal` of containers opened from The Authority Engineer and maintain a record jointly signed by him and The Authority Engineer. No empty containers shall be removed from the site till completion of work or without the written approval of the Authority Engineer.

5.13 Storage of materials

All the materials brought at site shall be stored and stacked in a proper manner. The materials requiring protection from the Sun and rain shall be kept inside the temporary structures to be erected at site by the Contractor. The Contractor shall also follow the Manufacturers' instructions for storing and stacking the materials.

The storage facilities are to be created by the Contractor at his own expenses.

5.14 Instruments for measurement and testing

The Contractor shall provide, free of cost, all equipment, instruments, labor and all other allied assistance required by the Authority for measurement and testing of the works.

5.15 Co-ordination with other trades

The Contractor shall be responsible for coordinating this work with works of other trades

sufficiently ahead of time to avoid unnecessary hold ups. Hangers, sleeves, recesses etc. shall be left in time as the work proceeds.

5.16 Site order book

The Contractor shall maintain a site order book, in which daily progress of the work and number of workers engaged shall be recorded. The site diary shall also be used by the Authority Engineer for writing his comments/instructions.

5.17 Up-keep of the site

It shall be the responsibility of the Contractor to clear away, from time to time, all debris and excess material generated by the activities of his workers.

5.18 Protection

All work shall be adequately protected, to the satisfaction of the Authority Engineer, so that the whole work is free from the damage throughout the period of construction up to the time of handing over.

Special care must be taken to prevent damage and scratching of all fittings and fixtures. Tool marks on exposed fixtures shall not be accepted. Protective paper on fixtures shall be removed with hot water only at the final completion of the work.

Before handing over the work, the Contractor shall clean all elements of the complete installation, remove plasters, splashes, stickers, rust stains and all other foreign matter and leave every part in acceptable condition and ready for use to the satisfaction of the Authority Engineer.

5.19 Removal of Filth

All night soil, filth or any other offensive matter met with during the execution of the works, immediately after it is taken out of any trench, sewer or cess-pool, shall not be deposited upon the surface of any street or where it is likely to be nuisance or passed into any sewer or drain but shall be at once put into carts and removed to a suitable place to be provided by the Contractor.

5.20 Excavation to be Taken to Proper Depths

The trenches shall be excavated to such a depth that the sewers shall rest on concrete as per specifications and drawings so that the inverts may be at levels given on the sections. In bad ground the Authority Engineer may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewer with concrete, broken stone, gravel or other materials. Any such extra excavation, if ordered by the Authority Engineer, shall be extra as per provisions in the Contract conditions, but if the Contractor should excavate the trench to a greater depth than is required as per drawings without a specific order

to than effect of the Authority Engineer, the extra depth shall have to be filled up with concrete at the Contractor's own costs and charges to the requirements and satisfaction of the Authority Engineer.

5.21 Refilling

After the sewer or other work has been laid and proved to be watertight, the trench or other excavations shall be refilled. Utmost care shall be taken in doing this, so that no damage shall be caused to the sewer and other permanent work. The filling in the haunches and up to 75 cm above the crown of the sewer shall consist of the finest selected materials placed carefully in 15 cm layers and flooded and consolidated. After this has been laid, the trench and the other excavation shall be filled carefully in 150 mm layers with materials taken from the excavation, each layer being watered for proper consolidation unless the Authority Engineer shall otherwise direct.

5.22 Contractor to Restore Settlements and Damages

The Contractor shall, at his own costs and charges, make good promptly during the whole period of the works are in hand, any settlement that may occur in the surfaces of roads, berms, footpaths, gardens, open spaces, etc. whether public or private, caused by his trenches or his other excavations and he shall be liable for any accidents caused thereby. He shall also, at his own expense and charges, repair and make good any damage done to buildings and other property. If in the opinion of the Authority Engineer, the Contractor fails to make good or pay or satisfy the expenses of making good such works / property, the Authority Engineer shall be at liberty to get the work done by other means and the expenses thereof shall be paid by the Contractor or deducted from any money that may be or become due to him or recovered from him in any other manner according to the conditions of the contract.

5.23 Disposal of Surplus Soil

The Contractor shall at his own costs and charges, provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled, the surplus soil shall be immediately removed, the surface properly restored, and roadways and sides left clear.

5.24 Timbering of Sewer & Trenches

The Contractor shall at all times support efficiently and effectively the sides of the sewer trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy strata and below the surface of the subsoil water level, without any extra cost.

All timbering, sheeting and piling with their walling's and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place. The Contractor shall be held responsible and

accountable for the sufficiency of all timbering, bracing, sheeting and piling used for, all damage to persons and property resulting from the improper quality, strength, placing, maintaining or removing of the same.

5.25 Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from accident to any of such buildings.

5.26 Removal of Water from sewer

The Contractor shall at all times, during the progress of work, keep the trenches and excavations free from water which shall be disposed in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any roads or streets, nor cause any interference with the use of the same by the public.

5.27 Excess Excavation

If any excavation is carried out at any point or points to a greater width than the specified cross section of the sewer with its envelope, the same shall be filled with concrete by the Contractor at his own expenses and charge to the requirements of the Authority Engineer.

5.28 Width of Trenches

Unless specified otherwise by the Authority Engineer, the width at bottom of trenches for pipes of different diameters laid at different depths shall be as given below: -

- a) For all diameters, up to an average depth of 120 cm, width of trench in cm = diameter of pipe + 30 cm.
- b) For all diameters or depths above 120 cm; width of trench in cm = diameter of pipe + 40 cm; and
- c) Notwithstanding (a) and (b), the total width of trench at the top should not be less than 75 cm for depths exceeding 90 cm.

5.29 UPVC pipes for underground water supply piping

5.29.1 Specifications

All water supply pipes shall be uPVC pipes as per ASTM D-1785 AND as per the ASTM D 2467 for fittings. (80 sch). They shall be cylindrical, straight and to standard dimensions.

5.29.2 Laying

The pipes shall be laid on a bed of 15 cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate of 40 mm nominal size) mix or as specified,

If the bottom of the trench is rock or very hard ground that cannot be easily excavated to a smooth surface, the pipes shall be laid on concrete cradles to ensure even bearing.

The pipes shall be surrounded with either a) pea gravel till 15 cm above the crown of the pipe or b) 15cm thick cement concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate of 40 mm nominal size) mix all around, as specified.

5.29.3 Jointing

uPVC pipes shall be jointed with solvent cement compound as per manufacturers recommendations, connection with gunmetal ball valve and uPVC piping with the supporting connectors to be considered as per the requirement.

The joint is composed of specially shaped spigot and socket ends on concrete pipes. A rubber ring shall be placed on the spigot which shall be forced into the socket of the pipe previously laid. This compresses the rubber rings as it rolls into the annular space formed between the two surfaces of spigot and the socket, stiff mixture of cement mortar 1:2 (1 cement: 2 fine sand) shall then be filled into the remaining annular space and rammed with a caulking tool. After day's work any extraneous materials shall be removed from the inside of the of the pipe and newly made joint shall be cured.

5.30 Testing of pipes

The Authority's Engineer shall have the right to conduct any test to ascertain the quality of the pipes supplied by the contractor. The contractor should make all necessary arrangements for testing the pipes. All the charges and expenses towards the testing shall be borne by the contractor.

If on examination of any sample from any portion of the supply, the material is found to be substandard and not fully in accordance with the relevant specification, the entire consignment shall be rejected. In case of doubt whether the materials conform to the specification or not, the decision of the Authority's Engineer shall be final.

5.31 Valve

5.31.1 General

Each valve body shall be marked with cast or stamped lettering giving the following information's:

- a) The manufacturer's name or trademark
- b) The size of the valve
- c) The guaranteed working pressure

Isolating valves on the water supply lines shall be full bore ball valve type for pipe diameters up to 50 mm. For 65 mm dia and 80 mm dia., these shall be gate valve type and diameters above 80 mm, these shall be sluice valve type.

5.31.2 Float Valve

Float valves 50 mm and smaller shall be of brass, gun metal or other equally suitable corrosion resistant alloy in accordance with IS:1703-1977 or approved equal. The float valves shall have copper or plastic floats suitably reinforced to hold the threaded insert. The float valves fixed to the system shall be secured with backnuts.

5.31.3 Full Way Ball Valve

The valves shall be of full-bore type and of quality approved by the Authority. The body and ball shall be of copper alloy and stem seat shall be of teflon.

5.31.4 Non-Return Valves

Non-return valves are to be **IS:778-1984** manufactured from gun-metal or dezincification resistant brass.

5.31.5 Pressure Reducing Valve

The valve shall be suitable for water application and shall conform to relevant BIS standard. The valve should be installed in a vertical portion on horizontal line. In all cases, a stop valve should be installed in an easily accessible position on the inlet side of the pressure reducing valve. A safety valve and a pressure gauge must always be installed on the reduced pressure or outlet side of the pressure reducing valve. To avoid any dirt from entering the valve, it is advisable to fit a strainer on the inlet or high-pressure line. The pressure reducing valve and accessories should conform to relevant BIS standard and of approved make.

5.31.6 Butterfly Valves

The valve shall of cast iron conforming to relevant IS:13095. The valve shall be of quality approved by the Authority/Authority Engineer.

5.32 Laying and jointing of pipes

5.32.1 General

The specification for laying and jointing shall generally conform with IS: 783 – 1985.

5.32.2 Earth work excavation

5.32.2.1 Trench excavation

The width and depth of excavation of trench shall be as per relevant BIS. Excavation shall include shoring, strutting, bailing and pumping water whenever necessary.

The contractor shall deposit the surplus earth if any from trench work at proper place as may be directed by the Authority's Engineer.

Wherever earthen road or gravel road is cut for the laying of pipes, the contractor shall restore the surface after the pipes and specials are laid and jointed with available materials to the satisfaction of the Authority's Engineer without extra cost either for cutting or relaying. The clause shall not apply to the cutting of concrete or macadam or brick surfacing or black top roads. The pipes shall be laid to correct levels and gradients, as may be directed by the Authority's Engineer, after fixing the sight rails as in Clause No. 106 of TNBP without extra cost.

If the floor of the trench is other than rock, hard clay or boulders, the floor shall be rounded to fit the curve of the pipe to form an even bedding for the pipe for a width equal to half the outer diameter of the pipe.

If the floor of the trench is in rock, hard or clay which will otherwise not provide uniform support for the pipe, the floor shall be excavated below the proposed bottom level of the pipe to a depth of 20cm and the trench shall be refilled with approved soil or river sand as may be directed by the Authority's Engineer and properly compacted to a level of 10cm above bottom of the pipe. If river sand is used for refilling, the sand shall be paid for separately.

5.32.2.2 Hard rock

Rock requiring blasting shall exclude all rock such as soft rock, disintegrated rock, small boulders, all of which can be removed either with pickaxe or crow bars and shall apply to rocks of different kinds when cannot be removed by any of these means. In case of difference of opinion, the Authority's Engineer's decision as to which rock shall be considered as –rock requiring blasting shall be final.

Refilling of the trench in reaches where the excavation is in rocky soil shall be with approved soil which is surplus from trench work operations elsewhere along the alignment or which shall be obtained from new borrow pits.

It is to be distinctly understood that if surplus soil from trench work elsewhere along the alignment is used, no extra payment shall be paid for conveyance of the soil to the refilling site; no payment will be made for any excess earth brought to site and it shall be disposed

of by the contractor at his own cost. Hard rock which is blasted and removed will be measured and paid for on stack measurements with a percentage deduction of 40% for voids. The stacking shall be as directed by the Authority's Engineer.

5.33 Pump sets and accessories

5.33.1 General

1. All the materials used shall conform to the relevant BIS and should be delivered at site of work. The contractor is responsible for safe custody of machinery and other equipment's under this contract till handing over to the Authority.
2. The rates should include all the minor items of civil works, if any required for installation complete
3. All necessary civil works for creation of all equipment's and accessories offered by the contractor under this contract should be done by the contractor.
4. Test certificates for machinery and equipment's should produce along with supply
5. The contractor should enclose the performance curve duly indicating the duty point for the size of the impeller selected (family curve should not be furnished) the performance curve should furnish complete range of operation and the curve should be authenticated by the manufacturer or his authorized dealer. In the event of non-compliance, the offer shall be summarily rejected
6. The contractor shall make necessary arrangements to get supply of electricity from TNEB for operating the machinery and equipment's. Necessary vouchers in original for the payment made to the EB shall be produced to the Authority by the contractor which shall be reimbursed by the Authority.
7. Before supply of machinery, equipment's and other accessories prior approval of the Authority's Engineer should be obtained giving the name of makes and other details required.
8. Obtaining approval or electrical layout diagram for the installation of all the equipment's (transformers, generators, pump sets and other accessorize) and obtaining safety certificate on completion of work from Chief Electrical Inspector to Government of Tamil Nadu should be arranged and got approved by the contractor at his cost.

9. The contractor should get the layout approval in time before execution and for the size and capacity of the equipment's before the supply of the same. After execution of the Safety Certificate if any modification or alteration suggested by the Chief Electrical Inspector on the installation work done by the contractor should be carried out by the contractor at his cost.
10. The right of choosing the make among the makes offered by the contractor's rest with the Authority only.
11. The submersible pumps centrifugal pumps, turbine pumps submersible motors, motors for turbine and centrifugal pump set transformer, generators, Panel Boards to be supplied by the contractor will be inspected by the Inspecting Agency fixed by the Authority at the manufacturers premises and test certificate will be issued. The contractor should make necessary arrangements for the inspecting staff at his own cost for testing the above pump sets.

All tests necessary to ensure that the plant and machinery or equipment complies with the specification and guarantees shall be carried out at site and at the contractor 's cost and such test shall be carried out within one month of completion of erection. Should the result of these test not done within the margin specified, the tests shall if reported within one month from the date of plant is ready for retest and the contractor shall repay to the Authority's Engineer all reasonable expenses to which he may be put by such test.

12. If the complete plant or any portion thereof is found to be defective the Authority's Engineer shall give the contractor a notice in writing to verify such defects. If the contractor fails to rectify the defects within the specified period, the Authority's Engineer will rectify the defects at the contractor 's risk and cost.

5.33.2 Turbine pumps

The pump shall be of manufacturer latest standard design to give maximum efficiency when operated under the most exacting conditions at medium speed 1000/1500 RPM, conforming to IS 1710-1972 as amended up to date. The equipment shall conform to the following specifications:

i) Type of motors

The Motors (suitable for Turbine pump) shall be vertical hallow shaft AC squirrel cage induction motor with drip proof screen protected continuous rating suitable for operation

in the range of 360/440 volts 3 phase 50 cycles and the speed 1000/1500 rpm.

ii) Output of motors

The motor shall be capable of developing the mechanical output for the required conditions and shall have continuous normal rating to suit the maximum load when operated at the pump speed. The efficiency and power factor shall be to suit the wide range at load conditions and shall be designed and manufactured in accordance with relevant BIS.

iii) Bearings

The motors shall be provided with suitable bearings of ample size readily available from stocks in India. The bearings shall be accurately fitted and provided with moisture and dust proof bushes. The contractor shall state the name of the manufacturers and the bearing number.

iv) Overload

The motors shall be capable of withstanding the overload specified in the relevant condition of B.I.S.

v) Temperature rise

The temperature rise in windings shall not exceed over an ambient temperature after a full load continuous run of 12 hours. The temperature rise shall not reach a value where there is risk of injury to any insulated materials of adjacent part irrespective of that has been mentioned above.

vi) Earth terminals

Provision shall be made for suitable double earth copper connections on base plate or motor frame and the earth terminal shall be fixed with lugs suitable for the size of earth wire in accordance with the rules of the Indian Electricity Act.

The motor HP shall be such that it should safely take the load when the total head is reduced by the rise of water level in river during flood conditions in the river.

The HP of motor offered shall have a margin of 10% above the BHP absorbed by the pump set at duty point and also above the maximum HP absorbed by the pump offered.

vii) Starting

The motor shall give full load torque when taking 1 to 1.5 time of full load current.

5.33.3 Centrifugal pumps

The pumps shall be designed, manufactured, erected, tested and commissioned as per standards laid down by IS 1520-1980 and as amended from time to time. The standard accessories required for may be supplied along with irrespective of whether such items are specifically mentioned or not in the specification. The design should ensure the noise pollution level below the permissible limit. The rotating parts are to be statically and dynamically balanced. The name plate in stainless steel should indicate the Sl. No., discharge, head, speed specific gravity of water to be pumped pump input, motor rating, make etc.

The casing should be free from blow holes, cracks and other imperfections conforming to relevant standard. Bearing housing shall be of such design to exclude entry of water bearing may be of oil lubricated or grease lubricated type. The shaft design should ensure the deflection not exceeding 1 mm per meter length. The flexible tyre type rubber coupling is recommended for coupling pump and motor of horizontal mounting

i) Accessories

Each pump shall be provided with the following accessories.

- i) Lifting Hook
- ii) Priming funnel
- i) Approved type of lubrication system
- ii) Drip water pipes
- iii) Pressure gauge as specified
- iv) Compound gauge as specified

ii) Name plate

Each pump shall be provided with name plate bearing the following particulars clearly marked on it.

- Make
- Index No.
- Liters per minute
- Total Head in meters
- No. of stages
- Diameter of delivery branch Revolution per minute
- Diameter of suction branch

iii) Base plate

The base plate shall be of extended type for accommodating the pumps and the motors and it shall be rigid substantial casting with machined faces for the feet of the pumps and motor and it shall be faced on the underside.

iv) Coupling

The shaft coupling for connecting up the Impeller shaft with the motor shaft shall be of flexible type. It shall be made of cast iron turned over to obtain perfect balance bored to shaft size and securely keyed to the shaft.

v) Characteristics curves

Performance curves for the pump indicating the head in meter, efficiency, B.H.P. observed at pump set against the output in liters per minute shall be furnished.

vi) Type of motors

The Motors (suitable for centrifugal pump) shall be AC squirrel cage induction motor with drip proof screen protected continuous rating suitable for operation in the range of 360/440 volts 3 phase 50 cycles at the speed of 1500 RPM.

vii) Output of motors

The motor shall be capable of developing the mechanical output for the required conditions, shall have continuous normal rating to suit the maximum load when operated at the pump speed. The efficiency and power factor shall be to start the wide range of load conditions and shall be designed and manufactured in accordance with relevant BIS.

viii) Bearings

The motors shall be provided with ball end or rollers S.S. bearings of ample size readily available from stocks in India. The bearings shall be accurately fitted and provided with moisture and dust proof bushes. The contractor shall state the name of the manufacturers and the bearing number.

ix) Overload

The motors shall be capable of withstanding the overload specified in the relevant condition of I.S

x) Temperature rise

The temperature rise in the windings shall not exceed over an ambient temperature after a full load continuous run of 12 hours. The temperature rise shall not reach a value where

there is risk of injury to any insulated materials of adjacent part irrespective of that has been mentioned above.

xi) Earth terminals

Provision shall be made for suitable double earth copper connections on base plate of motor frame and the earth terminal shall be fixed with lugs suitable for the size of earth wire in accordance with the rules of the Indian Electricity Act

xii) Technical data

The Contractor shall complete as fully as possible the attached annexures which should be returned duly filled in signed.

The motor HP shall be such that it should safely take the load when the total head is reduced by the rise of water level in river during flood conditions in the river.

The HP of motor offered shall have a margin of 10% above the BHP absorbed by the pump set at duty point and also above the maximum HP absorbed by the pump offered.

xiii) Starting

The motor shall give full load torque when taking 1 to 1.5 time of full load current.

xiv) Capacitor

Capacitor shall be designed to conform to 0.95 lagging Power factor for motor. The control switches are to be provided. The test certificate from TESTING AGENCY has to be furnished. The motor shall have a name plate giving the following information:

- a) Induction motor (Squirrel cage)
- b) Name of manufacturer
- c) Manufacturers number and frame reference
- d) Type of enclosure
- e) B.H.P.
- f) Rated output in K.W.
- g) Rated Voltage and winding connections
- h) Number of phases
- i) Frequency in HZ
- j) Current approximate in amperes at rated output
- k) Speed in revolutions per minute at rated output.

5.33.4 Submersible pumps

The pump shall be of latest standard designed to give maximum efficiency when operated under most exacting condition at speed 1500/ 3000 rpm. The equipment shall confirm to the following specifications as per IS 8030 – 1996.

i) Pump bowl

The pump bowl shall be manufactured to offer resistance to corrosion. The bowls may be equipped with replaceable bearing.

The bowl assembly shall bear a name plate giving the following information.

- a. Name of the manufacturer or trademark
- b. Serial Number of the pump set
- c. Pump type
- d. Number of stages
- e. Total head
- f. Capacity
- g. Speed

ii) Impellers

The impellers shall be open or closed or semi closed type. They shall be turned and accurately finished and balanced on their own pump shaft for maximum lifting capacity without overloading the prime mover irrespective of water level fluctuations. The impeller may be of the enclosed or semi enclosed type and shall be properly balanced. Dynamic balancing is recommended. Enclosed impellers may be equipped with sealing rings on their hubs.

6. Technical specification for civil and finishing works

6.1 Excavation, filling and metaling

6.1.1 General

This item refers to the clearing of site for construction of start, setting out of works, profiles, etc., excavation and filling of all open foundations, wet or dry, for the column and wall footings, trenches, pavements, inspection pits and basements, plinths, areas for levelling, drainage lines, water supply lines etc.

6.1.2 Clearing the site and setting out of works

The site on which the structure is to be built, as shown on the plan and the area required for setting out and other operations, shall be cleared of all obstructions, loose stones, materials and rubbish of all kinds, stumps, brush wood, shrubs and other growth, roots being entirely grubbed up without extra cost. The materials obtained will be the property of the Authority and the materials pronounced useful by the Authority Engineer shall be conveyed and properly stacked as directed by the Authority Engineer. All holes or hallow, whether originally existing or produced by the removal of loose stones or brushwood, shall be carefully filled up with earth, well rammed and levelled off up to the level of already filled or existing ground as directed.

Trees on the site shall not be cut unless authorized by the Authority Engineer, shall not be damaged during construction. The above work of cleaning the site shall be reckoned to be included in the rate paid for various items and no extra shall be paid.

The contractor shall be responsible for the true and proper setting out of the works. He shall be responsible for proper maintenance of all reference pillars, bench marks, stakes and other evidences existing in the field required in connection with the setting out of works, at his own cost, till physical completion of all the items of the work or prior to that if agreed to by the Authority Engineer.

The lines and levels of all structures shall be carefully set out and frequently checked, care being taken to ensure that correct gradients and levels are obtained everywhere. No earthwork or structural works shall be commenced until the center line has been referenced.

All such benchmarks, reference pillars etc., established by the contractor shall be subject to check and approval of the Authority Engineer or his authorized representative at all times and the contractor shall ensure safeguarding all survey monuments, benchmarks, beacons etc. Any variations noticed in the work as a result of improper establishment or maintenance of these shall

be at the risk and expenses of the contractor.

6.1.3 Classification of soil for excavation purposes

All materials encountered in the excavation shall be classified as under:

- a) Soils shall include sand, gravel, clay, silt and other similar soft or loose materials and all materials of earthy or sandy nature, small size stone or gravel, soft and hard murrum, stiff clay etc., which can be ploughed or excavated by ordinary spade, pick, shovel etc., without restoring to barring, wedging and or blasting.
- b) Soft laterite shall include all rocks such as slate, shale, laterite, conglomerates, all decomposed and weathered rock, highly fissured rock, old masonry, concrete foundation and pavements, which can be removed by barring, wedges, etc., but not by ordinary spade, pick, shovel etc.
- c) Hard laterite rock shall include all rock occurring in masses and boulders larger than 0.3 cum in volume which in the opinion of the Authority Engineer can be best be removed by blasting but on account of restriction to blasting at this site will have to be removed by cold chisels or wedges, line drilling or jack hammer.

The decision of the Authority Engineer regarding the classification of soil and rock shall be final and binding.

6.1.4 Excavation

6.1.4.1 Excavation shall include careful removal of all materials or whatever nature and whether dry or wet, necessary for the construction of work, exactly in accordance with lines, levels, grades and curves shown on the plans or as directed by the Authority Engineer. It shall be taken to exact widths and levels of the lowest step of foundation/footing and the sides shall be left to plumb where the nature of the soil permits it. Any shoring, strutting and timbering or cutting of extra widths of trenches required for providing working space shall be done by the contractor, the same shall be deemed to have been included in the quoted rate. The contractor shall notify the Authority Engineer before starting excavation and take cross section levels (for purposes of measurements) jointly with the Authority Engineer before the ground is disturbed.

6.1.4.2 The bottom of the foundation shall be levelled both longitudinally and transversally or stepped as directed. Should any of the excavation be carried down to a level below the specified level, the contractor shall fill in such extra excavation at his own cost with M100 concrete, well rammed into position until it is brought up to the proper level, filling with

excavation material not being permitted for this purpose.

6.1.4.3 The corners of the excavated pits shall be made true and square and all loose debris shall be removed to the satisfaction of the Authority Engineer. Before any foundation concrete is placed, the Authority Engineer shall inspect the foundation trenches. If any loose patches or pockets come to light on inspection, these shall be dug out as directed and filled and rammed with M100 concrete. Just before laying the foundation concrete all bottom of trenches shall be lightly watered and thoroughly rammed.

6.1.4.4 The contractor shall provide suitable drainage arrangements, to prevent surface water from any source entering the foundation pits, at his own cost.

6.1.4.5 Any obstacle encountered during excavation shall be reported immediately to the Authority Engineer and shall be dealt with as instructed by him. Removal of buried piping or cables shall not be done without prior permission of the Authority Engineer and the contractor shall take all measures to protect such lines. Cost of such protective measures and deemed to be included in the rates for various items of excavation. No blasting shall be permitted for excavation of foundation even in rocky formation without the prior permission of the Authority Engineer.

6.1.4.6 The contractor shall not undertake any concreting in foundation until the excavation pits is approved by the Authority Engineer.

6.1.4.7 Excavation below ground water table

For all foundations below ground water table, excavation shall be done first just up to ground water level and further excavation to founding level shall be done just before concreting. As soon as founding strata is reached, lean concrete mud mat shall be placed and concreting of foundation shall be carried out with minimum loss of time. During entire operation, excavation shall be kept dry by dewatering. The contractor shall programme his work to ensure that the above procedure is strictly followed.

6.1.4.8 Backfilling near structures

Backfill shall not be dropped directly upon or against structure/facility where there is a danger of displacement damage* Trucks or heavy equipment for depositing compacting backfill shall not be used within 1.5 m building of walls, piers or other facilities which may damage by their, weights, or operation or method compaction. The method of depositing and compact backfill shall be approved by Authority Engineer.

6.1.4.9 Excavation in hard rock scope

This specification covers general requirements of excavation in all types of hard rock as classified in specification "Earth work in grading, Excavation, Backfilling".

Unless otherwise stated herein, IS Specification "IS-4081: Safety code for Blasting and related Drilling operations" shall be followed. After removal of overburden, if any, excavation shall be continued in rock to such widths, lengths, depths and profiles as are shown on the drawings or such other lines and grades as may be specified by Authority Engineer. As far as possible all blasting shall be completed prior to commencement of construction. At all stage of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible condition. The quantity and strength of explosive used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Authority Engineer, shall be taken during the blasting operations and care shall be taken so that no damage is caused to the adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, the contractor shall repair the same at his cost to the satisfaction of Authority Engineer. As excavation approaches its final lines and levels, the depth of holes and amount of explosives used shall be progressively and suitably reduced, in this section wherever blasting is referred it means only controlled blasting.

Specific of Authority Engineer will have to be taken by the contractor for blasting rock and he shall also obtain a valid Blasting License from the authorities concerned. If permission for blasting is refused by Authority Engineer, the rock shall be removed by wedging, barring, heating and quenching or other approved means. All loose or loosened rock in the sides shall be removed by barring, wedging etc. The unit rates for excavation in hard rock shall include the cost of all these operations.

The Contractor shall obtain necessary license for storage of explosives, fuses and detonators issued to him from authorized stores, from the authorities dealing with explosives. The fees, if any, required for obtaining such license shall be borne by contractor. The Contractor shall have to make necessary storage facilities for the explosives, etc., as per rules of local, State and Central Government authorities and statutory bodies/ regulations. Explosives shall be kept dry. and shall not be exposed to direct rays of Sun or to be stored in the vicinity of fire, stoves, steam pipes or heated metal etc. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the place of storage, A portable magazine of approved design should be provided by the Contractor at his cost. and the same shall be as far as possible away from the area to be blasted. Engineer's prior approval shall be taken for the location proposed for the portable magazine.

In no case shall blasting be allowed closer than 30 m to any structure or to locations where concrete has been placed. In the latter case, the concrete must be at least 7 days old.

For blasting operations, the following points shall be observed.

- a) The Contractor shall employ a competent and experienced supervisor' and' licensed blaster in-charge of each set of operation/ who shall be held personally responsible to ensure that all safety regulations are carried out.
- b) Before any blasting is carried out the Contractor shall intimate Authority Engineer and obtain his approval in writing in resorting to such operations. He shall intimate the hours of firing charges, the nature of explosives to be used and precautions taken for ensuring safety.
- c) Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m radius from the firing point, at least 15 minutes before firing time by sounding warning whistle. The area shall also be \given warning by sounding a distinguishing whistle.
- d) The Blasting of rock near any existing buildings, equipment or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by M.S. plates with adequate dead weight over them. Blasting shall be' done with small charges only and where directed by Authority Engineer, a trench shall have to be cut by chiseling prior to the blasting operation separating the area under blasting from the existing structures.
- e) The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.
- f) A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into the hole and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or dust or similar inert material.
- g) Contractor shall preferably detonate the explosives electrically.

- h) The explosive shall be exploded by means of primer which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.
- i) In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatin with detonator and fuse wire may be used. Under water or for excavation in rock with substantial accumulated seepage electric detonation shall be used.
- j) Holes for charging explosives shall be drilled with pneumatic drills. The drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.
- k) When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond and over break limit of 75mm shall be filled up as instructed by the Authority Engineer, with concrete of strength not less than M 10. The cost of filling such excess depth shall be borne by contractor and the excavation carried out beyond limit specified above will not be paid for stepping in rock excavation shall be done by hand trimming.
- l) Contractor shall be responsible for any accident to workmen, public or the Authority, property due to blasting operations. The Contractor shall also be responsible for strict observance of rules, laid by Inspector of Explosives, or any other Authority duly constituted under the State and / or Union Government.

6.1.4.10 Shoring

- a) Any shoring, strutting and timbering required for protecting the sides of excavation and for ensuring the safety of workmen and equipment, shall not be paid for separately. The contractor shall be responsible for the design of the shoring which shall however be strong enough to resist side thrust and prevent slips, slow and damage to adjacent works and property. It shall be removed as directed after all the items of work, which it is required are completed.
- b) Shoring shall include all labor, materials, erection of the poling boards, wales, ballies etc., keeping in position as required and dismantling and receiving the same after the work is over, as directed.

6.1.4.11 Dewatering

The rate quoted for excavation shall include bailing or pumping out all water which may accumulate in the excavation during the progress of the work either from seepage, rain or any other cause and diverting surface if any, by bund or other means. The bunds shall be removed after their purpose is served. Pumping out water from any foundation enclosure, basements or trenches shall be done generally in such a manner as to preclude the possibility of any damage to the foundation trenches, concrete or masonry or any adjacent structure. The excavation shall be kept free from water:

- a) During inspection and measurement,
- b) When placing of concrete or masonry is in progress and until they have come above the natural water level,
- c) Till the Authority Engineer considers that the concrete or mortar have set and hardened sufficiently and
- d) During back filling and consolidating

6.1.4.12 **Protection and safety**

Foundation pits and similar excavation, road blockades, obstruction etc. shall be adequately fenced and marked at night with red lights and a watchman keep in-charge to avoid accidents. Adequate protective measures shall be taken to see that the foundation excavation does not affect or damage adjoining structures. All required measures shall be taken by the contractor, at his own cost to ensure safety of the excavation, the people working in or near the excavation and people and property in the vicinity. He shall be entirely responsible for any injury to life and a damage to property caused by his negligence or accident due to his constructional operations.

6.1.4.13 **Stacking of excavated materials**

All materials excavated from the foundation, of whatever kind they may be, shall be placed at a distance of more than 1.5m from the edge of the foundation or as directed by the Authority Engineer. All excavated material will remain the property of the Authority. Rate for excavation shall include the cost of sorting out of useful materials and stacking them separately or transporting them as directed. Material suitable for filling or other use shall be stacked in convenient places. Materials not useful in any way shall be disposed-off. The Authority Engineer shall be the final authority as to what is useful material. The site shall be left clean of all debris at the completion of the work. Notwithstanding the above, it may be noted that in this particular work, as there is no space to stack the excavated earth at site, the contractor has to convey the earth excavated to a place selected by him and arrange to stack there temporarily. The useful earth (which would be decided by the Authority Engineer) shall be brought back for refilling and the balance if any shall be disposed of by the contractor. All the expenses incurred in the above operation of transportation of earth to and fro will be borne by the contractor and the rates built into the item No. (1) will be inclusive of all the above operations.

6.1.4.14 Back filling around foundations in trenches and plinth

- a) Back filling material shall be as approved by the Authority Engineer or as specified in drawing.
- b) Back filling for excavations in trenches around foundation and elsewhere shall consist of one of the following materials as the Authority Engineer may direct in each location.
 - Selected earth from excavated soil heap
 - Selected earth brought from borrow area
 - Sand filling
 - Lean concrete filling
- c) Filling shall be done after the concrete or masonry in the foundation has fully set and its curing completed. It shall be done in such a manner as not to cause undue thrust on any part of the structure.
- d) Back filling around completed foundations shall be done to the lines and levels shown on the drawings, including any trimming of the surfaces, as may be necessary. This will be done with selected and approved earth from excavation or otherwise with borrowed materials as directed by the Authority Engineer. Where sufficient suitable material is not available from the excavation, The Authority Engineer may direct to import suitable earth from different sources. The refilling shall be done in horizontal layers of thickness not exceeding 15cms from pocket with careful watering, ramming and rolling etc., to obtain necessary level of compaction.
- e) The contractor shall not fill in and around any work, until it has been approved by the Authority Engineer
- f) Back filling around liquid retaining structures and piping shall be done only after testing of structures against leakage is done and approval of Authority Engineer is taken

6.1.4.15 Metaling

- a) Graded coarse aggregate layer below floor, pavements and plinth protection
 - Graded coarse aggregate layer of thickness as shown on the drawing shall be provided after the structural foundations and plinth constructions have been built and the filling in the plinth has been watered and thoroughly consolidated. Excavation for cable ducts, pits, trenches and pockets other than those for structural foundations and plinth shall be made only after the graded coarse aggregate layer is laid and consolidated

- **Materials:** The aggregate to be of the quality as specified for concrete elsewhere. The sizes to be used are 50mm to 40mm, 40mm to 25mm and 25mm to 20mm.
- **Construction Procedure:** The bed on which the graded coarse aggregate layer is to be laid shall be cleared of all loose materials levelled, watered and compacted and got approved by the Authority Engineer before laying the aggregate layer.

b) The metal shall be mixed thoroughly in a proportion of 2 parts of 50mm metals, to 1 part each of 40mm and 25mm. The mixing shall be done before laying the same at site. It shall be laid in 2 layers of 10cm thickness and each layer shall be consolidated to a thickness of 7.5cm by an 8T to 10T capacity roller. At places which have no access for mechanical rollers, hand rollers after obtaining permission from Authority Engineer. While laying, rolling and consolidating, precautions shall be taken to ensure that no damage occurs to the masonry or any other portion of the structure. But special care shall be taken for compaction near masonry and concrete structures. Proper manual and vibratory tamping equipment shall be employed for satisfactory compaction in such area. Weak spots if any shall be rectified at contractors own cost. After the graded coarse aggregate has been thoroughly consolidated, murrum to completely fill the interstices shall be sprayed gradually over the surface and dry rolling shall be done with murrum for each layer. Finally, the surface shall be finished with a layer of murrum moistened and rolled over so as to provide an even surface. The maximum thickness of the finished murrum layer shall not exceed 12mm. The quoted rate shall include the cost of murrum layer also.

6.1.4.16 **Disposal of excavated earth**

Surplus earth and soil, which are rejected for back filling shall be removed from construction area to the area demarcated by the Authority Engineer. The materials shall be conveyed by suitable means including trucks, if necessary and disposed-off as directed by the Authority Engineer, loading and unloading incidental to this transportation shall be included in the quoted rate.

6.1.4.17 **Back filling**

Back filling shall be done by extracting suitable approved earth from excavated soil, carriage up to directed locations, placing, watering, compacting in layers, trimming and dressing, finished surface and disposal of surplus material. Back filling may also be done with other borrowed materials approved by Authority Engineer.

6.1.4.18 **Metaling**

Graded coarse aggregate layer shall include for consolidating the layers and surface finishing

with murrum layer not more than 12 mm thick and all other incidental work required to complete the item as per specifications.

6.1.4.19 Disposal

Quantity generated due to voids in back filled volume of earth shall be removed by the contractor. The Authority's Engineer may also direct the contractor to remove surplus earth, concrete debris or any other waste material from site to the areas of disposal

6.2 Concrete works

6.2.1 General scope

This specification covers the general requirements for concrete to be used on jobs using on-site production facilities including requirements in regard to the quality handling, storage of ingredients, proportioning, batching, mixing and testing of concrete and also requirements in regard to the quality, storage, bending and fixing of reinforcement. This also covers the transportation of concrete from the mixer to the place of final deposit and the placing, curing, protecting, repairing and finishing of concrete.

6.2.2 Relevant codes and specifications

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

6.2.2.1 IS code for materials

- a) IS: 269 – Specification for ordinary, rapid hardening and low heat and Portland cement.
- b) IS: 455 – Specification for Portland blast furnace slag cement.
- c) IS: 1489 – Specification for Portland pozzolana cement.
- d) IS: 4031 – Method of Physical tests for Portland cement.
- e) IS: 650 – Specification for standard sand for testing of cement.
- f) IS: 383 – Specification for coarse and fine aggregates from natural sources for concrete.
- g) IS: 516 – Method of test for strength of concrete.
- h) IS: 1199 – Method of sampling and analysis of concrete.
- i) IS: 432 – Specification for mild steel and medium (Part I & II) tensile steel bars and hard drawn steel wire for concrete reinforcement.
- j) IS: 1139 – Specification for hot rolled mild steel and medium tensile steel deformed bars for concrete reinforcement.
- k) IS: 1566 – Specification for plain hard drawn steel wire fabric for concrete reinforcement.
- l) IS: 1786 – Specification for high tensile steel bars for concrete reinforcement.

- m) IS: 2090 – Specification for high tensile steel bars used in pre-stressed concrete.
- n) IS: 4990 – Specification for plywood for concrete shuttering work.
- o) IS: 2645 – Specification for integral cement water proofing compound.
- p) IS: 6925 & IS: 903 – Specifications for admixtures.
- q) IS: 8112 – Specification for 43 grade cement.

6.2.2.2 IS code for equipment

- a) IS: 1791 – Specification for batch type concrete mixer.
- b) IS: 2438 – Specification for Roller Pan mixer.
- c) IS: 2505 – Specification for concrete vibrators immersion type.
- d) IS: 2506 – Specification for screed board concrete vibrator.
- e) IS: 2514 – Specification for concrete vibrating tables.
- f) IS: 3366 – Specification for pan vibrators.
- g) IS: 4656 – Specification for form vibrators for concrete.
- h) IS: 2722 – Specification for portable swing weigh batchers for concrete (single and double buckets types).
- i) IS: 2750 – Specification for steel scaffolding.

6.2.2.3 Code of practice for concreting works

- a) IS: 456 – Code of practice for plain and reinforced concrete.
- b) IS: 1343 – Code of practice for pre-stressed concrete.
- c) IS: 3370 – Code of practice for concrete structures (Parts I to IV) for storage of liquids.
- d) IS: 3935 – Code of practice for composite construction.
- e) IS: 3201 – Criteria for design and construction of precast concrete trusses.
- f) IS: 2204 – Code of practice for construction of reinforced concrete shell roof.
- g) IS: 2210 – Criteria for the design of RC shell structures and folded plates.
- h) IS: 2751 – Code of practice for welding of mild steel bars used for reinforced concrete construction.
- i) IS: 2502 – Code of practice for bending and fixing of bars for concrete reinforcement.
- j) IS: 3414 – Code of practice for design and installation of joints in buildings.
- k) IS: 3558 – Code of practice for use of immersion vibrators for consolidating concrete.
- l) IS: 4014 – Code of practice for steel tubular scaffolding (Part I & II)
- m) IS: 2571 – Code of practice for laying in-situ cement concrete flooring.
- n) IS: 10262 – Code of practice for mix design.
- o) SP: 23 – Handbook for concrete mix design.

6.2.2.4 Code of practice for measurement

- a) IS: 1200 – Method of measurement of building works.

b) IS: 3385 – Code of practice for measurement of civil engineering works.

6.2.2.5 Code of practice for construction safety

a) IS: 3696 – Safety code for scaffolding and ladders (Part I & II).

6.2.3 Materials

All materials shall be obtained from sources approved by the Authority. The agreed source or quality of any material shall not be changed during the course of the contract except with the approval of the Authority.

When requested by the Authority, the Contractor shall provide a certificate from the manufacturer, for each and every delivery of material, showing the source, quantity delivered and confirming that the material has been tested and conforms to the required Indian Standard.

6.2.3.1 Testing of concrete materials

Prior to the commencement of concrete work, the Contractor shall get all cement, aggregates and water tested in the laboratories approved by the Authority and shall keep approved samples in the site office for inspection of the Authority at any time of the concreting operation.

During construction also, the materials shall be sampled and tested as often as deemed necessary by the Authority. Samples shall be taken and tested in accordance with the latest revisions of relevant Indian Standard Specifications and the cost thereto shall be borne by the Contractor.

6.2.3.2 Cement

The cement used throughout the work shall be to the approval of the Authority. A certificate shall be obtained from the manufacturers and produced to the Authority for each delivery of cement and in case of Ordinary Portland Cement it shall comply with the requirements of IS: 269 and IS: 8112. The Contractor shall store the cement in sheds to be provided by him for this purpose at site. The Cement shall be delivered to the site in bags sealed with the manufacturer's seal and different types of cement shall be stored separately. The storage sheds with watertight walls and roof, shall be maintained in a perfectly dry and well-ventilated condition, 30 cm above ground level and the cement shall be stored as per instructions issued in the booklet of the Associated Cement Company. It shall be turned over from the bottom as and when required by the Architects. Any cement which has been deteriorated, caked or which has been damaged due to any reason whatsoever shall not be used. No cement shall be used for the works that has been stored at site for more than three months unless it is retested. Test samples of cement may be drawn from each consignment as delivered and tested by the Contractor. Should the result of such test show that any sample does not comply with the specified requirement, the whole

consignment from which the sample was taken, shall be rejected and forthwith removed entirely from the site and replaced with cement of satisfactory quality.

6.2.3.3 Sand

Sand to be used for concrete shall be well graded mixture from coarse to fine grains, comply with the requirements of IS: 383 and IS: 515. It shall be clean, hard and free from salt, earth, clay and other impurities. Fine sand of uniform size or silt shall not be used. It shall comply with sieve analysis in accordance with IS: 2386 (Part I and II). Unless initially clean, all sand shall be thoroughly and carefully cleaned by screening and washing in fresh and clean water. The screened and washed sand shall not contain more than 8% by volume of clay, dust and silt immediately after allowing it to settle for 3 hours in water.

FM of sand shall neither be less than 2.2 nor more than 3.2.

Field tests shall be carried out regularly to ensure the suitability of sand.

Sample loads shall be available at site for the inspection of the Authority and if approved by them all sand in the work shall be of similar quality.

In case of sand containing moisture the proportions of concrete materials shall be adjusted to give the correct mixture.

6.2.3.4 Coarse aggregate

The coarse aggregate for the reinforced concrete work shall consist of crushed gravel, black trap, granite or other stone to the approval of the Authority and shall be free from dust. If considered necessary by the Authority the aggregate shall be washed specially until an approved cleanliness is obtained. The use of laminated stone, flat or flaky material will not be permitted. The combined coarse aggregate shall in all respects be so graded as to allow 95% to 100% by weight to pass a 20mm IS sieve; 25% to 55% by weight to pass a 10mm IS sieve and 0% to 10% by weight to pass a 5mm IS sieve. The aggregates of different sizes shall be stored in separate stacks in clean state and free from all dirt.

The coarse aggregate where absorption of water after 24 hours immersion is more than 5% by weight shall not be used.

When required by the Authority tests indicated in IS: 383 shall be carried out by Contractor at his cost to show the acceptability of the materials. Strong piles of aggregate shall have good drainage, preclude inclusion of foreign matter and preserve the gradation.

6.2.3.5 Water

Water used for all purposes in this contract shall be free from oil, acid, vegetable matter, salts or dirt of any kind which will have adverse effect on cement or steel in the case of reinforced concrete. Whenever called for, the Contractor shall produce test results for water being used on work.

Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 90% of the average strength of three similar concrete cubes prepared with distilled water. Sea water shall not be used.

6.2.3.6 Admixtures

Plasticizers may be used in the concrete work to achieve better workability. Admixtures or cements containing additives (such as accelerators, retarders, water proofing agents etc.) shall not be used unless specified or otherwise directed or approved by the Authority.

6.2.3.7 Steel reinforcement

The following types of reinforcement shall be used.

- a) Mild steel round bars conforming to IS: 432 (Part-I)
- b) Hot-rolled deformed bars conforming to IS: 1139
- c) Cold-twisted bars conforming to IS: 1786

The contractor shall produce a test certificate of the manufacturer for each consignment.

Bars up to 25 mm diameter shall stand bending cold to an angle 180 Deg. round a diameter equal to that of the test piece without fracture of the outside skin of the bent portion. If independent tests are considered necessary, they shall be carried out to IS: 223. No bar shall be (+/-) 2.50% over or under the areas specified. Immediately before deposition of the concrete, reinforcement shall be well cleaned and made perfectly free from dirt, loose, rust, scales, paint, oil wash, grease or any other coatings which may destroy or reduce bond.

6.2.4 Fabrication and placement of reinforcement

All steel reinforcement shall be fabricated and fixed in accordance with IS: 2502. Bars shall be firmly bound together with annealed steel wire not thinner than 16 SWG at sufficient intersections to ensure that the network of rods will retain its original form and the mesh will be so temporarily supported as to retain its correct position in the formwork during the process of depositing the concrete. An adequate number of MS chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. All splices and lengths of overlaps in reinforcement shall be strictly in accordance with the drawings. The overlaps shall be staggered,

and their positions shall be approved by the Authority. No welding of reinforcement is permitted unless approved by the Authority in writing. The ends of wire ties must not project towards the face of the concrete, and all ends shall be cut off or bent inwards so that there is no risk of rust staining the surface of concrete. Off cuts of binding wire must be removed from the inside of forms after the steel fixing operations are over.

Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original positions, care shall be taken to ensure that at no time is the radius of the bend less than 4 bar diameters for deformed bars. Care shall also be taken when bending back bars, to ensure that the concrete around the bar is not damaged.

Where reinforcing bars are lapped with dowels provided in concrete work:

If the lap length to provide in concrete work is less than the minimum lap length specified on the drawings for development of full strength of the connection, bars shall be spliced by welding. Such welding shall conform in all respects to the provisions given in Appendix 'A' of SP: 34 (S&T)-1987, Handbook on concrete reinforcement and detailing, Bureau of Indian Standards. If the contractor has failed to provide sufficient lap length as shown on the drawings through his own fault, the bars shall be spliced by welding and such welded splice shall not be payable.

6.2.5 Spacer blocks

To maintain the specified amount of concrete cover to the reinforcement, small precast concrete blocks of grade similar to that of concrete to be placed shall be used.

- a) At each end of reinforcing bar, not less than 25mm, nor less than twice the diameter of bar.
- b) For a longitudinal reinforcing bar in a beam, not less than 25mm, nor less than the diameter of the bar.
- c) For a longitudinal reinforcing bar in a column, not less than 40mm nor less than the diameter of the bar.
- d) For tensile, compressive, shear or other reinforcement in a slab, not less than 15mm, nor less than the diameter of the bar.
- e) For vertical or horizontal reinforcement in concrete walls not less than 15mm nor less than the diameter of the bar.
- f) For reinforcement in footings, pile caps and raft foundations not less than 50mm.

6.2.6 Prevention of rust staining

Reinforcement left projecting above a concrete surface shall be cement washed if exposed in such a way that rust staining of concrete surfaces is likely. Any rust staining of exposed surfaces shall be cleaned immediately.

6.2.7 Storage and handling of reinforcement

Reinforcement shall be stacked off the ground in clean conditions and protected from contamination and excessive rusting. The reinforcement shall be clean and free from oil, grease, loose rust, loose mill scale, salt and chemical contaminants at the time of fixing in position and concreting.

6.2.8 Proportion for concrete

The Contractor shall design concrete mixes to produce concrete of the required strengths. The contractor must submit full designs of the mixes for approval of the Authority and trial mixes will be prepared by the contractor in the presence of the Authority, having workability, strength, minimum cement content and finish as criteria.

Concrete surfaces, which are to be finished with cement rendering shall be thoroughly hacked with approved hand tools immediately after removal of formwork so as to bring about adequate bond between the concrete and cement rendering.

Notwithstanding the acceptance by the Authority of any mix design and series of trial mixes, variations may be made to the proportions when considered necessary by the Authority. Such variations may be made to nominal mixes if used, but variations of this nature will not be allowed to affect the unit price of concrete.

For both Nominal as well as Design Mix concrete, the quantity of cement shall be determined by weight. Where standard bags of cement are used, their weight shall be checked at frequent intervals and any loss in weight due to leakage etc. shall be made good.

In the case of Nominal Mix Concrete, aggregates shall be measured by volume, cement by weight and mixing water in graduated liter cans. In the case of controlled concrete all aggregates and cement shall be measured by weight in approved weigh batching equipment. Mixing water shall be measured in graduated liter cans.

While calculating the amount of mixing water, the moisture content of the aggregate shall be taken into account. The grades of concrete shall be in accordance with Table below. The cement content of the mixes specified shall not exceed the minimum content specified in para 2.20 by more than 5%.

Grade of Concrete	Minimum Compressive strength N/ mm ²		
	At 7 days	At 28 days	Remarks
M 15	10	15	--
M 20	13.5	20	--
M 25	17	25	--
M 30	20	30	--
M 40	28	40	--

The above specified compressive strengths shall be for the use of ordinary Portland cement in concrete. When rapid hardening Portland cement is used, the 28 days compressive strength requirements specified in Table shall be met at 7 days. Where other cements are used, the Authority shall specify the corresponding requirements preferably on the basis of preliminary tests.

In order to get a relatively quicker idea of the quality of concrete, compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests and it shall not be less than 67% of the 28 days Cube Strength. In all cases 28 days compressive strength shall alone be the criterion for acceptance or rejection of the concrete.

Design mix concrete is preferred to Nominal mix. If Design mix concrete cannot be used for any reason on the work for grades of M20 or lower, nominal mixes may be used with the permission of the Authority.

If Nominal mix concrete does not yield the specified strength, such concrete shall be classified as belonging to the appropriate lower grade. Nominal mix concrete proportion for a given grade shall not, nowhere, be placed in higher grade on the ground that the test strengths are higher than the minimum specified. As long as the quality of the materials does not change, a mix design earlier in use may be considered for later work.

The proportion of fine aggregate to coarse aggregate in Nominal mix is generally 1:2 but subject to an upper limit of 1:1-1/2 and lower limit 1:2-1/2 depending upon the nature of aggregates. The cement content of the mix for any nominal mix shall be proportionately increased if the quantity of water in a mix has to be increased to overcome the difficulties of placement and compaction so that water cement ratio is not exceeded.

To improve workability of concrete and cement, grout admixtures conforming to IS: 6925 and IS: 9103 could be permitted subject to the approval of the Authority. Admixtures generating hydrogen, nitrogen etc. should not be used. Nothing extra will however be paid for the same.

6.2.9 Mixing of concrete and placing by pumping / pneumatic placers

Mixing of concrete shall continue until there is a uniform distribution of material and the concrete is uniform in color and consistency and shall be for at least two minutes.

Mixers and weigh batches shall be maintained in first class condition throughout the contract and any mixer or plant which is faulty shall not be used. The drums on all mixers shall revolve at the speed recommended by the manufacturer. A mixer of any type which has been out of use for more than 20 minutes shall be thoroughly cleaned out before any fresh concrete is mixed. The subsequent 1st batch shall have additional cement to allow for sticking in the drum. All equipment's shall be maintained in a clean, serviceable condition and their accuracy periodically checked. All controlled mix of concrete shall be from RMC plants, which are duly approved.

Concrete may be conveyed and placed by mechanically operated equipment's like pumps or pneumatic placers only with the written permission of the Authority.

6.2.10 Compressive strength

The Contractor shall keep on site minimum six standard 15 cm test cube moulds and ancillary equipment for preparing test cubes. Before the Contractor commences any concrete construction, he shall make six cubes of mix concrete with the cement, sand, aggregate and water which he proposes using on the contract and shall have them tested at a Laboratory approved by the Authority. Three cubes shall be tested at 7 days and three cubes at 28 days after casting and curing but shall not be limited to six cubes, but additional cubes have to be cast as per IS: 456–2000, for 7 days strength and 28 days strength separately. In all cases the cubes shall give the minimum compressive strength for Preliminary Tests specified above. No concrete construction shall be commenced until Preliminary Tests on the six cubes referred above have been completed and result show the concrete to have the minimum compressive strength.

As construction proceeds samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested in accordance with IS: 516. Three test specimens shall be made for each sample for testing at 28 days. Additional cubes may be required for various purposes as to determine the strength of concrete at 7 days or at the time of striking formwork, or to determine the duration of curing, or to check the testing error. The test strength of the sample shall be the average of the strength of three specimens. The individual variation should not be more than (+/-) 15 percent of the average. If more the results of the sample are invalid, any part of the work from which the cubes fail to give the required minimum compressive strength shall be dealt with the Contractor as directed by the Authority and at the expenses of the Contractor.

6.2.11 Design mix concrete

All designs mix concrete shall be designed on the basis of preliminary tests. The contractor shall make trial mixes using samples of aggregates and cement, typical of those to be used in the works. If possible, the concreting plant and the methods of transporting and depositing the concrete to be employed in the work shall be used to working conditions with the trial mixes.

All these preliminary tests approvals etc. shall be got done well in advance by the contractor before any concreting is contemplated. Failure on the part of the contractor to do so and the consequent delay in the completion of the works will not entitle him for any compensation whatsoever, either financially or by way of extension of time.

Based upon the successful preliminary crushing and workability tests, the contractor shall submit mix design proposals to the Authority Engineer who will have the right to reject any trial mix not deemed satisfactory. The design mix shall be done for the ready-mix concrete of all the grades, as well as of the batching mixing separately through a certified agency. The Design is to be got approved by the Employer before execution.

It shall be the ultimate responsibility of the contractor for selection of the trial mix to the complete satisfaction of the Authority Engineer.

6.2.12 Cement content, water cement ratio and workability

From durability consideration, strict control on the cement content and water ratio and in the process of concrete making, laying, compaction and curing must be exercised, the aim being to achieve a dense and impermeable concrete.

The following limit in respect of cement content and water cement ratios shall be maintained:

Structural Member	Min. cement content in kg/ m ³ (for 20mm nominal size of aggregate)	Maximum water cement ratio
a) PCC members	(As per IS: 456)	0.45
b) RCC members		0.40
c) PSC members		0.40

The cement content shall be as low as possible but not less than the quantities as specified above.

The concrete is also liable to be rejected or repaired as per the instructions of the Authority, if it is porous or honeycombed, its placing has been interrupted without providing a construction joint

or the reinforcement has been disproportionately displaced.

The Contractor shall keep a daily record showing the date when each portion of concrete is poured in slab, beam, column etc., curing period, removal of formwork and test cube results at 7 days and 28 days period. They shall be sent immediately to the Authority.

6.2.13 Tests & standards of acceptance

6.2.13.1 Slump test

The Contractor shall keep at the site of the works for the constant use of the Authority's representative, a standard slump test mould and shall provide facilities throughout the construction for tests to be made as and when the Authority may require. The slump cannot be definitely stated until tests have been made using the materials adopted for the work, but it is anticipated, that the slump of between 25mm to 50mm will be required.

The Contractor at his own expense shall establish a field laboratory to carry out all preliminary tests, work tests and also to work out grading and proportioning of aggregates in order to obtain and maintain uniform quality of work. A 150 mm cube testing machine shall be installed by the contractor at his own expense to ascertain the strength of concrete from time to time. The contractor shall supply all materials, labor and testing machines for preparing and testing sample as required by the Authority. The concrete shall also be got tested in an independent laboratory approved by the Authority Engineer at the discretion of the Authority Engineer or his authorized representative at no extra cost.

6.2.13.2 Defective concrete

Any concrete which gives results below the results specified in relevant paras or becomes severely damaged due to cracking or shows excessive honeycombing and exposure of reinforcement or exhibits any fault which in the opinion of the Authority Engineer, seriously impairs its function, may be declared defective concrete. Such concrete shall be cut out and removed from the site by contractor at his own expense to the satisfaction of the Authority Engineer. Alternatively, the contractor shall carry out at his own expense, whatever other remedy the Authority Engineer may reasonably require having regard to all the circumstances.

6.2.13.3 Tests

In case of doubt regarding grade of concrete used, either due to poor workmanship or bases on results of cube crushing strength, test of concrete on the basis of any or all of the following shall be carried out. The Authority Engineer shall be the final authority for interpreting the results of all these tests and the contractor shall carry out these tests at his own expenses without any

additional cost to the Employer.

a) Core test

The points from which cores are to be taken and the number and size of cores required shall be the discretion of the Authority Engineer. Core shall be prepared and tested as described in relevant code. Concrete in the member represented by a core test shall be considered acceptable if the average equivalent strength of 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75%.

In case the strength of individual core is found unsatisfactory and below the specified stipulation, approval is to be obtained from the Authority Engineer after submitting necessary proofs in writing on safety and stability of the structure. Decision on acceptance/rejection to this effect given by the Authority Engineer shall be final binding on the contractor.

b) Other non-destructive test e.g. rebound hammer test, ultrasonic test - as directed by the Authority Engineer.

6.2.14 Transporting placing and compaction of concrete

The concrete shall be transported maintaining required workability in a manner such as to avoid the segregation of the constituent materials, and loss of any of the ingredients. It shall be deposited as nearly as practicable in its final position to avoid re-handling. It shall be placed and compacted before setting commences and should not be subsequently disturbed. Methods of pouring should be such as to preclude segregation, and to avoid displacement of reinforcement and movement of formwork.

The concrete should be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into the corner of the formwork without formation of honey combing, pinholes or surface irregularities and any other defects whatsoever. The use of mechanical vibrators having capacity of producing vibrations at a rate not less than 5000 cycles per minute is recommended. Over vibration or vibration of very wet concrete is harmful and should be avoided; under vibration is also harmful. In addition to mechanical vibration, sufficient hand tools must be used to ensure full consolidation around reinforcement and at edges and corners.

The deposition of concrete shall be carried out as continuously as possible to reduce to a minimum joint between new concrete which has set. Where construction joints are necessary, they shall be formed at right angles to the axis of the member concerned by the insertion of rigid

stopping off form, against which concrete can be properly rammed. Concrete shall not be dropped from a height of more than 1.0 M. No unset concrete shall be brought into contact with unset concrete containing cement of different type. Special permission and instructions shall be obtained when concrete has to be deposited under water. Under water concreting shall be done with the help of tremi pipeline only. Concrete shall contain 10% more cement than that required for the specific mix placed in dry condition.

Accumulation of set concrete on the reinforcement shall be avoided. Before fresh concrete is deposited upon or against any concrete which has already hardened, the surface of hardened concrete shall be well roughened if necessary, by chipping and all laitance removed. The surface shall then be swept clean with wire brushes, thoroughly wetted and covered with a thin layer of cement mortar.

Care should be taken such that there are no cold joints while laying concrete.

Use of Vibrators:

Immersion vibrator shall be inserted vertically at points not more than 450mm apart and withdrawn when air bubble ceases to come to the surface. Immersion vibrator shall be withdrawn slowly.

The immersion vibrator shall penetrate the layer being placed and also penetrate the layer below while the under layer is still plastic to ensure good bond and homogeneity between the two layers and prevent the formation of cold joints.

The use of surface vibrators will not be permitted under normal conditions. However, for thin slabs, such as highways, runways and similar constructions, surface vibration by specially designed vibrators may be permitted upon approval of Authority Engineer.

6.2.15 Protection of concrete

Newly placed concrete shall be protected by approved means from rain, sun and drying winds. Concrete placed below the ground shall be protected from falling earth during and after placing. Approved means shall be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion, deleterious ground water, mixing with earth or other materials that may impair the strength and durability of concrete.

6.2.16 Working in extreme weather

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

be adequately protected as soon it is in position. No concreting shall be carried out during period of continuous heavy rain unless it is completely covered during mixing, transporting and placing. In extreme hot weather, concreting shall be restricted to mornings and evenings. Time between mixing and placing of concrete shall be kept to the minimum and formwork shall be cooled by sprinkling with water before it starts drying out.

6.2.17 Construction joints

The minimum number of joints should be used, and their constructions should be simple. They should be either horizontal or vertical because concreting sloping surfaces are usually unsatisfactory.

Where concrete is placed in vertical members e.g. walls columns and the like, the lifts of concrete shall finish or in sloping members at right angles to the axis of the members, the joint line matching the features of the finished work. Concreting shall be carried out continuously up to the construction joints.

Laitance, both on the horizontal and vertical surfaces of the concrete, should be removed before fresh concrete is adhesion and sand wet blasted. Various methods for removal can be used. But they should not dislodge the coarse aggregate particles. Concrete may be brushed with a stiff brush soon after casting while the concrete is still fresh, and while it has only slightly stiffened.

If the concrete has partially hardened, it may be treated by wire brushing or with a high-pressure water jet, followed by drying with an air jet, immediately before the new concrete is placed.

Fully hardened concrete should be treated with mechanical hand tools or grit blasting, taking care not to split or crack aggregate particles. The best time for treating the joints is a matter of judgement because it depends on the rate of setting and hardening (which is itself dependent on the temperature of the concrete) before further concrete is cast the surface should be thoroughly cleaned to remove debris and accumulated rubbish, one effective method being by air jet.

Where there is likely to be a delay before placing the next concrete lift protruding reinforcement should be protected before the next lift is placed, rust, loose mortar, or other contamination should be removed from the bars and where conditions are particularly aggressive and there has been a substantial delay between lifts, the concrete should be cut back to expose the bars for a length of about 50 mm to ensure that contaminated concrete is removed.

In all cases, when construction joints are made, it is essential to ensure that the joint surface is not contaminated with release agents, dust, or curing membrane and that the reinforcement is

fixed firmly in position at the correct cover.

Concrete in beams shall be placed throughout without a joint but if the provision of a joint is unavoidable the joint shall be vertical within the middle third of the span unless otherwise shown on drawings. Where a beam intersects a girder, the joints in the girder shall offset a distance equal to twice the width of the beam and additional reinforcement provided for shear the joints shall be vertical throughout the full thickness of the concrete member a joint in a slab shall be vertical and parallel to the principal reinforcement where it is unavoidable at the right angles to the principal reinforcement the joint shall be vertical at the middle third of the span.

6.2.18 Concreting at construction joints

When the form work is fixed for the concreting work, it should be inspected to ensure that no leakage is seen from the fresh concrete.

The practice of first placing a layer of mortar or grout when concreting joints is not recommended. The old surface should be soaked with water, without leaking puddles immediately before starting concreting then the wet concrete should be thoroughly compacted against it.

When fresh concrete is cast against existing mature concrete or masonry, the older surface should be thoroughly cleaned and soaked to prevent the absorption of water from the new concrete. Standing water should be removed shortly before the new concrete is placed and the new concrete should be thoroughly vibrated in the region of the joint. Chemical bonding agents shall be used with the approval of the Authority Engineer at no extra cost.

The use of epoxy for bonding fresh concrete used for repairs will be permitted upon written approval of Authority Engineer. Epoxies shall be applied in strict accordance with the instruction of the manufacturer.

6.2.19 Structural joints

Expansion joints or other permanent structural joints shall be provided in position and of the form described in the drawings or elsewhere.

In no case shall the reinforcement, corner protecting angles or other fixed metal items, embedded or bonded into concrete, run continuously through an expansion joint. The placing of concrete on either side of the expansion joint shall be done separately after an interval of at least seven days.

6.2.20 Cutting into concrete

No concrete shall be cut into, nor shall it be interfered with in any way, without the prior approval in writing of the Architect. Necessary holes shall be provided as required for plumbing work and for electrical pipes at the time of execution.

6.2.21 Curing of concrete

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least fourteen days from the date of placing of concrete.

Approved curing compounds may be used in lieu of moist curing with the permission of the Architect. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set and care shall be taken so as the compound shall not affect the concrete. The surface shall be cleaned by using wire brushes before plastering without additional cost.

6.2.22 Inserts

The contractor shall fix all necessary steel plates, pipe holes, pockets, dowels etc. in the shuttering of concrete work, to enable subsequent fixing of supports, brackets, ceilings, precast members etc., as indicated in the drawings or as required by the Authority Engineer of Work.

6.2.23 Finishing

Immediately on removal of forms, the RCC work shall be examined by the Authority Engineer before any defects are made good.

6.2.23.1 The work that has sagged or contains honeycombing to an extent detrimental to structural safety or architectural concept shall be rejected.

6.2.23.2 Surface defect of a minor nature be accepted to acceptance of such work by the Authority Engineer and the same shall be rectified in an approved manner.

- a) Surface defects which require repair when form is removed usually consist of bulges due to the movement of forms, ridges at form joints, honey combed areas, damage resulting from the stripping of forms and bolt hole. Bulges and ridges are to be removed by careful chipping or tooling and the surface is then rubbed with a grinding stone, honey combed and other defective areas must be chipped out, the edges being cut as straight as possible and perpendicularly to the surface or preferably slightly undercut to provide a key at the edge of the patch . bolt holes shall be closed by cement mortar to ensure through filling.

- b) Shallow patches are first treated with a coat of thin grout composed of one part of cement and one part of sand and then filled with mortar similar to that used in the concrete. The mortar is placed in layers is given a scratch finish to secure bond with the succeeding layer. The last layer is finished to match the surroundings concrete by floating, rubbing or tolling on formed surfaces by pressing the form material against the patch while the mortar is still plastic. Bonding compound shall be used without any extra cost.
- c) Large and deep patches require filling up with concrete held in place by forms. Such patches are to be reinforced and carefully dwelled to the hardened concrete.
- d) The same amount of care to cure the material in the patches should be taken as with the whole structure. Curing must be started as soon as possible, after the patch is finished to prevent early drying. Damp hessian may be used but, in some location, it may be difficult to hold it in place. A membrane curing in these cases will be most convenient.
- e) On receiving approval of the Authority Engineer the exposed concrete surfaces of substructure and superstructure above well cap shall be finished with two coats of cement-based paint of approved shade and quality.

6.2.24 Pre-cast concrete

All aforesaid specifications for concrete shall apply to precast concrete in addition to the following variations.

The concrete in one precast piece shall be placed in one operation. No piece shall be removed from the mould or erected until sufficiently matured to ensure that no damage shall be done to the piece.

All details of jointing, inserts, anchors and bearing widths shall be as shown on the drawings.

All precast concrete members shall be clearly marked to indicate the top of the member and its location.

Units shall be stored, transported and placed with due care so that they will not be overstressed or damaged.

Precast units shall be adequately braced and supported during erection to ensure proper alignment and safety, and such bracings and supports shall be maintained until there are adequate permanent connections.

6.2.25 Plum concrete course

The unevenness in the founding strata shall be levelled using plum concrete. The pockets in the founding strata shall be filled with plain cement concrete of lean mix. Plums above 160mm and up to any reasonable size shall be embedded in the plain cement concrete layer up to a maximum limit of 20 percent by volume of plain concrete when specifically permitted by the Authority Engineer. The plums shall be distributed evenly and shall be not closer than 150mm from the surface.

6.2.26 Levelling course

It shall be plain cement concrete of leaner mix which shall be proportional as stipulated and placed in position conforming to line and level shown on the drawing and compacted by approved means and cured.

6.2.27 Supervision

Constant and strict supervision at all items of the construction is necessary during the progress of the work, including the proportioning and mixing of the concrete. Supervision is also of extreme importance to check the reinforcement and its placing before being covered. Before any important operations, such as concreting or striking off the formwork is started, notice shall be given to the Authority.

6.2.28 Formwork

The Form work shall be designed for rigidity and durability, strength, water tightness, easy removal, surface finish required for concrete in contract with shuttering and economy.

Material used in form work shall be 12mm thick film faced shuttering plywood, steel props, steel plates, or specially designed and manufactured moulds out of plastic or reinforced fiber glass or steel.

Use shall depend upon its location, type of finish specified subject to acceptability by Authority Engineer. Form work designed with proposed material in use should be able to retain its shape, lines and dimensions shown in the drawings. It should safely carry the full load of concrete self-weight, reinforcement weight together with any live and impact load likely to occur during concreting.

Material used shall conform to relevant IS codes. It is the contractor's responsibility to entirely achieve the standard expected to the satisfaction of the Authority Engineer.

6.2.28.1 Workmanship

Erection of form work may be from pre-moulded, prefabricated, pre-assembled plates or forms reasonable enough to transport and erect at site to correct line and level as set out at site. Supports shall be firm and maintained in position by nails, cross bracings, tie rods, locking bolts and nuts. It shall be rigid and stiff so as to retain its shape during and after concreting.

Joints shall be watertight, and no cement slurry shall be allowed to slip through.

Prefabricated or site fabricated forms shall be assembled, so as to de-shutter without any jerk to the green concrete. For this double wedge shall be used. Wedges shall be nailed, the heads reasonably left out, allowing easy removal while de-shuttering.

Prefabricated or site fabricated forms shall be of sufficient thickness and with the required supporting runners in either direction. Supporting runners shall be standardized in size for easy replacement and universal use at site.

Props shall be of steel only. Size and vertically shall be approved by the Authority Engineer. Its spacing shall be as per design. It shall be vertical and to plumb. Base shall be a proper steel plate or timber plank, for equal distribution of load. The concreting of the upper floor shall be done only after 14 days of concreting of lower floor.

Beams and slabs shall have camber of 4mm per meter or as directed by the Authority Engineer.

All angles and corners shall be sharp and well defined in places where concrete edges are permanently exposed and require no further treatment, they shall be chamfered in a triangle of 25 x 25mm. Props of steel or timber shall be provided with adequate horizontal and cross-bracing. Steel props shall use steel pipes and steel couplers. If use of timber is permitted, planks of 100 x 25 mm shall be used and shall be secured by nailing them to timber props. No other material shall be permitted.

At the design and erection stage, the following additional points shall be considered and incorporated into the shutters.

- a) Openings for cleaning prior to start of concreting.
- b) Pouring points shall avoid high drops and provide easy access to vibrator needles.

Surfaces shall be treated with mould releasing oil or emulsion as approved by the Authority Engineer prior to reinforcement laying.

The following points shall be observed very carefully:

- a) Joints of moulds shall be watertight. It is easy to check from the bottom and make sure that no light is visible.
- b) Props shall be on solid base, plumbed, in one straight line and braced horizontally and cross.
- c) Tie bars in beams, walls and columns shall be at the correct place and fully tight.
- d) Wedges shall be fully secured and nailed with heads left out for easy removal.
- e) All saw dust, dirt, shavings and any other unwanted materials shall be cleaned and hosed out.
- f) Provisions shall be made for watching form work while concreting and any other platform needed for movement of workers without any disturbance of reinforcement.

Form work shall be erected in accordance with:

- a) IS: 3696 - Safety code of scaffolds and ladders.
- b) IS: 4014 - Code of practice for steel tubular scaffolding I and II. Part - 2 safety regulation for scaffolding.
- c) IS: 8989 - Safety code for erection of concrete framed structures.

6.2.28.2 **Special fair faced finish**

Where special fair faced finish is specified, the contractor shall be responsible for producing a perfectly smooth surface to the concrete, free from projections or imperfections of any description. Arises must be clean, sharp and perfectly sound. The form work must be designed so that it can be erected and maintained perfectly plumb and all surfaces must be true planes free from winding or other deformities throughout. Tying wires through the concrete to hold the form work together will not be permitted and either exterior bracing or through bolts are to be employed. If the latter are used the bolts shall subsequently be removed and the holes plugged with cement mortar. The pattern of holes has to be to the approval of the Authority. No part of any metal tie or spacer remaining permanently embedded in the concrete shall be nearer than 50mm to the finished surface of the concrete. Concrete faces must be protected at all times during and after construction against accidental damage or disfiguration and the contractor will be responsible for taking all necessary measures to ensure that the work is perfectly sound and free from blemishes, stains, etc. when finally handed over.

6.2.28.3 **Removal of formwork**

Under normal circumstances and where Ordinary Portland Cement is used, forms shall be removed after expiry of the following periods. As per IS: 456-2000

- a) Walls, columns and vertical faces – 24 to 48 hours
- b) Slabs (props left under) – 7 days
- c) Beams soffits (props left under) – 7 days
- d) Removal of props under slabs

- Spanning up to 4.5 M – 7 days
 - Spanning over 4.5 M – 14 days
- e) Removal of props under beams and arches
- Spanning up to 6 M – 14 days
 - Spanning over 6 M – 21 days

For other cements, the stripping time shall be suitably modified in consultation with the Authority Engineer.

Where the shape of elements is such that the form work has re-entrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage or cracking that might occur due to the restraint imposed. For precast moulds, the stripping time shall be 24 hours. The mould may be lifted and stored in the yard within 24 hours to 48 hours as approved by the Authority Engineer.

6.2.28.4 Openings / inserts

All required openings and pockets shall be provided as detailed in the drawing. They may be enumerated or paid on area basis as detailed in the BOQ. The contractor shall provide for the required material, labor, for fixing and supporting during concreting, in his quoted price. It is imperative that all openings and pockets shall be de-shuttered with care and all corners of openings shall be preserved. All openings/pockets shall be in a correct line and level. After concreting, the openings shall be secured against any accident by proper covering and guard-rail and warning notice, if any.

The contractor shall clean and grout the pocket at a later date with a non-shrinking compound added to the grout mix or non-shrinking cement shall be used. It shall be well-cured and protected to correct line and level till handing over.

Inserts are material such as timber, steel, plastic, dowels, bolts, locks, brackets, pipes etc. left in concrete partly or fully embedded to receive connection with foreign member at a later date. These may be fabricated by the contractor or provided by the Authority as received from specialist, manufacturer, etc. These shall be protected from weathering and damage in course of the construction. The cleaning required after concreting and any treatment such as oiling, greasing or covering with paint etc., shall be carried out by the contractor at his cost.

It is very important that the providing and fixing as contemplated in the BOQ shall be carried out with the “utmost precision” and to the entire satisfaction of the Authority Engineer. Any deviation from that as shown in the drawings or instructions shall be rectified by the contractor

at his own cost and responsibility.

6.2.28.5 Preparation of formwork before concreting

a) Special provision

Wherever the concreting in narrow members is required to be carried out within shutters of considerable depth, temporary openings in the sides of the shutters shall, if so, directed by the Authority Engineer, be provided to facilitate the pouring and consolidation of the concrete. Small temporary openings shall be provided as necessary at the bottom of shutters of walls and deep beams to permit the expulsion of rubbish, etc.

b) Discoloration

Formation of blotches and stains due to detachment of form work panel from the concrete when adjacent portion to the same lift is still adhering, shall not be allowed to occur, and for this purpose, all shutters shall be struck off at the same time.

6.3 Brick work

6.3.1 Indian standard codes

The following Indian Standard codes apply to this section.

I.S. no.	Subject
IS:1077-1986	Specification for common burnt clay building Bricks.
IS:1905-1980	Code of practice for structural safety of building masonry wall (Second Revision)
IS:2116-1980	Specification of sand for masonry mortar (First Revision)
IS:5454-1978	Method of sampling of clay building Bricks (First Revision)
IS:2250	Code of practice for preparation and use of masonry cement.

6.3.2 Materials

6.3.2.1 Cement

Cement shall be of ordinary Portland cement, Portland blast furnace slag cement or pozzolana cement as specified.

6.3.2.2 Sand

Unless otherwise indicated sand for masonry mortar shall consists of natural sand, crushed stone sand or crushed gravel sand or the combination of any of these conforming to IS: 2160-1980 specification for sand for masonry mortar. Sand shall be hard, durable, clean and free from adherent coating and shall not contain clay and impurities such as iron, pyrites, salt, coal, mica,

shale or similar laminated or other materials.

The maximum quantity of clay, fine silt and fine dust in sand shall not be more than 5% by mass. Organic impurities shall be below that the obtained by comparison with a standard solution.

6.3.2.3 Common burnt clay building bricks

Common burnt clay building bricks (hereinafter termed as “Bricks”) shall conform to the requirement laid down in IS: 1077-1986, specification for common burnt clay building bricks. The class of Bricks, based on minimum compressive strength, 35, 50, 75, 100 or 125 and their sub class A or B shall be indicated. Sub class A bricks shall have smooth rectangle faces with sharp corners and shall be uniform in color.

a) Dimensions - Size of Standard Bricks shall be as under

Type of bricks	Nominal size	Actual size
Modular Bricks	20x10x10 cms	19 x 9 x 9 cms
Old size Bricks (FPS)	9x4.5x3 inches OR 23 x 11.3 x 7.5 cms	9x 4 ³ / ₈ x 2 ³ / ₄ inch

b) Tolerance:

The permissible to tolerance on the dimensions of the Bricks unless otherwise indicated, shall be + or – 3% for class A Bricks and + or – 8% sub class B Bricks.

c) General Quality:

Bricks may be hand or machine moulded and shall be made from suitable soils. They shall be free from cracks, flows and nodules of free line. Bricks of 7.5 cms, 10 cms thickness (height) shall be moulded with frog 1 to 2 cms deep on one of its flat surfaces.

d) Compressive Strength:

The compressive strength of individual bricks shall not fall below the minimum average compressive strength specified for class of bricks by more than twenty percent.

e) Water Absorption:

The average water absorption of Bricks, after immersion in cold water for 24 hours shall not be more than Twenty percent (for Bricks up to Class 125).

f) Efflorescence:

The rating of Efflorescence of the Bricks shall not be more than moderate (for Bricks Class 125).

g) Handling and Storage:

Bricks shall not be dumped at site; they shall be stacked in regular tiers on even ground as they are unloaded to minimize breakage and defacement of Bricks. Bricks stacked for facing and any particular purpose/ situation of use shall be stacked separately.

6.3.3 Masonry mortars

- a) Proportioning: Mortar should be of the mix as indicated; the mix specified by volume in proportion of cement to dry sand.
- b) Preparation of Cement Mortar – Mixing should be done preferably in mechanical mixer. If hand mixing, operation shall be carried on a clean watertight platform. Cement and sand shall be mixed dry in the required proportion to obtain a uniform color. The required quantity of water shall then be added, and the mortar hoed back and forth for 5 to 10 minutes with addition of water to a workable consistency. In the case of mechanical mixing the mortar shall be mixed for at least three minutes after addition of water. Cement mortar should be freshly mixed for immediate use. Any mortar which has commenced to set shall be discarded and removed from the site.

6.3.4 Setting out

All Brick work shall be set out and built to the respective dimensions, thickness and height as indicated.

6.3.5 Scaffolding

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on that. Scaffolding shall provide to allow easy approach to every part of work, overhead work shall not be allowed. For exposed brick facing double scaffolding having two sets of vertical supports shall be provided. For brick work, which is to be plastered over, single scaffolding may be provided. In single scaffolding one end of put logs shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put long shall be left out. Such hole shall not be allowed in the case of pillar or narrow masonry portions, between the openings, which are less than 1 M in width or are immediately under or near the structural member supported by the walls. The holes left shall be made good on removal of scaffolding to match with the face work/ surrounding area.

6.3.6 Soaking of bricks

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of bricks. Alternatively, bricks can be soaked in stacks by profusely spraying with clean water on regular intervals for a period not less than six hours.

6.3.7 Laying

All loose materials, dirt and set lumps of materials which may be laying over the surface on which brick work is to be freshly started shall be removed with wire brush and surface wetted slightly. Brick shall be laid on a fully bed of mortar. When laying, the Brick shall be properly bedded and slightly pressed with handle of trowel, so that the mortar can get into all pores of the brick surface to ensure proper adhesion. All the joints should be properly flushed and packed with mortar, so that no hollow space is left. Care shall be taken to see that the required quantity of water is added to the mortar at the mixing platform to obtain required consistency. Addition of water during laying of course shall not be permitted. In the case of walls two brick thick and over, the joints shall be grouted to every course in addition to bedding and flushing with mortar.

While using old size bricks, (FPS conventional bricks) top courses of plinth, parapet, steps and top of walls below roof slab or floor slab shall be laid on brick on edge, applicable in case of additional bricks unless directed otherwise. Care shall be taken that brick forming top courses and ends of wall are properly keyed into position.

Brick shall be laid frog up however, when the top course is exposed, brick shall be laid with frog down, care shall be taken to fill the frogs with before embedding the bricks in position.

All quoins shall accurately construct, and the height of course checked with storey rods as the work proceeds. Acute and abuts quoins shall be bonded. Where practicable, in the same way as square quoins, abuts quoins shall be formed with squint showing a three-quarter brick on one face and quarter brick on the other.

6.3.8 Bond

All brick work shall be built in English bond, unless otherwise indicated, half brick wall shall be built in stretcher bond. Header bond shall be used for walls curved on plan for better alignment. Header bond shall also be used in foundation footings; stretcher may be used when the thickness of wall renders uses of header impracticable. When the thickness of footings is uniform for the number of course, the top course of the footing shall be header. Half or cut bricks shall not be used except where necessary to complete the bond.

Overlap in stretcher bond is usually half brick and is obtained by commencing each alternate course with the half brick. The overlap of the header bond which is usually half the width of the brick is obtained by introducing three quarter brick, in each alternate course at quoins. In general, the cross joints in any course of brick work shall not be nearer than quarter of the brick length, from these in the course below or above it.

6.3.9 Uniformity

The Brick work shall be built, in uniform layers, corners and other advance work shall be raked back. No part of the wall during its construction shall rise more than one meter above the general construction level, to avoid unequal settlement. Part of wall left at different levels shall be properly raked back. Toothing may be done where future construction is contemplated but shall not be used alternative to raking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

6.3.10 Alignments and perpend

The wall shall be taken truly plumb or true to required batter, where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate course directly one over the other. (Quoins, jambs) and other angles shall be properly plumbed as the work proceeds. The maximum permissible tolerance in masonry shall be as under.

- a) Deviation from vertical within a storey per 3 M height - 6 mm
- b) Deviation from vertical in total height of building - 12.5 mm
- c) Deviation of bed joints from horizontal.
 - In any length up to 12 M – 6 mm
 - In any length over 12 M – 12.5 mm total

6.3.11 Thickness of joints

Thickness of joints be such that four courses and three joints shall be taken consecutively shall measure as follows unless and otherwise specified.

- a) Old size brick – equal to four lines the actual thickness plus 4 cms.
- b) Modular brick – equal to 39 cms

6.3.12 Striking joints

Where no pointing, plastering or other finish is indicated, the green mortar shall be neatly struck flush, where pointing, plastering or other finishes indicated, the joint shall be raked out to a depth of not less than 10 mm for plastering and 15 mm for pointing.

6.3.13 Protection against damage

Care shall be taken during the construction, the edges of jambs, sills, heads etc., are not damaged. In inclement weather, newly built work shall be covered with gunny bags or tarpaulins, so as to prevent the mortar from being washed away.

6.3.14 Curing

The Brick work shall be constantly kept wet for at least seven days.

6.3.15 Facing

In the case of walls of one brick thick and under at least one face shall be kept even and in proper plane, while the other face may be slightly rough. In the case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

6.3.16 Cleaning

Face of the brick work shall be cleaned on the same day it is laid and all mortar droppings removed.

6.3.17 Half brick masonry

Half brick masonry walls shall be provided with PCC 1:3:6, 75 mm thick band reinforced with 2 nos, 8 mm tor steel rods at every 5th course for the full length of wall.

6.4 Concrete block masonry works - solid/ hollow/ light weight concrete blocks**6.4.1 Indian standards**

The following Indian standards applied to solid block masonry:

IS No.	Subject
IS:2185 (Part II)-1983	Specification for concrete masonry units (Part II) hollow and solid light weight concrete blocks

6.4.2 Materials**6.4.2.1 Concrete block**

- a) Concrete block, hollow or solid shall be referred to by its nominal dimensions. The term “Nominal” means that the dimension includes the thickness of the mortar joint. Actual dimensions shall be 10 mm short of the nominal dimension.
- b) The nominal dimensions of the concrete block shall be as follows:
 - Length – 400, 500 or 600 mm
 - Height – 100 or 200 mm
 - Width – 75, 100, 150, 200, 250 or 300
- c) In addition, block shall be manufactured in half length of 200, 250 or 300 mm the correspond to the full lengths. The nominal dimensions of the units are so designed that taking account of thickness of mortar joints, they will produce wall lengths and heights which will conform to the principals of modular co-ordinations

- d) The maximum variations in the length of units shall not be more than + or – 5mm and maximum variation in height and width of unit, not more than + or - 3mm.
- e) The surface characteristics of the blocks intended to be plastered or rendered, shall be such as to provide satisfactory bond with the plaster.
- f) Faces of block shall be flat and rectangular, opposite faces shall be parallel and all arises shall be squared. The ends of block which forms the vertical joints may be plain but unless tongue and grooved or double ends are indicated
- g) The block shall be cured in an immersion tank or in the curing yard and shall be kept continuously moist for at least 21 days. When blocks are cured in immersion tank, the water in the tank shall be changed at least every four days
- h) Steam curing of blocks may be adopted provided the requirements of pressure or non-pressure steam curing is fulfilled. After curing the block shall be dried in shade before being on the work. They shall be stacked with voids horizontal (for hollow blocks) to facilitate through passing of air, the block shall be allowed to complete their initial shrinkage before they are laid in a wall.

6.4.3 Wetting of blocks

Blocks will be wetted before or during laying in the walls, in case the climatic condition so require the top and the sides of the blocks, may only be slightly moistened so as to prevent absorption of water from the mortar and ensure development of required bond with the mortar.

6.4.4 Laying

Blocks shall be laid in mortar, as indicated and thoroughly bedded in mortar spread over the entire top surface of the previous course of the blocks uniform layer of not less than 10mm in thickness and not more than 12mm.

All courses shall be laid truly horizontal and all vertical joints made truly vertical. Block shall break joints with those above and below or not less than quarter of their length. Precast half-length closers (and not cut from a full-size block) shall be used. Care shall be taken during construction to see the edges of the blocks are not damaged.

6.4.5 Intersecting walls

When two walls meet or intersect and a course are to be laid up at the same time, a true bond between at least 50% of the units at the intersection is necessary. When such intersecting walls laid up separately, pockets with 20mm maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built into these pockets

6.4.6 Finishes

Rendering shall not be applied to the walls when these are wet, joints for plastering are pointing

as specified shall be raked to a depth of 10mm. Joints on internal faces, unless otherwise indicated, shall be raked for plastering. If the internal faces of masonry are not to be plastered, the joints shall be finished flush as the work proceeds or pointed flush where indicated.

6.4.7 100mm block work

100 mm solid block wall will be provided with PCC 1:3:6, 75 mm thick band reinforced with two Nos. 8 mm dia. tor steel rods at every 5th course for the full length of wall.

6.5 Plastering

6.5.1 Indian standards

The following Indian standards apply to the section:

IS No.	Subject
IS:1542-1977	Specification for sand for plaster (First Revision)

6.5.2 Materials

6.5.2.1 Cement

Cement shall be ordinary port land cement or port land blast furnace cement or port land pozzolana cement as specified.

6.5.2.2 Sand

Sand for plastering shall conform to IS: 1542-1977 – Specification for sand for plaster. Sand shall consist of natural sand, except where crushed stone sand or crushed gravel sand or combination of any of these indicated. The sand shall be hard, durable, clean and free from adherent coating and organic matter and shall not contain appreciable amount of clay balls, sand shall be obtained from approved sources.

Sand shall not contain any harmful impurities, such as iron pyrites, alkalis, salts, coal, mica shale or similar laminated materials, soft fragments, sea shells and organic impurities in such quantities as to affect adversely the hardening, the strength and durability or the appearance of plaster or applied decoration or to cause corrosion of metal lathing, or other metal in contact with plaster. The maximum quantity of clay, fine silt, stone dust shall not be more than 5 percent by weight.

The particle size, grading of sand for plaster work shall be as under, unless otherwise specified to conform to the sample maintained by the Authority Engineer.

IS sieve designation	Percentage passing by weight
----------------------	------------------------------

10 mm	100
4.75 mm	95 – 100
2.36 mm	95 – 100
1.18 mm	90 – 100
600 Microns	80 – 100
300 Microns	20 – 65
150 Microns	0 – 5

6.5.2.3 Water

Water used for mixing and curing shall be clean, free from deleterious matter and also from unusual proportion of dissolved salts. Sea water or tidal astuary or brackish water shall not be used. Water fit for drinking is normally suitable.

6.5.3 Workmanship

6.5.3.1 Scaffolding

Where possible independent scaffolding shall be used to obviate the subsequent restoration of masonry in put log and other breaks in the work. Stage scaffolding shall be provided for ceiling plastering.

6.5.3.2 Cement mortar

Mortar should be of the mix as indicated, the mix specified by volume in proportion of dry cement and dry sand.

6.5.3.3 Preparation of cement mortar

Mixing should be done preferably mechanical mixer. If hand mixing operation shall be carried on a clean watertight platform. Cement and Sand shall be mixed dry in the required proportion to obtain uniform color. The required quantity of color shall then be added, and the mortar hoed back and forth five to ten minutes with addition of water to a workable consistency. In the case of mechanical mixing the mortar shall be mixed for at least three minutes after addition of water. The cement mortar freshly mixed for immediate use. Any mortar which has commence to set shall be discarded and removed from the site.

6.5.3.4 Preparation of background for application of mortar

All dirt, dust and other foreign matter all masonry and laitance on the concrete surface shall be removed by watering and brushing as required. If the background contains soluble salts, particularly sulphates, the application of plaster shall be done one after the efflorescence of the salts is complete and efflorescence is completely removed from the surface. Any trace of Algae or

Moss formation shall be removed. Joints in brick work shall be raked out to a depth not less than 10 mm as your proceeds, local projections in brick work beyond the general wall face shall be trimmed off where necessary.

6.5.3.5 ROUGHNESS

Smooth surface of in situ concrete walls and ceiling etc., shall be roughened by wire brushing, if it is not hard, and by hacking or bush hammering if it is hard, to provide for proper adhesion. Projecting burrs of mortar because of gaps at joints in shuttering shall be removed. Surface shall be kept clean with wire brushes, in addition concrete surface shall be pock marked with a pointed tool at facing of about 50 mm the pocks made to be not less than 3 mm deep.

6.5.3.6 Suction adjustments

Adequate drying intervals shall be allowed between the erection and plastering to bring the surface suitable for suction adjustment. High rate of suction makes the plaster, weak, pours and friable. The wall shall not be soaked but only damped evenly before applying the plaster. If the surface becomes dry in spots such areas shall be moistened again to restore uniform suction. Excessive water leads to failure of bond between the plaster and background.

6.5.3.7 Evenness

Any local unevenness must be levelled, and projections removed to avoid variance in thickness of plaster.

6.5.3.8 Immobility

Differential movements between the background and the plaster due to moisture change, temperature change, structural settlement, deflection etc., cause cracks. The major part of such movements shall be allowed to set in before the plaster is applied.

6.5.3.9 Precaution against discontinuity in background

All straight cut groove through the plaster at the junction of wall to ceiling may be provided where directed. Holes left in the wall after removing scaffolding, shall be filled up with respective masonry and the patch plaster up true and in conformity with rest of the wall so that no sign of patch work shows out.

6.5.3.10 Plastering

The type and mix of water for plastering, the number of coats to be applied, and surface finished of the plaster and the background to which the plaster is to be applied shall be as indicated.

The mortar for dubbing out and rendering coat shall be of the same type and mix. Dubbing out

may be executed as a separate coat or along with the rendering coat.

Plastering operation shall not be started until all necessary fixtures such as doors and window frames, mantle pieces or completed and all pipes and conduits to be embedded have been installed and surfaces to be plastered have been passed by Authority Engineer.

6.5.3.11 Protection

All existing work and fittings that are likely to be damaged in the application of plastering shall be protected. Care shall be taken to avoid, as far as possible, the splashing of mortar on to the finish surfaces such as joinery, paint work and glazing, all such splashes shall be cleaned off immediately.

Screeds 15x 15 cm. shall be laid vertically and horizontally not more than 2 M apart to serve as guides in bringing the work to an even surface.

Plastering shall be done from top to bottom and care shall be taken to avoid joints in continuous surface.

6.5.3.12 Maintenance of proper time intervals

To avoid breakdown of adhesion between successive course, drying shrinkage of first coat shall be allowed to be materially completed before a subsequent coat is applied.

All corners, arises angles, junctions shall be truly vertical or horizontal as the case may be and shall be carefully finished. Rounding or chamfering of corners, arises and junctions shall be carried out with proper templates to the required size. Plastering of cornices, decorate feature etc. shall normally be completed before the finishing coat is applied.

In suspending the work at the end of the day, the plaster shall be cut clean to the line both horizontally and vertically. When recommencing the plastering, the edge of the old work shall be scraped clean and wetted with cement slurry before plaster is applied to the adjacent area. Partially set and dried mortar shall be not be re-tampered for use.

6.5.3.13 Cleaning on completion

On completion of work affected by plastering shall be left clean, special care shall be taken while removing any set mortar from glass and joinery, etc., to avoid damaging their surface.

6.5.4 Trueness of plastering system

The finished plaster surface shall not show any deviation more than 4 mm when checked with

straight edge of 2 m length placed against the surface.

6.5.5 One coat plaster work

Mortar shall be firmly applied to masonry walls and well pressed into the joints and forcing into surface depression to obtain a permanent bond. The plaster shall be laid in a little more than the required thickness and levelled with wooden float. On concrete walls, rendering shall be dashed on to the roughened surface to ensure adequate bond. The dashing of rendering coat shall be done using a strong whipping motion at right angles to the face of walls. The surface shall be finished even and fair, unless indicated to be finished even and smooth. The surface of the dubbing out, if carried out separately, shall be left rough or scored to provide key for the plaster coat.

6.5.6 Two coat plaster work

6.5.6.1 First Coat: The first coat of specified thickness shall be applied in a manner similar to one coat plaster work. Before the first coat hardens, the surface of cement plaster shall be scored to provide key for second coat. The rendering coat shall be kept damp for at least two days. It shall then be allowed to become thoroughly dry.

6.5.6.2 Second Coat: Before starting to apply second coat, the surface of the rendering coat shall be damped evenly. The second coat shall be completed to the specified thickness in exactly the same manner as the one coat plaster work.

6.5.7 Water proofing plaster

Integral water proofing compound shall be mixed with cement in proportion indicated by weight. Care shall be taken to ensure water proofing material gets well and integrally mixed with cement.

6.5.8 Curing

Each coat shall be kept damp continuously for at least two days. Moistening shall commence as soon as the plaster has hardened sufficiently and is not susceptible to injury. The water shall be applied preferably by using a fine fog spray. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used. Excessive vaporization on the sunny or wind word side of buildings in hot dry weather shall prevented by hanging mattings or gunny bags on the outside of the plaster and keeping them wet.

6.5.9 NEERU finish

After applying and finishing the under coats i.e., (under coat + floating coat) as described, and

before they set, the finishing coat shall be applied to a thickness of not more than 1.5 mm with specially prepared lime putty i.e., Neeru to which about 5 percent cement has been added.

It shall then be well polished with trowel. While troweling is going on, soap stone powder contained in thin muslin bags shall be dusted over the surface and worked in.

When the surface of outer walls is to be treated with sunk or grooved line works like squares or rectangles, by drawing vertical and / or horizontal lines at intervals, such lines (which may be V-grooved or U-shaped) shall be marked on the floating coat when it is not yet set and neatly finished off in the finishing coat with a wood lath having an edge of requisite thickness and slope on one of its sides.

NOTE: In each case the finishing done shall be uniform all over the surface and to the entire satisfaction of the Authority Engineer. A sample of considerable area shall be first made in consultation with the Authority Engineer and shall be got approved before starting the work.

6.5.10 Curing

Moistening shall be commenced as soon as the plaster has hardened sufficiently and is not susceptible to injury. Soaking of wall shall be avoided and only as much water as can be readily absorbed shall be used.

All plaster work shall be kept damp continuously for a period of 14 days. To prevent excessive evaporation on the sunny or wind ward side of the buildings in hot, dry weather, matting or gunny bags may be hung over on the outside of the plaster in the beginning and kept moist. Should the mortar of the plaster perish through neglect of watering or for any other default and if the work is not done as specified above, the plaster shall be removed and redone at the contractor's expenses.

6.6 Floor finishes

6.6.1 Indian standards

The following Indian standards apply to the section:

Sl. No.	Subject
IS:777 – 1970	Specification for glazed earthenware tiles (First Revision with Amendment No. 1)
IS:1237 - 1980	Specification for cement concrete flooring tiles (First Revision)
IS:4557 - 1982	Specification for ceramic unglazed, vitreous acid resistant tiles (First Revision)

IS:8042 - 1978	Specification for white port land cement
IS:5491	Code of Practice for laying in-situ granolithic concrete floor topping.

6.6.2 Materials

6.6.2.1 Cement shall be ordinary port land cement conforming to IS:269–1976.

6.6.2.2 White cement shall conform to IS:8042–1978 specification for white port land cement.

6.6.2.3 Aggregates (Coarse and fine) and cement concrete and granolithic concrete shall conform to IS:383–1970.

Aggregate for granolithic concrete shall consist of crushed granite, basalt, trap quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of aggregate shall be as given below.

Table 1 - Grading of Aggregate

IS sieve Designation	Percentage by weight passing IS sieve		
	Coarse aggregate	Fine aggregate	
		Zone I	Zone II
12.5	90 to 100		
10	40 to 85	90 to 100	90 to 100
4.75	0 to 10	60 to 95	75 to 100
2.36		30 to 70	55 to 90
1.18		30 to 70	55 to 90
600		15 to 34	35 to 39
300		5 to 20	8 to 30
150		0 to 10	0 to 10

Sand for mortar for laying slabs/ tiles shall conform to IS:2116–1980.

6.6.3 Cement concrete flooring (cast in-situ) granolithic concrete floor

6.6.3.1 Proportion of granolithic concrete

The proportion of the granolithic concrete floor topping shall be 1:1:2 (cement, fine aggregate, Coarse aggregate) by volume mixing, laying, finishing and curing etc. shall be carried out as specified.

6.6.3.2 Size of panels:

The floor topping shall be divided into suitable panels. Size panel is governed by the thickness of floor finish, the type of construction, local condition of temperature, humidity and the season

in which flooring is laid. Generally, no dimension of panel shall exceed 4 M in case of floor topping laid monolithically with the base concrete, and 2 M in case of floor topping laid separately on a hardened base. In case of ground floor, topping panel may synchronize with that of the base concrete. Length of a panel shall not exceed one and half a time its breadth. The exact dimensions of the panels shall be as directed by the Authority Engineer.

6.6.3.3 Form work to sides of concrete flooring:

Form shall be provided as specified, where glass or aluminum dividing strips are provided form work may not be provided. The boarding/ battens shall be fixed in position with their top at proper level, giving slope where require. The flooring shall butt against the masonry of the wall. Before being laid in position, the form or screed strips shall preferably have coated with thick coat of lime wash.

6.6.3.4 Joints:

Construction joints between base of the floor finish need only be plain, untreated vertical butt joints and shall be placed over any joint in the base.

6.6.3.5 Laying the topping:

The surface of base concrete shall be thoroughly cleaned of all dirt, loose particles, caked mortar droppings and laitance, if any, by scrubbing with coir or steel wire brush. Where the concrete has hardened so much that roughening of surface by wire brush is not possible, the entire surface shall be roughened by chipping or hacking. Before laying the topping, the surface shall be soaked with water at least for twelve hours and surplus water shall be removed by mopping immediately before the topping is laid in position.

The form shall be fixed over the base concrete dividing it into suitable panels. Before placing the concrete mix for topping, neat cement slurry at the rate of 3 Kg/ Sqm. shall be thoroughly brushed into the prepared surface of the base concrete just ahead of the finish. The topping then shall be laid, thoroughly tamped or vibrated, the surface floated with wooden float to a fair and even surface. The surface shall be tested and finished and specified.

6.6.3.6 Finishing the surface fair smooth:

Where an even smooth surface is indicated, the surface, after being floated with a wooden or steel float, shall be finished with a steel trowel. Finishing operations shall start shortly after the compaction of concrete and shall be spread over the period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowel three times at intervals so as to produce a uniform, hard and close-knit surface. Immediately after laying, only just sufficient troweling shall be done to give a level surface. Excessive troweling in the earlier stages

shall be avoided as this tends to work a layer rich in cement to the surface. Sometimes after the first troweling and after duration depending upon the temperature and atmospheric conditions, the surface shall be retro welled to close in pores in the surface, and to bring to surface and scrap of any excess water in concrete laitance (it shall not be troweled back into the topping). The final troweling shall be done well before the concrete has become too hard but at such a time the considerable pressure to make any impression on the surface. Spreading and troweling of a rich mix of dry cement and fine aggregate on the surface shall not be permitted. Where the surface is to be finished with a steel trowel using extra cement, it shall be clearly indicated.

6.6.4 Cement concrete flooring tiles

6.6.4.1 Cement concrete flooring tiles shall be of heavy-duty floor tiles as per IS:1237-1980.

6.6.4.2 Materials

- a) **Cement** – Cement used in the manufacture of tiles shall be ordinary Portland cement conforming to IS:269-1976.
- b) **Aggregate** – Aggregates used in the backing layer of tiles shall conform to requirement of IS:383-1970. For the wearing layer unless otherwise specified aggregate shall consist of marble chips or any other natural stone chips of similar characteristics and hardness, marble powder or dolomite powder or mixture of the two.

6.6.4.3 Manufacture

Cement concrete flooring tiles shall be manufactured from a mixture of cement, natural aggregate and coloring material where required by pressure process. During manufacture, the tiles shall be subjected to a pressure of not less than 140 Kg per Sq.cm.

The proportion of cement to aggregate in the backing of the tiles shall not be leaner than 1:3 by mass. On removal of mold, the tiles should be kept in moist condition continuously for such a period that would ensure their conformity to the requirements of the IS standards. Tiles shall be stored under cover.

6.6.4.4 Dimensions

The size of cement concrete flooring shall be as follows;

Table 2 - Size of cement concrete flooring

Length (MM)	Breadth (MM)	Thickness (MM)
200	200	20
250	250	22
300	300	25

6.6.4.5 Tolerances

Tolerances for length or breadth of tiles shall be + or – 1 mm.

Tolerance on thickness shall be + 5 mm. In addition, the difference in thickness between the thickest and thinnest tile in the sample shall not exceed 3 mm. Thickness of wearing layer for heavy duty cement tile shall be 6 mm.

6.6.4.6 General quality

Unless otherwise specified the tiles shall be supplied with initial grinding and grouting of the wearing layer. The wearing layer of the tiles shall be free from projections, depressions, cracks, holes, cavities and other blemishes. The edge of the wearing layer may be rounded.

6.6.4.7 Finish

The color and texture of wearing layer shall be uniform throughout its thickness. No appreciable difference in appearance of the tiles, from the point of view of color aggregate, its type and its distribution on the surface of wearing layer shall be present.

6.6.4.8 Physical requirements

- a) Flatness of the tile surface - The tiles when tested, the amount of concavity and convexity shall not exceed 1 mm.
- b) Perpendicularity – When tested the longest gap between the arm of the ‘square’ and the edge of the tile shall not exceed 2 percent of the length of the edge.
- c) Straightness - When tested the gap between thread and plane of the tile shall not exceed 1 percent of the length of the edge.
- d) Water absorption – When tested, the average percentage of water absorption shall not exceed 10.
- e) Wet Transverse Strength – When tested the average wet transverse strength shall not be less than 30 Kg. Per Sq.cm.
- f) Resistance to Wear – When tested the wear shall not exceed the following value;
 - For general purpose tiles
 - Average wear – 3.5 mm
 - Wear on individual specimen – 4.0 mm
 - For heavy duty floor tiles
 - Average wear – 2.0 mm
 - Wear on individual specimen – 2.5 mm

6.6.4.9 Cement mortar screed

The screed bed for laying cement concrete tile shall be cement and sand mortar 1:6 in the case

of floor and cement and sand mortar 1:3 in the case of skirting and dado. The base shall be cleaned of all scum, laitance or plaster droppings or any other loose foreign matter. It shall be properly wetted without allowing any water pools on the surface. The mortar shall then be evenly spread over the base for two rows of tiles and about 3 to 5 meters in length. The top of mortar shall be kept rough, so that cement slurry can be absorbed. The thickness of the bedding shall be not less than 15 mm in any place.

6.6.4.10 **Laying of tiles**

Laying of tiles shall commence by the time the bedding becomes sufficiently hard to offer rigid cushion for the tiles. Neat cement slurry of honey like consistency shall be spread over the mortar bed, over such an area at a time as would accommodate about 20 tiles. The tiles shall be fixed in this grout one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joint shall not exceed 1.5 mm width.

After the tiles have been laid in a room or the days laying work is completed, the surplus cement slurry and the joints shall be cleaned and washed fairly deep with the help of broom stick. It shall be seen that the cement slurry is cleaned before it sets hard.

The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the color of the matrix of the tiles.

Tiles which are fixed in the floor adjoining the wall, shall go about 10 mm under the plaster, skirting or dado. For this purpose, the wall plaster may be left and finished by about 50 mm above the level of the proposed finished flooring, skirting or dado and the unfinished strip may be plastered later on after the tiles are fixed.

After fixing, the flooring shall be kept moist and allowed to mature undisturbed for seven days, so that the bedding and joints set properly. After this it may be used for light traffic. Heavy traffic shall not be allowed on the floor for at least fourteen days after fixing the tiles.

Wherever big area floors are to be laid, the level of the center portion of the floor shall be kept about 10 mm higher than the level marked at the wall.

6.6.4.11 **Grinding and polishing**

Grinding and polishing of the tiles shall be commenced only after the floor as well as the joints are properly set but in no case earlier than fourteen days of laying.

Grinding shall preferably be done using a machine except for skirting and dado, chequered or

grooved tiles shall be polished by hand.

For grinding tile flooring, the first grinding shall be with carborundum stone of 48 to 60 grit. When the floor is rubbed even, the chips show uniformity it shall be cleaned with water making bare pin holes. Grouting in the same shade is then briskly applied so that all pin holes are properly filled in. The grout shall be kept moist for a week for proper setting. Thereafter the second grinding operation with carborundum stone of 120 grit is commenced. The floor is grouted again to fill in fine pin holes. After curing for a week, the floor is left with this protective film till other works are completed. Final grinding is done with carborundum of 220 to 350 grit using plenty of water. When surface is rendered smooth it is washed with water. Afterwards oxalic acid powder is vigorously applied with machine fitted with Hessian bobs to bring out shine. Floor is then washed clean and dry linen applied to suck in moisture.

Where indicated, wax polish shall finally be applied mechanically with clezian Hessian bobs. Superfluous wax is mopped-up with saw dust to prevent slipperiness. Saw dust may be allowed to remain on the surface till occupation. This will protect the surface and help to increase luster. When saw dust is spread, water should not be spilled as this is likely to leave stain on the polished surface.

In the case of plain cement and colored cement tiles, the process of polishing shall be the same as described for terrazzo tiles except that initial grinding with carborundum stone to 48 to 60 grit is not necessary.

6.7 Joinery

6.7.1 Indian standards

The following IS standards applying to this section

Table 3 - IS standard for Joinery

IS No.	Subject
IS:2202 (Part I)-1983	Specification for wooden flush door shutters (solid core type) Part I - Plywood face panels (Fourth revision)
IS:287-1973	Recommendation for maximum permissible moisture content of timber used for different purpose (second revision with Amdt. 1)

6.7.2 Materials

- a) Timber for door frames (First class teak wood)

- b) Timber shall be of good quality, well-seasoned, fairly uniform in color and texture and free from blemishes, hollow pockets and loose knots. Non coniferous sawn timber (hard wood) shall be free from bow, any kind of decay, live insect attack, spiral or twisted grains, splits across the grains, spring, warp, cup shake.
- c) Timber shall be obtained either in cut sizes or as sleepers and cut to required size well in advance of commencement of fabrication and stacked at site of work in a suitable manner for seasoning.

6.7.3 Seasoning

Timber shall be seasoned, before being planned to the required sizes to a moisture not exceeding the specified maximum moisture content.

6.7.4 Moisture content

The maximum permissible moisture content of timber for different uses, whether kiln or air seasoned, shall not exceed the limits laid down in IS:287-1973. Recommendation for maximum permissible moisture content of timber used for different purpose.

6.7.5 Tolerances

Seasoned timber (whether air or kiln dried) shall be deemed to conform to the moisture content requirements if the average moisture content of all samples from a given lot is within + 3 percent and the moisture content of individual sample is within + 5 percent of the maximum permissible content for the particular end use and locality.

6.7.6 Workmanship

All members of the timber frames shall be straight without any warp or bow, and shall be exactly at right angles, which shall be checked from the inside surface of the respective members. Frame shall have smooth well-planned surfaces except the surface touching the wall, lintels, sills etc., which may be left clean sawn, unless it is required for straightening up or to obtain over all sizes. Rebates, rounding's and molding etc. shall be done before the members are jointed into frame.

Timber frames shall have dovetail joints. The jam post shall be through tenoned into the mortices of the transom to fill width and the thickness of tenoned shall not be less than 15 mm. The tenons shall be closely fitted into the mortices without any wedging or filling and shall be pinned with hard wood or bamboo dowels not less than 10 mm dia. The depth of the rebate in the frames for housing the shutter shall be 15 mm. The joints before putting together shall be glued with synthetic adhesive conforming to IS: 851-1978 or IS:4835-1979.

All door frames shall be clamped together so as to square and flat before being built in. Each

assembled door frame shall be fitted with temporary cross batten. The faces of frame abetting the wall, lintel, cill etc., shall be given two coats of hot tar before fixing, unless otherwise indicated.

6.7.7 Fixing of chowkates and frames

Timber frames of door shall be installed by “Built in method”. Unless indicated to be installed by prepared opening method. Precaution shall be taken to fix the door frames so as to take care of final floor level, and whether shutter opens inside or outside. Hold fast shall be tightly fixed to the frame by means of bolts or screws as indicated, the bolt hole in the frame being plugged suitably and flush neat unless otherwise indicated.

6.7.8 Built in Method

Masonry in the wall shall be built after installation of frames, so that the hold fast and pins, if any, at the bottom are well anchored to them. Suitable arrangements shall be made to hold the frame in rectangular shape and prevent warping and distortion of frames during construction. Usually one cross batten at the middle, one cross batten at the bottom and two cross battens diagonally will be necessary to hold the frame rectangular.

6.7.9 Pressed steel frames of doors

Steel frames for wooden shutter shall be pressed out of commercial mild steel sheets of 1.25 mm thickness and shall comply with the requirements of IS:4351-1976, specification for steel door frames. The size, type (profile) and dimensions of the frames as indicated. The tolerance over the profile size shall be + or – 2 mm. Steel frame shall be of approved make.

6.7.10 Flush door shutters

Flush door shutters shall be solid core type with block board coat, as indicated and shall conform to IS:2202 (Part I)-1983, specification for wooden flush door shutters (solid core type) Part-I plywood face panels. Except with regard to the sizes of shutter which shall be as indicated. Flush door shutter shall be non-decorative (commercial) type. Flush door shutters internally lipped, internal lipping may be provided separately or as one piece with the frame. The width of frame including lipping shall not be less 50 mm. Where separate lipping is specially desired, it shall be as indicated. Internal lipping shall have total depth of not less than 25 mm, joints shall not be permitted in lipping.

In the case of doubled leaved shutters, rebating shall be splayed or square as directed. Where separate lipping is indicated the depth of lipping at the meeting of stiles shall not be less than 35 mm.

Flush door shall be free from twist, or warp in plane and all the four edges of the door shutters shall be square. Both the faces of the door shutter shall be sanded to a smooth even texture.

Tolerance on nominal thickness shall be + or – 1.2 mm. Thickness of shutter shall be uniform through the variation not exceeding + or – 0.8 mm when measured at any two points.

6.7.11 Builders hardware

6.7.11.1 Aluminum butt hinges

Hinges shall be well made, shall be free from flaws and defects. All hinges shall be cut clean and square. The hole for the hinge pin shall be central and square to the knuckles/ boss. All sharp edges and corners shall be removed. The movements of hinges shall be free, easy and square and working shall not have any play or shake. The hinge pin shall fit inside the knuckles firmly notched and properly finished, so as to not to allow any play or shake. All screw holes shall be clean counter sunk, suitable for counter sunk head wood screws. Aluminum butt hinges shall comply with IS:205-1978, specification for nonferrous metal butt hinges, and shall be of extruded aluminum alloy. Aluminum hinges shall be anodized. The hinge pin shall be aluminum alloy, shall be hard, anodized and sealed with oil, wax or lanolin. Aluminum butt hinges shall be of the size indicated.

6.7.11.2 Mortice lock (vertical type)

These shall conform to IS:2209-1976, specification for mortice lock (vertical type). These shall be brass or aluminum or as indicated. Number of levers shall also be as indicated.

6.7.11.3 Handles

These shall conform to IS:208-1979, specification for door handles. Handles shall be of cast aluminum, aluminum alloy fabricated handles. Door handles shall be finished smooth, when the grip portion of the handle is jointed with the base piece by mechanical means, the arrangements shall be such that the assembled handle shall have adequate strength. Aluminum handles shall be anodized.

6.7.11.4 Aluminum tower bolt

These shall conform to IS:204 (Part-II)-1978, specification for tower bolts (Part-II) nonferrous metal. Aluminum tower bolts shall be of extruded section of aluminum alloy, shall be of barrel bolts shall have a knob integral with bolts and of robust construction. The type and size as indicated.

6.7.11.5 Aluminum alloy sliding door bolt (ALDROP)

These shall comply with I.S. 2681-1979 specification for nonferrous sliding door bolt for use with pad lock. Aluminum alloy sliding door bolts with hasp, staple and fixing clips of sheet, casting or extruded sections or casting of aluminum alloy.

The sliding door bolt shall have smooth sliding action. The hasp, when not cast integral with the bolt, shall be properly secured to the bolt. Sliding bolt shall be provided with fixing bolts. Aluminum bolts shall be anodized.

6.7.11.6 Workmanship

All builder's hardware shall be fixed to joinery in a secure and efficient manner. Special attention shall be given to the size and fixing of screws to ensure that the screws are driven (and not hammered) tight and heads of the screw do not protrude. All hinges shall be counter sunk into the edge of the timber joinery and frames to a depth equal to the thickness of the leaf of hinge.

6.8 Metal works - Anodized aluminum doors, windows and ventilators

6.8.1 Material

Aluminum sections incorporated in doors, windows, ventilators shall conform to designation 63400 given in IS:737-1986.

6.8.2 Workmanship

- a) Minimum average thickness of anodizing (coating of anodizing) on all aluminum section and fittings shall be 15 microns and shall conform to IS:1868-1983.
- b) Testing of anodizing coating shall be in accordance with IS:5523-1983.
- c) Fixing of frames, shutters shall be as per manufacturer's instructions.
- d) PVC protected sheeting shall be used while fixing the frame of doors/ windows and ventilators to avoid damages, scratches etc.

6.8.3 Glazing

6.8.3.1 Sheet glass for glazing shall conform to IS:2835-1977, specification for transparent sheet glass, and shall be of the quality.

- a) "A" Quality or selected quality (SQ) for selected glazing/ where indicated.
- b) "B" Quality, ordinary quality (OQ) for glazing purpose.

6.8.3.2 Sheet glass shall be flat, transparent and clear, as judged by the naked eye, it may however, possess a light tint when viewed edge wise. It shall be free from cracks and other defects.

6.8.3.3 Tolerance on the thickness of glass sheet shall be as under.

Table 4 - Tolerance on the thickness of glass sheet

Nominal thickness	Tolerance
2.0, 2.5, 3.0 & 4.0 mm	+ or – 0.2 mm
4.0, 5.5 & 6.3 mm	+ or – 0.3 mm

6.8.4 Cleaning of glazing

Glass shall be washed with warm water and soap or mild detergent followed by clean water rinse and dried with cloth or wash leather. Glass with broken or textured surface shall be cleaned with stiff plastic or bristle brush. For removing any obstinate dirt, glass shall be polished with whiting in water or spirit. Organic solvents may be used for special purpose such as petrol or benzene for removing tar, turpentine for paint that as not dried hard and paraffin for grease. The solvent shall be carefully cleaned off the glass afterwards. Plaster or mortar splashes on the glass shall be removed with thin razor blade.

6.8.5 Frosting or obscuring

The grinding of glass shall be done uniformly and evenly as to avoid any patchy work. The ground glass shall be thoroughly cleaned so that does not catch stains.

6.9 Painting works**6.9.1 Indian standards**

The following IS standards applying to this section

Table 5 – IS Standard for Painting works

IS No.	Subject
IS:5410-1969	Specification for cement paint, color as required.
IS:2932-1974	Enamel, synthetic, exterior, under coating and finishing (First Revision)

6.9.2 Cement paint

6.9.2.1 Cement paint shall comply with IS:5410-1969, Specification for cement paint, color as required. The material shall be in powder form, free from lumps that are not friable and when mixed with required volume of water shall be suitable for use on porous surface of masonry, concrete and rough plaster work.

6.9.2.2 Preparation of surface

- a) The surface shall be thoroughly cleaned of all dirt, mortar drops, efflorescence, chalking, grease and foreign matter.

- b) Before applying cement paint the surface shall be thoroughly wetted to control surface suction. The surface shall be moist but not dripping wet when paint is applied. Surfaces which readily absorb moisture, shall be wetted in one operation not more than one hour before painting. Surface which absorb moisture slowly shall be wetted in at least two operations not less than 30 minutes.

6.9.2.3 Preparation of cement paint

Cement paint shall be made by adding equal volume of paint powder to water and the mix stirred to obtain a thick paste, which shall then be diluted to a brushable consistency in the proportion recommended by manufacturer. The recommendation of manufacturer shall be invariably followed. The water mixed paint shall be kept well stirred during use and shall be applied within one hour of preparation. To prevent algae and moss growth and efflorescence, silicon base water repellent compound may be added to mixture at the rate as recommended by the manufacturer. The lids of cement paint drums shall be kept tightly closed and not in use as the cement paint rapidly become air set.

6.9.2.4 Application of paint

- a) To maintain uniform mixture and to prevent segregation, the paint shall be stirred frequently in the bucket.
- b) Unless otherwise indicated new surface shall be treated with a minimum of two coats of cement paint of the same color. Not less than 24 hours shall be allowed between two coats and the second, or subsequent coat shall not be started until the preceding coat has become sufficiently hard to resist marking by the brush being used. In hot dry weather the preceding coat slightly moisten before applying the subsequent coat. The paint shall be brushed in uniform thickness and free from excessive brush marks. The laps shall be well brushed out.
- c) The color shall be even shade over the whole surface. If it is patchy or otherwise badly applied the work shall redone by the contractor at his own cost.

6.9.2.5 Curing

Painted surface shall be sprinkled with water using a fog spray two or three times a day. Curing shall be done between coats and for at least two days following the final coat. The curing shall be started as soon as the paint has hardened so as not to damage of the spray, about twelve hours after the application.

6.9.3 Painting woodwork

6.9.3.1 Preparation of new surface

All woodwork shall be dried free from dust, dirt or any extraneous materials. Flat portion shall be smoothened with abrasive paper used across the grain prior to painting. All loose knots removed, and holes filled.

6.9.3.2 Priming coat

On clean prepared surface a priming coat of paint shall be applied by brushing. Unless otherwise directed, the priming coat shall be applied before the woodwork fixed in position.

6.9.3.3 Filler coat

Filler coat where indicated, shall be applied with a putty knife and subsequently rubbed down to a level surface, with the abrasive paper. The filler coat shall be of an optimum thickness and shall be allowed to fully harden and flatten before subsequent coat is applied. As many layers or filler is necessary shall be applied allowing each coat to harden and flatten before next coat is applied.

6.9.3.4 Under coat

Under coat shall be applied by brush after the surface has been primed, stopped, filled and rubbed down to a smooth surface. After drying, the under coat shall be carefully rubbed down and wiped clean before the finishing coat is applied.

6.9.3.5 Finishing coat

The finishing coat shall be applied by brush, the finished surface shall be free from hair or brush marks, streaks, clogging of paint, puddles in the corner etc.

6.9.4 Painting steel and iron work**6.9.4.1 Preparation of new surfaces**

The surface shall be thoroughly cleaned of dirt, fluxing material, other foreign material and scrapped thoroughly with hand scrapper followed by wire brushing first with course and then with fine wire brushed and finally sand papering the surface to remove all mill scale and dust. The surface shall then be wiped finally with mineral turpentine to remove oil and grease etc.

Temporary rust protective materials applied to steel sheets to protect during transport and storage shall be removed with suitable solvent as a preliminary to other preparatory treatment.

Surfaces already pre-treated or primed in a factory shall be carefully inspected and damage areas shall be thoroughly degreased and cleaned of all dust and touch up.

6.9.4.2 Primer coat

Immediately after the preparation of the surface priming coat shall be applied by brush, working in the paint into the fine dents and ensuring a continuous film without runs and holds.

6.9.4.3 Filler coat

After the primer coat is harden and dry, the surface shall be rough sanded without scratching or in any way damaging primer coat and surface cleaned free from dust. Deep dents and scratches, if any shall be filled with paste filler using a good putty knife pressing firmly into the dents applying in optimum layers. Each layer shall be allowed to dry hard and then cut down by wet rubbing to a smooth finish.

Where indicated, after the paste filler is hard dry, a coat of liquid filler shall be applied by brush to fill all fine dents allowed to hard dry and then wet rubbed to a smooth finish.

6.9.4.4 Under coat

Under coating shall be applied by brush. The film shall be allowed to hard dry, wet rubbed and cut down to a smooth finish ensuring that at no place under coat is completely removed.

6.9.4.5 Finishing coat

Finishing coat shall be applied by brush. Special care shall be taken while painting over bolts, nuts, rivets and overlaps etc.

6.9.4.6 Woodwork: doors, windows etc.

Table 6 - Coefficient for Woodwork: Doors, Windows Etc.

Sl. No.	Description	Co-efficient
01	Paneled or framed and braced	1.5 (for each side)
02	Ledged and battened or ledged battened	1.5 (for each side)
03	Flush	1.25 (for each side)
04	Part paneled, and part glazed or gauged.	1.0 (for each side)
05	Fully glazed or gauged	0.5 (for each side)
06	Fully venetianed or louvered	1.5 (for each side)
07	Trellis or Jafri work	2 (for painting all over)

6.9.4.7 Steel work: door, window etc.

Table 7 - Coefficient for Steel Work: Doors, Windows Etc.

Sl. No.	Description	Co-efficient
---------	-------------	--------------

01	Plain sheeted steel doors	1.5 (for each side)
02	Fully glazed or gauged	0.5 (for each side)
03	Part paneled, and part glazed or gauged.	1 (for each side)
04	Corrugated sheeted	1.5 (for each side)
05	Rolling shutters	1.5 (for each side)
06	Collapsible gates	1.5 (for painting all over)

6.9.4.8 General work

Table 8 - Coefficients for General work

Sl. No.	Description	Co-efficient
01	Expanded metal, grill work and gratings balustrade, railings	1 (for painting all over)
02	Fencings and gates including standards, braces rail, stays	1 (for painting all over)
03	Corrugated iron sheeting in roofs, side claddings etc.,	1.14 (for each side)
04	A.C. Corrugated sheeting.	1.20 (for each side)
05	A.C. Semi corrugated sheeting	1.10 (for each side)
06	Nainital pattern roofing with plain sheets.	1.10 (for each side)
07	Nainital pattern roofing with corrugated sheets	1.25 (for each side)
08	Wire gauge shutters including painting of wire gauge.	1 (for each side)

6.10 Anti-termite treatment

The buildings shall be adequately protected against attack by subterranean termites by suitable chemical treatment measures. The work shall be carried out by a specialist pest control agency approved by the Authority.

The work to be carried out by the specialist firm and shall carry a guarantee for the satisfactory performance of the treatment for a minimum period of 10 years.

The treatment shall be carried out generally in accordance with the stipulations laid down by IS:6313 (Part –II)-1971 (code of practice for anti-termite measures in buildings - Part II – pre-construction chemical treatment measures) subject to the minimum requirements given in these specifications.

6.10.1 Minimum specifications

The earth filling immediately under the stone soling (under floors) bottom and side fills of all foundations (excepting foundations) and soil along external perimeter of all buildings shall be chemically treated against termites. The chemicals to be used for the treatment shall be Choropyriphos 20% E.C. conforming to the requirement and concentration laid down in IS:6313 (Part-II)-1981.

The chemical solution shall be prepared by mixing the chemical with the appropriate quantity of water to obtain a chemical emulsion of the correct concentration as stipulated above. The prepared emulsion shall be applied as described below.

Column pits, wall trenches etc. – The bottom surface and sides of the excavations (up to a height of 30 cm from the bottom) made for column foundations, wall foundations etc. (excepting RCC foundations) shall be treated with the chemical emulsion at the rate of 5 liters per Sqm of surface area.

6.10.2 Treatment to back fill

After the column foundations, wall foundations etc. come up the back fill in immediate contact with the foundation structure shall be treated @ 15 liters per Sqm of the surface of the sub-structure for each side. If water is used for ramming, operation is completely by roding earth at 15cm. centers close to the wall face and spraying the chemical with the above doze. The earth is to be returned in layers and the treatment shall also be carried out in similar stages. The chemical emulsion shall be directed towards the masonry wall surfaces so that the earth in contact with these surfaces is well treated with the chemicals.

In the case of RCC walls and columns, the treatment shall start at the depth of 50cm below natural ground level. From this depth the back fill around the RCC columns, walls etc. shall be treated at the rate of 15 liters per Sqm of the surfaces.

6.10.3 Top surfaces of plinth filling

The top surface of the plinth fill (just below the stone soling) shall be treated with chemical emulsion at 5 Liters per Sqm. of the surface before the stone laid. If the filled earth has been well consolidated and does not permit the emulsion to seep through, holes up to 50 to 75mm deep at 150mm centers both ways may be made with crowbars to facilitate saturation of the soil with the chemical emulsion.

6.10.4 Junction of wall and floor

A channel of size 3 x3 cm shall be made at all the junctions of walls and columns with the floor

(before laying the soling) and rod holes made in the channel up to the ground level at 15 cm centers. The solution is poured into the channel @ 15 liters per Sqm of the vertical surface and allowed to soak through the holes fully so that the solid in contact with the chemical. The soil shall be tamped back into the channel and consolidation to original conditions.

6.10.5 External perimeter of building

After the building is complete, holes shall be made along the external perimeter of the building at intervals 15cm and depths of 30cms and the emulsion shall be allowed to soak through these holes fully at the rate of 5 liters per R.M. of the perimeter wall.

6.10.6 Soil surrounding pipes

Wherever may service pipes enter the soil inside the area of the foundation of any building, the soil surrounding the point of entry of each pipe at the foundation, floor etc., shall be fully soaked with the chemical solution for a distance of atleast one meter from the point of such entry.

6.10.7 Expansion joints

Soil beneath expansion joints at ground floor level shall be specially treated as directed. The joint itself shall also be treated as directed by the Architect.

6.10.8 Treatment under APRON

The soil below the concrete for stone aprons to be provided around the perimeter walls of all building shall also be treated with the chemical solution @ 5 liters per Sqm.

6.10.9 Treatment over DPC

Top of concrete damp proof course in external and internal walls shall be given a liberal coat of chemical solution when the concrete is still green.

6.10.10 Spraying equipment

To facilitate proper penetration of the chemical into the soil, a pressure pump of adequate capacity and sprayers shall be employed to apply the solution.

6.11 Miscellaneous items

6.11.1 Brush bond

Surface should be cleaned from oil, grease, wax, dirt and any other foreign material spelled and deeply disintegrated into concrete should be removed to sound concrete and repaired. This has 2 components, brush bond powder and NITO bond BB acrylic emulsion.

Then the NITO bond BB is poured into a plastic or metal drum to this an equal volume of clean water is added. Then mixing is started with a slow speed drill (350 to 450 RPM). The powder component is added gradually to the liquid avoiding lump formation and mixed for 2.3min, Mix and use, do not mix none material.

Then the material will be applied on the surface by mixing a short, stiff bristle brush, preferably 100 to 150mm wide. Apply with a paint in 2 coats.

7. List of Approved Makes

7.1 Water supply Pipeline

SL. No.	Item description	Make
01	uPVC PIPES – SCH -80	ASTRAL / ASHIRWAD/ SUPREME/PRINCE/
02	uPVC FITTINGS– SCH -80	ASTRAL / ASHIRWAD/ SUPREME/PRINCE/
03	BUTTERFLY VALVE (50mm to 100mm)	INTERVALVE / AUDCO / NORMAT
04	NON-RETURN VALVE	INTERVALVE / AUDCO
05	BALL VALVE (15mm to 40mm)	ASTRAL / ASHIRWAD/ SUPREME/PRINCE/
06	AIR RELEASE VALVE	RB / TBS / CIMBRIO
07	RCC HUME PIPES	Np3 or Local brand
08	STONE WARE PIPES	MYSORE STONE WARE / TSL
09	PVC PIPES (Agricultural series)	PRINCE / SUPEREME / FINOLEX
10	PVC FITTINGS (Fabricated)	CLARION / SRI VINAYAKA
11	PVC FITTINGS (Moulded)	PRINCE / SUPEREME / FINOLEX
12	MANHOLE COVER - Cast iron	BIC / NECO
13	MANHOLE COVER - (RCC Precast)	RAJVAIBHAV / SFRC
14	ENAMEL PAINT	ASIAN PAINTS / SHALIMAR
15	PRESSURE REDUCER VALVE	HAWK / TBS / CIMBRIO
16	Y' STAINER	RB / TBS / CIMBRIO
17	DWC PIPES & FITTINGS	ASTRAL / ASHIRWAD
18	HDPE PIPES – PE -80	MAKE: RISHI/ ASHIRWAD/ SUPREME OR EQUALENT

7.2 Civil and finishing works

SL. No.	Item description	Make
01	Cement (43/ 53 Grade)	ACC, Birla Super, Ultra-tech, Ramco, Bharti, Coromandel
02	Reinforcement Steel	TISCO, IISCO, SAIL, JSW
03	Structural Steel	TISCO, IISCO, SAIL, JSW
04	Ready Mix Concrete	ACC, Ultra-tech
05	Concrete Admixtures	FOSROC, Roff, Sika, Dr. Fixit

SL. No.	Item description	Make
06	Water proofing compounds	FOSROC, Roff, Sika, Dr. Fixit
07	Concrete Blocks	Approved Sample having minimum compressive strength 35 Kg. / Sqcm
08	Table Moulded Bricks	Approved Sample
09	Galvanized steel door frame	Size 125 x 60mm and Approved Sample
10	Flush Door Shutters	Both sides commercial ply veneered and 35mm thick and Approved Sample
11	UPVC Windows/ Ventilators	Powder Coated finish and Approved Sample
12	Hardware fixtures for Doors (Administrative Building)	Stainless Steel finish and Approved Sample
13	Hardware fixtures for Doors (Security/ Pump room)	MS oxidized finish and Approved Sample
14	Paints/ Primers	Asian, Berger, Nippon

7.3 Pump/motor/valve

Sl. No.	Description	Make
1	Centrifugal pump	Kirloskar, Jyothi, Best and Crompton Mather and Platt, Inorthington, Flow More
2	Turbine pump	Kirloskar, Jyothi Best and Crompton Mather and Platt, Inorthington, Flow more Fair Banks Morse
3	Submersible pump and motor	KSB, Calama, Waterman, Atlanta
4	Make of motor	JyothiNGEF, GEC, Crompton and Greeves, Siemens
5	Make of transformer	Kirloskar, GEC Indo TECH, Hindustan
6	Diesel Generator	Kirloskar, GEC
7	Starter	L&T, Cutler Hammer, Siemens, MEI
8	Switch fuse and circuit breakers	L&T, Cutler Hammer, Siemens, MEI

Sl. No.	Description	Make
9	Cables	Finolex, Unista, Uniflex
10	Valves	Kirloskar, Venus, Upadaya CALSONS

8. Testing

Third party testing of material such as Steel, Cement, Cubes, Design Mix, Bricks / Solid Blocks, Electrical Wires / Cables, pipes, and any other item must be facilitated by Contractor as per the directions of Authority's Engineer. Testing will have to be arranged by Contractor for every batch of material (such as cement, steel, electricals wires/cables, pipes etc.) that is brought to the site, and approved by the Authority Engineer before the material can be used.

8.1 Special Conditions for sending the cement concrete cubes for testing

The contractor should make arrangements for getting mould to the site for casting of cubes for testing of concrete strength.

1. **Mould** : The concrete mould should be as per IS Specification (IS-516-1959) the details of which are as follows:

The mould shall be of metal, preferably steel or cast iron, and stout enough to prevent distortion. It shall be constructed in such a manner as to facilitate the removal of the moulded specimen without damage and shall be so machined that when it is assembled ready for use, the dimensions and internal faces shall be accurate within following limits.

The height of the mould and the distance between opposite faces shall be the specified size $\pm 0.2\text{mm}$. The angle between adjacent internal faces and top and bottom planes of the mould shall be $90^\circ \pm 0.50^\circ$. The interior faces of the mould shall be plane surface with a permissible variation of 0.03 mm. Each mould shall be provided with a metal base plate having a plane surface and to support the mould during the filling without leakage and it shall be preferably attached to the mould by springs for screws.

The interior surfaces of the mould shall be thinly coated with mould oil to prevent adhesion of the concrete.

2. **Compacting**: The concrete shall be filled into the mould in layers approximately 5 cm deep. Each layer shall be compacted either by hand or by vibration as described below (as per ISI).

When compacting by hand, the standard tamping bar shall be used and the strokes of the bar shall be distributed in a uniform manner over the cross section of the mould as prescribed in I.S.I. and for cubical specimen in no case, shall be concrete be subjected to less than 35 strokes per layer for 15 cm cubes (as per I.S.I.).

When compacting by vibration each layer shall be vibrated by means of an electric or pneumatic hammer of vibrator (as per I.S.I.).

3. The concrete cubes shall be cured for 28 days and send on 29th day. If the day falls on a holiday the cubes shall be sent on the next working day.
4. All the charges connected with the cube testing etc. shall be borne by the contractor.

5. If the concrete cube is found to be of lesser strength, then reduction in agreement rates shall be adopted as per the powers delegated to Authority's Engineer.

6. For working out the reduction of rates following procedures will be adopted .

When the strength of cubes tested is between 75% and 100% of the following strength the agreement rates should be reduced proportionately to the allowable strength of concrete (e.g.) concrete mix C.C. 1:2:4 (150 kg/cm²) cube strength achieved during testing - 120 kgs (i.e.) above 75%

When the strength of cube tested falls below 75% of the allowable strength, the R.C. Component from where the cube samples are collected shall be rejected . However, as an additional check, non-destructive test will be conducted through recognized institutions like Anna University etc., where the concrete component can be rejected or reduced rate to be adopted will then be decided. However, for working out the reduced rate, the cubes strength value only should be taken and worked out as given in para (6) above.

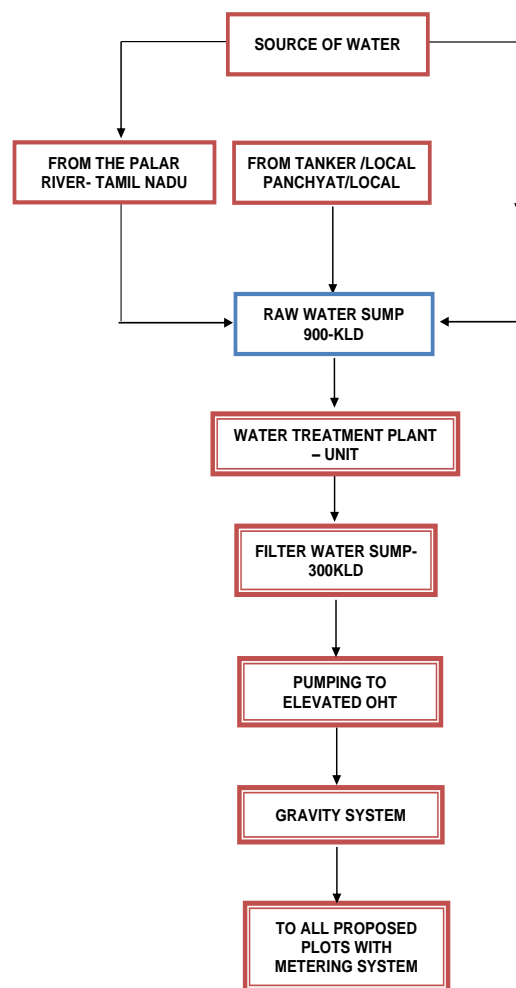
Additional specifications for quality of materials and tests to be conducted (as applicable) is provided in **Appendix 1.**

9. Intent Diagram

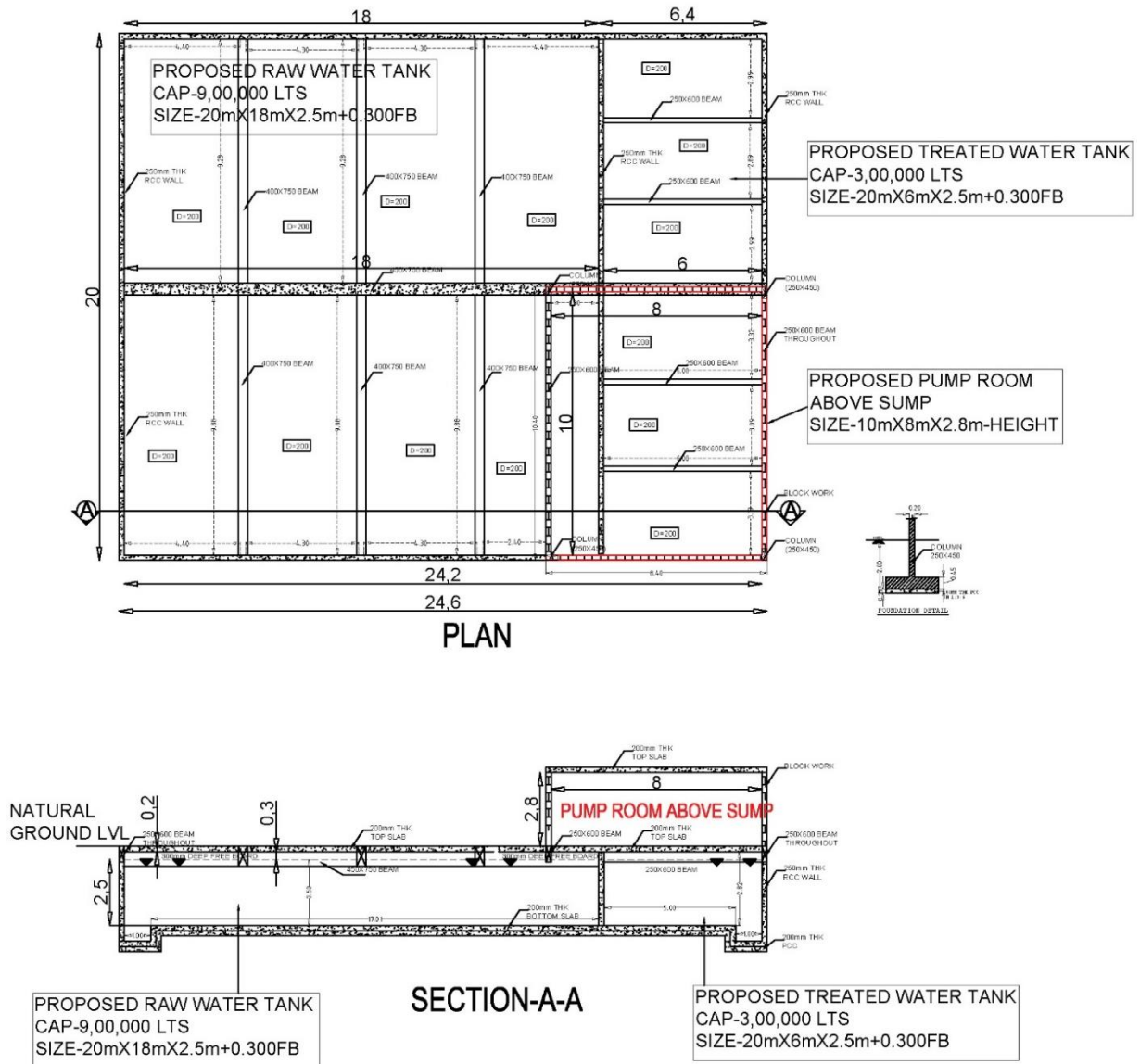
Please also refer to the following references for the Intent Diagrams (in A3 size)

Schedule number	Reference number	Title
8	5.1	Water supply network
8	5.2	Overhead tank – Plan and Section
8	5.3	Underground sump – Plan and Section

9.1 Water supply block diagram:

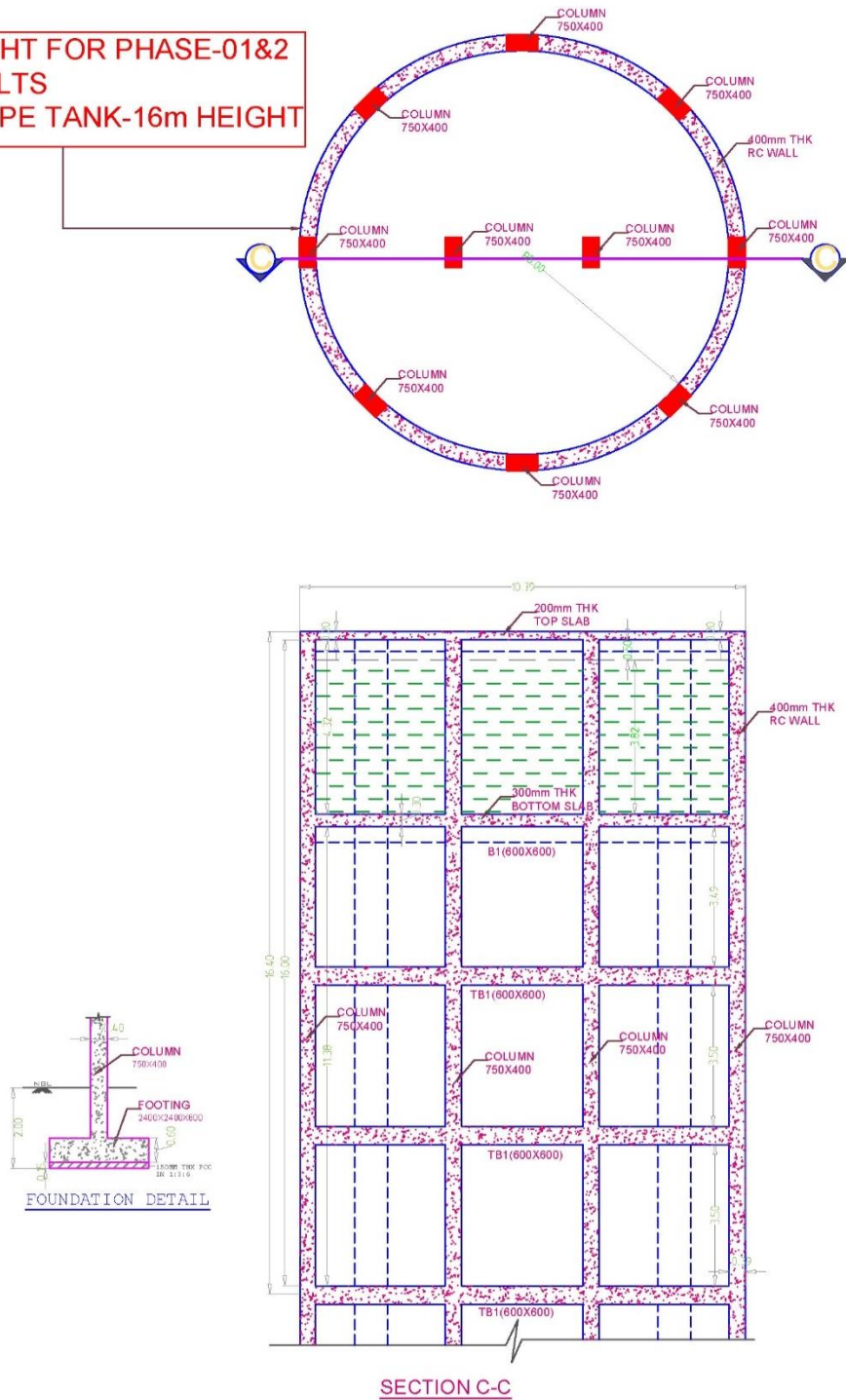


9.2 Sump plan and section



9.3 Overhead plan and section

PROPOSED OHT FOR PHASE-01&2
CAP-3,00,000 LTS
CIRCULAR TYPE TANK-16m HEIGHT



Appendix 1: Additional specification for quality of materials and tests to be conducted (as applicable)

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
1	Water	Lab Test: Local Source: Once in three months Outsource: Once in a month	a)	To neutralize 100 ml of water using Phenolphthalein as an indicator (Acidity)	Not more than 5 ml (or 50 mg/Lit) of 0.02 normal NaOH	IS 456 - 2000, Clause 5.4
				To neutralize 100 ml of water using mixed indicator (Alkalinity)	Not more than 25 ml (or 250 mg/lit) of 0.02 normal H ₂ SO ₂	
				Solids: (i) Total dissolved solids (ii) Sulphates (as SO ₂) (iii) Chlorides (as Cl) (iv) Suspended Matter	3000 mg/Lit	
					400 mg/Lit	
					2000 mg/Lit for Concrete not containing embedded steel and 500 mg/Lit for Reinforced Concrete work	
					2000 mg / Lit	
			d)	pH value	Not less than 6	
			a)	pH value	Not less than 6	
		Field Test: (Using Litmus Paper) Local Source – Once in Fortnight Outsource – For each Load (Lorry Load)				
2	Cement (43 Grade)	One test for every 300 tonnes of single brand (Test to be done, if there is change in brand)				IS 269 - 2015
			a)	Initial setting time	Not less than 30 minutes	
			b)	Final setting time	Not more than 600 minutes	
			c)	Fineness of Cement		
				(i) By permeability method	Not less than 225 m ² /kg	

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
				(Or)		
				(ii) By Standard Sieve Test	Retained not more than 10%	
			d)	Soundness of Cement		
				(i) By Le-Chatelier Method	Expansion not more than 10 mm	
				(Or)		
				(ii) By Auto Clave Test	0.80%	
			e)	Compressive Strength of C.M (1:3) Cube		
				(i) 3 days (72 +/- 1 hr)	Not less than 23 Mpa (or) 230 Kg/Cm ²	
				(ii) 7 days (168 +/- 2 hrs)	Not less than 33 Mpa (or) 330 Kg/Cm ²	
				(iii) 28 days (672 +/- 4 hrs)	Not less than 43 MPA (or) 430 Kg/Cm ²	
3	Steel					
	a) Mild Steel (Grade 1 – Fee 250)	Each Load and Each Diameter (Min. 3 Samples)	a)	Yield Stress	Min 250 N/mm ² (Or) 25 Kg/mm ²	IS 432 (Part-1) 1982
			b)	Elongation	Min 23.0%	
			c)	Ultimate Tensile Stress	Min 410 N/mm ² (Or) 41 Kg/mm ²	
	b) High Strength Deformed Bars (Fe 415)	Each Load and Each Diameter (Min. 3 Samples)	a)	0.20% Proof Stress / Yield Stress	Min. 415 N/mm ² 41.50 Kg/mm ²	IS 1786 - 2008
			b)	Elongation	Min. 14.50%	
			c)	Tensile Stress	10% more than the actual proof stress. But not less than 485 N/mm ² (or) 48.50 Kg/mm ²	
	c) High Strength Deformed Bars (Fe 500)	Each Load and each Diameter (Min. 3 Samples)	a)	0.20% Proof Stress / Yield Stress	Min. 500 N/mm ² (or) 50.0 Kg/mm ²	IS 1786 - 2008
			b)	Elongation	Min. 12.0%	
			c)	Tensile Stress	8% more than the actual 0.2 percent proof stress. But not less than 545 N/mm ² (or) 54.50 Kg/mm ²	
4	Sand	Each Load		Clay, Fine Silt and Fine Dust	Not more than 5% by mass	IS 2116 - 1980
5	Coarse Aggregate	Every Quarry				IS 383 - 1970
			a)	Either Crushing Value (or) Impact Value		
				Crushing Value		

S.No.	Material to be Tested	Sampling		Name of test	Permissible Limits	Standards
				Aggregates used for concrete other than wearing surfaces	Not more than 45%	
				Aggregates used for concrete for wearing surfaces (such as roads, pavements)	Not more than 30%	
				(Or Alternatively)		
				Impact Value		
				Aggregates used for concrete other than wearing surfaces	Not more than 45% by weight	
				Aggregates used for concrete for wearing surfaces (such as roads, pavements)	Not more than 30% by weight	
			b)	Abrasion Value		
				For Aggregates to be used in concrete for wearing surfaces	Not more than 30%	
				For Aggregates to be used in other concrete	Not more than 50%	
6	Bricks	Lot Size – For Every One Lakh Bricks – (Number of Samples 20 Nos.)		For Class 35		IS 1077 - 1992
			a)	Compressive Strength	Not Less than 35 Kg/cm ² (or) 3.50 N/mm ²	
			b)	Water Absorption	Not more than 20% by weight	
			c)	Efflorescence	Rating not more than Moderate	
				For Class 50		
			a)	Compressive Strength	Not Less than 50 Kg/cm ² (or) 5.0 N/mm ²	
			b)	Water Absorption	Not more than 20% by weight	
			c)	Efflorescence	Rating not more than Moderate	
7	Hydraulic pressed tiles	One test for area upto 1999 sq.m and one additional test for every 1000 sq.m and part thereof				IS 2690 - 1993
			a)	Water Absorption	Shall not exceed 15%	
			b)	Flexural Strength	Shall not be less than 20 Kg/cm ²	

S.No.	Material to be Tested	Sampling	Name of test	Permissible Limits	Standards
8	Electric Cable	One test for each brand, each size	Conductor resistance at 20°C		IS 664-1990
			For 1.5 Sq.mm cable	Max allowable limit 12.10 Ohm/Km	
			For 2.5 Sq.mm cable	Max allowable limit 7.40 Ohm/Km	
			For 4.0 Sq.mm cable	Max allowable limit 4.95 Ohm/Km	
10	Wood	One sample for each work	Lab test – Moisture test	Not more than 12%	IS 287 - 1993
			Field test – Visual observation	Free from rotten, unsound knots (or) knots in cluster	IS 3629 - 1960
11	Cube test in lab		Compressive strength of 150 mm cube		IS 456 - 2000
		1 to 5 m ² – 1 set	M20 (1:1.5:3)		
		6 – 15 m ² - 2 sets	7 days	Not less than 135 Kg/cm ²	
		16 – 30 m ² – 3 sets	28 days	Not less than 200 Kg/cm	
		31 to 50 m ² – 4 sets	M20 (1:1:2)		
		> 50 m ² – 4 plus one for each add 50 m ²	7 days	Not less than 170 Kg/cm ²	
		(1 set = 3 cubes)	28 days	Not less than 250 Kg/cm	
			M30		
12	Slump Test Slump test at site for all reinforced concrete at regular intervals (Slump in mm)	Type of work	With vibration	Without vibration	
		Mass concrete, large section, roads and pave	10 to 25	50 to 75	
		RCC foundation, substructures, thick walls and other heavy section	26 to 50	40 to 115	
13	M-Sand	Thin vertical sections such as walls, beams, columns with congested reinforcement	40 to 50	100 to 175	

S.No.	Material to be Tested	Sampling	Name of test	Permissible Limits	Standards
		When using concrete pump	50 to 100		IS 383 – 2016 (3 rd Revision) For Zone-II
13.1	Test for size and grading of aggregate		IS sieve size in mm		IS: 2386 (Part – I) 1963
		a)	10 mm	Shall be 100%	
		b)	4.75 mm	Shall be between 90 & 100%	
		c)	2.36 mm	Shall be between 75 & 100%	
		d)	1.18 mm	Shall be between 55 & 90%	
		e)	600 micron	Shall be between 35 & 59%	
		f)	300 micron	Shall be between 8 & 30%	
		g)	150 micron	Shall be between 0 & 10%	
13.2	Test for Specific Gravity			Shall be between 2.1 and 3.2	
13.3	Test for water absorption, %			Shall not be more than 5%	
13.4	Test for bulk density				IS: 2386 (Part-III) 1963
		a)	Bulk density in KG/1-loose condition	Limit not specified	
		b)	Bulk density in KG/1-compacted condition	Limit not specified	
13.5	Test for deleterious materials				
		a)	Coal and lignite	Shall not be more than 1%	
		b)	Clay lumps	Shall not be more than 1%	
		c)	Material finer than 75 mm IS sieve	Shall not be more than 10%	
		d)	Organic Impurities	Shall pass the test	
		e)	Silt content	Limit not specified	
13.6	Test for soundness of Aggregate				
			% loss of weight of the material after 5 cycles when tested with sodium sulphate solution	Shall not be more than 10%	
13.7	Test for Total Alkali Content				
			Total alkali content as Na ² O equivalent percentage	Shall not be more than 0.3%	

S.No.	Material to be Tested	Sampling	Name of test	Permissible Limits	Standards
13.8	Test for Sulphate content		Test for sulphate content as SO ₃	Shall not be more than 0.5%	
13.9	Test for Acid Soluble Chloride content		Acid Chloride content percent	Shall not be more than 0.04%	
13.10	Test for Alkali Aggregated reactivity		Acceleration mortar bar method The average expansion of accelerated mortar bar after 16 days of casting percentage	<ol style="list-style-type: none"> 1. Expansions of <0.10% - Indicates Innocuous behaviour of aggregate 2. Expansions between 0.10 and 0.20% includes both Innocuous and deleterious aggregate 3. Expansion >0.20% indicative of Potentially deleterious aggregate 	
13.11	Test for bulking of sand percentage		Bulking of sand percentage	Limit not specified	IS: 2386 (Part-II) 1963