

DI PIPE, VALVES AND SPECIALS

Providing and supplying D.I. K-9 pipes for following nominal bore diameter with internal cement mortar lining including all taxes, insurance, transportation, freight charges, octroi. inspection charges, loading, unloading, conveyance to departmental stores, stocking etc. complete. (IS 8329-2000)

(i) 100 mm to 500 mm Diameter

This item includes:

Note: Wherever International Standards or Indian standards / specifications are mentioned, their equivalent or higher standards / specifications are also acceptable Supply and Delivery of Ductile Iron Pipe as per IS:8329-2000 or its latest revision or amendments if any including jointing material as EPDM ring as per IS 5382- 1985 and ISO: 4633-1996 or its latest revision or amendments if any Standards

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

- ✓ ISO: 10803-1997 Design method for ductile iron pipes
- ✓ IS:8329-2000 Centrifugally Cast (spun) ductile iron pressure pipes for water, gas and sewage
- ✓ ISO:2531-1991 Ductile iron pipes, fittings and accessories for pressure pipelines.
- ✓ ISO:4179-1985 Ductile iron pipes for pressure and non pressure-Centrifugal
- ✓ cement mortar lining - General requirements.
- ✓ IS:8112 Specification for 43 Grade ordinary Portland cement.
- ✓ BS:3416 Bitumen based coatings for cold application, suitable for use in contact with potable water.
- ✓ ISO:8179-1995 Ductile iron pipes-External coating-Part-1 Metallic Zinc with finishing layer.
- ✓ IS:638 Sheet rubber jointing and rubber insertion jointing.
- ✓ ISO: 4633-1996 Rubber seals-Joint rings.
- ✓ IS:5382-1985 Specification for Rubber sealing rings for gas mains, water mains and sewers.
- ✓ AWWA C600 Installation of ductile iron water mains and their appurtenances.

Internal Diameter:

The nominal values of the internal diameters of pipe, expressed in millimeters are approximately equal to the number indicating their nominal sizes DN.

Length:

The working length of socket and spigot pipes shall be 5 m ,5.5 m, or 6 metres.

Thickness:

The wall thickness of pipe 'e' in mm shall be calculated as a function of the nominal diameter by the following equation with minimum of 5 mm

$$e = K(0.5 + 0.001 DN)$$

where : e = wall thickness in mm, DN = the nominal diameter, K = the whole number coefficient

EPDM Rubber Gasket:

Rubber Gasket shall be suitably for Push-on-Joint.

The spigot ends shall be suitably chamfered or rounded off to facilitate smooth entry of pipe in the socket fitted with the rubber gasket Rubber Gasket shall confirm to IS 5382-1985 and ISO : 4633-1996 its latest revision or amendments if any

Sampling Criteria:

Sampling criteria for various tests, unless specified in IS 8329-2000, shall be as laid down in IS 11606. Mechanical test, Brinell Hardness test, Hydrostatic test etc are shall be as per IS 8329-2000

Tolerances on External Diameter:

The nominal external diameter (DE) of the spigot end of socket and spigot pipes and when measured circumferentially using a diameter tape shall confirm to the requirements specified as follow. The positive tolerance is +1 mm and applies to all thickness classes of pipes. The maximum negative tolerance of the external diameter are specified as follow:

DN	Nominal	Positive Tolerance	Negative Tolerance
80	98	+1	-2.2
100	11	+1	-2.8
125	14	+1	-2.8
150	17	+1	-2.9
200	22	+1	-3.0
250	27	+1	-3.1
300	32	+1	-3.3
350	37	+1	-3.4
400	42	+1	-3.5
450	48	+1	-3.6
500	53	+1	-3.8
600	63	+1	-4.0

Tolerance on Ovality:

Pipes shall be as far as possible circular internally and externally. The tolerance for out-or- roundness of the socket and spigot ends is given below:

Nominal Diameter	Allowable Difference Between Minor Axis
80 to 300	1.0
350 to 600	1.7
700	2.0
750 to 800	2.4
900 to 1000	3.5

Tolerance in thickness

The tolerance on wall thickness (e) and the flange thickness (b) of the pipes shall be as below:

Dimensions	Tolerance in mm
Wal thickness	- (1.3 + 0.001 DN)
Flange thickness	+ (2+0.05b) & -

Coating

Pipe shall be delivered internally and externally coated

External Coating: Pipe shall be metallic zinc coated and after that it shall be given a finishing layer of bituminous paint as per IS - 8329-2000 Zinc coating shall comply with IS:8329/EN 545/ ISO 8179. Only molten zinc spray coating shall be acceptable. The average mass of sprayed metal shall not be less than 130 g/sqm with a local minimum of 110 g/sqm.

Bitumen overcoat shall be of normal thickness of 70 microns unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II suitable for tropical climates factory applied preferably through an automatic process. Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

Internal lining: Internally pipe shall be Portland Cement mortar lined (as per IS - 8329-2000). The mortar shall contain by mass at least one part of cement to 3.5 part of sand. All pipes and fittings shall be internally lined with cement mortar using high speed centrifugal process in accordance with IWO 4179/IS 8329. Cement mortar lining shall be applied at the pipe manufacturing shop in conformity with the aforesaid standards. No admixtures in the mortar shall be used without the approval of the Engineer. The sand to cement proportion of sand if justified by the sieve analysis.

Pipe lining shall be inspected on site and any damage or defective areas shall be made good to the satisfaction of the Engineer.

Lining shall be uniform in thickness all along the pipe. The minimum thickness of factory applied cement mortar lining shall be as per IS: 8329 Annex-B or ISO 4179. This is given below.

Nominal Pipe Size	Nominal lining
Up to 300	3
350-600	5
700-1200	6
1400-2000	9

Joint

Jointing of DI pipes and fittings shall be push-on type Push-on-joints

The Contractor shall source the push-on-joint gaskets only from the pipe manufactures. In turn the pipe manufacturer shall supply at least 10% additional quantity of gaskets over and above the requirement to the Contractor at no extra cost.

The gasket used for joints shall be suitable for natural and purified water conveyance. In jointing DI pipes and fittings, the Contractor shall take into account the manufacturer's recommendations as to the methods and equipments to be used in assembling the joints. In particular the Contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, so that once the rubber ring is correctly positioned before the joint is made, does not get damaged by friction or sharp edges of the spigot Chamfer. The rubber rings and the recommend lubricant shall be obtained only through the pipe manufacturer.

Rubber ring bundles form every lot shall carry with them manufacturers test certificate for the following mechanical properties.

- Hardness
- Tensile strength
- Compression set
- Accelerated aging test
- Water absorption test
- Stress relaxation test
- Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the type of joint, the size of the pipe with which they are to be used, the manufacturer's name and trade mark, the month and year of manufacture and the shelf life.

Testing of Pipe:

The main test among others to be conducted shall be as per IS:8329-2000 or with its latest revision/amendments.

[a] Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes as specified in the Standards. The frequency and sampling of tests for each batch of pipes shall be in accordance with IS 11606-1986. The test results so obtained for all the pipes and fittings of different sizes shall be submitted to Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per IS;8329/EN 545 for pipes and IS:9523/EN 545 for fittings.

[b] Brinell Hardness Test

For checking the Brinell hardness the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS:1500. The test shall comply with the requirements specified in IS: 1500/ISO 6506.

[c] Re-tests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

[d] Flow Test shall be done in two stages:

Stage 1

Pipe line shall be laid by resting the pipe line on supports at joints. The pipeline and all joints of pipes shall be made thoroughly sound and water tight and any joint which may be observed to be leaky shall be immediately corrected. Thus after satisfactory flow test sand bedding shall be filled pipe line after laying pipe line. The refilling of trench shall be carried out then after.

Stage 2

After total laying & refilling of trenches, flow test shall be carried out again for particular section of length as suggested by engineer in charge.

Quality Assurance

The manufacturer shall have a laid down Quality Assurance Plan for the manufacture of the products offered which shall be submitted along with the tenders.

MARKING :

The methods of marking all the pipes to be delivered under scope of contract shall ensure that all the information will remain legible even after transportation, storage in open space etc. In general the legible and indelible marking upon the goods shall indicate the followings;

- i) Certification mark on each pipe.
- ii) Manufacturers brand name and/or trademark.
- iii) Purchasers mark as "RMC" be inscribed
- iv) The outside diameter and pressure rating.
- v) Batch number or lot number.
- vi) Inspector's mark on each pipe

INSPECTION

Inspection of pipes and specials will be carried out by Executive engineer or his representative agency appointed by RMC. All the expenditure for inspection shall be borne by the contractor except inspection charges if any in case of inspection agency appointed by RMC shall be paid by RMC.

PAYMENT

The payment shall be on RMT basis.

Mode of Payment : Payment restricted to 70% on receipt of material at project site, 20% payment on lowering, laying, jointing, refilling and disposal of surplus stuff, 10% payment on hydraulic testing and commissioning of

project. Payment for 2 Km. of unlaidd pipes of each diameter except 100 mm dia. will be paid on receipt at site. Payment for 100 mm dia. Pipe upto 5 Km. will be paid on receipt at site.

Lowering, laying and jointing C. I. S & S Spun pipes suitable for Tyton joints / Mortar lined I. Pipes of various classes with CI / MS specials of following diameters in proper position, grade and alignment as directed by Engineer-in-charge including hydraulic testing etc. comp.

The pipes & joints shall be procured, supplied by the Contractor at work site at his own cost. Every care shall be taken in carting them to site. During transportation any damage shall be occurring to pipes for fittings the replacement of pipes given by the contractor at his own cost.

The trenches shall be well leveled so that pipes are laid evenly among them. The pipes shall be fixed within two rubber rings to be supplied by department at the place shown in schedule A, if directed by the Engineer-in-charge or mentioned in item of schedule B. The specification for titan joints i.e. Rubber Rings shall be as per details specification material section.

The contractor shall make his own arrangement for obtaining permission for storing & stacking of pipes etc. from land boards whether they are Government, Municipal Local Bodies or Private land owner. Every pipes before lowering into the trenches shall be got checked and thoroughly cleaned and the beds of the trenches shall be properly graded and leveled as required on the line, without any claim for extra cost whether it is require The pipe shall be carefully lowered into the trenches with the help of a suitable type of chain pulley blocks, which shall first be approved by the Engineer-in-Charge. Each pipe shall be properly jacked and the spigot perfectly fixed into the socket. No jointing operation shall be started unless the gradients levels are approved by the Engineer-in-Charge or his representatives.

The pipes shall be laid complete in centerline ranged accurately by means of a string attached to both marked center of site rails and no deviation shall be permissible without the permission of Engineer-in-Charge. The pipe shall be laid in reasonably dry trenches and no circumstances on slushy bedding.

The pipes shall be brushed before lowering any laying or remove any soil or dirt etc. that may have accumulate

The inside socket and outside of the spigot-shall be carefully cleane The pipe shall be lowered carefully with socket and toward and the flow of water or up till or as directed and spigot and should be carefully inserted into the socket and the space shall be filled with the joint.

TESTING OF WATER PIPES:

After each section of the pipeline has been completed it shall be tested for

water tightness before being covered. The contractor shall at his own cost fill up water in pipe line and given necessary hydraulic test section by section and the pipe line shall stand the pressure which shall exceed the working pressure by

(a) 50% of the highest pressure in the section.

(b) 30m whichever is less without showing any leakage or sweating anywhere in the pipes joints specials valves etc. if any defect are found the contractor shall be made good the same at his own cost.

Any leaking joints shall be made good and above test pressure in to be lowered gradually after satisfactory test is & over.

RMC/ OWNER will not be able to provide water for testing of the pipelines & water containers of the project. This shall have to be managed by the contractor at his costs and risk.

The hydraulic test shall be given again if considered necessary by the Executive Engineer or his representative to show that no further leakages or sweating is there. The contractor shall have to make necessary arrangements for water testing as well as plugging the opening of pipes etc. as directed without claiming any extra cost. The pipelines shall be kept filled with water for a work lines shall be kept filled with water for a week or till it is situated for testing is done.

If the pipe lines are laid in detached sanctioned & not in continuous length due to any reasons such as non-availability of specials or due to obstacle etc. The contractor shall see that no end of pipes length is kept open-ends are immediately covered up either by suitable blank flange or cap slug or by means of double layer gunny bags clothes tied properly by mild steel wire without any claim for extra- cost. The rate shall be per meter of pipe line laid including all specials and fitting jointly etc. Cutting and waste shall not be paid separately. The length shall be measured not on the straight line and curves along the center line over the pipe and specials correct up to 1 cm.

Method Of Measurement Of Pipes:

The measurement shall be recorded in running meter of pipe length laid along center line or axis of pipe line..

No payment shall be made for overlaps etc.

The payment shall be paid after completion of whole item as mentioned in price bid on Running Meter basis.

Mode of Payment : Payment restricted to 70 % on completion of laying & jointing & 30% on giving hydraulic test.

Manufacture, Supply & Delivery of Ductile Iron Flange socket spigot bends, tees, reducers or any other specials as per BS-EN-545/1995 Class-A series K12 suitable for use with I. Pipes manufactured as per IS:8329/1994 delivery of specials is to be made to RMC/ OWNER store or site of works any where in Gujarat including all taxes, loading, unloading, carting, stacking, insurance, inspection charges, octroi etc. complete.

- A) Manufacture, supply and delivery of Ductile Iron Flange Socket spigot bends, tees, reducers or any other specials as per BS-EN-545 / 1995 class-A series K-12 suitable for use with DI pipes manufactured as per IS 8329/1994 delivery of specials is to be made to site of works including all taxes, loading, unloading, carting, stacking, insurance, inspection charges, Octroi etc. complete with internal cement mortar lining with EPDM rubber gaskets.
- B) Manufacture, supply and delivery of flanges, Tee, bends, tail piece, reducers, air valve raiser pipes or any other specials suitable for use with DI pipes and delivery of specials is to be made to site of works anywhere in Gujarat including all taxes, loading, unloading, carting, stacking, insurance, inspection charges, Octroi etc. complete.
- C) Manufacture, supply and delivery of CID joints with Rubber Rings of Standard quality or any other specials suitable for use with I. pipes and delivery of specials is to be made to site of works anywhere in Gujarat including all taxes, loading, unloading, carting, stacking, insurance, inspection charges, Octroi etc. complete
- D) DI Specials with all types of diameters suitable of K9 grade pipes with inner cement mortal lining. The necessary DI Specials required during the lowering & lying of Ductile Iron Pipe shall be supplied by the agency and shall be as per standard specification.
- E) It shall be of best quality as per requirement Rate shall be including loading,
- F) unloading, carting, insurance and labour charge etc. complete.

PAYMENT

The payment shall be made on kg. basis.

Mode of Payment : Payment restricted to 70 % on completion of laying & jointing & 30% on giving hydraulic test.

Providing and supplying ISI mark CI / D/F Sluice Valves as per IS:14846 (Latest Edition) of following class and diameter including all taxes. insurance. transportation, freight charges, octroi, inspection charges. loading, unloading. conveyance to departmental stores, stacking etc. complete

Design Features

Sluice valve shall conform to IS 14846 (ISI Marked). Except pump house, these valves are to be installed in valve chamber. All valves of pump house and rising mains shall be non-rising stem type.

The valves shall be free from sharp projections, which are likely to catch and hold stringy materials. Valves shall close with clockwise rotation of the hand wheel. The direction of closing and opening shall be marked on the hand wheel.

Necessary joining materials viz. bolts, nuts, washers, packing etc. shall be provided by the contractor at his cost. The valves shall be fixed so as to have axis perfectly horizontal. If required the contractor shall also carry out drilling of holes of appropriate diameter in flanges in required numbers. A hand wheel shall be provided for emergency operation. The hand wheel drive shall be mechanically independent. The valve design shall take care of the pressure drop across the valve disc in case of partial opening of the valve and shall take care of the erosion and cavitation effect on the body and disc during such operation. Valve(s) subjected to back pressure shall have the valve seat, disc and the operator suitably designed to ensure trouble-free operation. The shaft diameter shall take into consideration, the maximum torque required for the valve operation, the maximum differential pressure across the valve disc when the valve is closed and the shock load due to accidental closure of the valve disc. The disc shall be designed for maximum differential pressure across the valve as well as the shock load due to accidental closure of the valve. Disc design shall offer minimum head loss. Disc shall also offer minimum resistance to flow. Disc shape shall be contoured. Valve seats shall be of a design that permits removal and replacement at site and shall be securely clamped on the body or disc of the valve. Seat material shall be suitable for the operating conditions and handling fluid and may be suitably reinforced, if require. The seat design shall permit easy removal for replacement purposes without the need for removing the valve from the line. No deposited or welded seat rings permitted. The valve bearings shall be of 'self-lubricated' type and shall not have any harmful effect due to handling fluid. Adjustable thrust bearing(s) shall be provided to hold the valve disc securely in the center of the valve seat. Each Sluice Valve shall be provided with a hand wheel for manual operation. For the Valves located at inaccessible position, it shall be provided with extension spindle and floor stand or hand lever / round chain to facilitate manual operation.

Hydrostatic Test

Each valve body shall be subjected to hydrostatic test (Body and Seat) as per IS 14846. For valves subjected to back pressure condition, leakage test shall be carried out on both sides of the disc.

Performance Test

Each valve complete with operator shall be shop operated at least three (3) times from fully closed to fully open conditions and reverse, hold at intermediate positions under no flow condition, to prove the workability of the assembly.

Positive material Identification (PMI Test)

PMI test shall be checked at random for Stainless steel parts.

Test Certificates

When specified by Owner, the manufacturer shall issue a test certificate confirming that the valves have been tested in accordance with this standard and stating the actual pressures and medium used in the test.

Marking

Marking shall be cast integral on the body or on a plate securely attached to the body for 'DN' size, 'PN' rating, Heat Number and Serial number.

Painting

Each valve shall be drained, cleaned, prepared and suitable protected with 2 coats of red oxide and then black bituminous paint for minimum of 150 micron DFT on surfaces before dispatch.

Electric Actuator

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control require The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication. The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.

The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions. The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation.

Each starter shall be equipped as follows: i. A.C. electric motor. ii. Reduction gear unit. iii. Torque switch mechanism complete with set of torque switches. iv. Limit switch mechanism complete with set of limit switches. v. Hand wheel for manual operation. vi. Hand-auto changeover lever with suitable locking arrangement. vii. Local control switch / push buttons viii. 415 V / 240 V AC control transformer.

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ time the maximum required torque

and shall be suitable for at least 15 minutes continuous operation. All local controls shall be protected by a lockable cover.

Datasheet:

SLUICE VALVE/GATE VALVE					
Sr No	Component	PN-1.0/1.6	PN-2.0	PN-2.5	PN-4.0
1	Body	CI IS 210 Gr. FG260	ASTM A216 Gr.	ASTM A216 Gr.	ASTM A216 Gr. WCB/ ASTM
2	Bonnet	CI IS 210 Gr. FG260	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB/ ASTM A351 Gr. CF8
3	Wedge	CI IS 210 Gr.	ASTM A217 Gr. CA15	ASTM A217 Gr. CA15	ASTM A217 Gr. CA15
4	Gland	CI IS 210 Gr. FG260	ASTM A216 Gr.	ASTM A216 Gr.	ASTM A216 Gr. WCB/ ASTM
5	Stem	SS 410	SS 410	SS304	SS 316
	Body				
7	Gland Packing	Jute and Hemp	Graphoil Filler	Graphoil Filler with SS 304 wire winding	Graphoil Filler with SS 304 wire winding
8	Nut Bolts	Carbon steel	ASTM A320 Gr L7 and ASTM A194 Gr 4	ASTM A320 Gr L7 and ASTM A194 Gr 4	ASTM A320 Gr L7 and ASTM A194 Gr 4
9	Wedge Nut and Stem Nut	IS 318 Gr LTB-2	SS 304	SS 304	SS 304

10	Hand Wheel	Cast Iron	Cast Steel	Cast Steel	Cast Steel/SS
11	Flange End	IS 1538	ASME/ANSI B16.5 Class 150	ASME/ANSI B16.5 Class 300	ASME/ANSI B16.5 Class 400

Mode of measurement and payment:

The measurement shall be taken **per number of sluice valve** of specified size. The rate will be **per number** fitted in a pipe line.

5% amount shall be withheld for hydraulic test and same shall be released after satisfactory hydraulic test.

Lowering, laying and jointing in position following C. I./ D/F Reflux valves, Butterfly valves, Sluice valves and Air valves including cost of all labour, jointing material, including nut bolts and giving satisfactory hydraulic testing, etc. complete.

Lowering, Laying and Jointing of Sluice valve

- (i) Cast iron double flanged sluice valve/butterfly valves with two tail pieces suitable to pipe shall be supplied by the board and they shall be carted by the contractor at his own cost from the departmental store or any other store as directed. The rate shall include loading, unloading and stacking at site.
- (ii) The sluice valve/butterfly valves and tail pieces shall be examined before laying for cracks and other flaws. They shall be undamaged in all respect.
- (iii) The sluice valves/butterfly valves shall be operated before laying.
- (iv) All grits and foreign materials shall be removed from the inside of the valves before placing.
- (v) All the four faces shall be thoroughly cleaned and coated with a thin layer of mineral grease.
- (vi) The tightening of gland shall be checked with a pair of inside-calipers. Clearance between the top of stuffing box and the underside of the gland shall be uniform all the sides.

JOINTING MATERIAL

The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool etc.

All tools and plant required for installation of sluice valve shall be provided by the contractor.

All jointing materials shall be not approved from the engineer-in-charge before us

The nut and bolts shall conform to Item No MSP-19 of specification of

materials.

The rubber packing shall confirm all specifications as narrated in Item No MSP-20 of specifications of materials.

INSTALLATION

The sluice valve/butterfly valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.

If necessary tail pieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.

The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice/butterfly valve bore. It shall be even at both the inner and outer edges.

The flange faces thoroughly grease

If flange faces are not free, the contractor shall use thin fibers of lead wool.

After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.

The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.

Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.

The sluice valve/butterfly valve shall be installed in such a way that its spindle shall remain in truly vertical position.

The other end of tail piece shall be fitted with pipes so that continuous lines can work.

Extra excavation required for facility of lowering and fixing sluice valve shall not be paid for.

TESTING

After installation of sluice valve/butterfly valve the same is tested to 11/2 times of its test pressure.

The joints sluice valve/butterfly valve shall withstand the test pressure of pipelines.

Defects noticed during test and operation of sluice valve shall be rectified by the contractor at his own cost without any extra claim to the entire

satisfaction of the Engineer-in-charge.

MODE OF MEASUREMENT AND PAYMENT

The measurement shall be taken per number of sluice valve/butter fly valve of specified size.

The rate shall be per number fitted in a pipe line as per schedule of payment.

For non-testing of valve 30% of the rate quoted shall be withheld till testing is given.

**02 CHAPTER
CIVIL AND BUILDING WORKS**

1.1 Design Submissions

- 1.1.1 Complete detailed design calculations of foundations and superstructure together with general arrangement drawings and explanatory sketches shall be submitted to EMPLOYER. Separate calculations for foundations or superstructures submitted independent of each other shall be deemed to be incomplete and will not be accepted by EMPLOYER.
- 1.1.2 The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

1.2 Design Standards

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

- 1.2.2 All reinforced concrete structural design shall generally conform to the following publications of the Indian Standards Institution :

I.S. 456	Code of Practice for plain and reinforced concrete
I.S. 875	Code of Practice for design loads for buildings and structures (Part 1 to 5)
I.S. 3370	Code of Practice for concrete structures for the storage of liquids (Part I to IV)
I.S. 1893	Criteria for earthquake resistant design of structures
I.S. 2974	Code of Practice for design and construction of machine foundations (Part 1 to 4)

- 1.2.3 All structural steel design shall generally conform to the following publications of the Indian Standards Institution :

I.S. 800:	Code of Practice for general construction in steel
I.S. 806:	Code of Practice for use of steel tubes in general building construction

1.3 Design Life

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

1.4 Design Loading

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

1.4.1 Dead Load

This shall comprise all permanent construction including walls, floors, roofs, partitions, stairways, fixed service equipment and other items of machinery.

The following minimum loads shall be considered in design of structures :

(i)	Weight of water	:	9.81 kN/m ³
(ii)	Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered.	:	20.00 kN/m ³
(iii)	Weight of plain concrete	:	24.00 kN/m ³
(iv)	Weight of reinforced concrete	:	25.00 kN/m ³
(v)	Weight of brickwork (exclusive of plaster)	:	22.00 N/m ² per mm thickness of brickwork
(vi)	Weight of plaster to masonry surface	:	18.00 N/m ² per mm thickness
(vii)	Weight of granolithic terrazzo finish or rendering screed, etc.	:	24.00 N/m ² per mm thickness

1.4.2 Live Load

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

(i)	Live load on roofs (accessible)	:	1.50 kN/m ²
	(Non-accessible)	:	0.75 kN/m ²
(ii)	Live load on floors supporting equipment such as pumps, blowers, compressors, valves, etc.	:	10.00 kN/m ²
(iii)	Live load on all other floors walkways, stairways and platforms.	:	5.00 kN/m ²

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

1.4.3 Wind Load

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

1.4.4 Earthquake Load

This shall be computed as per I.S. 1893. An importance factor appropriate to the type of structure shall be considered for design of all the structures. Rajkot is falling under seismic zone-3. However, all the structures shall have to be designed with the criteria of zone-4.

1.4.5 Dynamic Load

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

1.5 Joints

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

~~1.5.2 Expansion joints of suitable gap at suitable intervals not more than 30 m shall be provided in all walls, floors and roof slabs of water retaining structures.~~

1.5.3 Construction joints shall be provided at right angles to the general direction of the member. The locations of construction joints shall be decided on convenience of construction. To avoid segregation of concrete in walls, horizontal construction joints are normally to be provided at every 2-m height. PVC waterstops of 150 mm width shall be used for walls and 230 mm width for base slabs.

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

1.5.5 No structural expansion joint is permitted in liquid retaining structure.

1.6 Design Conditions for Underground or Partly Underground Liquid Retaining Structures.

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

- (i) liquid depth to be considered up to full height of wall and no relief due to soil pressure from other side to be considered.
- (ii) structure empty condition (i.e., empty of liquid, any material, etc.) : full earth pressure with saturation and surcharge pressure wherever applicable, to be considered.
- (iii) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall.
- (iv) partition wall between two compartments : to be designed as one compartment empty and other full for both the directions.
- (v) structures shall be designed for uplift in empty conditions with no live load. Water table is to be considered up to ground level while designing the structure for uplift. Rock anchors shall not be allowed to resist the uplift pressure.
- (vi) walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilisation and dynamic water loads.
- (vii) underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation.

1.6.2 Design Conditions for Elevated Service Reservoir.

- (i) The foundation depth shall be minimum 3 mt or up to hard rock strata whichever is more.

- (ii) In case of supporting structure as a shaft, the minimum diameter of the shaft shall be 12 mt. and tolerance limit in the diameter will be $\pm 0.5\%$. The thickness of the shaft shall not be less than 250 mm and grade of concrete for shaft and foundation shall be M-30.

1.7 Foundations

- (i) The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be as per IS 1904.
- (ii) Maximum safe bearing capacity of soil strata shall be taken as indicated in geotechnical reports.
- (iii) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by EMPLOYER.
- (iv) Where there is level difference between the natural ground level & the foundations of structure or floor slabs, this difference shall be filled up in the following ways:
 - In case of non-liquid retaining structures the natural top soil shall be removed till a firm strata is reached (minimum depth of soil removed shall be 500 mm.) and the level difference shall be made up by compacted backfill as per specifications. However the thickness of each layer shall not exceed 150 mm. The area of backfilling for floor slabs shall be confined to prevent soil from slipping out during compaction. The safe bearing capacity of this well compacted backfilled soil shall not exceed 100 kN/sq.m.
 - In case of liquid retaining structures, the natural top soil shall be removed as described above and the level difference shall be made up with Plain Cement Concrete (1:5:10)

1.8 Design Requirements

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

- a) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade CC 1:2:4 for all-structures.
- b) All structural reinforced concrete for water retaining structures shall be of a minimum M30 grade with a maximum 20 mm aggregate size for footings and base slabs and with a maximum 20 mm aggregate size for all other structural members. For non water retaining structures the concrete shall be of M25 grade. The structures shall have to be designed as per IS : 3370 (Part I-IV).
- c) The reinforced concrete for water retaining structures shall have a minimum cement content of 400 kg/m³ with a maximum 20 mm size aggregate.
- d) If limit state design method is adopted, as per IS 3370 – 2009, at serviceability load, maximum stress in reinforcement shall not exceed 0.5 f_y (Where f_y is characteristic strength of reinforcement)
- e) The minimum reinforcement for water retaining structures in each direction should be 0.35% of cross section. The minimum clear cover to all reinforcement including stirrups and links shall be 50 mm for all water retaining structures.
- f) All buildings shall have a minimum 1 metre wide, 100 mm thick plinth protection paving in CC 1:2:4 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compacted strata.
- g) Any structure or pipeline crossing below roads shall be designed for Class A of IRC loading.
- h) The bridges & bridge supporting structures shall be designed to safely withstand the loading.
- i) All pipes & conduits laid below the structural plinth & road works shall be embedded in reinforced concrete of grade CC 1:2:4 of minimum thickness 150 mm.
- j) Approved quality water proofing compound (chloride free) shall be added during concreting of all liquid containing structure in the proportions specified by manufacturer or 2 % by weight of cement whichever is higher.

- k) The wall and floor panels shall be poured in sequential order with a minimum time gap of 4 days.

The following minimum thickness shall be used for different reinforced concrete members, irrespective of design thickness:

- | | | |
|---|---|--------|
| (i) Walls for liquid retaining structures | : | 250 mm |
| (ii) Channel / Launder | : | 150mm |
| (iii) Roof slabs for liquid retaining structures
(other than flat slabs) | : | 150 mm |
| (iii) Bottom slabs for liquid retaining structures | : | 200 mm |
| (iv) Floor slabs including roof slabs, walkways,
canopy slabs | : | 125 mm |
| (v) Walls of cables / pipe trenches,
underground pits etc. | : | 125 mm |
| (vi) Column footings | : | 300 mm |
| (vii) Parapets, chajja | : | 100 mm |
| (viii) Precast trench cover | : | 100 mm |
- In Mix design, the water cement ratio should not exceed 0.45. The exposure condition to be considered as severe.

1.9 Materials in General

- 1.9.1 The term "materials" shall mean all materials, goods and articles of every kind whether raw, processed or manufactured and equipment and plant of every kind to be supplied by the Contractor for incorporation in the Works.
- 1.9.2 Except as may be otherwise specified for particular parts of the works the provision of clauses in "Materials and Workmanship" shall apply to materials and workmanship for any part of the works.
- 1.9.3 All materials shall be new and of the kinds and qualities described in the Contract and shall be at least equal to approved samples.
- 1.9.4 As soon as practicable after receiving the order to commence the Works, the Contractor shall inform EMPLOYER of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of EMPLOYER which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep EMPLOYER informed of orders for and delivery dates of all materials.
- 1.9.5 Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

1.10 Samples and Tests of Materials

- 1.10.1 The Contractor shall submit samples of such materials as may be required by EMPLOYER and shall carry out the specified tests directed by EMPLOYER at the Site, at the supplier's premises or at a laboratory approved by EMPLOYER. EMPLOYER may appoint separate third party inspection for the material testing to ensure the quality of the work. The Contractor shall replace the defective material as an outcome of these tests.
- 1.10.2 Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by EMPLOYER.

- 1.10.3 The Contractor shall give EMPLOYER seven days' notice in writing of the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at a laboratory approved by EMPLOYER. Representative of EMPLOYER shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by EMPLOYER to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to EMPLOYER's Representative within seven days of every test such number of certified copies (minimum six) of the test results as EMPLOYER may require.
- 1.10.4 Approval by EMPLOYER as to the placing of orders for materials or as to samples or tests shall not prejudice any of EMPLOYER's powers under the Contract.
- 1.10.5 The provisions of this clause shall also apply fully to materials supplied under any nominated sub-contract.
- 1.10.6 If need arises, non destructive of the structural components shall be carried out by the agency as per directions of engineer in charge of client at his own cost.

1.11 Standards

- 1.11.1 Materials and workmanship shall comply with the relevant Indian Standards (with amendments) current on the date of submission of the tender.
- 1.11.2 Where the relevant standard provides for the furnishing of a certificate to EMPLOYER, at his request, stating that the materials supplied comply in all respects with the standard, the Contractor shall obtain the certificate and forward it to EMPLOYER.
- 1.11.3 The specifications, standards and codes listed below are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.
- 1.11.4 In case of discrepancy between the Bid Specification and the Standards referred to herein, the Bid Specification shall govern.

a) Materials

IS : 269	Specification for 33 grade ordinary Portland cement
IS : 383	Specification for coarse and fine aggregates from natural sources for concrete
IS : 428	Specification for distemper, oil emulsion, colour as required
IS : 432	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (Parts 1 & 2)
IS : 455	Specification for Portland slag cement
IS : 458	Specification for precast concrete pipes(with and without reinforcement)
IS : 650	Specification for standard sand for testing of cement
IS : 651	Specification for salt glazed stoneware pipes and fittings
IS : 777	Specification for glazed earthenware tiles
IS : 808	Specification for dimensions for hot rolled steel beam, column, channel and angle sections
IS : 814	Specification for covered electrodes for manual metal arc welding of Carbon and Carbon Manganese steel
IS : 1003	Specification for timber paneled and glazed shutters(Parts 1 & 2)
IS : 1038	Specification for steel doors, windows and ventilators
IS : 1077	Specification for common burnt clay building bricks
IS : 1398	Specification for packing paper, water proof, bitumen laminated

IS : 1489	Specification for Portland pozzolana cement (Parts 1 & 2)
IS : 1566	Specification for hard drawn steel wire fabric for concrete reinforcement
IS : 1580	Specification for bituminous compounds for water proofing and caulking purposes
IS : 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement
IS : 1852	Specification for rolling and cutting tolerances for hot rolled steel products
IS : 1948	Specification for aluminium doors, windows and ventilators
IS : 1977	Specification for structural steel (ordinary quality)
IS : 2062	Specification for steel for general structural purposes
IS : 2185	Specification for concrete masonry units (Parts 1 & 2)
IS : 2202	Specification for wooden flush door shutters (Parts 1 & 2)
IS : 2645	Specification for integral cement water proofing compounds
IS : 2750	Specification for steel scaffoldings
IS : 2835	Specification for flat transparent sheet glass
IS : 3384	Specification for bitumen primer for use in waterproofing and damp roofing
IS : 3502	Specification for steel chequered plates
IS : 4021	Specification for timber door, window and ventilator frames
IS : 4350	Specification for concrete porous pipes for under drainage
IS : 4351	Specification for steel door frames
IS : 4990	Specification for plywood for concrete shuttering work
IS : 8112	Specification for 43 grade ordinary Portland cement
IS : 9862	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
IS : 10262	Recommended guidelines for concrete mix design
IS : 12269	Specification for 53 grade ordinary Portland cement
IS : 12330	Specification for sulphate resisting Portland cement
IS : 12709	Glass fibre reinforced plastics (GRP) pipes, joints and fittings for use for potable water supply

b) Tests

IS : 516	Method of test for strength of concrete
IS : 1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS : 1199	Methods of sampling and analysis of concrete
IS : 2386	Methods of test for aggregates for concrete(Parts 1 to 8)
IS : 2720	Methods of test for soils (Parts 1 to 39)
IS : 3025	Methods for sampling and test (physical and chemical) for water and wastewater (Parts 1 to 44)
IS : 3495	Method of test for burnt clay building bricks(Parts 1 to 4)
IS : 3613	Acceptance tests for wire flux combination for submerged arc welding
IS : 4020	Methods of tests for wooden flush doors Type tests
IS : 4031	Methods of physical tests for hydraulic cement (Parts 1 to 15)
IS : 5807	Method of test for clear finishes for wooden furniture (Parts 1 to 6)
IS : 7318	Approval tests for welders when welding procedure approval is not required (Parts 1 and 2)

c) Codes of Practice

IS :456	Code of practice for plain and reinforced concrete
IS : 783	Code of practice for laying of concrete pipes
IS : 800	Code of practice for general construction in steel
IS : 806	Code of practice for use of steel tubes in general building construction
IS : 816	Code of practice for use of metal arc welding for general construction in mild steel

IS : 817	Code of practice for training and testing of metal arc welders
IS : 875	Code of practice for design loads (other than earthquake) for building structures(Parts 1 to 5)
IS : 1081	Code of practice for fixing and glazing of metal (steel and aluminum) doors, windows and ventilators
IS : 1172	Code of practice for basic requirements for water supply, drainage and sanitation
IS : 1477	Code of practice for painting of ferrous metals in buildings (Parts 1&2)
IS : 1597	Code of practice for construction of stone masonry (Parts 1 &2)
IS : 1742	Code of practice for building drainage
IS : 1893	Criteria for earthquake resistant design of structures
IS : 2065	Code of practice for water supply in buildings
IS : 2212	Code of practice for brickwork
IS : 2338	Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
IS : 2394	Code of practice for application of lime plaster finish
IS : 2395	Code of practice for painting, concrete, masonry and plaster surfaces (Parts 1 & 2)
IS : 2470	Code of practice for installation of septic tanks (Parts 1 & 2)
IS : 2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS : 2571	Code of practice for laying in situ cement concrete flooring
IS : 2595	Code of practice for radiographic testing
IS : 2751	Recommended practice for welding of mild steel plain and deformed bars for reinforced construction
IS : 2974	Code of practice for design and construction of machine foundations (Parts 1 to 4)
IS : 3114	Code of practice for laying of Cast Iron pipes
IS : 3370	Code of practice for concrete structures for the storage of liquids (Parts 1 to 4)
IS : 3414	Code of practice for design and installation of joints in buildings
IS : 3558	Code of practice for use of immersion vibrators for consolidating concrete
IS : 3658	Code of practice for liquid penetrant flaw detection
IS : 3935	Code of practice for composite construction
IS : 4000	Code of practice for High strength bolts in steel structures
IS : 4014	Code of practice for steel tubular scaffolding (Parts 1 & 2)
IS : 4111	Code of practice for ancillary structures in sewerage system (Parts 1-4)
IS : 13920	Code of practice for laying of glazed stoneware pipes
IS: 4326	Code of practice for Earthquake Resistant Design and Construction of Buildings
IS : 4353	Recommendations for submerged arc welding of mild steel and low alloy steels
IS : 5329	Code of practice for sanitary pipe work above ground for buildings
IS : 5334	Code of practice for magnetic particle flaw detection of welds
IS : 5822	Code of practice for laying of welded steel pipes for water supply
IS : 7215	Tolerances for fabrication of steel structures
IS : 9595	Recommendations for metal arc welding of carbon and carbon manganese steels
IS : 10005	SI units and recommendations for the use of their multiples and of certain other units

d) Construction Safety

IS : 3696	Safety code for scaffolds and ladder (Parts 1 & 2)
IS : 3764	Safety code for Excavation work
IS : 7205	Safety code for erection of structural steel work

1.12 Orientation

1.12.1 The works shall be laid out within the confines of the Site in order to interface to the existing infrastructure of roadways and inlet and outlet pipework . Underground services requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of EMPLOYER, be relocated by the Contractor.

1.13 Buildings and Structures

1.13.1 All the building and structure works shall generally comply with the following EMPLOYER's requirements unless otherwise specified elsewhere.

1. All building works shall be of reinforced concrete framework.
2. All external walls shall be in 230 mm thick brick masonry built cement mortar in 1:4. Transoms and mullions of 115 mm x 230 mm size with four numbers 6 mm bars and 6 mm links at 150 mm c/c shall be provided to form panels not exceeding 3500 mm x 3500 mm in size.
3. All internal partition walls except for toilets and Residential units shall be in 230 mm thick brick masonry built in cement mortar 1:4 with transoms and mullions as in (2) above. Toilet partition walls shall be in 115 mm thick brick masonry built in cement mortar 1:4 and shall have transoms and mullions as in (2) above and shall form panels not exceeding 1200 mm x 1200 mm in size.
 - (a) Finishes to concrete liquid retaining structures (for details, refer clause 3.16 of this volume) shall be :

F1	-	External surfaces, buried
F2	-	External surfaces exposed and up to 300 mm below ground level
F2	-	Internal surfaces
 - (b) Finishes to other concrete structures (for details, refer clause 3.16 of this volume) shall be :

F1	-	Buried
F1	-	Exposed, where plastering is specified
F2	-	Exposed
4. All internal masonry surfaces finish shall have 15 mm thick plain faced cement plaster in cement mortar (1:4) with neat lime or neeru finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.
5. All external masonry surfaces shall have 20 mm thick sand faced cement plaster in cement mortar (1:3) in two coats. Waterproofing compound of approved make and quality shall be added to the cement mortar in proportions as specified by the manufacturer.
6. All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

7. All staircases shall have 25 mm thick chequered mosaic tiles for treads and 25 mm thick plain mosaic tiles of approved shade for risers set in cement mortar or lime mortar to give an overall thickness of 50 mm.

Stairways shall be provided to permit access between different levels within buildings. All roof tops and overhead tanks shall be made accessible with ladder provision. Vertical ladders fitted with landing point extensions will be permitted where considered appropriate by the EMPLOYER to access areas not frequently visited.

8. All floor cut-outs and cable ducts, etc. shall be covered with precast concrete covers in outdoor areas and mild steel chequered plates of adequate thickness in indoor areas. All uncovered openings shall be protected with M.S. hand railing of 32 NB (M).
9. All staircases shall be provided with 32 NB (M) galvanised M.S. pipe hand railing for protection.
10. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W downtake inlet points.
11. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water. Chajjas, canopies and roof projections shall have drip moulds.
12. Building plinth shall be minimum 600 mm above average finished ground level around building.
13. All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with handrailings.
14. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act.
15. All rooms in the buildings shall be provided with appropriate sign boards indicating the function of the rooms involved.
16. The design of buildings shall be suitable for the climatic conditions existing on site. Buildings shall as far as is possible permit the entry of natural light.

1.14 Roadways, & Pathways

- 1.14.1 A comprehensive network of roadways shall be provided around the structures to link in with the existing road network and permit access to the units for necessary maintenance, delivery of consumables and personnel access. All roads shall be of asphalt macadam / CC Pavement and minimum 5 metres wide with 1.5 m wide paved shoulders on both side. Vehicular access shall be provided for all Plant structures and buildings. All roads shall be provided with drainage and shall be constructed to prevent standing water.

1.15 Site Drainage

The contractor shall provide a site drainage system which shall comprise of the Storm Water Drainage and Foul Drainage.

1.15.1 Storm Water Drainage

Storm water drains adjacent to the existing and proposed roads (under this Contract) shall be sized for a rainfall intensity of 80 mm/hr, allowing for 100% runoff. Drains adjacent to roads shall be in RCC (M25) of appropriate thickness, topped with M25 precast concrete covers and plastered internally in cement mortar (1:4), 20 mm thick.

The storm water drainage system shall be designed to cater for the run-off from the structures, if necessary.

1.17.2 All drains (except storm water drains adjacent to roads) shall be covered and designed structurally for appropriate loads.

1.16 Valve Chambers

All valve chambers are to be of an adequate size to facilitate maintenance and operation. The base slab of valve chambers shall slope towards a sump pit from which water can be pumped to keep the chamber dry. All valve chambers shall be constructed in M20 grade reinforced concrete / 8mm thk. MS plate cover. Chambers shall have removable reinforced concrete covers, as appropriate, approach ladders and valve supports.

1.17 Landscaping

1.19.1 The GSR plot site shall be landscaped once the Works are substantially complete. The landscaping scheme shall be submitted and got approved from EMPLOYER prior to start of actual work.

1.19.2 Landscaping shall include planting of suitable trees and development of grassed areas. Landscaping in general shall meet ecological and environmental conditions of the site. Road widths shall determine the size of the tree height and spread to be selected for planting. Trees suitable for local conditions shall be selected. Medicinal and fruit trees shall be avoided.

1.19.3 Tree Planting

Pits dug a few days in advance of actual planting shall be allowed to weather and be filled with top soil mixed with manure. Size of the pit shall be as per standard requirement. Only one tree shall be planted in each pit. A guard made of bamboo with wire mesh shall be provided.

2.0 EARTHWORKS

2.1 Applicable Codes

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

- | | | |
|----|------------------|---|
| a) | IS 783 - 1985 - | Code of practice for laying of concrete pipes. |
| b) | IS 3764 - 1992 | - Excavation work - Code of Safety . |
| c) | IS 2720 | - Methods of test for soils: |
| | (Part-1) - 1983 | - Part 1 Preparation of dry soil samples for various tests. |
| | (Part-2) - 1986 | - Part 2 Determination of Water Content. |
| | (Part-4) - 1985 | - Part 4 Grain size analysis. |
| | (Part-5) - 1985 | - Part 5 Determination of liquid and plastic limit. |
| | (Part-7) - 1980 | - Part 7 Determination of water content - dry density relation using light compaction. |
| | (Part-9) - 1971 | - Part 9 Determination of dry density - moisture content by constant weight of soil method. |
| | (Part-14) - 1983 | - Part 14 Determination of density index (relative density) of cohesionless soils. |
| | (Part-22) - 1978 | - Part 22 Determination of organic matter. |
| | (Part-26) - 1987 | - Part 26 Determination of pH Value. |
| | (Part-27) - 1987 | - Part 27 Determination of total soluble sulphates. |
| | (Part-28) - 1974 | - Part 28 Determination of dry density of soils in place, by the sand replacement method. |
| | (Part-33) - 1971 | - Part 33 Determination of the density in place by the ring and water replacement method. |
| | (Part-34) - 1972 | - Part 34 Determination of density of soil in place by rubber balloon method. |
| | (Part-38) - 1976 | - Part 38 Compaction control test (Hilf Method) |

2.2 General

- 2.2.1 The Contractor shall furnish all tools, plant, instruments, qualified supervisory personnel, labour, materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Employer's Requirements.

- 2.2.2 The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area perpendicular to established reference/grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.
- 2.2.3 The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.
- 2.2.4 Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Employer's Representative. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.
- 2.2.5 Topsoil shall be stock piled separately for later re-use.

2.3 Clearing the site

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

2.4 Excavation

- 2.4.1 All excavation work shall be carried out by mechanical equipment unless, in the opinion of Employer's Representative, the work involved requires it to be carried out by manual methods.
- 2.4.2 Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings provided by the Contractor or such other lines and grades as may be agreed with the Employer's Representative. Rough excavation shall be carried out to a depth of 150mm above the final level. The balance shall be excavated with special care. Soft pockets shall be removed below the final level and extra excavation filled up with lean concrete as approved by the Employer's Representative. The final excavation should be carried out just prior to laying the blinding course.
- 2.4.3 To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the drawings provided by the Contractor as agreed with the Employer's Representative. Should any excavation be taken below the specified elevations, the Contractor shall fill it up with concrete of the same class as in the foundation resting thereon, upto the required elevation at no cost to the Employer.
- 2.4.4 All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Employer's Representative shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips.

Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

2.4.5 This work shall consist of removing, as hereinafter set forth, existing buildings, roofs, ceiling, flooring and paving, concrete and brick work, partitions, wood work, steel and iron work, doors and windows, pipes and sewer lines, posts or struts, fencing wire mesh, glazing, culverts, bridges, pavements, kerbs and other structures like guard-rails, utility services, catch basins, inlets, etc., which are in place but interfere with the new construction or are not suitable to remain in place, and of salvaging and disposing of the resulting materials and back filling the resulting trenches and pits.

2.4.6 Unless otherwise directed on the project specifications, all the following items are included in the excavation:

1. Removing all surface obstructions including shrubs, jungle etc.
2. Making all necessary excavations true to line and grade,
3. Furnishing and installing all shoring and bracing as necessary or as directed
4. Pumping and bailing out water to keep trenches free of water during pipe laying and jointing and thereafter until joints mature,
5. Providing for uninterrupted surface water flow during work in progress,
6. Providing for disposing off water flows from storm, drains, nallas or other sources, suitably,
7. Protecting all pipes, conduits, culverts, railway tracks, utility poles, wire fences, buildings, and other public and private property adjacent to or in the line of work,
8. Removing all shoring and bracing which is not ordered to be left in place or not required by the project plans or specifications to remain in place,
9. Hauling away and disposing of excavated materials not necessary or else unsuitable for back filling purpose. The extra excavated soil will have to be properly as directed,
10. Backfilling the trenches as directed or as per specifications,
11. Restoring all property injured or disturbed by these construction activities to the condition as near its original condition as possible,
12. Restoring the surface and repairing of all roads, streets, alleys, walks, drives, working spaces, and rights of way to a condition as good as prior to excavation.

2.4.7 Slips and Slides

If slips, slides, over-breaks or subsidence occur in cutting during the process of construction, they shall be removed at the cost of the contractor as ordered by the Engineer. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

2.5 Rock

2.5.1 General

‘Rock’ means a natural aggregate of mineral crystals which for its excavation would normally require the use of heavy pneumatic/hydraulic breaker and/or cutting equipment or explosives. The term shall exclude any material that can be removed by ordinary excavating machinery and which in any individual mass has a volume not exceeding 1m^3 or 0.25m^3 where the net width of excavation is less than 2 m. Ordinary excavating machinery means a hydraulic back hoe with rated output of 50 KW or less.

2.5.2 Before classification of material as rock the Contractor shall demonstrate to the satisfaction of the Employer’s Representative his inability to excavate it without resort to heavy percussion tools complete with rock bits, hydraulic wedges or blasting. Excavation by the use of explosive will not normally be permitted except for pipeline.

2.5.3 Material shall not be classified as rock unless the Employer's Representative has agreed to such classification on the basis of such a demonstration before its excavation. Excavations where rock has been encountered and classified as such shall not be backfilled before examination of the excavated faces by the Employer's Representative to enable the extent of the rock excavation to be determined.

2.5.4 Excavation by the Use of Explosives

Unless otherwise stated herein, I.S. Specification " IS:4081: Safety Code for Blasting and related Drilling Operations" shall be followed. As far as possible all blasting shall be completed prior to commencement of construction. At all stages 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 explosives used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Employer's Representative, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Employer's Representative at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

2.5.5 The contractor shall obtain a valid Blasting License from the authorities concerned. 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 magazine. The magazine shall be built as away as possible from the area to be blasted. Employer's Representative's prior approval shall be taken for the location proposed for the magazine.

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

2.5.7 For blasting operations, the following points shall be observed.

- i) 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.
- ii) Before any blasting is carried out, Contractor shall intimate Employer's Representative and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.
- iii) 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 a warning by sounding a distinguishing whistle.
- iv) The blasting of rock near any existing buildings, equipments 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 MS plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Employer's Representative, a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.
- v) 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.

- vi) 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 place 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 stone dust or similar inert material.
- vii) Contractor shall preferably detonate the explosives electrically.
- viii) The explosives shall be exploded by means of a 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.
- ix) 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. Underwater or for excavation in rock with substantial accumulated seepage electric detonation shall be used.
- x) 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.
- xi) 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 an overbreak limit of 75 mm shall be filled up as instructed by Employer's Representative, with concrete of strength not less than M10. Stopping in rock excavation shall be done by hand trimming.
- xii) Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. 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 as applicable at the place of excavation.

2.6 Stripping Loose Rock

- 2.6.1 All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Employer's Representative, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion which was originally sound and safe.
- 2.6.2 Any material not requiring removal in order to complete the permanent works, but which, in the opinion of Employer's Representative, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

2.7 Fill, Backfilling and Site Grading

2.7.1 General

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

- 2.7.2 No earthfill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Employer's Representative.

2.7.3 Material

To the extent available, selected surplus soil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of

earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murum or earth to fill the voids and the mixture used for filling.

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

2.7.5 Filling in pits and trenches around foundations of structures, walls, etc.

As soon as the work in foundations has been accepted and measured, the spaces around the foundations, structures, pits, trenches, etc., shall be cleared of all debris, and filled with earth in layers not exceeding 15 cm, each layer being watered, rammed and properly consolidated, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of Employer's Representative. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the Employer's Representative is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and leveled to a proper profile to the approval of the Employer's Representative.

2.7.6 Plinth Filling

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

2.7.7 Compaction of the plinth fill shall be carried out by means of 12 ton rollers smooth wheeled, sheep-foot or wobbly wheeled rollers. In case of compaction of granular material such as sands and gravel, vibratory rollers shall be used. A smaller weight roller may be used only if permitted by the Employer's Representative. As rolling proceeds, water sprinkling shall be done to assist consolidation. Water shall not be sprinkled in case of sandy fills.

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

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

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

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

2.7.12 Sand Filling in Plinth and Other Places

Where backfilling is required to be carried out with local sand it shall be clean, medium grained and free from impurities. The filled-in-sand shall be kept flooded with water for 24 hours to ensure maximum consolidation. The surface of the consolidated sand shall be dressed to required level or slope. Construction of floors or other structures on sand fill shall not be started until the Employer's Representative has inspected and approved the fill.

2.7.13 Filling in Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipe and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care so that no damage is caused to the pipes.

2.7.14 Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of the centre line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15 cm.

2.7.15 In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murum, etc. The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

2.7.16 Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

2.8 General Site Grading

2.8.1 Site grading shall be carried out as indicated in the drawings and as approved by the Employer's Representative. Excavation shall be carried out as specified in the Employer's Requirements. Filling and compaction shall be carried out as specified under Clause 2.7 and elsewhere unless otherwise indicated below.

2.8.2 If no compaction is called for, the fill may be deposited to the full height in one operation and levelled. If the fill has to be compacted, it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 2.7 before the next layer is deposited.

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

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

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

2.8.6 If so specified, the rock as obtained from excavation may be used for filling and levelling to indicated grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cms approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 ton roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

2.9 Fill Density

2.9.1 The compaction, under the plant road area and building plinths shall comply with minimum 95% compaction by Standard Proctor at moisture content differing not more than 4% from the optimum moisture content. The Contractor shall demonstrate adequately by field and laboratory tests that the specified density has been obtained. In other areas the soil should be backfilled and compacted suitably as specified by the Engineer.

2.10 Timber Shoring

2.10.1 Close timbering shall be done by completely covering the sides of the trenches and pits generally with short, upright members called 'polling boards'. These shall be of minimum 25 cm x 4 cm sections or as approved by the Employer's Representative. The boards shall generally be placed in position vertically side by side without any gap on each side of the excavation and shall be secured by horizontal walling of strong wood at maximum 1.2 metre spacings, strutted with ballies or as approved by the Employer's Representative. The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

2.10.2 Timber shoring shall be 'close' or 'open' type, depending on the nature of soil and the depth of pit or trench. The type of timbering shall be as approved by the Employer's Representative. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. from collapsing.

2.10.3 Timber shoring may also be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the Employer's Representative.

2.10.4 The withdrawal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

2.10.5 In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width. The detailed arrangement, sizes of the timber and the spacings shall be subject to the approval of the Employer's Representative. In all other respects, the Employer's Requirements for close timbering shall apply to open timbering.

2.10.6 In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of

excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

2.11 Dewatering

- 2.11.1 The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Employer's Representative, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.
- 2.11.2 The Contractor shall study the sub-soil conditions carefully and shall conduct any tests necessary at the site with the approval of the Employer's Representative to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.
- 2.11.3 The scheme for dewatering and disposal of water shall be approved by the Employer's Representative. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a build up of water in the opinion of the Employer's Representative obstructs the progress of the work, leads to insanitary conditions by stagnation, retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.
- 2.11.4 When there is a continuous inflow of water and the quantum of water to be handled is considered in the opinion of Employer's Representative, to be large, a well point system-single stage or multistage, shall be adopted. The Contractor shall submit to the Employer's Representative, details of his well point system including the stages, the spacing, number and diameter of well points, headers etc., and the number, capacity and location of pumps for approval.

2.12 Rain Water Drainage

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

3.0 CONCRETE WORKS

3.1 Applicable Codes

3.1.1 Materials

- 1) IS:269 Specification for 33 grade ordinary portland cement.
- 2) IS:455 Specification for portland slag cement.
- 3) IS:1489 Specification for portland-pozzolana cement (Part 1&2).
- 4) IS:8112 Specification for 43 grade ordinary portland cement.
- 5) IS:12269 Specification for 53 grade ordinary portland cement.
- 6) IS:12330 Specification for sulphate resisting portland cement.
- 7) IS:383 Specification for coarse and fine aggregates from natural sources for concrete.
- 8) IS:432 Specification for mild steel and medium (tensile steel bars and hard-drawn steel) wires for concrete reinforcement. (Part 1 and 2)
- 9) IS:1786 Specification for high strength deformed steel bars and wires for concrete reinforcement.
- 10) IS:1566 Specification for hard-drawn steel wire fabric for concrete reinforcement.
- 11) IS:9103 Specification for admixtures for concrete.
- 12) IS:2645 Specification for integral cement water- proofing compounds.
- 13) IS:4990 Specification for plywood for concrete shuttering work.

3.1.2 Material Testing

- 1) IS:4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)
- 2) IS:4032 Method chemical analysis of hydraulic cement.
- 3) IS:650 Specification for standard sand for testing of cement.
- 4) IS:2430 Methods for sampling of aggregates for concrete.
- 5) IS:2386 Methods of test for aggregates for concrete (Parts 1 to 8)
- 6) IS:3025 Methods of sampling and test (physical and chemical) for water used in industry.
- 7) IS:6925 Methods of test for determination of water soluble chlorides in concrete admixtures.

3.1.3 Material Storage

- 1) IS:4082 Recommendations on stacking and storing of construction materials at site.

3.1.4 Concrete Mix Design

- 1) IS:10262 Recommended guidelines for concrete mix design.
- 2) SP:23 (S&T) Handbook on Concrete Mixes

3.1.5 Concrete Testing

- 1) IS.1199 Method of sampling and analysis of concrete.
- 2) IS:516 Method of test for strength of concrete.
- 3) IS:9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.
- 4) IS:8142 Method of test for determining setting time of concrete by penetration resistance.
- 5) IS:9284 Method of test for abrasion resistance of concrete.
- 6) IS:2770 Methods of testing bond in reinforced concrete.

3.1.6 Equipments

- 1) IS:1791 Specification for batch type concrete mixers.
- 2) IS:2438 Specification for roller pan mixer.
- 3) IS:4925 Specification for concrete batching and mixing plant.
- 4) IS:5892 Specification for concrete transit mixer and agitator.
- 5) IS:7242 Specification for concrete spreaders.
- 6) IS:2505 General Requirements for concrete vibrators: Immersion type.
- 7) IS:2506 General Requirements for screed board concrete vibrators.
- 8) IS:2514 Specification for concrete vibrating tables.
- 9) IS:3366 Specification for pan vibrators.
- 10) IS:4656 Specification for form vibrators for concrete.
- 11) IS:11993 Code of practice for use of screed board concrete vibrators.
- 12) IS:7251 Specification for concrete finishers.

- 13) IS:2722 Specification for portable swing weigh batchers for concrete (single and double bucket type).
- 14) IS:2750 Specification for steel scaffoldings.

3.1.7 Codes Of Practice

- 1) IS:456 Code of practice for plain and reinforced concrete.
- 2) IS:457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
- 3) IS:3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
- 4) IS:3935 Code of practice for composite construction.
- 5) IS:2204 Code of practice for construction of reinforced concrete shell roof.
- 6) IS:2210 Criteria for the design of reinforced concrete shell structures and folded plates.
- 7) IS:2502 Code of practice for bending and fixing of bars for concrete reinforcement.
- 8) IS:5525 Recommendation for detailing of reinforcement in reinforced concrete works.
- 9) IS:2751 Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
- 10) IS:9417 Specification for welding cold worked bars for reinforced concrete construction.
- 11) IS:3558 Code of practice for use of immersion vibrators for consolidating concrete.
- 12) IS:3414 Code of practice for design and installation of joints in buildings.
- 13) IS:4326 Code of practice for earthquake resistant design and construction of building.
- 14) IS:4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)
- 15) IS:2571 Code of practice for laying insitu cement concrete flooring.
- 16) IS:7861 Code of practice for extreme weather concreting : Part 1 Recommended practice for hot weather concreting.

3.1.8 Construction Safety

- 1) IS.3696 Safety code for scaffolds and ladders. (Parts 1 & 2)
- 2) IS:7969 Safety code for handling and storage of building materials.

3) IS:8989 Safety code for erection of concrete framed structures.

3.2 General

3.2.1 The EMPLOYER shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, the concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the EMPLOYER's approval obtained, prior to starting of concrete work. This shall, however, not relieve the Contractor of any of his responsibilities. All materials which do not conform to the Specifications shall be rejected.

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

3.3 Materials

3.3.1 Cement

Cement shall be ordinary portland cement conforming to IS:269, IS:8112 or IS:12269 for all structures.

3.3.2 Where Portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.

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

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

3.3.5 Aggregates (General)

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS:383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

3.3.6 Aggregates shall be washed and screened before use where necessary or if directed by the EMPLOYER.

3.3.7 Aggregates containing reactive materials shall be used only after tests conclusively prove that there will be no adverse effect on strength, durability and finish, including long term effects, on the concrete.

3.3.8 The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

3.3.9 The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 1/4 of the minimum thickness of the member.

3.3.10 Plums 160 mm and above of a reasonable size may be used in mass concrete fill where directed. Plums shall not constitute more than 20% by volume of the concrete.

3.3.11 Water

Water used for both mixing and curing shall conform to IS:456. Potable waters are generally satisfactory. Water containing any excess of acid, alkali, sugar or salt shall not be used.

3.3.12 Reinforcement

All reinforcement steel shall be of TMT Fe-500 grade and welded wire fabric to IS:1566 as shown or specified on the drawing.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust, or any other substance that will destroy or reduce bond.

3.3.13 Admixtures

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

3.3.13.2 Admixtures may be used in concrete as per manufacturer's instructions only with the approval of the EMPLOYER. An admixture's suitability and effectiveness shall be verified by trial mixes with the other materials used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embeddings.

3.3.13.3 Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted such as in mass concrete works, it shall be dissolved in water and added to the mixing water by an amount not exceeding 1.5 percent of the weight of the cement in each batch of concrete. The designed concrete mix shall be corrected accordingly.

3.3.14 Wastage

Wastage allowance for cement and steel shall not be considered and no extra payment shall become payable to the Contractor on any account.

3.4 Samples and Tests

3.4.1 All materials used for the works shall be tested before use.

3.4.2 Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by the EMPLOYER samples shall also be got tested by the Contractor in a laboratory approved by the EMPLOYER at no extra cost to Employer. EMPLOYER may appoint separate third party inspection for the material testing to ensure the quality of the work. The Contractor shall replace the defective material as an outcome of these tests.

3.4.3 Sampling and testing shall be as per IS:2386 under the supervision of the EMPLOYER.

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

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

3.5 Storing of Materials

- 3.5.1 All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS:4082 shall be complied with.
- 3.5.2 The Contractor will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by the EMPLOYER. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.
- 3.5.3 Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.
- 3.5.4 The Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.
- 3.5.5 The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

3.6 Concrete

3.6.1 General

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

3.6.1a Ready mix concrete

Minimum cement consumption shall be as specified in tender document. However, necessary computer print out for consumption of all materials and admixtures if permitted shall be made available as and when required in any frequencies as directed by Engineer –in-charge.

Necessary slump requirements at the pouring places shall be made available with ready mix concrete.

Concrete mix shall be design for 33% higher strength than the grade of concrete specified. The proportions for ingredients chosen shall be such that concrete has adequate workability for condition prevailing on the work in question and can be properly compacted with the means available. Use of cementitious material like Fly ash etc. shall not be permissible.

Except where it can be shown to the satisfaction of the Engineer-in-charge that a supply of properly graded aggregate of uniform quality can be maintained till the completion of work, grading of aggregate should be strictly controlled. The different sizes shall be stocked in separate stock piles. Required quality of material shall be stock-piled several hours, preferably a day, before use. Grading of coarse and fine aggregate shall be checked as frequently as possible, frequency for a given job being determined by the Engineer-in-charge to ensure that the suppliers are maintaining the uniform grading as approved for samples used in the design mix.

The quantity of both cement and aggregate shall be determined by weight. Water shall either be measured by volume in calibrated tanks or weighed. All measuring equipment shall be maintained in a clean and serviceable condition. Their accuracy shall be periodically checked.

It is most important to keep the specified water – cement ratio constants and its correct value. To this end, the moisture content in both fine and coarse aggregates shall be determined by the Engineer-in-charge according to the weather conditions. The amount of mixing water shall then be adjusted to compensate for variations in the moisture content. For the determination of moisture content in the aggregates, IS: 2386 (Part-III) shall be referred to. Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content.

The special Conditions / Specification regarding RMC are as follows.

The details like locations, capacity, experience, delivery schedule etc. of the RMC agency shall be submitted by the successfully tenderer for prior approval of the undersigned.

The RMC shall be conforming to IS :4926 with its latest amendments.

All the responsibility of RMC i.e. procurement for all materials, operation of plant and machinery, transit mixers, pumping machineries relevant piping etc. shall be on the account of the contractor.

The client shall not be held responsible for any delay / damage / loss due to deployment of RMC for this project.

All taxes for the RMC shall have to be borne by the contractor as per prevailing rates.

RMC process shall be fully automatic and computerized

When a transit mixer is used for transportation of concrete, no extra water should be added to the concrete from else where after initial introduction of mixing water from the batch, except when on arrival at the site of the work, the slump of the concrete is less than that specified : such additional water to bring the mixer under such pressure and direction of flow that requirements for uniformity are met.

Records and certificates : The contractor shall keep from the manufacture batch records of the quantities by mass of all mixing and of the results of all tests. If required by the client, the contractor shall furnish certificates, at agreed intervals, giving this information.

The contractor shall supply the following information for guidance of the manufacturer :

The type of cement to be used

Details Specification of aggregates to be used.

Type of admixture to be used. If specified.

Min. acceptable strength

Slump of concrete or compaction factor

Ages at which the test cubes or beams are to be tested and the frequency and number of test to be made.

Any other requirement.

Tolerance : Unless otherwise agreed to between the AMC and the contractor, the concrete shall be deemed to comply with the requirements of this, if these results of testes where applicable lie with in the tolerance specified below.

Consistency of workability : The slump average of two tests shall not differ from the specified value by + 10 mm for a specified slump of 75 mm. The compacting factor average of two test shall be within + 0.03 of the value specified. If any other method of determining consistency to be used a suitable tolerance shall be agreed to be between the purchaser and the manufacture. The tests for consistency or workability shall be complete within 15 minutes of the time of receipt of the ready mix concrete at the site.

Aggregate : When tested in accordance with IS 2386 (Part-I) 1963, the quantity of aggregate larger than the max size specified by the purchaser shall not exceed 5% of the qty. of coarse aggregate and all such pass sieve of next higher size.

If ready mix concrete is used for structural concrete work, mix design as approved by employer should be got approved accordingly and stringent quality control to be done. Prior approval to be taken from employer in case of external RMC plant deployed by contractor for the selection of external RMC plant.

3.6.2 Design Mix Concrete

3.6.2.1 Mix Design & Testing

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

3.6.2.1.2 The minimum cement content for Design Mix Concrete shall be as per Appendix-A of IS:456 or as given below, whichever is higher.

Grade of Concrete	Minimum Cement Content in Kg/Cu.m of Concrete
M15	320
M20	360
M25	380
M30	410

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

3.6.2.1.4 It shall be the Contractor's sole responsibility to carry out the mix designs at his own cost. He shall furnish to the EMPLOYER at least 30 days before concreting operations, a statement of proportions proposed to be used for the various concrete mixes and the strength results obtained. The strength requirements of the concrete mixes ascertained on 150 mm cubes as per IS:516 shall comply with the requirements of IS:456.

Grade of Concrete	Minimum Compressive Strength N/sq. mm at 7 days	Specified Characteristic Compressive Strength N/sq. mm at 28 days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

3.6.2.1.5 A range of slumps which shall generally be used for various types of construction unless otherwise instructed by the EMPLOYER is given below :

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

3.6.2.2 Batching & Mixing of Concrete

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

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

3.6.2.2.3 Arrangement should be made by the Contractor to have the cubes tested in an approved laboratory or in field with prior consent of the EMPLOYER. Sampling and testing of strength and workability of concrete shall be as per IS:1199, IS:516 and IS:456, IS 3370.

3.6.3 Nominal Mix Concrete

3.6.3.1 Mix Design & Testing

Mix design and preliminary tests are not necessary for Nominal Mix Concrete. However works tests shall be carried out as per IS:456. Proportions for Nominal Mix Concrete and w/c ratio may be adopted as per Table 3 of IS:456. However it will be the Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

3.6.3.2 Batching & Mixing of Concrete

Based on the adopted nominal mixes, aggregates shall be measured by volume. However cement shall be by weight only.

3.7 Formwork

All formwork shall be designed as per IS-14687.

- 3.7.1 Formwork shall be all inclusive and shall consist of but not be limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs etc. including ties, anchors, hangers, inserts, falsework, wedges etc.
- 3.7.2 The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the EMPLOYER, the drawings and calculations for the design of the formwork shall be submitted to the EMPLOYER for approval.

Formwork shall be designed to fulfill the following requirements :

- (a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.
 - (b) Made of suitable materials.
 - (c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
 - (d) Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.
 - (e) Capable of easy striking out without shock, disturbance or damage to the concrete.
 - (f) Soffit forms capable of imparting a camber if required.
 - (g) Soffit forms and supports capable of being left in position if required.
 - (h) Capable of being cleaned and/or coated if necessary immediately prior to casting the concrete; design temporary openings where necessary for these purposes and to facilitate the preparation of construction joints.
- 3.7.4 The formwork may be of timber, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the EMPLOYER. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.
- 3.7.5 The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved mould oil applied before fixing reinforcement. All rubbish, particularly chippings, shavings, sawdust, wire pieces dust etc. shall be removed from the interior of the forms before the concrete is placed. Where directed, cleaning of forms shall be done by blasting with a jet of compressed air at no extra cost.
- 3.7.6 Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be used. Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of the EMPLOYER. The Contractor shall equip himself with enough shuttering to allow for wastage so as to complete the job in time.
- 3.7.7 Permanent formwork shall be checked for its durability and compatibility with adjoining concrete before it is used in the structure. It shall be properly anchored to the concrete.
- 3.7.8 Wire ties passing through beams, columns and walls shall not be allowed. In their place bolts passing through sleeves shall be used. Formwork spacers left insitu shall not impair the desired appearance or durability of the structure by causing spalling, rust staining or allowing the passage of moisture.

- 3.7.9 For liquid retaining structures, sleeves shall not be provided for through bolts nor shall through bolts be removed if provided. The bolts, in the latter case, shall be cut at 25 mm depth from the surface and the hole made good by cement mortar of the same proportion as the concrete just after striking the formwork.
- 3.7.10 Where specified all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.
- 3.7.11 Forms for substructure may be omitted when, in the opinion of the EMPLOYER, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be larger, as approved by the EMPLOYER, than that required as per drawing to compensate for irregularities in excavation.
- 3.7.12 The Contractor shall provide adequate props carried down to a firm bearing without overloading any of the structures.
- 3.7.13 The shuttering for beams and slabs shall be so erected that the side shuttering of beams can be removed without disturbing the bottom shuttering. If the shuttering for a column is erected for the full height of the column, one side shall be built up in sections as placing of concrete proceeds or windows left for placing concrete from the side to limit the drop of concrete to 1.0m or as approved by the EMPLOYER. The Contractor shall temporarily and securely fix items to be cast (embedments/ inserts) in a manner that will not hinder the striking of forms or permit loss of grout.
- 3.7.14 Formwork showing excessive distortion, during any stage of construction, shall be repositioned and strengthened. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at Contractor's cost.
- 3.7.15 The striking time for formwork shall be determined based on the following requirements:
- (a) Development of adequate concrete strength;
 - (b) Permissible deflection at time of striking form work;
 - (c) Curing procedure employed - its efficiency and effectiveness;
 - (d) Subsequent surface treatment to be done;
 - (e) Prevention of thermal cracking at re-entrant angles;
 - (f) Ambient temperatures; and
 - (g) Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).
- 3.7.16 Under normal circumstances (generally where temperatures are above 20°C) forms may be struck after expiry of the time period given in IS:456 unless approved otherwise by the EMPLOYER. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the EMPLOYER. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

3.8 Reinforcement Workmanship

- 3.8.1 Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5°C. Local warming may be permitted if steel is kept below 10° C.
- 3.8.2 All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by EMPLOYER.

- 3.8.3 Re-bending or straightening incorrectly bent bars shall not be done without the approval of the EMPLOYER.
- 3.8.4 Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the EMPLOYER prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.
- 3.8.5 Binding wire shall be 16 gauge soft annealed wire. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.
- 3.8.6 Substitution of reinforcement, laps/splices not shown on drawing shall be subject to EMPLOYER's approval.

3.9 Tolerances

- 3.9.1 Tolerance for formwork and concrete dimensions shall be as per IS:456 unless specified otherwise.
- 3.9.2 Tolerances specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.
- 3.9.3 The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below :

(a)	Deviation from specified dimensions of cross section of columns and beams	- 6 mm + 12 mm
(b)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel or dowels	
1)	Dimension in plan	- 12 mm + 50 mm
2)	Eccentricity	0.02 times the width of the footing in the direction of deviation but not more than 50 mm
3)	Thickness	± 0.05 times the specified thickness

3.10 Preparation Prior to Concrete Placement

- 3.10.1 Before concrete is actually placed in position, the inside of the formwork shall be cleaned and mould oil applied, inserts and reinforcement shall be correctly positioned and securely held, necessary openings, pockets, etc. provided.
- 3.10.2 All arrangements-formwork, equipment and proposed procedure, shall be approved by the EMPLOYER. Contractor shall maintain separate Pour Card for each pour as per the format enclosed.

3.11 Transporting, Placing and Compacting Concrete

- 3.11.1 Concrete shall be transported from the mixing plant to the formwork with minimum time lapse by methods that shall maintain the required workability and will prevent segregation, loss of any ingredients or ingress of foreign matter or water.

- 3.11.2 In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m.
- 3.11.3 Concrete shall not be placed in flowing water. Under water, concrete shall be placed in position by tremies or by pipeline from the mixer and shall never be allowed to fall freely through the water.
- 3.11.4 While placing concrete the Contractor shall proceed as specified below and also ensure the following:**
- (a) Continuously between construction joints and pre- determined abutments.
 - (b) Without disturbance to forms or reinforcement.
 - (c) Without disturbance to pipes, ducts, fixings and the like to be cast in; ensure that such items are securely fixed. Ensure that concrete cannot enter open ends of pipes and conduits etc.
 - (d) Without dropping in a manner that could cause segregation or shock.
 - (e) In deep pours only when the concrete and formwork designed for this purpose and by using suitable chutes or pipes.
 - (f) Do not place if the workability is such that full compaction cannot be achieved.
 - (g) Without disturbing the unsupported sides of excavations; prevent contamination of concrete with earth. Provide sheeting if necessary. In supported excavations, withdraw the linings progressively as concrete is placed.
 - (h) If placed directly onto hardcore or any other porous material, dampen the surface to reduce loss of water from the concrete.
 - (i) Ensure that there is no damage or displacement to sheet membranes.
 - (j) Record the time and location of placing structural concrete.
- 3.11.5 Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set. Over-vibration shall be avoided.
- 3.11.6 Concrete may be conveyed and placed by mechanically operated equipment after getting the complete procedure approved by the EMPLOYER. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped, the concrete mix shall be specially designed to suit pumping. Care shall be taken to avoid stoppages in work once pumping has started.
- 3.11.7 Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the EMPLOYER. Concrete shall be protected against damage until final acceptance.

3.12 Mass Concrete Works

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

3.13 Curing

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

- (a) Premature drying out, particularly by solar radiation and wind;
- (b) leaching out by rain and flowing water;
- (c) rapid cooling during the first few days after placing;
- (d) high internal thermal gradients;
- (e) low temperature or frost;
- (f) vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

3.13.2 All concrete, unless approved otherwise by the EMPLOYER, shall be cured by use of continuous sprays or ponded water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 7 days. The quality of curing water shall be the same as that used for mixing.

3.13.3 Where a curing membrane is approved to be used by the EMPLOYER, the same shall be of a non-wax base and shall not impair the concrete finish in any manner. The curing compound to be used shall be approved by the EMPLOYER before use and shall be applied with spraying equipment capable of a smooth, even textured coat.

3.13.4 Curing may also be done by covering the surface with an impermeable material such as polyethylene, which shall be well sealed and fastened.

3.14 Construction Joints and Keys

3.14.1 Construction joints will be as shown on the drawing or as approved by the EMPLOYER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the EMPLOYER.

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

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

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

3.15 Foundation Bedding

- 3.15.1 All earth surfaces upon which or against which concrete is to be placed, shall be well compacted and free from standing water, mud or debris. Soft or spongy areas shall be cleaned out and back filled with either soil-cement mixture, lean concrete or clean sand compacted as approved by the EMPLOYER. The surfaces of absorptive soils shall be moistened.
- 3.15.2 Concrete shall not be deposited on large sloping rock surfaces. The rock shall be cut to form rough steps or benches by picking, barring or wedging. The rock surface shall be kept wet for 2 to 4 hours before concreting.

3.16 Finishes

3.16.1 General

The formwork for concrete works shall be such as to give the finish as specified. The Contractor shall make good any unavoidable defects as approved consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly compacted concrete) will not be accepted. The Contractor shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes. Inside and outside 15 mm thick smooth cement plaster in CM (1:3) with water proofing compound shall be done in all water retaining structures.

3.16.2 Surface Finish Type F1

The main requirement is that of dense, well compacted concrete. No treatment is required except repair of defective areas, filling all form tie holes and cleaning up of loose or adhering debris. For surfaces below grade which will receive waterproofing treatment the concrete shall be free of surface irregularities which would interfere with proper and effective application of waterproofing material specified for use.

3.16.3 Surface Finish Type F2

The appearance shall be that of a smooth dense, well- compacted concrete showing the slight marks of well fitted shuttering joints. The Contractor shall make good any blemishes.

3.16.4 Surface Finish Type F3

This finish shall give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discolouration, blemishes, arises, airholes etc. Only lined or coated plywood with very tight joints shall be used to achieve this finish. The panel size shall be uniform and as large as practicable. Any minor blemishes that might occur shall be made good by the Contractor.

3.16.5 Integral Cement Finish on Concrete Floor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the EMPLOYER shall be supplied and used as recommended by the manufacturer.

3.17 Repair and Replacement of Unsatisfactory Concrete work

- 3.17.1 Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc. shall be inspected by the EMPLOYER who may permit patching of the defective areas or reject the concrete work.
- 3.17.2 All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.
- 3.17.3 Rejected concrete shall be removed and replaced by the Contractor at no additional cost to the Employer.
- 3.17.4 For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the EMPLOYER.
- 3.17.5 Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the EMPLOYER as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as approved by the EMPLOYER.

3.18 Vacuum Dewatering of Slabs

- 3.18.1 Where specified floor slabs, either grade or suspended, shall be finished by vacuum dewatering including all operations such as poker vibration, surface vibration, vacuum processing, floating and trowelling as per equipment manufacturers recommendation. The equipment to be used shall be subject to the EMPLOYER's approval.

3.19 Hot Weather Requirements

- 3.19.1 Concreting during hot weather shall be carried out as per IS:7861 (Part I).
- 3.19.2 Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40° C at the time of placement of fresh concrete.
- 3.19.3 Where directed by the EMPLOYER, the Contractor shall spray non-wax based curing compound on unformed concrete surfaces at no extra costs.

3.20 Cold Weather Requirements

- 3.20.1 Concreting during cold weather shall be carried out as per Is : 7861 (Part II).
- 3.20.2 The ambient temperature during placement and upto final set shall not fall below 5 Deg.C. Approved antifreeze/accelerating additives shall be used where directed.
- 3.20.3 For major and large scale concreting works the temperature of concrete at times of mixing and placing, the thermal conductivity of the formwork and its insulation and stripping period shall be closely monitored.

3.21 Liquid Retaining Structures

- 3.21.1 The Contractor shall take special care for concrete for liquid retaining structures, underground structures and those others specifically called for to guarantee the finish and water tightness.
- 3.21.2 The minimum level of surface finish for liquid retaining structures shall be Type F2. All such structures shall be hydro-tested.

- 3.21.3 The Contractor shall make all arrangements for hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipe lines etc.
- 3.21.4 The Contractor shall also make all temporary arrangements that may have to be made to ensure stability of the structures during construction.
- 3.21.5 Any leakage that may occur during the hydro-test or subsequently during the defects liability period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, guniting or such other methods as may be approved by the EMPLOYER. All such rectification shall be done by the CONTRACTOR to the entire satisfaction of the EMPLOYER at no extra cost to the EMPLOYER.

3.22 Testing Concrete Structures for Leakage

- 3.22.1 Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the EMPLOYER, as described below :
- 3.22.2 In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.
- 3.22.3 In the case of structures whose external faces are buried and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the watertightness of the structure. The EMPLOYER shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.
- 3.22.4 Each compartment/segment of the structure shall be tested individually and then all together.
- 3.22.5 For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

3.23 Optional Tests

- 3.23.1 If the EMPLOYER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the EMPLOYER, as per relevant IS Codes. Contractor shall have to pay for these tests.
- 3.23.2 In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the EMPLOYER reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The EMPLOYER also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer.

Alternately EMPLOYER also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

3.24 Grouting

3.24.1 Standard Grout

Grout shall be provided as specified on the drawings.

The proportion of Standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surfaces to be grouted shall be thoroughly roughened and cleaned. All structural steel elements to be grouted, shall be cleaned of oil, grease, dirt etc. The use of hot, strong caustic solution for this purpose will be permitted. Prior to grouting, the hardened concrete shall be saturated with water and just before grouting, water in all pockets shall be removed. Grouting once started shall be done quickly and continuously. Variation in grout mixes and procedures shall be permitted if approved by the EMPLOYER. The grout proportions shall be limited as follows :

Use	Grout Thickness	Mix Proportions	W/C Ratio (max)
a) Fluid mix	Under 25mm	One part Portland Cement to one part sand	0.44
b) General mix	25mm and over but less than 50mm	One part Portland Cement to 2 parts of sand	0.53
c) Stiff mix	50mm and over	One part Portland Cement to 3 parts of sand	0.53

3.24.2 Non-Shrink Grout

Non-shrink grout where required shall be provided in strict accordance with the manufacturer's instructions / specifications on the drawings.

3.24.3 General

3.24.3.1 Inspection

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of EMPLOYER. Materials rejected by EMPLOYER shall be expressly removed from site and shall be replaced by Contractor immediately.

3.24.3.2 Clean-Up

Upon the completion of concrete work, all forms, equipment, construction tools, protective coverings and any debris, scraps of wood, etc. resulting from the work shall be removed and the premises left clean.

3.24.3.3 Acceptance Criteria

Any concrete work shall satisfy the requirements given below individually and collectively for it to be acceptable.

- a) properties of constituent materials;
- b) characteristic compressive strength;
- c) specified mix proportions;
- d) minimum cement content;
- e) maximum free-water/cement ratio;
- f) workability;

- g) temperature of fresh concrete;
- h) density of fully compacted concrete;
- i) cover to embedded steel;
- j) curing;
- k) tolerances in dimensions;
- l) tolerances in levels;
- m) durability;
- n) surface finishes;
- o) special requirements such as;
 - i) water tightness
 - ii) resistance to aggressive chemicals
 - iii) resistance to freezing and thawing
 - iv) very high strength
 - v) improved fire resistance
 - vi) wear resistance
 - vii) resistance to early thermal cracking

3.24.4 The EMPLOYER's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the Contractor.

3.24.5 For work not accepted, the EMPLOYER may review and decide whether remedial measures are feasible so as to render the work acceptable. The EMPLOYER shall in that case direct the Contractor to undertake and execute the remedial measures. These shall be expeditiously and effectively implemented by the Contractor. Nothing extra shall become payable to the Contractor by the Employer for executing the remedial measures.

3.25 Waterstops

3.25.1 Material

The material for the PVC waterstops shall be a plastic compound with the basic resin of polyvinyl chloride and additional resins, plasticizers, inhibitors, which satisfies the performance characteristics specified below as per IS:12200. Testing shall be in accordance with IS:8543.

- | | | | |
|-----|-------------------------|---|---------------------------------|
| a) | Tensile strength | : | 3.6 N/mm ² minimum |
| b) | Ultimate elongation | : | 300% minimum |
| c) | Tear resistance | : | 4.9 N/mm ² minimum |
| d) | Stiffness in flexure | : | 2.46 N/mm ² minimum |
| e) | Accelerated extraction | | |
| | i) Tensile strength | : | 10.50 N/mm ² minimum |
| | ii) Ultimate elongation | : | 250% minimum |
| (f) | Effect of Alkali | : | 7 days |
| | i) Weight increase | : | 0.10% maximum |
| | ii) Weight decrease | : | 0.10% maximum |
| | iii) Hardness change | : | ± 5 points |
| (g) | Effect of Alkali | : | 28 days |
| | i) Weight increase: | : | 0.40% maximum |
| | ii) Weight decrease | : | 0.30% maximum |
| | iii) Dimension change | : | ±1% |

3.25.2 PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use.

3.25.3 PVC water stops shall be of approved manufacture. Samples and the test certificate shall be got approved by the EMPLOYER before procurement for incorporation in the works.

3.25.4 Workmanship

- 3.25.4.1 Waterstops shall be cleaned before placing them in position. Oil or grease shall be removed thoroughly using water and suitable detergents.
- 3.25.4.2 Waterstops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of waterstops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.
- 3.25.4.3 Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregates shall be used for concreting in this region also.

3.26 Preformed Fillers and Joint Sealing Compound

3.26.1 Materials

- 3.26.1.1 Preformed filler for expansion/isolation joints shall be non-extruding and resilient type of bitumen impregnated fibres conforming to IS:1838 (Part I).
- 3.26.1.2 Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS:702. Bitumen primer shall conform to IS:3384.
- 3.26.1.3 Sealing compound for filling the joints above the preformed bitumen filler shall conform to Grade 'A' as per IS:1834.

3.26.2 Workmanship

- 3.26.2.1 The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipment's. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.
- 3.26.2.2 The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.
- 3.26.2.3 Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS: 3384 in order to improve the adhesive quality of the sealing compound.
- 3.26.2.4 Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

CONCRETE POUR CARD				
POUR NO. :		DATE :		
DRG. NO. :		STRUCTURE :		
CONCRETE GRADE/QUANTITY/ :		MAX. AGGREGATE SIZE /		
SLUMP :		START / COMPLETION TIME :		
SL. NO.	ITEM			Remarks If Any
1.	BEFORE CONCRETING CENTRELINES CHECKED	YES/NO		
2.	FORMWORK AND STAGING CHECKED FOR ACCURACY, STRENGTH & FINISH	YES/NO		
3.	REINFORCEMENT CHECKED	YES/NO		
4.	COVER TO REINFORCEMENT CHECKED	YES/NO		
5.	VERIFIED TEST CERTIFICATE FOR CEMENT/STEEL	YES / NO		
6.	ADEQUACY OF MATERIALS / EQUIPMENT FOR POUR	YES / NO		
7.	EMBEDDED PARTS (LOCATION & PLUMB) CHECKED	CIVIL	YES/NO	
		MECH.	YES/NO	
		ELEC.	YES/NO	
8.	SOFFIT(S) & POUR TOP(T) LEVELS CHECKED BEFORE (B) & AFTER (A) FORM REMOVAL (ONLY OF BEAMS OF OVER 10 M SPAN & IMPORTANT STRUCTURE LIKE T.G. ETC.)	S(B) T(B) S(B) T(B)		
9.	CONSTRUCTION JOINTS LOCATION & TIME (IF NOT AS PER DRAWING)			
10.	CEMENT CONSUMPTION IN KGS.			
11.	NUMBER OF CUBES AND IDENTIFICATION MARKS			
12.	TEST CUBE RESULTS (7 DAYS / 28 DAYS)			
13.	CONCRETE CONDITION ON FORM REMOVAL	V.GOOD/GOOD/FAIR /POOR		

Contractor's Representative

EMPLOYER's Representative

NOTES: 1. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, CONTRACTOR & SITE OFFICE.

UNDER REMARKS INDICATE DEVIATIONS FROM DWGS. & SPECIFICATIONS, CONGESTION IN REINFORCEMENT IF ANY, UNUSUAL OCCURRENCES SUCH AS FAILURE OF EQUIPMENTS, SINKING OF SUPPORTS / PROPS. HEAVY RAINS AFFECTING CONCRETING, POOR COMPACTION, IMPROPER CURING, OTHER DEFICIENCIES, OBSERVATIONS ETC.

4.0 STRUCTURAL STEEL WORK

4.1 Applicable Codes and Specifications

4.1.1 The supply, fabrication, erection and painting of structural steel works shall comply with the following specifications, standards and codes unless otherwise specified herein. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

1. IS : 808 Dimensions for Hot Rolled Steel sections
2. IS : 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel
3. IS : 800 Code of Practice for General Construction in Steel
4. IS : 801 **Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction**
5. IS : 806 Code of Practice for Use of Steel Tubes in General Building Construction
6. IS : 7205 Safety Code for Erection of Structural Steel Work
7. IS : 7215 Tolerances for Fabrication of Steel Structures
8. IS : 4000 High Strength Bolts in Steel Structure – Code of Practice
9. AISC Specifications for Design, Fabrication and Erection of Buildings
10. IS : 1161 Steel Tubes for structural purposes
11. **IS:102 Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.**
12. IS:110 Ready Mixed paint, brushing, grey filler for enamels for use over primers.
13. IS:117 Ready Mixed paint, Brushing, Finishing, Exterior Semigloss for general purposes, to Indian Standard colours.
14. IS:158 Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
15. IS:159 Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required.
16. IS:341 Black Japan, Types A, B and C
17. IS:2339 Aluminium paint for general purposes, in Dual container
18. IS:2932 Specification for enamel, synthetic, exterior, type 1, (a) undercoating, (b) finishing
19. IS:2933 Specification for enamel, exterior, type 2, (a) undercoating, (b) finishing
20. IS:5905 Sprayed aluminium and zinc coatings on Iron and Steel.
21. IS:6005 Code of practice for phosphating of Iron and Steel.

22. IS:9862 Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
23. IS:13183 Aluminium paint, Heat resistant.
24. SIS-05-5900 (Swedish Standard)
25. IS : 1239 Mild steel tubes, tubulars and other Wrought steel fittings
Part 1 – Mild steel tubes
Part 2 – Mild steel tubulars and other wrought steel pipe fittings

26. IS : 1363 Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range (Parts 1 to 3) M5 to M64)
27. IS : 1367 Technical Supply Conditions for Threaded Fasteners (All parts)
28. IS : 1852 Rolling and Cutting Tolerances for Hot Rolled Steel Products
29. IS : 1977 Structural Steel (Ordinary Quality)

30. IS : 2062	Steel for General Structural Purposes
31. IS : 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
32. IS : 3502	Steel Chequered Plate
33. IS : 3757	High Strength Structural Bolts
34. IS : 5369	General Requirements for Plain Washers and Lock Washers
35. IS : 5372	Taper Washers for Channels
36. IS : 5374	Taper Washer for 1 Beams
37. IS : 6610	Heavy Washers for Steel Structures
38. IS : 8500	Structural Steel-microalloyed (medium and high strength qualities)
39. IS : 803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
40. IS : 816	Code of Practice for use of Metal Arc Welding for General construction in Mild Steel
41. IS : 822	Code of Procedure for Inspection of Welds
42. IS : 1182	Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
43. IS : 1200	Method of Measurement in Building Civil Works
44. IS : 1477	Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
45. IS : 2595	Code of Practice for Radiographic Testing
46. IS : 3658	Code of Practice for Liquid Penetrant Flaw Detection
47. IS : 5334	Code of Practice for Magnetic Particle Flaw Detection of Welds
48. IS : 9595	Recommendations for Metal Arc Welding of Carbon and Carbon Manganese Steel

4.2 Steel Materials

4.2.1 Steel materials shall comply with the referred to in **Sub-Clause 4.1**.

4.2.2 All materials used shall be new, unused and free from defects.

4.2.3 Steel conforming to IS:1977 shall be used only for the following :

Fe310-0(St 32-0)	For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.
Fe410-0(St 42-0)	For structures not subjected to dynamic loading other than wind loads such as :Platform roofs, foot over bridges, building, factory sheds etc.
Fe510-0(St 42-0)	Grade steel shall not be used <ul style="list-style-type: none"> a) If welding is to be employed for fabrication b) If site is in severe earthquake zone c) If plastic theory of design is used

4.2.4 Drawings prepared by the **VENDOR/CONTRACTOR**

4.2.4.1 The **VENDOR/CONTRACTOR** shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible.

4.2.4.2 All fabrication drawings shall be submitted to the **EMPLOYER** for approval.

- 4.2.4.3 No fabrication drawings will be accepted for EMPLOYER's approval unless checked and approved by the VENDOR/CONTRACTOR's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections.
- 4.2.4.4 Fabrication shall be started by the VENDOR/CONTRACTOR only after EMPLOYER's approval of fabrication drawings. Approval by the EMPLOYER of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon. The EMPLOYER's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.
- 4.2.4.5 The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.

4.3 Fabrication

4.3.1 General

- 4.3.1.1 All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished. Unless otherwise approved by the EMPLOYER, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather.

4.3.2 Connections

4.3.2.1 Shop/field connections shall be as per approved fabrication drawings.

- 4.3.2.2 In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.
- 4.3.2.3 In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.
- 4.3.2.4 All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.
- 4.3.2.5 All bolts, nuts, washers, electrodes, screws etc., shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.
- 4.3.2.6 All members likely to collect rain water shall have drain holes provided.

4.3.3 Straightening

4.3.3.1 All materials, shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or forging shall not be resorted to without the prior approval of the EMPLOYER in writing.

4.3.4 Rolling and Forming

4.3.4.1 Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

4.3.5 High Strength Friction Grip Bolting

4.3.5.1 Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used.

4.3.6 Welding

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

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

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

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

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

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

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

4.3.6.8 All welds shall be inspected for flaws by any of the methods described under **Sub-clause 4.6.3**. The choice of the method adopted shall be agreed with the EMPLOYER.

4.3.6.9 The correction of defective welds shall be carried out in a manner approved by the EMPLOYER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means approved by the EMPLOYER shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. The cost of all such tests and operations incidental to correction shall be borne by the Contractor.

4.4 Tolerances

- 4.4.1 The dimensional and weight tolerances for rolled shapes shall be in accordance with IS : 1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS : 7215.
- 4.4.2 Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

4.5 End Milling

- 4.5.1 Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment.

4.6 Inspection

4.6.1 General

- 4.6.1.1 The Contractor shall give due notice to the EMPLOYER in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the EMPLOYER's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the EMPLOYER if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer may make because of defective or unsatisfactory materials and/or workmanship.
- 4.6.1.2 No materials shall be painted or despatched to site without inspection and approval by the EMPLOYER unless such inspection is waived in writing by the EMPLOYER.
- 4.6.1.3 The Contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.
- 4.6.1.4 For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the EMPLOYER.
- 4.6.1.5 Inspection and tests on structural steel members shall be as set forth below.

4.6.2 Material Testing

- 4.6.2.1 If mill test reports are not available for any steel materials the same shall be tested by the Contractor to the Employer's Representative's satisfaction to demonstrate conformity with the relevant specification.

4.6.3 Tests on Welds

- 4.6.3.1 **Magnetic Particle Test**
Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the EMPLOYER.

4.6.3.2 Liquid Penetrant Inspection

In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked.

4.6.3.3 Radiographic Inspection

All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code.

4.6.4 Dimensions, Workmanship & Cleanliness

4.6.4.1 Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in accordance with the requirements shown in the Contractor's approved fabrication drawings.

4.6.5 Test Failure

4.6.5.1 In the event of failure of any member to satisfy inspection or test requirement, the Contractor shall notify the EMPLOYER. The Contractor must obtain permission from the EMPLOYER before any repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the EMPLOYER.

4.6.5.2 The EMPLOYER has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the Employer, only in case of successful testing.

4.6.5.3 The Contractor shall maintain records of all inspection and testing which shall be made available to the EMPLOYER.

4.7 Shop Matching

4.7.1 For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc., if so desired by the EMPLOYER. All these shop assemblies shall be carried out by the Contractor.

4.8 Drilling Holes for other works

4.8.1 As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the VENDOR/CONTRACTOR at no extra cost of the EMPLOYER. The information for such extra holes will be supplied by the EMPLOYER/EMPLOYER.

4.9 Marking of Members

4.9.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.

4.9.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location.

- 4.9.3 Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends.

4.10 Errors

- 4.10.1 Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the EMPLOYER as defective workmanship. Where the EMPLOYER rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to the Specifications by the Contractor, at no cost to the Employer.

4.11 Painting of Steel Works

All fabricated steel material, except those galvanised shall receive protective paint coating as specified in specification, which is described below.

4.11.1 Materials

- 4.11.1.1 Red-oxide – zinc chrome primer shall conform to IS:2074.
- 4.11.1.2 Synthetic enamel paint shall conform to IS : 2932.
- 4.11.1.3 Aluminium paint shall conform to IS:2339.
- 4.11.1.4 All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the EMPLOYER for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

4.11.2 Workmanship

- 4.11.2.1 Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS:1477 (Part 2).
- 4.11.2.2 The type of paint, number of coats etc. shall be as specified in the respective items of work.
- 4.11.2.3 Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.
- 4.11.2.4 All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS:1477 (Part – I) and as indicated in the item of work.
- 4.11.2.5 It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from ‘holidays’.
- 4.11.2.6 After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

4.11.2.7 The first finishing coat of paint shall be applied by brushing and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.

4.11.2.8 At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the EMPLOYER.

4.12 Acceptance of Steel, its Handling & Storage

4.12.1 The Contractor shall carefully check the steel to be erected at the time of acceptance. Any fabrication defects observed should be brought to the notice of the EMPLOYER.

4.12.2 No dragging of steel shall be permitted. All steel shall be stored 300mm above ground on suitable packing to avoid damage. It shall be stored in the order required for erection, with erection marks visible. All storage areas shall be prepared and maintained by the Contractor. Steel shall not be stored in the vicinity of areas where excavation or grading will be done and, if so stored temporarily, this shall be removed by the Contractor well before such excavation and/or grading commences to a safe distance to avoid burial under debris.

4.12.3 Scratched or abraded steel shall be given a coat of primer in accordance with the Specifications for protection after unloading and handling prior to erection. All milled and machined surfaces shall be properly protected from rust/corrosion by suitable coating and also from damage.

4.13 Anchor Bolts & Foundations

4.13.1 The Contractor shall carefully check the location and layout of anchor bolts embedded in foundations constructed, to ensure that the structures can be properly erected as shown on the drawings. Any discrepancy in the anchor bolts/foundation shall be reported to the EMPLOYER.

4.13.2 Leveling of column bases to the required elevation may be done either by providing shims or three nuts on the upper threaded portion of the anchor bolt. All shim stock required for keeping the specified thickness of grout and in connection with erection of structures on foundations, crane brackets or at any other locations shall be of good M.S. plates and shall be supplied by the Contractor at his cost.

4.13.3 A certain amount of cleaning of foundations and preparing the area is considered normal and shall be carried out by the Contractor at no extra cost.

4.13.4 Where beams bear in pockets or on walls, bearing plates shall be set and levelled as part of the work. All grouting under column base plates or beam bearing plates will be carried out by the Contractor.

4.14 Assembly & connections

4.14.1 Field connections may be effected either by riveting, bolting, welding or by use of high strength friction grip bolts as shown on the design and erection drawings.

4.14.2 All field connection work shall be carried as per the drawings. All bolts, nuts, washers, rivets, electrodes required for field connections shall be supplied by the Contractor free of cost.

4.14.3 All assembling shall be carried on a level platform.

4.14.4 Drifts shall be used only for drawing the work to proper position and must not be used to such an extent as to damage the holes. Size of drifts larger than the normal diameter of hole shall not be used. Any damaged holes or burrs must be rectified to the satisfaction of the EMPLOYER.

4.14.5 Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the EMPLOYER.

4.15 Erection

4.15.1 All structural steel shall be erected as shown on the drawings prepared by the Contractor. Proper size steel cable slings, etc., shall be used for hoisting. Guys shall not be anchored to existing structures, foundations, etc., unless so permitted by the EMPLOYER in writing. Care shall be taken to see that ropes in use are always in good condition.

4.15.2 Steel columns in the basement, if any, are to be lowered and erected carefully with the help of a crane and/or derrick without damaging the basement walls or floor.

4.15.3 Structural steel frames shall be erected plumb and true. Frames shall be lifted at points such that they are not liable to buckle and deform. Trusses shall be lifted only at node points. In the case of trusses, roof girders, all of the purlins and wind bracing shall be placed simultaneously and the columns shall be erected truly plumb on screed bars over the pedestals. All steel columns and beams shall be checked for plumb and level individually before and after connections are made. Temporary bracings shall be introduced wherever necessary to take care of all loads to which the structure may be subjected, including erection equipment and the operation thereof. Such bracings shall be left in place as long as may be required for safety and stability.

4.15.4 Chequered plates shall be fixed to supporting members by tack welding or by countersunk bolts as shown/specified in relevant drawings and/or as approved by the EMPLOYER. The edges shall be made smooth and no burrs or jagged ends shall be left. While splicing, care should be taken so that there is continuity in pattern between the two portions. Care should also be taken to avoid distortion of the plate while welding. The erection of chequered plates shall include :

- a) Welding of stiffening angles/vertical stiffening ribs
- b) Cutting to size and making holes to required shape wherever necessary to allow service piping and/or cables to pass through
- c) Splicing as shown in relevant drawings
- d) Smoothening of edges
- e) Fixing of chequered plates by tack welding or by countersunk bolts
- f) Providing lifting hooks for ease of lifting.

4.15.5 As erection progresses, the work shall be securely bolted to take care of all dead load, wind, seismic and erection stresses.

4.15.6 No riveting or welding or final bolting shall be done until the structure has been properly aligned and approved by the EMPLOYER. No cutting, heating or enlarging of the holes shall be carried out without the prior written approval of the EMPLOYER.

4.15.7 Test certificates shall be furnished by the Contractor.

4.16 Inspection

4.16.1 The EMPLOYER shall have free access to all parts of the job during erection and all erection shall be subjected to his approval. In case of faulty erection, all dismantling and

re-erection required will be at the Contractor's cost. No paint shall be applied to rivet heads or field welds or bolts until these have been approved by the EMPLOYER.

4.17 Tolerances

4.17.1 General

Tolerances mentioned below shall be achieved after the entire structure or part thereof is in line, level and plumb.

4.17.2 Columns

Deviation of column axes at foundation top level with respect to true axes :

- (a) In longitudinal direction ± 5 mm
- (b) In lateral direction ± 5 mm

Deviation in the level of bearing surface of columns at foundation top with respect to true level

± 5 mm

Out of plumbness (verticality) of column axis from true vertical axis, as measured at column top :

- (a) For columns upto and including 15 metres in height $\pm 1/1000$ of column height in mm or ± 15 mm whichever is less
- (b) For columns exceeding 15 metres in height $\pm 1/1000$ of column height in mm or ± 20 mm whichever is less

Deviation in straightness in longitudinal and transverse planes of column at any point along the height $\pm 1/1000$ of column height in mm or ± 10 mm whichever is less

Difference in erected position of adjacent pairs of columns along length or across width of building prior to connecting trusses/beams with respect to true distance ± 10 mm

Deviation in any bearing or seating level with respect to true level ± 5 mm

Deviation in differences in bearing level of a member on adjacent pair of columns both across and along the building ± 10 mm

4.17.3 Trusses And Beams

Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord $\pm 1/250$ of height of truss in mm or ± 15 mm whichever is less

Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss $\pm 1/1500$ of span of truss in mm or ± 15 mm whichever is less

Lateral shift in location of truss from its true vertical position ± 10 mm

Lateral shift in location of purlin true position ± 5 mm

Deviation in difference of bearing levels of trusses or beams from the true difference

- i) ± 20 mm for trusses
- ii) For beams :
 - Depth < 1800 mm : ± 6 mm
 - Depth > 1800 mm : ± 10 mm

Deviation in sag in chords and diagonals of truss between node points $1/1500$ of length in mm or 10 mm whichever is smaller

Deviation in sweep of trusses, beams etc. in the horizontal plane 1/1000 of span in mm subject to a maximum of 10 mm

4.17.4 Crane Girders & Rails

Shift in the centre line of crane rail with respect to centre line of web of crane girder ±5 mm

Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point ±5 mm

Difference in alignment of crane rail in plan measured between any two points 2 metres apart along rail ±1 mm

Deviation in crane track with respect to Time gauge

(a) For track gauges upto and including 15 metres ±5 mm

(b) For track gauges more than 15 metres ± [5 + 0.25 (S-15)] where S in metres is true gauge

Deviation in the crane rail level at any point from true level ±1/1200 of the gauge distance or ±10mm whichever is less

Difference in the crane rail actual levels between any two points 2 metres apart along the rail length ±2 mm

Difference in levels between crane track Rails at

(a) Supports of crane girders ±15 mm

(b) Mid span of crane girders ± 20 mm

Relative shift of crane rail surfaces at a joint in plane and elevation 2 mm subject to grinding of surfaces for smooth transition

Relative shift in the location of crane stops (end buffers) along the crane tracks with track gauge S in mm 1/1000 of track gauge S in mm subject to maximum of 20 mm

4.17.5 Painting

After steel has been erected, all bare and abraded spots, rivet heads, field welds, bolt heads and nuts shall be spot painted with primer. Before paint is applied, the surface shall be dry and free from dust, dirt, scale and grease. All surfaces inaccessible after erection shall receive two coats of the approved paint before erection.

4.18 Clean up of Work site

During erection, the Contractor shall at all times keep the working and storage areas used by him free from accumulation of waste materials or rubbish. Before completion of erection, he shall remove or dispose of in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to the EMPLOYER.

5.0 PLUMBING WORKS FOR WATER SUPPLY AND SANITARY ARRANGEMENTS

5.1 Applicable Codes

5.1.1 The following standards and codes are made a part of this Employer's Requirement. All standards, codes of practice referred to herein shall be the latest editions including all official amendments and revisions.

- IS : 210 : Specification for grey iron castings
- IS : 269 : Specification for ordinary and low heat portland cement
- IS : 383 : Specification for coarse and fine aggregates from natural sources for concrete
- IS : 432 : Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement
- IS : 456 : Code of Practice for plain and reinforced concrete
- IS : 458 : Concrete Pipes (with and without reinforcement).
- IS : 516 : Methods of tests for strength of concrete
- IS : 554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
- IS : 651 : Salt glazed stoneware pipes and fittings.
- IS : 774 : Flushing Cisterns for water closets and urinals (valveless siphonic type)
- IS : 775 : Cast iron brackets and supports for wash basins and sinks.
- IS : 781 : Sand-cast brass screw-down bib taps and stop taps for water services.
- IS : 783 : Code of practice for laying of concrete pipes.
- IS : 1068 : Electroplated coatings of nickel and chromium of iron and steel.
- IS : 1077 : Specification for common burnt clay building bricks
- IS : 1786 : Specification for high strength deformed steel bars and wires for concrete reinforcement
- IS : 1239 : Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II)
- IS : 1536 : Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
- IS : 1626 : Asbestos cement building pipes, gutters and fittings (spigot and socket types).
- IS : 1703 : Copper Alloy float valves (horizontal plunger type) for water supply purposes.
- IS : 1726 : Cast iron manhole covers and frames.
- IS : 1729 : Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
- IS : 1742 : Code of practice for buildings drainage
- IS : 2116 : Specification for sand for masonry mortars
- IS : 2212 : Code of practice for brickwork
- IS : 2250 : Code of practice for preparation and use of masonry mortars
- IS : 2326 : Automatic flushing cisterns for urinals
- IS : 2470 : Code of practice for design and construction of septic tanks (Parts I & II)
- IS : 2556 : Vitreous sanitary appliances (Part I to Part XV)
- IS : 2963 : Specification for copper alloy waste fittings for wash basins and sinks
- IS : 3006 : Specification for chemically resistant glazed stoneware pipes and fittings
- IS : 3311 : Waste plug and its accessories for sinks and wash basins
- IS : 5455 : Specification for cast iron steps for manholes
- IS : 4127 : Code of Practice for laying of glazed stoneware pipes
- IS : 3495 : Methods of tests of burnt clay building bricks
- IS : 4111 : Code of practice for ancillary structures in sewerage system manholes
- IS : 5382 : Specification for rubber sealing rings for gas mains, water mains and sewers

- IS : 5329 : Code of practice for sanitary pipe work above ground for buildings
IS : 5434 : Non-ferrous alloy bottle traps for marine use

5.2 Sanitary Installation

- 5.2.1 The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Employer's Representative.
- 5.2.2 Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.
- 5.2.3 All sanitary and plumbing work shall be carried out by licensed plumbers.
- 5.2.4 All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of size, and design as approved by the Employer's Representative.
- 5.2.5 All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, 'P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used.
- 5.2.6 Joints between iron and earthenware pipes shall be made perfectly air and water tight by caulking with neat cement mortar.

5.3 Indian Type Water Closet

- 5.3.1 This shall be the long pan pattern with separate footrests made of white glazed earthenware, white glazed vitreous china or of white glazed fire clay. The general requirements shall conform to IS:2556 (Parts III and X). Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush type. The flushing rim and inlet shall be of the self draining type. It shall have a weephole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise approved by the Employer's Representative. The inside of the bottom of pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth enable easy and quick disposal while flushing. The exterior surface shall be unglazed and sufficiently rough or grooved at right angles to the axis of the outlet. Pans shall be provided with a trap 'P' or 'S' type with a minimum 50 mm water seal and 50 mm dia. vent horn. Pan shall be laid at the correct location and level over a bed of lime concrete using brick aggregates (1 part lime mortar to 2 parts brick bats with lime mortar to 2 parts of sand) or cement-sand admixture as specified in the drawings.

5.4 European Type Water Closet

- 5.4.1 Water closets shall be either of white glazed earthenware, white glazed vitreous china or white glazed fire clay as specified and shall be of "Siphonic Wash down type" conforming to IS.2556 (Part VIII). The closets shall be of one piece construction with approved plastic/bakelite seat and cover. Each water closet shall have 4 fixing holes having a minimum diameter of 6.5 mm for fixing to floor and shall have an integral flushing rim of suitable type. It shall also have an inlet of supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. The water closet shall have a weephole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an antisiphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps

shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the bottom of the trap in line with the back plate, shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

5.5 Urinals

5.5.1 Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of 6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

5.6 Wash Basins

5.6.1 Wash basins shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative and conforming to IS.2556

Type	Size
Flat Back	630 x 450 mm
Flat Back	550 x 400 mm

5.6.2 Wash basins shall be of one piece construction, including a combined overflow. All internal angles shall be designed so as to facilitate cleaning. Each shall have a rim sloping inside towards the bowl on all sides except skirting at the back. Basins shall be provided with single or double tap holes as approved. The tap holes shall be square. A suitable tap hole button shall be supplied if one tap hole is not required in installation. Each basin shall have a circular waste hole to which the interior of basin shall drain. The waste hole shall be either rebated or bevelled internally with diameter of 65 mm at top and a depth of 10 mm to suit a waste plug having 64 mm diameter. Each basin shall be provided with a non-ferrous 32 mm waste fittings. Stud slots to receive the brackets on the under side of the wash basins shall be suitable for a bracket with stud not exceeding 13 mm diameter, 5 mm high and 305 mm from the back of basin to the centre of the stud. The stud slots shall be of depth sufficient to take 5 mm stud. Every basin shall have an integral soap holder recess or recesses which shall fully drain into the bowl. The position of the chain stay-hole shall not be lower than the overflow slot. A slot type of overflow having an area of not less than 5 sq.cm. shall be provided and shall be so designed as to facilitate cleaning of the overflow. The Employer's Requirements for waste plug, chain and stay shall be the same as given for sinks.

5.6.3.1 All the waste fittings shall be chromium plated. Bottle trap shall conform to IS. 5434. The chromium plating shall be of service grade No. 2 conforming to IS.1068.

5.7 Sinks

5.7.1 The sinks shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Employer's Representative conforming to IS.2556 (Part V) and shall be of the following sizes:

450 x 300 x 150 mm

600 x 450 x 200 mm

5.7.2 They shall be of one piece construction, including a combined overflow. The floor of the sink shall gently slope towards the outlet. The outlet shall in all cases be suitable for waste fittings having flange of 64 mm diameter and the waste hole shall have a minimum diameter of 65 mm at the bottom to suit the waste fittings. The waste hole shall be either rebated or bevelled having a depth of 10 mm. Each sink shall be provided with a non-ferrous 40 mm dia. waste fitting. The sink shall have overflow of the weir type and the inverts shall be 30 mm below the top edge. Each sink shall be provided with a waste plug, of suitable dia. chain and stay. The plug shall be of rubber or other equally suitable material and shall be water tight when fitted. Plug chains shall be of brass wire chromium plated. It shall have an overall length from the collar to the stay of not less than 300 mm. There shall be a triangular or D shackle at each end, one of which shall be brazed to the plug and the other securely fixed to the stay. The 150 mm long shank of the waste shall be threaded conforming to the requirements of IS.2556 for sinks only. The waste fittings and plug fittings shall be chromium plated. The chromium plating shall be of service grade No.2 conforming to IS.1068.

5.8 Flushing Cisterns

5.8.1 The flushing cisterns shall be automatic or manually operated, high level or low level, as approved by the Employer's Representative. For water closets and urinals high level cistern is intended to operate with minimum height of 125 cm and a low level cistern a maximum height of 30 cm between the top of the pan and the underside of the cistern. They shall be of cast iron, glazed earthenware, or pressed steel complying iron, glazed requirement of IS.774. Automatic flushing cistern for urinals shall conform to IS.2326.

5.9 Cast Iron Soil Waste and Vent Pipes and Fittings

5.9.1 All cast iron pipes and fittings shall be of uniform thickness with strong and deep sockets, free from flaws, air holes, cracks, sand holes and other defects and conform to IS.1536 . The diameter approved shall be internal diameter of pipe. The pipes and fittings shall be true to shape, smooth and cylindrical and shall ring clearly when struck over with a light hand hammer. All pipes and fittings shall be properly cleaned of all foreign material before being fixed.

5.9.2 All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by W.I. or M.S. holder bat clamps, unless projecting ears with fixing holes are provided at socket end of pipe. The pipes shall be installed, truly vertical or to the lines and slopes as indicated. The clamps shall be fixed to the walls by embedding their hooks in cement concrete blocks (1:2:4) 10 cm x 10 cm making necessary holes in the walls at proper places. All holes and breakages shall be made good. The clamps shall be kept 25 mm clear of the finished face of the walls to facilitate cleaning and painting of pipes.

5.9.3 The annular space between the socket and spigot shall be filled with a gasket of hemp or spun yarn soaked in neat cement slurry. The joint shall then be filled with stiff cement mortar 1:2 (1 cement : 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45°. The joint shall be kept wet for not less than 7 days by tying a piece of gunny bag kept moist. Joints shall be perfectly air tight as well as water tight.

- 5.9.4 C.I. pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red leadprimer. Two coats of zinc paint with white base and mixed with pigment of required colour to get the approved shade shall be given over the base primer coat.
- 5.9.5 The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions approved for the corresponding sizes of straight pipes.
- 5.9.6 The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm dia. puff pipe where the length of the waste is more than 1800 mm or the floor trap is connected to a waste stack through bends.
- 5.9.7 All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Employer's Representative and left in working condition after completion. The smoke test shall be carried out as stated under :
- 5.9.8 Smoke shall be pumped into the pipe at the lowest and from a smoke machine which consists of a bellow and a burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline.
- 5.9.9 Water test and air test shall be conducted as stipulated in IS.5329.

5.10 Galvanised Mild Steel (G.I) Pipes

- 5.10.1 The pipes shall be galvanised mild steel welded pipes and seamless screwed and sockets tubes conforming to the requirements of IS.1239, for medium grade. They shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.
- 5.10.2 All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.
- 5.10.3 The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as approved for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS.554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.
- 5.10.4 The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as the make them slack, water tight joint. The screw- thread of pipes and fittings shall be protected from damage until they are fitted.

- 5.10.5 The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.
- 5.10.6 Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.
- 5.10.7 For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc. provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion/contraction and other movements/maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as approved by the Employer's Representative.
- 5.10.8 G.I. pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS.3114.
- 5.10.9 The work of excavation and backfilling shall be done true to line and gradient in accordance with general Employer's Requirements for earthworks in trenches for pipes laid underground.
- 5.10.10 The pipes shall be laid on a layer of 10.0 cm sand and filled upto 15 cm above the pipes. A sand cushion of 15cm on either side of the pipe shall also be provided. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. when excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.
- 5.10.11 The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Employer's Representative and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped, the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking shall be removed and replaced by the Contractor.
- 5.10.12 The G.I. pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe, G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of

the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

5.11 Stoneware Pipes and Fittings

5.11.1 All pipes with spigot and socket ends shall conform to IS.651/3006 and shall be of grade 'A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

5.11.2 The following information shall be clearly marked on each pipe and fitting :

- (a) Internal diameter;
- (b) Grade;
- (c) Date of manufacture;
- (d) Name of manufacturer or his registered trade-mark or both.

All pipes and fittings shall have ISI mark.

5.11.3 Jointing of GSW pipes and fittings shall be done as per the requirements of the following Employer's Requirements and the relevant IS. After jointing, extraneous material if any, shall be removed from the inside of the pipes and fittings and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS : 5382.

5.11.4 Spigot and Socket Joint (Cement Joint)

5.11.4.1 The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed around the joint and inserted in it by means of a caulking tool. More skeins of yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more than one-fourth of the depth or socket.

5.11.4.2 Cement mortar (1:1) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall then be caulked into the joint with a caulking tool. More cement mortar shall be added until the space of joint has been completely filled with tightly caulked mortar. The joint shall then be finished of neatly outside the socket at an angle of 45 degrees.

5.11.4.3 The cement mortar joints shall be cured at least for seven days before testing.

5.11.4.4 The approximate quantity of cement required for each joint for certain common sizes of pipes are give below for guidance :

Nominal diameter of pipe (mm)	Cement (kg)
150	1.5
200	2.0
250	2.5
300	3.25
350	4.5
400	5.5
450	6.5

5.11.5 Spigot and Socket Joint (Bituminous Joint)

5.11.5.1 The general requirements for this type of joint shall be as specified in 5.12.1 The material for jointing shall consist of composition of asphalt and sand in the ratio of 1:7. Asphalt and sand shall be boiled together and filled into the socket in a molten state with the aid of special moulds.

5.11.6 Spigot and Socket Joint (Rubber Ring Joint)

5.11.6.1 The pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The rubber rings conforming to IS : 5382 shall be used, and the manufacturer's instructions shall be deemed to form a part of this Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

5.11.7 Cleaning of Pipes

5.11.7.1 As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length as approved by the Employer's Representative, the Contractor shall run through the pipes both backward and forward a double disc or solid or closed cylinder 50 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipeline shall be securely closed as approved by the Employer's Representative to prevent entry of mud or silt etc.

5.11.7.2 If as a result of the removal of any obstruction the Employer's Representative considers that damages may have been caused to the pipe lines, he shall be entitled to order the length to be tested immediately. Should such test prove unsatisfactory the Contractor shall repair the pipeline and carry out such further tests as are required by the Employer's Representative.

5.11.7.3 It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Employer's Representative is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably illuminated by projected sunlight or otherwise.

5.11.7.4 After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following Employer's Requirements and as approved by the Employer's Representative. All equipment for testing at work site shall be supplied and erected by the Contractor. Water for testing of pipeline shall be arranged by him. Damage during testing shall be the Contractor's responsibility and shall be rectified by him to the full satisfaction of the Employer's Representative. Water used for test shall be removed from pipes and not released to the excavated trenches.

5.11.7.5 After the joints have thoroughly set and have been checked by the Employer's Representative and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by the Contractor to be water tight. Before commencing the hydraulic test, the pipelines shall be filled with water and maintained full for 24 hours by adding water, if necessary, under a head of 0.6 m of water. The test shall be carried out by suitably plugging the low end of the drain and the ends of connections, if any, and filling the system with water. A knuckle bend shall be temporarily jointed at the top end and a sufficient length of vertical pipe jointed to it so as to provide the required test head; or the top end may be plugged with a connection to a hose ending in a funnel which could be raised or lowered till the required head is obtained and fixed suitably for observation. The pipeline shall be subjected to a test pressure of at least 2.5 m head of water at the highest point of the section under test. The tolerance of two litres per centimeter of diameter per

kilometer may be allowed during a period of 10 minutes. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

5.11.7.6 If any damage is caused to the pipeline during the execution of work or while cleaning/testing the pipeline as specified. The Contractor shall be held responsible for the same and shall replace the damaged pipeline and re-test the same to the full satisfaction of the Employer's Representative.

5.11.7.7 Water for testing of pipeline shall be arranged by the Contractor.

5.12 Stop Cock and Bib Cock

5.12.1 A bibcock (bibtap) is a draw off tap with a horizontal inlet and free outlet and stopcock (stop tap) is a valve with a suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of the screw down type. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be either crutch or butterfly type securely fixed to the spindle. The cocks shall open in anti-clockwise direction. When the bib cocks and stop cocks are required to be chromium plated, the chromium plating shall be of service Grade No. 2 conforming to IS.1068. in finish and appearance, the plated articles shall be free from plating defects such as blisters, pits, roughness and shall not be stained or discoloured.

5.12.2 These fittings shall be of brass heavy class, chromium plated (C.P) and of approved manufacture and pattern with screwed or flanged ends as specified. The fittings shall in all respects comply with the requirements of IS.781. The standard size of brass fittings shall be designated by the nominal bore of the pipe to which the fittings are attached. A sample of each kind of fitting shall be approved by the Employer's Representative and all supplies made according to the approved samples.

5.12.3 All cast fittings shall be sound and free from laps, blow holes and fittings, both internal and external surfaces shall be clean, smooth and free from sand etc. Burning, plugging stopping or patching of the casting shall not be permitted. The bodies, bonnets, spindles and other parts shall be truly machined and when assembled the parts shall be axial, parallel and cylindrical with surfaces smoothly finished. The area of the waterway of the fittings shall not be less than the area of the nominal bore.

5.12.4 The fittings shall be fully examined and cleared of all foreign matter before being fixed. The fittings shall be fitted in the pipe line in a workman like manner. The joints between fittings and pipes shall be made leak- proof. The joints and fittings shall be leak proof when subjected to a pressure test approved by the Employer's Representative and the defective fittings and joints shall be replaced or redone.

5.13 Soak Pit

5.13.1 Soak pit shall be constructed at the location specified by the Employer's Representative. Earthwork excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit upto 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 shall be constructed above this level upto ground. Well burnt brick aggregates of nominal size 40 mm to 80 mm and coarse sand shall be filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

5.14 Manholes

5.14.1 Location

Manholes shall be constructed at places approved by the Employer's Representative.

5.14.2 Excavation

Excavation, shoring, dewatering etc. for the pits of manholes, laying of pipes and fittings/specials shall be done in accordance with Employer's Requirements described elsewhere in the document.

5.14.3 Bed Concrete

The bed concrete for manholes shall be done in accordance with Employer's Requirements described elsewhere in the document.

5.14.4 Bricks

5.14.4.1 Bricks used for construction of manholes shall conform to the relevant Indian Standards. They shall be sound, hard, homogeneous in texture, well burnt in kiln without being vitrified, table moulded, deep red, cherry or copper coloured, of regular shape and size and shall have sharp and square and parallel faces. The bricks shall be free from pores, chips, flaws or humps of any kind. Bricks containing ungrounded particles and/or which absorb water more than 1/6th of their weight when soaked in water for twenty-four hours shall be rejected. Overburnt or underburnt bricks shall be liable to rejection. The bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 50 kg/sq.cm. unless otherwise noted in drawings. The class and quality requirements of bricks shall be as laid down in IS : 1077.

5.14.4.2 The size of the brick shall be 23.0 x 11.5 x 7.5 cm. unless otherwise specified; but tolerance upto ± 3 mm in each direction shall be permitted. Only full size brick shall be used for masonry work. Brick bats shall be used only with the permission of Employer's Representative to make up required wall length or for bonding. Sample bricks shall be submitted to the Employer's Representative for approval and bricks supplied shall conform to approved samples. If required by the Employer's Representative, brick sample shall be tested as per IS : 3495 by Contractor. Bricks rejected by the Employer's Representative shall be removed from the Site within 24 hours.

5.14.5 Cement Mortar

5.14.5.1 Mortar for brick masonry shall be prepared as per IS : 2250. Manholes shall be constructed in brick masonry with cement mortar (1:2) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg. of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by the Employer's Representative. If required by the Employer's Representative sand shall be thoroughly washed till it is free of any contamination.

5.14.5.2 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry conditions. Water shall then be added and mixing continued to give a uniform mix of required consistency. Cement mortar shall be used within 25 minutes of mixing. Mortar left unused in the specified period shall be rejected.

5.14.5.3 The Contractor shall arrange for tests on mortar samples if so required by Employer's Representative. Retempering of mortar shall not be permitted.

5.14.6 Brick Masonry

- 5.14.6.1 All bricks shall be thoroughly soaked in clean water for atleast one hour immediately before being laid. The cement mortar for brick masonry work of manholes shall be in the proportion specified in 5.14.5. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.
- 5.14.6.2 All brickwork shall be plumb and square unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS : 2212.
- 5.14.6.3 Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

5.14.7 Cement Plaster

- 5.14.7.1 All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.
- 5.14.7.2 The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.
- 5.14.7.3 Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damaged. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.
- 5.14.7.4 Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

5.14.7.5 Plastering work shall be carried out in two layers, the first layer being 14 mm thick and the second layer being 6 mm thick. The first layer shall be dashed against the prepared surface with a trowel to obtain an even surface. The second layer shall then be applied and finished leaving an even and uniform surface, trowel finished unless otherwise approved by the Employer's Representative.

5.14.8 Cement Concrete Channel

5.14.8.1 The channel for the manhole shall be constructed in cement concrete of M15 grade. Both sides of the channel shall be taken up to the level of the crown of the outgoing sewer. They shall be benched up in concrete and rendered in cement mortar (1:1) of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

5.14.9 Pipe Entering or Leaving Manhole

5.14.9.1 Whenever a pipe enters or leaves a manhole, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks.

5.14.10 Cast Iron Steps

5.14.10.1 Cast iron steps shall be as per IS : 5455. The steps shall be of grey cast iron of grade 15 as per IS : 210. The steps shall be clean, well cast and they shall be free from air and sand holes, cold shuts and warpings. The portion of the step which projects from the wall of the manhole shall have a raised chequered design to provide an adequate non-slip grip. C.I. steps shall weigh not less than 4.5 kg each and shall be of 150 mm x 375 mm overall dimensions. These steps shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63 degrees C and shall not be brittle as to chip of at temperature of 0 degree C.

5.14.10.2 Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be fixed in the brick work at the interval of 300 mm vertically and staggered at 380 mm horizontally centre to centre. In case of pipe diameter greater than 600 mm, box type C.I. steps weighing 19 kg each shall be provided at 300 mm vertically in channel of manhole.

5.14.11 Frame and Covers

5.14.11.1 Frame and covers for manholes shall be of required type and dimensions as per the relevant drawings prepared by the Contractor. Following information shall be clearly marked on each cover.

Year of manufacture,

Identification mark of the Employer: EMPLOYER

Arrow showing direction of flow

5.14.11.2 Cast Iron Frame and Cover

The cast iron frame and cover shall be of grey cast iron as per IS : 1726. The general requirements for casting and coating of CI frame and cover shall be as specified for CI steps in Clause 5.15.10. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequer shall be not less than 4 mm. The locking device for the cover shall be provided as approved by the Employer's Representative. The CI covers for the load test shall be selected at one for every lot of fifty or part thereof for each type and size manufactured and as approved by the Employer's Representative. The frame shall be fixed in cement concrete of M15 grade all round and finished with neat

cement. The manhole frame shall have 560 mm diameter clear opening and shall weigh not less than 208 kg. including cover. In case of rectangular CI frame and cover of 900 mm x 600 mm clear opening, the total weight shall not be less than 275 kg. In case of scraper manhole the frame shall have clear opening of 1200 mm x 900 mm and shall weigh not less than 900 kg including cover. The manhole cover and frame shall be painted with three coats of anti-corrosive paint after fixing in position.

5.14.11.3 Fibre Reinforced Concrete Frame and Cover

Fibre reinforced concrete frame and cover shall be capable of withstanding load of 35 tonnes. The frame shall be fixed in cement concrete of M15 grade all around and finished with neat cement. The fibre reinforced frame shall have clear opening of 560 mm diameter and weighing 102 kg. The cover shall have a minimum thickness of 100 mm and weighing 78 kg. The fibres shall constitute 1% of the weight of the concrete in the form of 50 mm to 100 mm long high tensile steel wires. For the cover, MS sheet lapping of 18 gauge shall be provided to avoid damage to the edges. Similarly for frame, MS angle/flat shall be provided along the edge. Both MS sheet and angle shall be painted with black bituminous paint. The cover should have suitable lifting arrangement. The fibre reinforced frame and cover shall be manufactured as approved.

5.14.11.4 Reinforced Cement Concrete Frame and Cover

Reinforced cement concrete frame and cover for manholes shall be of required dimensions and shape as shown on the drawing prepared by the Contractor. The frame and cover shall be cast in cement concrete of M25 grade. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

5.14.12 Drop Manhole

5.14.12.1 When a sewer connects a main sewer, and where the difference in level between water line (peak flow levels) of main line and the invert level of branch lines is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection within 600 mm, a drop connection shall be provided for which a manhole shall be constructed as per relevant drawing, incorporating a vertical drop pipe from the higher sewer to the lower one. This pipe shall be provided outside the shaft and encased in concrete. A continuation of the branch sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange. The diameter of the back drop should be at least as large as that of the incoming pipe. The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

5.14.12.2 In the case of sewers over 450 mm in diameter the drop in level may be accomplished by one of the following approved methods:

- (a) A cascade;
- (b) A ramp;
- (c) By drops in previous manholes.

5.14.13 RCC Manhole

- 5.14.13.1 M25 grade of concrete used for construction of RCC manhole shall have minimum cement content of 360 kg/cum of concrete. Minimum cover to the reinforcement shall be 50 mm.

5.14.14 Vent Shafts

- 5.14.14.1 General

Vent shafts shall be erected at such places as approved by the Employer's Representative.

- 5.14.14.2 Mild Steel Vent Shaft

Mild steel vent shaft shall be of 150 mm diameter and 12.17 m height from ground level with C.I. ornamental cap. This shall be fixed firmly and encased in cement concrete of M15 grade as shown on relevant drawing with necessary mild steel bolts, plates etc. for foundation. The vent shaft shall be painted with one coat of silver paint over one coat of red lead oxide paint. The vent shaft shall be connected to manhole by 150 mm diameter glazed stoneware pipe encased by M10 concrete of 150 mm thickness all around as approved by the Employer's Representative.

- 5.14.14.3 RCC Vent Shaft

Reinforced cement concrete vent shaft shall be of M25 grade concrete, 200 mm diameter at bottom and tapered to 100 mm diameter at top (both inside clear openings) and 6 m height from ground level. The vent shaft shall be embedded in concrete of M10 grade and anchored by 2 nos. of 16 mm diameter and 600 mm long MS bars. The vent shaft shall be connected to manhole as specified in (b) above through a brick masonry flue chamber.

5.14.15 Miscellaneous

- 5.14.15.1 If any damage is caused to the other services such as water supply pipeline, sewer, cable, etc. during the construction of manholes and erection of vent shafts, the Contractor shall be held responsible for the same and shall replace the damaged services to the full satisfaction of the Employer's Representative.

- 5.14.15.2 The interior of manholes shall be cleared of all debris after construction and before testing the same for water tightness by the Contractor.

6.0 APPROACH AS WELL AS INTERNAL ROAD WORKS

(Part A) Flexible Pavement

6.1 Applicable Codes and Client's Requirements

The following specifications, standards and codes are referred to in this part.

IS : 73	:	Specification for Paving Bitumen
IS : 215	:	Specification for Road Tar
IS : 217	:	Specification for Cutback Bitumen
IS : 454	:	Specification for Digboi type Cutback Bitumen
IS : 460	:	Specification for Test sieves
(Parts 1 to 3)		
IS : 1077	:	Common burnt clay building bricks - Specification
IS : 1124	:	Method of test for determination of water absorption, apparent specific gravity and porosity of building stones
IS : 1195	:	Specification for Bitumen Mastic for Flooring
IS : 1196	:	Code of Practice for Laying Bitumen Mastic Flooring
IS : 1834	:	Specification for Hot Applied Sealing Compounds for Joints in Concrete
IS : 2386	:	Methods of test for aggregates for concrete
(Parts 1 to 8)		
IS : 2720	:	Method of Test for Soils
(Part 5)		Determination of Liquid and plastic limit
IS : 6241	:	Method of test for determination of stripping value of road aggregates.
IRC : 16	:	Specification for priming of Base Course with Bituminous Primers.
IRC : 17	:	Tentative specification for Single Coat Bituminous Surface Dressing
IRC : 19	:	Standard specifications and code of practice for water bound macadam
IRC : 27	:	Specification for bituminous macadam
MoRTH	:	Specifications for road and bridge works

All earthwork shall be according to Employer's Requirements specified elsewhere.

6.1.1 Access to Abutting Properties

For the duration of the works the contractor shall at all times provide convenient access to paths, steps, bridge or drives for all entrances to property abutting the site and maintain them clear, tidy, and free from mud and objectionable matter

6.2 Road Construction

6.2.1 Road shall consist of the following :

- a) Well compacted sub-grade layer.
- b) Providing and laying sub-base of 260 mm thick with 40 mm to 90 mm size aggregates compacted to 200 mm thick in two layers with watering, rolling etc., as per specification complete.
- c) Providing and laying base course of 105 mm size with 40 mm to 60 mm size aggregates compacted to 75 mm thickness in one layer with watering, rolling etc., as per specifications.
- d) Providing and applying Prime Coat with bituminous emulsion (Slow Setting) at 7.5 kg/10Sqm
- e) Providing and applying Tack Coat with bituminous emulsion (Rapid Setting) at 2.5 kg/10Sqm

- f) Providing 70 mm compacted thickness of asphalt Macadam as per specification consisting of premixed asphaltic carpet and seal coat.

6.3 Materials

6.3.1 General

All materials shall be obtained from local sources and shall be subject to Employer's Representative's approval prior to use.

6.3.2 Soling Stone

It shall be clean, sound, dense, hard, tough, durable stone of uniform quality free from unsound material, cracks, decay and weathering. Water absorption shall not be more than 5 percent. The stone shall be in the smallest dimension equal to thickness of the soling course specified with a tolerance of 25 mm. Soling Stone shall be sufficiently flat bedded. The height of the soling stone shall be equal to the specified thickness of soling. The length and breadth shall not exceed twice the specified thickness.

6.3.3 Stone Aggregate/Metal

Coarse aggregate, stone chippings shall consist of natural or crushed stone, clean, hard, tough, durable and free from excess of flat, elongated, soft and disintegrated particles, dirt, salt, alkali, vegetable matter, adherent coatings, organic and other objectionable matter, and shall conform to the physical requirements given in Tables 7.1 or 6.2 hereunder, as applicable. Aggregate for bituminous wearing courses shall in addition have good hydrophobic properties i.e. capacity of retaining the film of bituminous material applied to the stone in all weather conditions and especially in wet conditions. Basalt, dolerite are good in this respect; granite, quartzite are comparatively poor.

Table – 6.1 Physical Requirements of Coarse Aggregate for Water Bound Macadam (Sub Base/ Base Course)

Sl. No.	Test	Requirements	Test Method
1.	Los Angeles Abrasion Value* Or Aggregate Impact Value*	50 percent (max.) 40 percent (max.)	IS:2386 (Part – IV) IS:2386 (Part – IV) Or IS:5640***
2.	Flakiness Index **	15 percent (max.)	IS:2386 (Part I)

(*) Aggregate may satisfy requirements of either of two tests.

(**) Requirements of flakiness index shall be enforced only in case of crushed broken stone.

(***) Aggregates like brick, metal, kankar, laterite etc., which get softened in presence of water shall be tested for impact value under wet conditions in accordance with IS:5640.

Table – 6.2 Physical Requirements of Aggregates for Bituminous Wearing Course

Sl.No	Test	Requirements	Test Method
1.	Los Angeles Abrasion Value* Or Aggregate Impact Value*	40 percent (max.) 30 percent (max.)	IS:2386 (Part – IV) IS:2386 (Part – IV)
2.	Flakiness Index **	35 percent (max.)	IS:2386 (Part I)
3.	Stripping Value	25 percent (max.)	IS:6241
4.	Water Absorption	2 percent (max.)	IS:2386 (Part-III)
5.	Soundness		

Loss with Sodium Sulphate – 5 cycles	12 percent (max.)	IS:2386 (Part-V)
Loss with Magnesium Sulphate – 5 cycles	18 percent (max.)	

(*) Aggregate may satisfy requirements of either of two tests

(**) Requirement of flakiness index shall be enforced only in case of crushed broken stone

The coarse aggregate for water bound Macadam shall conform to one of the gradings given in Table-6.3 below :

Table – 6.3 Grading Requirements Of Coarse Aggregates For Water Bound Macadam

Grading No.	Size Range	Sieve Designation	Percent by Weight Passing the Sieve
1.	90mm to 45mm	125 mm 90 mm 63 mm 40 mm 22.4 mm	100 90-100 25-60 0-15 0-5
2.	63mm to 45mm	90 mm 63 mm 64 mm 65 mm 22.4 mm	100 90-100 25-75 0-15 0-5
3.	53mm to 22.4 mm	63 mm 64 mm 65 mm 22.4 mm 11.2 mm	100 95-100 65-90 0-10 0-5

6.3.4 Screenings for Water Bound Macadam

Screenings to fill voids in the coarse aggregate shall consist of the same materials as the coarse aggregate. However, where permitted, predominantly non-plastic material such as murum or gravel (other than river borne material) may be used for this purpose provided liquid limit and plasticity index of such material is below 20 and 6 respectively and fraction passing 75 micron sieve does not exceed 10 percent.

Screenings shall conform to the gradings set forth in Table – 6.4. Screenings of Type-A in Table-6.4 shall be used with coarse aggregate of grading 1 in Table – 6.3. Screenings of Type A or B, as approved, shall be used with coarse aggregates of grading 2. Type-B screenings shall be used with coarse aggregates of grading 3.

Table –6.4 Gradings For Screenings

Grading No.	Size Range	Sieve Designation	Percent by Weight Passing the Sieve
A	12.5 mm	12.5 mm 10.0 mm 4.75 mm 150 micron	100 90-100 10-30 0-8
B	10 mm	10 mm 4.75 mm 150 micron	100 85-100 10-30

- a) The use of screening shall be omitted in the case of soft aggregates such as brick metal, kankar, laterites etc. as they are likely to get crushed to a certain extent under rollers.

6.3.5 Binding Material

- 6.3.5.1 Binding material shall comprise of a suitable material, approved by Employer's Representative, have plasticity index value of less than 6 as determined in accordance with IS : 2720 (Part - V)
- 6.3.5.2 Application of binding material may not be necessary, when the screenings used are of crushable type such as murum or gravel.

6.3.6 Murum/Kankar/Gravel/Sand

- 6.3.6.1 Murum shall contain low plasticity binder material mixed with hard granular particles such as sand and/or gravel. Murum shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free from all impurities. Large lumps shall all be broken at the quarry and murum delivered at site must pass in every direction through a 63 mm ring. Murum shall not contain more than 5% to 8% of fines passing a 75 micron sieve.
- 6.3.6.2 Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense and shall not contain particles bigger than 12 mm and more than 10 percent silt.
- 6.3.6.3 Sand used for blinding the bituminous road surface, shall be coarse, sharp, gritty, clean, granular material. Only material passing through 4.75 mm sieve and retained on 75 micron sieve shall be used.

6.3.7 Bituminous Materials

- 6.3.7.1 Bituminous materials shall conform to IS : 73, IS : 215, IS : 217 or IS : 454 as applicable and be of the grade specified.

6.4 Earth work

6.4.1 Earthwork in Excavation

- 6.4.1.1 In general the excavation shall be in accordance to Employer's Requirement specified elsewhere.
- 6.4.1.2 Profiles of road excavation shall be laid at 50 m intervals to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.
- 6.4.1.3 Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approved by the Employer's Representative in writing. If excavation is done below the specified level or outside the section the Contractor shall be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for the subgrade.
- 6.4.1.4 The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections and side slopes as shown in the drawings or approved by Employer's Representative.

6.4.2 Earthwork in Embankment

- 6.4.2.1 The embankment shall be formed of earth obtained from approved source.
- 6.4.2.2 The ground over which embankment is to be formed shall be cleared of all brushwood, loose stones, vegetation, bushes, stumps, and all other objectionable matter and materials so removed shall be burnt off or disposed off as approved by Employer's Representative.
- 6.4.2.3 Profiles of embankment shall be set up with stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 metres on straight portions. Toe line may be marked with pick marks.
- 6.4.2.4 Before placing any embankment material the top 150 mm of soil strata receiving it shall be scarified and watered and compacted with one pass of 8-10T roller.
- 6.4.2.5 Embankment material shall be placed in successive horizontal layers of 200 mm depth extending to the full width of the embankment including the slopes at the level of the particular layer and 300 mm more on both sides to allow compaction of the full specified section. Before placing the next layer the surface of the underlayer shall be moistured and scarified with pick axes or spades to provide a satisfactory bond with the next layer. The extra loose stuff at the edges shall be trimmed later after completion of the bank work leaving the correct section fully compacted.
- 6.4.2.6 When boulders, broken stones and similar hard materials are mixed up with the embankment materials care shall be taken to see that they are distributed uniformly into the bank and that no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, leveled, and compacted as specified before the succeeding layer is placed. The surface of the embankment shall at all times during construction be maintained at such a cross fall as will shed water and prevent ponding.
- 6.4.2.7 If the bank materials contains less than the optimum moisture, water shall be added to the loose layers of the embankment to bring the moisture uniformly upto requirement. If the material contains more than the required moisture it shall be allowed to dry until the moisture is reduced to the required extent.
- 6.4.2.8 The moistured/dried loose layers shall be compacted with a power roller of 10 to 12 tonnes. The roller shall pass at least twice over the same area, once in the forward move and the second time in backward move.
- 6.4.2.9 To allow for subsequent settlement the finished level of the embankment shall be kept higher than the specified level by one centimetre for every metre of the height of the bank.
- 6.4.2.10 Embankment shall be finished and dressed smooth and even to conform to the alignment, levels, cross sections, and dimensions shown on drawings with due allowance for shrinkage. Any damage caused by rain, or due to any other reason shall be made good in the finishing operation.

6.5 Preparation of Subgrade

- 6.5.1 In general Earthwork in subgrade shall conform to Employer's Requirement specified elsewhere.

- 6.5.2 Immediately prior to the laying of the soling the subgrade shall be cleaned of all foreign substances, vegetation etc. Any ruts or soft yielding patches that appear shall be corrected and the subgrade dressed off parallel to the finished profile. The camber of subgrade shall conform in shape to that of the finished road surface. Camber boards shall be used to get the required section.
- 6.5.3 The prepared subgrade shall be lightly sprinkled with water, if necessary, and rolled with power roller of not less than 10 tonnes, till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content. Roller shall pass minimum 5 runs on the subgrade. Rolling shall commence at the edges and progress towards the centre longitudinally. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. Any undulations in the surface that develop due to rolling shall be made good with approved earth and subgrade rerolled.

6.6 Soling

- 6.6.1 Soling shall not be constructed on a wet subgrade.
- 6.6.2 Unless otherwise specified, the width of the soling shall be 230 mm more on either side than that of the waterbound macadam wearing course and the finished thickness of the soling course shall be 230 mm.
- 6.6.3 The soling stones shall be laid with the largest face downwards and in contact with each other. The stones shall break joint as far as possible. The height of the soling stone shall be equal to specified thickness of soling.
- 6.6.4 As the laying of rubble advances the soling shall be hand packed by wedging and packing with 80 mm metal in the joints of the soling and driving them by hammers in place so as to fill the voids as completely as possible. This operation of hand packing shall closely follow the rubble laying. The soling shall be laid and hand packed true to grade and section and these shall be often checked by boning rods, template boards and fish line etc. The grades, sections etc. of the soling shall correspond to those of the surfacing coming on it. The soling thus laid shall be finished by knocking out projecting stones and filling depressions by chips to come up to the grade and camber.
- 6.6.5 The quality of the 80 mm metal shall be same as specified for the soling and the longest dimension shall not be more than 100 mm and the shortest dimension not less than 50 mm.
- 6.6.6 The soling after it is properly laid and hand packed including filling of voids with 80 mm metal shall be rolled dry with 10 - 12 T power roller to refusal i.e., till the stones in the soling course cease to move under the roller and no more compaction can be achieved. Rolling shall start at the edges and work towards the centre. The roller shall run over the same surface of rolling for at least 8 times till the soling course is well consolidated. The surface shall be checked by templates and in case of unevenness high spots shall be knocked out and depressions filled by spalls and recompacted fully. Bunds shall be laid along the edges and compacted before starting rolling on soling to prevent spreading of stones.
- 6.6.7 Gravel shall be spread in thin layers over the above prepared soling surface, swept into the interstices with brooms, watered lightly to assist the filling of voids. Spreading of gravel, sweeping and watering shall continue till the interstices are completely filled. At all times only enough water shall be sprinkled to force the gravel into the voids and never so much as to soften the subgrade. The process of gravel filling shall be accompanied by rolling as for dry rolling of soling with a power roller weighing not less than 10 tonnes starting at edge and working towards the centre. The roller shall run over the same surface for at least eight times. Each pass of the roller shall uniformly overlap not less than one third of the track

made in the preceding pass. The surface shall be checked with templates of approved design (to be provided by Contractor) and high and low spots corrected by removing soling and repacking.

6.7 Water Bound Macadam Course

The surface over which water bound Macadam is to be laid shall be prepared to the specified grade and camber and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm. To prevent the spreading of the course aggregate during rolling, if necessary, two parallel mud walls 200 mm wide and of height equal to uncompacted Macadam course shall be made along the outer edges of the Macadam course having a clear distance between them equal to the width to be metalled.

W.B.M. sub-base course of specified thickness shall be provided. The course aggregate for this shall conform to requirements of sub-base in Table-1 and its grading shall conform to Grading 1 of Table - 6.3 and screening to Type B of Table-6.4.

W.B.M. base course : The coarse aggregate for this shall normally conform to requirements for Base in Table-1 and its grading shall confirm to Grading 3 of Table – 6.3 and screening to Type-B of Table-6.4.

6.7.1 Spreading Coarse Aggregate

6.7.1.1 The coarse aggregate shall be spread uniformly and evenly upon the prepared surface in such quantities that the thickness of each compacted layer does not exceed 75 mm or as otherwise specified. In no case, however, shall the thickness of each compacted layer exceed 100 mm.

6.7.1.2 The spreading shall be done from stockpiles by raking the stacks with rakes so as to leave behind mud and dust. In no case shall the aggregate be dumped in heaps directly on the surface prepared to receive the aggregate nor shall hauling over uncompacted or partially compacted sub-base/base be permitted. The surface of the aggregates spread shall be fully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be of uniform gradation with no pockets of fine material. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved plan. The coarse aggregate shall not normally be spread in lengths exceeding 3 days' average work ahead of the rolling and bonding of the proceeding section.

6.7.2 Rolling

6.7.2.1 Following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of not less than 10 tonne capacity or tandem or vibratory roller of approved type. Rolling shall begin from the edges and gradually progress towards the centre. First the edges/edge shall be compacted with roller running forward and backward and then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width. Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base. The rolled surface shall be checked transversely and longitudinally with templates and all undulations shall be corrected by loosening the surface, adding or removing necessary amounts of aggregate and rerolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be

permitted to make up depressions. Material which crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates. It shall be ensured that shoulders are also built-up simultaneously alongwith water bound macadam course.

6.7.3 Application of Screening

6.7.3.1 After the coarse aggregate has been rolled in accordance with Clause 6.9, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers. Screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all the voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall screenings be applied so fast and thick as to form cakes and ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate. Spreading, rolling and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

6.7.4 Sprinkling and Grouting

6.7.4.1 After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the sub-grade or sub-base does not get damaged due to the addition of excessive quantities of water during construction. In case the subgrade or sub-base gets damaged, the Contractor shall rectify the damaged portion.

6.7.5 Application of Binding Material

6.7.5.1 After the application of screenings in accordance with Clauses 6.7.3 and 6.7.4, the binding material where it is required to be used (See Clause 6.3.5) shall be applied successively in two or more thin layers at a slow and uniform rate. After each application, the surface shall be copiously sprinkled with water, the resulting slurry swept in with hand brooms or mechanical brooms to fill the voids properly and rolled, during which water shall be applied to the wheels of the rollers, if necessary, to wash down the binding material sticking to them. These operations shall continue until the resulting slurry after filling of voids, forms a wave ahead of the wheels of the moving roller.

6.7.6 Setting and Drying

6.7.6.1 After the final compaction of water bound Macadam course it shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as approved, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the Macadam has set.

6.7.7 Multiple Layered Course

6.7.7.1 When the total consolidated thickness of the water bound Macadam course is more than 100 mm, it shall be constructed in layers. Each layer shall be constructed as per all the

operations described above. The same degree of quality control and refinement shall be used for constructing each layer.

6.8 Premixed Asphaltic Carpet

This work shall consist of constructing in a single course of 20 mm thick Premixed Asphaltic Carpet on 50 mm thick Bituminous macadam to the following Employer's Requirements on a previously prepared base, to serve as a wearing coat.

6.8.1 Materials

- (a) **Binder**
This shall be paving bitumen of penetration grade within the range S 35 to S 90 or A 35 to A 90 (30-40 to 80/100) as per Indian Standard for 'Paving Bitumen' IS : 73. The actual grade of bitumen to be used shall be decided by the Employer's Representative appropriate to the region, traffic, rainfall and other environmental conditions.
- (b) **Course Aggregate**
It shall be crushed material retained on 2.36 mm (No. 8 ASTM) sieve and shall be crushed stone or gravel (shingle) and shall be as per Clause 6.3.3 and satisfy the physical requirements set forth in Table-6.2.
- (c) **Fine Aggregates**
The fine aggregates shall be the fraction passing 2.8 mm sieve and retained on 90 micron sieve consisting of crusher run screenings, natural sand or mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or deleterious substances.
- (d) **Filler**
The filler shall be an inert material, the whole of which passing 710 micron, sieve, at least 90 percent passing 180 micron sieve and not less than 70 percent passing 90 micron sieve. The filler shall be stone dust, cement, hydrated lime, fly ash or any other non-plastic mineral matter approved by the Employer's Representative.

6.8.2 COMPOSITION OF BITUMINOUS MACADAM

The mineral aggregates including mineral filler shall be so graded or combined as to confirm to the either of the limits set forth in Table-6.5 below :

Table – 6.5 COMPOSITION OF BITUMINOUS MACADAM

Mix designation	Grading 1	Grading 2
Nominal aggregate size	40mm 8	19mm
Layer thickness	80-100mm	50-75 mm
IS Sieve (mm)	Cumulative % by weight of total aggregate passing	
45	100	
37.5	90-100	
26.5	75-100	100
19	-	90-100
13.2	35-61	56-88
4.75	13-22	16-36
2.36	4-19	4-19
0.3	2-10	2-10
0.075	0-8	0-8

Bitumen content, % by weight of total mixture ¹	3.1-3.4	3.3-3.5
Bitumen grade	35 to 90	35 to 90

6.8.3 Mix Design

Apart from conformity with the grading and quality requirements of individual ingredients, the asphaltic concrete mix shall meet the requirements set forth in Table-6.6 hereunder.

6.8.4 Weather and Seasonal Limitations

Asphalt concrete shall not be laid during rainy weather or when the base course is damp or wet.

Table – 6.6 Requirement of Asphaltic Concrete Mix

Sr.No.	Description	Requirements
1.	Number of compaction blows, each end of Marshalling specimen	50
2.	Marshall stability (ASTM Designation-D-1559) determined on Marshall specimen	340 Kg. (min.)
3.	Marshall flow (mm)	2-4
4.	Percent Voids in mix	3-5
5.	Percent voids in mineral aggregate filled with bitumen	75-85
6.	Binder content percent by weight of mix	5-7.5

The contractor shall intimate to the Employer's Representative in writing, well in advance of the start of work, the job- mix formula proposed to be used by him for the work and shall give following details to the Employer's Representative for his approval.

- i) Source and location of all materials
- ii) Proportions of all materials expressed as follows where each is applicable :

Binder	As percentage by weight of total mix
Course aggregate	As percentage by weight of total aggregate including mineral filler
Fine aggregate	
Mineral filler	

- iii) A single definite percentage passing each sieve for the mixed aggregate.
- iv) The results of the best enumerated in Table-6.6 as obtained by the Contractor.
- v) Test results of physical characteristics of aggregates to be used.

Should a change in the source of material be proposed, a new job mix formula shall be established and got approved from the Employer's Representative before actual using of the materials.

6.8.5 Preparation of Base

- 6.8.5.1 The base on which premix carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section by repairing all potholes or patches and ruts. The potholes shall be drained of water and cut to regular shape with vertical sides. All loose and disintegrated material shall be removed. The pothole shall then be filled either with (i) Coarse aggregate and screenings conforming to Clause 3.0 and compacted with heavy hand rammers or approved mechanical tampers or (ii) premixed chippings binders (bitumen

grade 80/100) content of 3 percent by weight of total mix, after painting the sides and bottom of the holes with a thin application of bitumen, or a combination of both (i), (ii) as approved by Employer/Employer's Representative. The surface shall be thoroughly swept and scraped clean and free of dust and other foreign matter.

6.8.6 Tack Coat

6.8.6.1 The binder used for tack coat shall be bitumen of suitable penetration grade within 80/100 conforming to IS:73. The actual grade of bitumen to be used shall be decided by the Employer's Representative, appropriate to the region, traffic, rainfall and other environmental conditions. Binder shall be heated to the temperature appropriate to its grade and as approved by the Employer's Representative. The binder shall be sprayed on the prepared base at the rate of 1.0 kg/sq.m. The binder shall be applied uniformly with the aid of either self propelled or towed bitumen pressure sprayer with self heating arrangement and spraying nozzle arrangement capable of spraying bitumen at the above specified rate and temperature so as to provide uniform unbroken spread of bitumen. The tack coat shall be applied just ahead of oncoming premixed asphalt carpet.

6.8.7 Preparation of Mix and Laying

6.8.7.1 Hot mix plant of adequate capacity and capable of producing a proper and uniform quality mix shall be used for preparing the mix. The plant may be either a weigh batch type or volumetric proportioning continuous or drum mix type. The stone aggregate shall be surface dry and contain not more than 2 percent moisture before use. It shall be first screened of dust and measured in boxes, heated to 155 deg.C - 163 deg. C and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion specified. The binder shall be heated to 140 deg. C to 177 deg. C in boilers and maintained at that temperature. At no time shall the difference in temperature between the aggregate and binder exceed 14 deg. C. The heated binder shall be drawn from the boiler into a suitable container or in a bucket gauged to show the weight of bitumen in it.

6.8.7.2 Mixing shall be done in two stages. The coarse aggregate of the correct standard size and in the proportion as specified shall be fed into the mixer to which 2/3rd of the total specified quantity of bitumen heated to the appropriate temperature shall be added. When the coarse aggregate is well coated, the fine aggregate in the specified proportion followed by the balance 1/3rd quantity of total bitumen shall be fed into the mixer. Mixing shall be continued until a homogeneous mix is produced and all particles are uniformly coated with bitumen.

6.8.7.3 The hot mix shall be discharged from the mixer carried to the point of use in suitable tipper vehicles and shall be spread by means of a self propelled mechanical paver with a suitable screeds capable of spreading, tamping and finishing the mix to specified lines and levels to a thickness sufficient to achieve after consolidation the specified thickness. Temperature of the mix at the time of laying shall be in the range of 120 deg. C - 160 deg. C. However, in restricted locations and in narrow width where available equipment can not be operated in the opinion of the Employer's Representative, he may permit manual laying of the mix. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal joints shall be offset by at least 150 mm from those in the binder course (tack coat). All joints shall be cut vertical to the full thickness of the previously laid mix and the surface painted with hot bitumen before placing fresh material.

6.8.8 Rolling

6.8.8.1 Immediately after the spreading of mix it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km per hour. The initial or break down

rolling shall be with 8-12 ton three wheel roller and the surface finished by final rolling with the 8-10 ton tandem roller. Preferably before finishing with tandem, breakdown rolling shall be followed by an intermediate rolling with a fixed wheel pneumatic roller of 15 to 30 ton having a tyre pressure of 7 kg. per sq.m. The joints and edges shall be rolled with a 8 to 12 ton three wheel roller. Any high spots or depressions which become apparent shall be corrected by addition or removal of mix material. The roller shall uniformly overlap not less than a third of the track made in the preceding pass. The wheels of the roller shall be moistened with gunny bags to prevent the mix sticking to the wheels while rolling, but in no case shall fuel lubricating oil be used for this purpose. Rolling shall be continued till the mix is thoroughly compacted and all roller marks are eliminated.

6.8.9 Opening to Traffic

Traffic shall be allowed on the road after a lapse of minimum 24 hours, preferably 48 hours after laying as approved by the Employer's Representative.

6.9 Seal Coat

This work shall consist of application of a seal coat sealing the voids in a bituminous surface laid to the specified levels, grade and camber. Seal coat shall be either of the two types below :

Type A : Liquid seal coat comprising of an application of a layer of bituminous binder followed by a cover of stone chippings.

Type B : Premixed seal coat comprising of a thin application of fine aggregate premixed with bituminous binder.

6.9.1 Materials

6.9.1.1 Binder

This shall be 30/40, 60/70 or 80/100 grade straight run bitumen conforming to IS:73. The actual grade of bitumen to be used shall be approved by the Employer's Representative, appropriate to the region, traffic, rainfall and other environmental conditions. The quantity of binder to be utilized, shall be 9.8 kg and 6.8 kg per 10 sq.m. of area for Type A and Type B seal coat respectively.

6.9.1.2 Stone Chippings for Type A Seal Coat

These shall consist of angular fragments of clean, hard, tough and durable rock of uniform quality throughout. They should be free of elongated or flaky pieces, soft or disintegrated stone, vegetable or other deleterious matter. Stone chippings shall be of 10 mm size defined as 100 percent passing through 12.5 mm sieve and retained on 2.36 mm sieve. The quantity used for spreading shall be 0.09 cum per 10 sq.m.

6.9.1.3 Fine Aggregate for Type B Seal Coat

The fine aggregate shall be sand or fine grit and shall consist of clean, hard, durable, uncoated dry particles and shall be free from dust, soft or flaky material organic matter or other deleterious substances. The aggregate shall pass 1.7 mm sieve and be retained on 180 micron sieve. The quantity used for premixing shall be 0.06 cu.m. per 10 square metre area.

6.9.2 Preparation of Base

The seal coat shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat materials the surface shall be cleaned free of any dust or other extraneous matter.

6.9.3 Construction of Type A Seal Coat

6.9.3.1 Application of Binder
Binder shall be heated in boilers to 163 deg. C to 171 deg. C, maintained at the temperature and sprayed on the dry surface in a uniform manner with the help of mechanical sprayers. Excessive deposits of binder caused by stopping or starting of the sprayer through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

6.9.3.2 Application of Stone Chipping
Immediately after the application of the binder, stone chippings in a dry and clean state shall be spread uniformly on the complete surface. If necessary the surface shall be broomed to ensure uniform spread of chippings. The surface shall be checked by means of a camber board laid across the road and a 3 metre straight edge laid parallel to the centre line of the road and undulations if any, shall be corrected by addition or removal of blindage.

6.9.3.3 Rolling
Immediately after the application of the cover the material, the entire surface shall be rolled with a 8 to 10 tonne smooth wheeled roller. While rolling is in progress additional material shall be spread by hand in whatever quantities required to make up irregularities. Rolling shall continue until all material is firmly bedded in the binder and presents a uniform closed surface. Generally five to six passes shall be made for thorough compaction of the surface or as approved by the Employer's Representative. Along kerbs, manholes and at all places not accessible to roller, thorough compaction shall be secured by means of steel rammers or hand rollers. Traffic shall be allowed after 24 hours. After a period of seven days, surplus grit shall be swept and collected and shall be used for binding the spots where bleeding occurs.

6.9.4 Construction of Type B Seal Coat

6.9.4.1 Preparation of Mix and Laying
The aggregate shall be surface dry and contain not more than 2 percent moisture before use, and shall be heated to 155 deg. C - 163 deg. C and then loaded into the drum mixer according to the capacity of the mixing drum in the proportion specified. The binder shall be heated to 149 deg. C to 177 deg. C in boilers and maintained at that temperature. At no time shall the difference in temperature between the aggregate and binder exceed 14 deg. C. The heated binder shall be drawn from the boiler into a suitable container or in a bucket gauged to show the weight of bitumen in it. The mix shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

6.9.4.2 Rolling
As soon as sufficient length has been covered with the premixed material, the surface shall be rolled with 8 to 10 tonne smooth wheeled power rollers. Rolling shall be continued till the premixed material completely seals the voids in bituminous course and a smooth uniform surface is obtained.

6.9.4.3 Opening to traffic
Traffic may be allowed soon after final rolling when, the premixed material has cooled down to the surrounding temperature.

6.10 Quality Control

6.10.1 General

6.10.1.1 All materials incorporated and all works performed shall be strictly in conformity with the Specification requirements. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as approved by the Employer's Representative subject to the permitted tolerances described hereinafter. The contractor shall be fully

responsible for the quality of the work in the entire construction within the Contract. He shall, therefore, have his own independent and adequate set-up for ensuring the same.

- 6.10.1.2 The Contractor shall carry out quality control tests on the materials and work to the frequency specified. In the absence of clear indications about method and/or frequency of tests for any item, the approval of the Employer's Representative shall be obtained and he shall provide necessary co-operation and assistance in obtaining the samples for test and carrying out the field test as required by the Employer's Representative from time to time. This may include provision of Labour, attendance, assistance in packing and dispatching and any other assistance considered necessary in connection with the test.
- 6.10.1.3 For the work of embankment, subgrade and construction of subsequent layer of same or other material over the finished layer shall be done after obtaining approval from the Employer's Representative. Similar approval from the Employer's Representative shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.
- 6.10.1.4 The Contractor shall carry out modification in the procedure of work, if found necessary, as approved by the Employer's Representative during inspection. Works falling short of quality shall be rectified by the Contractor as approved by the Employer's Representative.

6.10.2 Permitted Tolerances

6.10.2.1 Horizontal Alignments

Horizontal alignments shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 25 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 40 mm.

6.10.2.2 Longitudinal Profile

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross- profile of the road shown on the drawings or as approved by the Employer's Representative beyond the tolerances mentioned below :

Subgrade	± 15 mm
Sub-base	± 20 mm
Base Course	± 15 mm
Wearing Course	± 10 mm

Provided, however, that the negative tolerance for wearing course shall not be permitted in conjunction with the positive tolerance for base course if the thickness of the former is thereby reduced by more than 6 mm.

6.10.2.3 Surface Regularity

The surface regularity of completed subgrade, sub-bases, base courses and wearing surfaces in the longitudinal and transverse directions shall be within the tolerances indicated in Table 6.7.

The longitudinal profile shall be checked with a 3 metre long straight edge, at the middle of each traffic lane along a line parallel to the centre line of the road. The transverse profile shall be checked with a set of three camber boards at intervals of 10 metres.

6.10.2.4 Rectification

Where the surface irregularity of subgrade and the various courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Employer's Representative.

i) Subgrade

Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by adding fresh material. The degree of compaction and the type of material to be used shall conform to the Clause 6.4.

ii) Water Bound Macadam

here the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompactd. The area treated at a place shall not be less than 5 metres long and 2 metres wide.

iii) Bituminous Constructions

For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material and recompacting to Employer's Requirements. Where the surface is high, the full depth of the layer shall be removed and replaced with fresh material and compacted to Employer's Requirements.

For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to Employer's Requirements. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 metre long and not less than 1 lane wide.

Table 6.7 Permitted Tolerance of Surface Regularity for Subgrade and Pavement Courses

Sl. No	Type of Construction	Longitudinal profile with 3 Cross profile metre straight edge					
		Maximum permissible undulation	Maximum number of undulations permitted in any 300 metres length exceeding : mm				Maximum permissible variation from specified profile under comber template : mm
1	2	3	4	5	6	7	8
1.	Earthen subgrade	24	30	-	-	-	15
2.	Granular/Lime/Cement/stabilised subbase	15	-	30	-	-	12
3.	Water bound macadam with over size metal (45-90 mm size)	15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (22-4-53 mm and 45-63 mm size)	12	-	-	30	-	8
5.	Bituminous macadam	8	-	-	-	10@@	4

Notes :

- @@ These are for machine laid surfaces. If laid manually due to unavoidable reasons, tolerance upto 50 percent above these values in this column may be permitted at the discretion of the Employer's Representative. However, this relaxation does not apply to the values of maximum undulation for longitudinal and cross profiles mentioned in columns 3 and 8 on the table.

2. Surface evenness requirements in respect of both the longitudinal and cross profiles should be simultaneously satisfied.

6.11 Tests

6.11.1 General

6.11.1.1 For ensuring the requisite quality of construction, the materials and works shall be subjected to quality control tests, as described hereinafter. The testing frequencies set forth are the desirable minimum and the Employer's Representative shall have the full authority to increase the frequencies of tests as he may deem necessary to satisfy himself that the materials and works comply with the appropriate Employer's Requirement.

6.11.1.2 Test procedures for the various quality control tests are indicated in the respective Sections of these Employer's Requirements or for certain tests within this Section. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the approval of the Employer's Representative.

6.11.2 Tests on earthwork for Embankment and Subgrade Construction

(a) Borrow material

- (i) Sand content [IS:2720(Part IV)]
1-2 tests per 8000 cu. metres of soil
- (ii) Plasticity Test [IS:2720(Part V)]
Each type to be tested , 1-2 tests per 8000 cu. metres of soil.
- (iii) Density Test [[IS:2720(Part VII)].
Each soil type to be tested, 1-2 tests per 8000 cubic metres of soil.
- (iv) Deleterious Content Test [IS:2720(Part XXVII)]
As and when required by the Employer's Representative.
- (v) Moisture Content Test [IS:2720(Part II)]
One test for every 250 cubic metres of soil.
- (vi) CBR Test on materials to be incorporated in the subgrade on soaked/uns soaked samples [[IS:2720(part XVI)]
One test for every 3000 m³ at least or closer as and when required by the Employer's Representative.

(b) Compaction control : Control shall be exercised by taking at least one measurement of density for each 1000 square metres of compacted area, or closer as required to yield the minimum number of test results for evaluation a days work on statistical basis. The determination of density shall be in accordance with IS:2720 (part XXVIII). Tests locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one tests in one set of measurements shall be 5 as long as it is felt that sufficient control over borrow material and the method of compaction is being exercised. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subject to the condition that the mean dry density equals or exceeds the specified density and the standard deviation for any set of results is below 0.08 gm/cc.

However, for earthwork in shoulders (earthen) and in top 500 mm portion of the embankment below the subgrade, at least one density measurement shall be taken for every 50 square metres of the compacted area provided further `that the number of tests in each set of measurements shall be at least 10. In other respects, the control shall be similar to that described earlier.

6.11.3 Tests on Sub-bases and Bases

(Excluding bitumen bound bases)

The tests and their frequencies for the different types of bases and sub-base shall be as given in Table 6.8. The evaluation of density results for compaction control shall be on lines similar to those set out in clause 6.18.2

**Table –6.8 Control Tests and Their Frequencies for Sub-Bases and Bases
(Excluding Bitumen Bound Bases)**

Sl.No	Types of Construction	Test	Frequency
1.	Granular sub-base	i) Gradation ii) Atterbergs limit iii) Moisture content prior to compaction iv) Density of compacted layer v) Deleterious constituents vi) C.B.R	One test per 200 m ³ One test per 200 m ³ One test per 250 m ² One test per 500 m ² As required As required
2.	Lime/Cement Stabilised	vii) Purity of lime (for lime-soil stabilization) viii) Lime/Cement content ix) Degree of pulverisation x) CBR test on a set of 3 specimens xi) Moisture content prior to compaction xii) Density of compacted layer xiii) Deleterious constituents	One test for each consignment subject to a minimum of one test per 5 tonnes of lime. Regularly, through procedural checks. Periodically as considered necessary. As required One test per 250 m ³ . One test per 500 m ² As required
3	Water Bound Macadam	xiv) Aggregate Impact Value xv) Grading xvi) Flakiness Index xvii) Atterbergs limits of binding material.	One test per 200m ³ of aggregate One test per 100 m ³ of aggregate One test per 200 m ³ of aggregate One test per 25 m ³ of binding material

6.11.4 Tests on Bituminous Constructions

The tests and their frequencies for the different types of bituminous works shall be as given Table 6.9 hereunder.

Table – 6.9 Control Tests and Their Frequency for Bituminous Works

Sl. No.	Types of Construction	Test	Frequency
1.	Prime Coat/Track Coat	i) Quality of binder ii) Binder temperature for a application iii) Rate of spread of binder	As Required As regular close intervals Two tests per day

Sl. No.	Types of Construction	Test	Frequency
2.	Seal Coat/Surface Dressing	iii) Quality of binder iv) Aggregate Impact Value v) Flakiness Index vi) Stripping value of aggregates vii) Water absorption of aggregates viii) Grading of aggregates ix) Temperature of binder of application x) Rate of spread of materials	As required One test per 50 m ³ of aggregate One test per 50 m ³ of aggregate Initially, one set of 8 representative specimens for each source of supply. Subsequently when warranted by changes in the quality of aggregate One test per 25 m ³ of aggregate At regular close intervals One test per 500 m ³ of aggregate
3	Bituminous Concrete/Macadam	xi) Quality of binder xii) Aggregate impact value, flakiness index and stripping value of aggregates xiii) Mix-grading xiv) Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling xv) Stability of mix (vide ASTM:D-1559) i) Binder content and gradation in the mix (Binder content test vide ASTM:D-2172) ii) Rate of spread of mixed material iii) Density of compacted layer	As required One test per 50-100m ³ of aggregate One set of test on individual constituents and mixed aggregates from the dryer for each 100 tonnes of mix subject to a maximum of two sets per plant per day. At regular close interval. For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value density, and void content, subject to a minimum of two sets being tested per plant per day. One test for each 100 tonnes of mix subject to a minimum of two tests per day per plant. Regular control through checks on the weight of mixed material and layer thickness. One test per 500 m ³ area

(Part B) C.C Pavement (Road)

Road shall consist of the following :

- a) Well compacted sub-grade layer.
- b) Providing and laying 100 mm thick PCC in M 10
- c) Providing and laying 200 mm thick Concrete in M 20
- d) TMT /Mild steel Reinforcement
- e) Providing and applying Trimix with dewatering machine and floater machine
- f) Groove Cutting & Filling with polysulfide selant

All the material shall confirm to the relevant Specification/ as per MORTH section 1000

Item of PCC ,RCC & TMT/Mild steel shall be executed as per relevant srelevant specification/MoRTh Specification

P/A Trimix with dewatering machine and floater machine on constructed Pavement

The purpose of vacuum processing is the removal of surplus water forms the concrete to provide quicker setting & earlier maximum strength properties. Vacuum dewatering takes place immediately after the screeding operation.

Upon the surface of the wet concrete is placed a filler pad consisting of two layers. The bottom layer is contract with the concrete is the fine nylon cloth to act as filler. The upper layer consists of a special type of plastic net & acts as a water duct. Finally the top cover consisting of a light plastic sheet is placed over the filler pad projecting slightly outside on all sides. The border of the top cover rests directly upon the wet concrete to produce an airtight seal.

The suction met is connected with suction houses to a vacuum pump. The normal atmospheric pressure in the pump is reduced by 90% & 90% of the atmospheric pressure compresses the concrete.

Concrete is submitted to a pressure of

Air pressure .1N / mm²

Depression .01N/mm²

= Effective pressure .09 N/ mm²

This pressure of about 9000 kp/m² compresses the concrete & compacts the aggregates. At the same time the excess water which not necessary for the hydration process of the cement is extracted from the concrete & consciously discharged with the air.

Apart from normal compaction through vibration, static compaction takes place during vacuum dewatering with ensuring reduction w/c ratio. The initial w/c/ ratio is reduced by 10 to 20%. This explains the noticeable improvement s of the concrete properties achieved through vacuum dewatering.

Vacuuming time is about 1 to 2 min. per cm concrete thickness depending on the particle shape in the mix. M250

One vacuum pump with two suction met can dewater 50 to 60 m². A 20 cm thick concrete slab takes about 30 min. dewater. Accordingly a normal daily production rate is about 400 m².

Making groove in Pavement and filling it with polysulfide selant

General

All joints in surface slabs shall be sealed using **polysulfide** sealant. Joints shall not be sealed before - 14 days after construction.

Preparation of joint grooves for sealing

Joint grooves usually are not constructed to provide the minimum width specified in the drawings when saw cut joints are adopted. They shall be widened subsequently by sawing before sealing, depth/width gauges shall be used to control the dimension of the groove.

If rough arrises develop when grooves are made, they shall be ground to provide a chamfer approximately 5 mm wide. If the groove is at an angle upto 10 degree from the perpendicular to the surface, the overhanging edge of the sealing groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10 degrees, the joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects upto a maximum width, including any chamfer, of 35 mm for transverse joints and 20 mm for longitudinal joints. If the spalling cannot be so eliminated then the arrises shall be repaired by an approved thin bonded arris repair using cementitious materials.

All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. If need-arises the Engineer may instruct cleaning by pressurised water jets. Depending upon the requirement of the sealant manufacturer, the sides of the grooves may have to be sand blasted to increase the bondage between sealant and concrete.

The groove shall be cleaned and dried at the Lime of priming and sealing.

Before sealing the temporary seal provided for blocking the ingress of dirt, soil etc., shall be removed. A highly compressible heat resistant paper-backed debonding strip as per drawing shall be inserted in the groove to serve the purpose of breaking the bond between sealant and the bottom of the groove and to plug the joint groove so that the sealant may not leak through the cracks. The width of debonding strip shall be more than the joint groove width so that it is held tightly in the groove. In the case of longitudinal joints, heat resistant tapes may be inserted to block the leakage through bottom of the joint.

Sealing with sealants

When sealants are applied, an appropriate primer shall also be used if recommended by the manufacturer and it shall be applied in accordance with their recommendation. The sealant shall be applied within the minimum and maximum drying times of the primer recommended by the manufacturer. Priming and sealing with applied sealants shall not be carried out when the naturally occurring temperature in the joint groove to be sealed is below 7° C.

If hot applied sealant is used it shall be heated and applied from a thermostatically controlled, indirectly heated preferably with oil jacketed melter and pourer having recirculating pump and extruder. For large road projects, sealant shall be applied with extruder having flexible hose and nozzle. The sealant shall not be heated to a temperature higher than the safe heating temperature and not for a period longer than the safe heating period, as specified by the manufacturer. The dispenser shall be cleaned out at the end of each day in accordance with the manufacturer's recommendations and reheated material shall not be used.

Cold applied sealants with chemical formulation like polysulphide may be used. These shall be mixed and applied within the time limit specified by the manufacturer. If primers are recommended they shall be applied neatly with an appropriate brush. The Movement Accommodation Factor (MAP) shall be more than 10 per cent.

The sealants applied at contraction phase of the slabs would result in bulging of the sealant over and above the slab. Therefore, the Contractor in consultation with the Engineer, shall establish the right

temperature and time for applying the sealant. Thermometer shall be hung on a pole in the site for facilitating control during the sealing operation.

Sealant shall be applied, slightly to a lower level than the slab with a tolerance of 5 ± 2 mm.

During sealing operation, it shall be seen that no air bubbles are introduced in the sealant either by vapours or by the scaling process.

Testing of applied sealants: Manufacturer's certificate shall be produced by the Contractor for establishing that the sealant is not more than six months old and stating that the sealant complies with the relevant standard as in Clause 602.2.8. The samples shall meet the requirement of AASHTO M 282 for hot applied sealant or BS 5212: (Pan-2) for cold applied sealant.

7.0 BUILDING DETAILS

7.1 Applicable Codes and Specifications

The following codes and standards are included in this section, as part of these specifications. However, respective IS codes for the works not mentioned here shall also be applicable for those particular items of work.

- IS:110 - Ready mixed paint, brushing, grey filler, for enamels for use over primers
- IS:269 - Specification for 33 grade ordinary portland cement
- IS:280 - Specification for mild steel wire for general engineering purposes
- IS:287 - Recommendations for maximum permissible moisture content of timber used for different purposes
- IS:304 - High Tensile Brass Ingots and Castings.
- IS:337 - Varnish, finishing interior
- IS:348 - French polish
- IS:383 - Specification for coarse and fine aggregates from natural sources for concrete
- IS:412 - Expanded metal steel sheets for general purposes
- IS:419 - Specification for putty for use on window frames
- IS:428 - Distemper, oil emulsion, colour as required
- IS:459 - Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets
- IS:702 - Specification for industrial bitumen
- IS:710 - Specification for marine plywood
- IS:712 - Specification for building limes
- IS:730 - Specification for hook bolts for corrugated sheet roofing
- IS:733 - Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes
- IS:777 - Specification for glazed earthenware tiles
- IS:1003 - Specification for timber panelled and glazed shutters (Parts 1 & 2)
- IS:1038 - Specification for steel doors, windows and ventilators
- IS:1077 - Specification for common burnt clay building bricks
- IS:1081 - Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators
- IS:1124 - Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
- IS:1237 - Specification for cement concrete flooring tiles
- IS:1322 - Bitumen felts for water proofing and damp proofing
- IS:1346 - Code of practice for water proofing of roofs with bitumen felts
- IS:1361 - Specification for steel windows for industrial buildings
- IS:1397 - Specification for kraft paper
- IS:1443 - Code of practice for laying and finishing of cement concrete flooring tiles
- IS:1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2)
- IS:1542 - Specification for sand for plaster
- IS:1580 - Specification for bituminous compounds for water-proofing and caulking purposes
- IS:1597 - Code of practice for construction of stone masonry : Part 1 Rubble stone masonry
- IS:1659 - Specification for block boards
- IS:1661 - Code of practice for application of cement and cement-lime plaster finishes
- IS:1834 - Specification for hot applied sealing compound for joint in concrete

- IS:1838 - Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type) : Part 1 Bitumen impregnated fibre
- IS:1948 - Specification for aluminium doors, windows and ventilators
- IS:1949 - Specification for aluminium windows for industrial buildings
- IS:2074 - Ready mixed paint, air drying, red oxide- zinc chrome, priming
- IS:2098 - Asbestos cement building boards
- IS:2114 - Code of practice for laying in-situ terrazzo floor finish
- IS:2116 - Specification for sand for masonry mortars
- IS:2185 - Specification for concrete masonry units (Parts 1,2 & 3)
- IS:2202 - Specification for wooden flush door shutters (Solid core type) : Parts 1 & 2
- IS:2212 - Code of practice for brickwork
- IS:2250 - Code of practice for preparation and use of masonry mortars
- IS:2338 - Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
- IS:2339 - Aluminium paint for general purposes, in dual container
- IS:2395 - Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
- IS:2402 - Code of practice for external rendered finishes
- IS:2571 - Code of practice for laying in-situ cement concrete flooring
- IS:2572 - Code of practice for construction of hollow concrete block masonry
- IS:2645 - Specification of integral cement waterproofing compounds
- IS:2690 - Specification for burnt clay flat terracing tiles : Part 1 Machine made
- IS:2691 - Specification for burnt clay facing bricks
- IS:2750 - Specification for steel scaffoldings
- IS:2835 - Flat transparent sheet glass
- IS:2932 - Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing
- IS:3007 - Code of practice for laying of asbestos cement sheets - corrugated and (Part 1 & 2) semi-corrugated sheets
- IS:3036 - Code of practice for laying lime concrete for a water-proofed roof finish
- IS:3067 - Code of practice of general design details and preparatory work for damp-proofing and water- proofing of buildings
- IS:3068 - Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
- IS:3384 - Specification for bitumen primer for use in water-proofing and damp-proofing
- IS:3461 - Specification for PVC-asbestos floor tiles
- IS:3462 - Specification for unbacked flexible PVC flooring
- IS:3495 - Method of test for burnt clay building bricks: Part 1 to 4
- IS:3536 - Specification for ready mixed paint, brushing, wood primer, pink
- IS:3564 - Specification for door closures (hydraulically regulated)
- IS:3614 - Specification for fire checks doors : Part –I Plate metal covered and rolling type
- IS:3614 - Specification for metallic and non-metallic fire check doors : Part-2 (Part – 2) - Resistance test and performance criteria
- IS:3696 - Safety code of scaffolds and ladders (Parts 1 & 2)
- IS:4020 - Methods of test for wooden flush door : Type test
- IS:4021 - Specification for timber door, window and ventilator frames
- IS:4351 - Specification for steel door frames
- IS:4443 - Code of practice for use of resin type chemical resistant mortars
- IS:4457 - Specification for ceramic unglazed vitreous acid resisting tile
- IS:4631 - Code of practice for laying epoxy resin floor toppings
- IS:4832 - Specification for chemical resistant mortars (Part II)

- IS:4860 - Specification for acid resistant bricks
- IS:4948 - Specification for welded steel wire fabric for general use
- IS:5318 - Code of practice for laying of flexible PVC sheet and tile flooring
- IS:5410 - Cement paint, colour as required
- IS:5411 - Specification for plastic emulsion paint (Parts 1 & 2)
- IS:5437 - Wired and figured glass
- IS:5491 - Code of practice for laying of in-situ granolithic concrete floor topping
- IS:6041 - Code of practice construction of autoclaved cellular concrete block masonry
- IS:6042 - Code of practice for construction of light weight concrete block masonry
- IS:6248 - Specification for metal rolling shutters and rolling grilles
- IS:7193 - Specification for glass fibre base coal tar pitch and bitumen felts
- IS:7452 - Specification for hot rolled steel sections for doors, windows and ventilators
- IS:8042 - Specification for white portland cement
- IS:8543 - Methods of testing plastics
- IS:8869 - Specification for washers for corrugated sheet roofing
- IS:9197 - Specification for epoxy resin, hardeners and epoxy resin composites for floor topping
- IS:9862 - Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
- IS:12200 - Code of practice for provision of waterstops at transverse contraction joints in masonry and concrete dams
- BS : 476 - Methods for determination of the fire resistance of elements of construction (General Principles)
- BS : 476 - Methods for determination of the fire resistance of load bearing elements of construction (Part – 21)
- BS : 476 - Methods for determination of the fire resistance of non-load bearing elements of construction (Part – 22)
- Part – IV - National Building code of India Fire Protection

7.2 Brickwork

7.2.1 Materials

- 7.2.1.1 Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work prepared by the Contractor.
- 7.2.1.2 The nominal size of the modular brick shall be 200mmx100mmx100mm with the permissible tolerances over the actual size of 190mmx90mmx90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mmx115mmx75mm with tolerance upto ± 3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.
- 7.2.1.3 Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the Items of work prepared by the Contractor.

- 7.2.1.4 The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.
- 7.2.1.5 Sample bricks shall be submitted to the EMPLOYER for approval and bricks supplied shall conform to approved samples. If demanded by EMPLOYER, brick samples shall be got tested as per IS: 3495 by Contractor. Bricks rejected by EMPLOYER shall be removed from the site of works within 24 hours.
- 7.2.1.6 Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work prepared by the Contractor. Sand for masonry mortar shall conform to IS:218. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by EMPLOYER. If so directed by the EMPLOYER, sand shall be screened and washed till it satisfies the limits of deleterious materials.
- 7.2.1.7 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the EMPLOYER. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances. The Contractor shall arrange for test on mortar samples if so directed by the EMPLOYER.

7.2.2 Workmanship

- 7.2.2.1 Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work prepared by the Contractor. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only as closers to make up required wall length or for bonding. Bricks shall be laid with frogs on top.
- 7.2.2.2 All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one metre. Brick work shall not be raised more than one metre per day.

- 7.2.2.3 Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.
- 7.2.2.4 During inclement weather conditions, newly built brick masonry works shall be protected by tarpaulin or other suitable covering to prevent mortar being washed away by rain.
- 7.2.2.5 Brickwork shall be kept constantly moist on all the faces for at least seven days after 24 hrs of laying. The arrangement for curing shall be got approved from the EMPLOYER.
- 7.2.2.6 Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS:2750 and IS:3696 (Part I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the EMPLOYER. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering/pointing.
- 7.2.2.7 In the event of usage of traditional bricks of size 230 mm x 115mm x 75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor slabs and at the top of the parapet shall be laid with bricks on edge.
- 7.2.2.8 All brickwork shall be built tightly against columns, floor slabs or other structural members.
- 7.2.2.9 To overcome the possibility of development of cracks in the brick masonry following measures shall be adopted.
- 7.2.2.10 For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.
- 7.2.2.11 RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50mm on either sides of the beam, duly finished on top with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.
- 7.2.2.12 Steel wire fabric shall be provided at the junction of brick masonry and concrete before taking up plastering work.
- 7.2.2.13 Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

- 7.2.2.14 Reinforced cement concrete transomes and mullions of dimensions as indicated in the construction Drawings to be prepared by the Contractor are generally required to be provided in the half brick partition walls.
- 7.2.2.15 Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.
- 7.2.2.15 Facing bricks of the type specified conforming to IS:2691 shall be laid in the positions indicated on the Drawings prepared by the Contractor and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.
- 7.2.2.16 Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works prepared by the Contractor. The pattern of laying the bricks shall be as specifically indicated in the Drawings prepared by the Contractor. For facing brickwork, double scaffolding shall be used. Faced works shall be kept clean and free from damage, discoloration etc., at all times.

7.3 Uncoursed Random Rubble Masonry, in Foundation, Plinth and Superstructure

7.3.1 Materials

- 7.3.1.1 Stones for the works shall be of the specified variety which are hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS:1597 (Part-I). The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS:1124. The Contractor shall supply sample stones to the EMPLOYER for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.
- 7.3.1.2 Cement-sand mortar for stone masonry works shall be in the proportion of 1:6. Materials and preparation of mortar shall be as specified in clause 7.2.1.

7.3.2 Workmanship

- 7.3.2.1 For All Works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.
- 7.3.2.2 For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.
- 7.3.2.3 Face stones shall extend back sufficiently and bond well with the masonry. The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourths the thickness of wall nor less than 150 mm. The height of stone may be upto a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

- 7.3.2.4 Chips and spalls shall be used wherever necessary to avoid thick mortar joints and to ensure that no hollow spaces are left in the masonry. The use of chips and spalls in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spalls and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.
- 7.3.2.5 The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.
- 7.3.2.6 Through or bond stones shall be provided in walls upto 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.
- 7.3.2.7 All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45deg. Masonry work shall not be raised by more than one metre per day.
- 7.3.2.8 Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of seven days for proper curing of the joints.
- 7.3.2.9 Type of scaffolding to be used shall be as specified in clause 7.2.2.

7.4 Coursed Rubble Masonry (First Sort) for Superstructure

7.4.1 Materials

- 7.4.1.1 The Material specification for the work shall be as per clause 7.3.1.

7.4.2 Workmanship

- 7.4.2.1 All Courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.
- 7.4.2.2 Face stones shall tail into the work for not less than their height and atleast 1/3rd the number of stones shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by atleast 75 mm.
- 7.4.2.3 The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for atleast 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40 mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed

on it. The remaining unexposed portion of the stone shall not project beyond the surface of bed and side joints.

- 7.4.2.4 No spalls or pinnings shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.
- 7.4.2.5 Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.
- 7.4.2.6 The requirement regarding through or bond stones shall be as specified in clause 7.3.2 with the further stipulation that these shall be provided at 1.5 m to 1.8m apart clear in every course but staggered at alternate courses.
- 7.4.2.7 The quoins which shall be of the same height as the course in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have a minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane.
- 7.4.2.8 Type of scaffolding to be used shall be as per Clause 7.2.2. Requirements of execution of the work and curing shall be as stipulated in clause 7.3.2 .

7.5 Concrete Block Masonry

7.5.1 Materials

- 7.5.1.1 Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS : 2185 (Part I).
- 7.5.1.2 Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS : 2185 (Part 3).
- 7.5.1.3 Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS:2185 (Part 3).
- 7.5.1.4 The height of the concrete masonry units shall not exceed either its length or six times its width.
- 7.5.1.5 The nominal dimensions of concrete block shall be as under.
 - a) Length 400, 500 or 600 mm
 - b) Height 100 or 200 mm
 - c) Width 100 to 300 mm in 50 mm increments
- 7.5.1.6 Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full length blocks.
- 7.5.1.7 Actual dimensions shall be 10mm short of the nominal dimensions.
- 7.5.1.8 The maximum variation in the length of the units shall not be more than ± 5 mm and maximum variation in height or width of the units shall not be more than ± 3 mm.

- 7.5.1.9 Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.
- 7.5.1.10 Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square.
- 7.5.1.11 The bedding surfaces shall be at right angles to the faces of the block.
- 7.5.1.12 The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.
- 7.5.1.13 Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of EMPLOYER.

7.5.2 Workmanship

- 7.5.2.1 The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.
- 7.5.2.2 The workmanship shall generally conform to the requirements of IS:2572 for concrete block masonry, IS:6042 for light weight concrete block masonry and IS:6041 for autoclaved cellular concrete block masonry works.
- 7.5.2.3 From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.
- 7.5.2.4 Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 7.2.1.
- 7.5.2.5 The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.
- 7.5.2.6 Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with

moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.

- 7.5.2.7 As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis.
- 7.5.2.8 For jambs of doors, windows and openings, should concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.
- 7.5.2.9 At intersection of walls, the courses shall laid up at the same time with a true masonry bond between atleast 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 7.2 for the brick work.
- 7.5.2.10 Curing of the mortar joints shall be carried out for atleast 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.
- 7.5.2.11 Double scaffolding as per clause 7.2.2 shall be adopted for execution of block masonry work.
- 7.5.2.12 Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.
- 7.5.2.13 Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

7.6 Damp - Proof Course

7.6.1 Materials and Workmanship

- 7.6.1.1 Where Specified, all the walls in a building shall be provided with damp-proof course cover plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm down graded coarse aggregates.
- 7.6.1.2 The surface of brick work/stone masonry work shall be levelled and prepared before laying the cement concrete. Side shuttering shall be properly fixed to ensure that slurry does not leak through and is also not disturbed during compaction. The upper and side surface shall be made rough to afford key to the masonry above and to the plaster.
- 7.6.1.3 Damp-proof course shall be cured properly for atleast seven days after which it shall be allowed to dry for taking up further work.

7.7 Miscellaneous Inserts, Bolts etc.

- 7.7.1 All the miscellaneous inserts such as bolts, pipes, plate embedments etc., shall be accurately installed in the building works at the correct location and levels, all as detailed in the

construction Drawings to be prepared by the Contractor prepared by the Contractor. Contractor shall prepare and use templates for this purpose, if so directed by the EMPLOYER. In the event, of any of the inserts are improperly installed, Contractor shall make necessary arrangements to remove and reinstall at the correct locations/levels, all as directed by the EMPLOYER.

7.8 Wood Work for Doors, Windows, Ventilators & Partitions

7.8.1 Materials

- 7.8.1.1 Timber To be used shall be first class Teak wood as per IS:4021. Timber shall be of the best quality and well seasoned by a suitable process before being planed to the required sizes. The maximum permissible moisture content shall be from 10 to 16 percent for timber 50mm and above in thickness and 8 to 14 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.
- 7.8.1.2 Flush door shutters of the solid core type with plywood face panels shall conform to IS:2202 (Part 1) and with particle board/hard board face panels shall conform to IS:2202 (Part 2).
- 7.8.1.3 Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.
- 7.8.1.4 Builder's hardware for fittings and fixtures shall be of the best quality from approved manufacturers.

7.8.2 Workmanship

- 7.8.2.1 The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.
- 7.8.2.2 All works shall be executed as per the detailed Drawings prepared by the Contractor and/or as directed by the EMPLOYER.
- 7.8.2.3 All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work prepared by the Contractor. The workmanship shall generally conform to the requirements specified in IS:4021.
- 7.8.2.4 The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar.
- 7.8.2.5 Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door and window frames, one at the centre and the other two at 300

mm from the top and bottom of the frame. For window and ventilator frames less than 1 m in height, two hold fasts on each side shall be fixed at quarter points.

- 7.8.2.6 Timber panelled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the Drawings prepared by the Contractor. The stiles and rails shall be joined by mortice and tenon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS:1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS:710 shall be used for doors where specified.
- 7.8.2.7 Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, venetian louvre opening, teak wood lipping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS:710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS:4020, if so desired by the EMPLOYER.
- 7.8.2.8 Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS:2835. The thickness and type of glazing to be provided shall be as specified.
- 7.8.2.9 The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminum shall be as specified. The number, size and type of the fittings and fixtures shall be as specified.
- 7.8.2.10 Woodwork shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the EMPLOYER. The type of finish and the number of coats shall be as stipulated in the respective items of work prepared by the Contractor. Preparation of the wood surfaces and application of the finishes shall be in accordance with clause 7.32.
- 7.8.2.11 Wooden hand railing and architrave's shall be of the size and shape with the fixing arrangement as indicated in the Drawings prepared by the Contractor.
- 7.8.2.12 The framework of the partitions with mullions and transoms shall be with the sections of dimensions as specified. Panels of double/single glazing/plywood shall be fixed as per details specified. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction Drawings prepared by the Contractor.
- 7.8.2.13 Any carpentry work which show defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per Specifications.

7.9 Steel Doors, Windows and Ventilators

7.9.1 Materials

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

- 7.9.1.2 Pressed steel door frames for steel flush doors shall be out of 1.25mm thick mild steel sheets of profiles as per IS : 4351.
- 7.9.1.3 Transparent sheet glass shall conform to the requirements of IS : 2835. Wired and figured glass shall be as per IS : 5437.
- 7.9.1.4 Builder's hardware of fittings and fixtures shall be of the best quality from the approved manufacturers.

7.9.2 Workmanship

- 7.9.2.1 All steel doors, windows and ventilators shall be of the type as specified in the respective items of work prepared by the Contractor and of sizes as indicated in the Drawings prepared by the Contractor prepared by the Contractor. Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS : 1038. Steel windows shall conform to IS : 1361, if so specified.
- 7.9.2.2 Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and metered. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS : 1038. Tolerance in overall dimensions shall be within ± 1.5 mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the EMPLOYER before further manufacture/purchase by the Contractor.
- 7.9.2.3 Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and / or as shown in the Drawings prepared by the Contractor for single or composite units.
- 7.9.2.4 For windows with fly proof mesh as per the item of work prepared by the Contractor, rotor operator arrangement, for the operation of the glazed shutters from the inside shall be provided.
- 7.9.2.5 Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock-strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as per the requirements of IS : 4351. Pressed steel doorframes shall be fixed as 'built-in' as the masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side and each course grouted with mortar to ensure solid contact with the doorframe, without leaving any voids. Temporary struts across the width shall be fixed, during erection to prevent bow/sag of the frame.
- 7.9.2.6 Door shutters of flush welded construction shall be 45mm thick, fabricated with two outer skills of 1.25mm thick steel sheets, 1mm thick steel sheet stiffeners and steel channels on all four edges. Double shutters shall have meeting stile edge beveled or rebated. Provision of glazed viewing panel, louvers shall be made as per the items of works and/or Drawings prepared by the Contractor. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting. Single sheet steel door shutters shall be fabricated out of 1.25mm thick steel sheets, mild steel angles and stiffeners as per the Drawings prepared by the Contractor.
- 7.9.2.7 Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The

dimensions of the masonry opening shall have 10mm clearance around the overall dimensions of the frame for this purpose. Any support of scaffolding members on the frames/glazing bars is prohibited.

- 7.9.2.8 Glazing of the units shall be either with flat transparent glass or wired / figured glass of the thickness as specified in the items of works prepared by the Contractor. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.
- 7.9.2.9 Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or with metal beads. Pre-formed PVC or rubber gaskets shall be provided for fixing the beads with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in Drawings prepared by the Contractor.
- 7.9.2.10 Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanised with thickness of the zinc coating as stipulated all as described in the respective items of works prepared by the Contractor.
- 7.9.2.11 The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the items of works prepared by the Contractor. The number, size and type of fittings and fixtures shall be as in the Drawings /items of works prepared by the Contractor.
- 7.9.2.12 Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081. Necessary holes etc required for fixing shall be made by the Contractor and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

7.10 Aluminum Doors, Windows, Ventilators & Partitions

7.10.1 Materials

- 7.10.1.1 Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS:733.
- 7.10.1.2 Transparent sheet glass shall conform to the requirements of IS:2835. Wired and figured glass shall be as per IS:5437.
- 7.10.1.3 Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

7.10.2 Workmanship

- 7.10.2.1 All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminum windows, shall conform to IS:1949, if so specified.
- 7.10.2.2 All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm.
- 7.10.2.3 Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within ± 1.5 mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plane. Punching of holes, slots and other

provisions to install fittings or fixtures later shall be made at the correct locations, as per the requirements.

- 7.10.2.4 Aluminium swing type doors, aluminum sliding windows, partitions shall be as specified.
- 7.10.2.5 IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running metre of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are being continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor, will be reviewed by the EMPLOYER and will be accepted only if they are equal to or marginally more than that given in the codes/as specified.
- 7.10.2.6 The framework of the partitions with mullions and transomes shall be with anodised aluminium box sections. Anodised aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the Drawings to be prepared by the Contractor. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction Drawings to be prepared by the Contractor.
- 7.10.2.7 Specific provisions as stipulated for steel doors, windows, ventilators under clause 7.9.2 shall also be applicable for this item work. Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works prepared by the Contractor. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

7.11 Steel Rolling Shutters

7.11.1 Materials and Workmanship

- 7.11.1.1 Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS:6248.
- 7.11.1.2 The type of rolling shutter shall be self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.
- 7.11.1.3 Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the Drawings prepared by the Contractor.
- 7.11.1.4 Shutters shall be built up of interlocking laths 75 mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50 m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.
- 7.11.1.5 The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS:6248 for various clear widths of the shutters.

- 7.11.1.6 Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.
- 7.11.1.7 Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.
- 7.11.1.8 All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site along with the number of coats and type of finish paint as specified in the respective items of works prepared by the Contractor. Painting shall be carried out as per clause 7.33.
- 7.11.1.9 In case of galvanised rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating shall be atleast 610gms/sq.m.
- 7.11.1.10 Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

7.12 Rubble Sub-Base

7.12.1 Materials

- 7.12.1.1 Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part I).
- 7.12.1.2 Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ± 10 mm. Stones shall not have a base area less than 250 sq cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the EMPLOYER.

7.12.2 Workmanship

- 7.12.2.1 Stones shall be hand packed carefully and laid with their largest base downwards resting flat on the prepared sub-grade and with their height equal to the thickness of the packing. Stones shall be laid breaking joints and in close contact with each other. All interstices between the stones shall be wedged-in by small stones of suitable size, well driven in by crow bars and hammers to ensure tight packing and complete filling-in of the interstices. The wedging shall be carried out simultaneously with the placing in position of rubble packing and shall not lag behind. After this, any interstices between the smaller wedged stones shall be infilled with clean hard sand by brooming so as to fill the joints completely.
- 7.12.2.2 The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

7.13 Base Concrete

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

7.13.2 Before placing the blinding concrete, the sub-base of rubble packing shall be properly wetted and rammed. Concrete for the base shall then be deposited between the forms, thoroughly tamped and the surface finished level with the top edges of the forms. Two or three hours after the concrete has been laid in position, the surface shall be roughened using steel wire brush to remove any scum or laitance and swept clean so that the coarse aggregates are exposed. The surface of the base concrete shall be left rough to provide adequate bond for the floor finish to be provided later.

7.14 Terrazzo and Plain Cement Tiling Work

7.14.1 Materials

7.14.1.1 Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS:1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14N/mm^2 .

7.14.1.2 The type, quality, size, thickness colour etc, of the tiles for flooring/dado/skirting shall be as specified.

7.14.1.3 The aggregates for terrazzo topping shall consist of marble chips which are hard, sound and dense. Cement to be used shall be either ordinary portland cement or white cement with or without colouring pigment. The binder mix shall be with 3 parts of cement to 1 part of marble powder by weight. The proportion of cement shall be inclusive of any pigments. For every one part of cement-marble powder binder mix, the proportion of aggregates shall be 1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

7.14.1.4 The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm upto 6mm or from 1mm upto 12mm. This shall be 6mm for tiles with chips varying from 1mm upto 25mm. The minimum thickness of wearing layer of cement/coloured cement tiles shall be 5mm. This shall be 6mm for heavy duty tiles. Pigment used in the wearing layer shall not exceed 10 percent of the weight of cement used in the mix.

7.14.2 Workmanship

7.14.2.1 Laying and finishing of tiles shall conform to the requirements of workmanship stipulated in IS:1443.

7.14.2.2 Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.

7.14.2.3 The base concrete shall be finished to a reasonably plane surface about 40 to 45mm below the level of finished floor. Before the tiling work is taken up, the base concrete or structural slab shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. using steel wire brush and well wetted without allowing any water pools on the surface.

7.14.2.4 A layer of 25mm average thickness of cement mortar consisting of one part of cement to 6 parts of sand shall be provided as bedding for the tiles over the base concrete. The thickness of bedding mortar shall not be less than 10mm at any place. The quantity of water to be added for the mortar shall be just adequate to obtain the workability for laying. Sand for the mortar shall conform to IS:2116 and shall have minimum fineness modulus of 1.5. The surface shall be left rough to provide a good bond for the tiles. The bedding shall be allowed to harden for a day before laying of the tiles.

- 7.14.2.5 Neat cement slurry using 4.4 kg of cement per sq.m of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the matrix of the tile. For this purpose white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.
- 7.14.2.6 About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those laid earlier, it is necessary that the Contractor shall procure sufficient quantity of extra tiles to meet this contingency.
- 7.14.2.7 Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.
- 7.14.2.8 Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish.
- 7.14.2.9 Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.
- 7.14.2.10 Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.
- 7.14.2.11 Machine grinding and polishing shall be commenced only after a lapse of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS:1443.
- 7.14.2.12 Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localised deviation of ± 3 mm in any 3m length is acceptable in a nominally flat floor.

7.15 In-Situ Terrazzo Work

7.15.1 Materials

7.15.1.1 The requirements of marble aggregates for terrazzo topping shall be as per clause 7.14.1.

7.15.1.2 Cement shall first be mixed with the marble powder in dry state. The mix thus obtained shall be mixed with the aggregates in the specified proportions. Care shall be taken not to get the materials into a heap which results in the coarsest chips falling to the edges and cement working to the centre at the bottom. Materials shall be kept, as far as possible, in an even layer during mixing. After the materials have been thoroughly mixed in the dry state, water shall be added, just adequate to obtain plastic consistency for the desired workability for laying. The mix shall be used in the works within 30 minutes of the addition of water to the cement.

7.15.2 Workmanship

7.15.2.1 The thickness, type, quality, size and colour of chips etc. for the in-situ terrazzo finish for flooring/dado/ skirting shall be as specified in the respective items of works prepared by the Contractor. Laying and finishing of in-situ work shall conform to the requirements of workmanship stipulated in IS: 2114.

7.15.2.2 In-situ terrazzo finish shall be laid over hardened concrete base. The finish layer consists of an under layer and terrazzo topping. The underlayer shall be of cement concrete of mix 1:2:4 using 10mm down graded coarse aggregates. The combined thickness of under layer and topping shall not be less than 30 mm for flooring and 20mm for dado/skirting work.

7.15.2.3 The minimum thickness of topping shall be 6mm if chips used are between 1mm to 4mm, 9mm if chips are between 4mm to 7mm and 12mm if chips are between 7mm to 10mm. If chips larger than 10mm size are used, the minimum thickness shall be one and one third the maximum size of chips.

7.15.2.4 Both the underlayer and later the topping shall be divided into panels not exceeding 2 sq.m for laying so as to reduce the possibility of development of cracks. The longer dimension of any panel shall not exceed 2m. Dividing strips shall be used to separate the panels. When the dividing strips are not provided, the bays shall be laid alternately, allowing an interval of atleast 24 hours between laying adjacent bays.

7.15.2.5 Dividing strips shall be either of aluminium, brass or other material as indicated in the items of works prepared by the Contractor. Aluminum strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work.

7.15.2.6 Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreading the under layer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided shall be fixed on the base and levelled to the correct height to suit the thickness of the finish. Just before spreading the under layer the surface shall be smeared with cement slurry at 2.75 Kg/sq.m. Over this slurry, the under layer shall be spread and levelled with a screeding board. The top surface shall be left rough to provide a good bond for the terrazzo topping.

- 7.15.2.7 Terrazzo topping shall be laid while the under layer is still plastic and normally between 18 to 24 hours after the under layer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a minimum of troweling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.
- 7.15.2.8 The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.
- 7.15.2.9 Machine grinding and polishing shall be commenced only after a lapse of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS: 2114.

7.16 Shahabad / Tandur/ Kota Stone Slab work

7.16.1 Materials

- 7.16.1.1 The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS : 1124.
- 7.16.1.2 The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be ± 5 mm. This shall be ± 2 mm on dimensions less than 100mm.
- 7.16.1.3 Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

7.16.2 Workmanship

- 7.16.2.1 The type, size, thickness and colour/shade etc. of the slabs for flooring/dado/skirting shall be as specified in the respective items of works prepared by the Contractor.
- 7.16.2.2 Preparation of the concrete base, laying and curing shall be as per clause 7.14.2.
- 7.16.2.3 Dado / skirting work shall be as per clause 7.14.2. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.
- 7.16.2.4 Grinding and polishing shall be as per clause 7.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

7.17 Carborundum Tile Finish

7.17.1 Materials

- 7.17.1.1 Carborundum tiles shall generally conform in all respects to the standards stipulated in IS:1237 for heavy duty tiles. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14 N/mm².

7.17.1.2 The topping shall be uniform and of thickness not less than 6mm. The quantity of carborundum grit shall be not less than 1.35 kg/sq.m used with cement with or without pigment. The carborundum grit shall pass through 1.18mm mesh and shall be retained on 0.60 mm mesh.

7.17.2 Workmanship

7.17.2.1 Requirements as detailed for terrazzo/cement tile finish under clause 7.14.2 shall be applicable for carborundum tile flooring.

7.18 Glazed Tile Finish

7.18.1 Materials

7.18.1.1 Glazed earthenware tiles shall conform to the requirements of IS: 777. Tiles shall be of the best quality from an approved manufacturer. The tiles shall be flat, true to shape and free from flaws such as crazing, blisters, pinholes, specks or welts. Edges and underside of the tiles shall be free from glaze and shall have ribs or indentations for a better anchorage with the bedding mortar. Dimensional tolerances shall be as specified in IS: 777.

7.18.2 Workmanship

7.18.2.1 The total thickness of glazed tile finish including the bedding mortar shall be 20 mm in flooring/dado/skirting. The minimum thickness of bedding mortar shall be 12mm for flooring and 10mm for dado/skirting work.

7.18.2.2 The bedding mortar shall consist of 1 part of cement to 3 parts of sand mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have minimum fineness modulus of 1.5.

7.18.2.3 Tiles shall be soaked in water for about 10 minutes just before laying. Where full size tiles cannot be fixed, tiles shall be cut to the required size using special cutting device and the edges rubbed smooth to ensure straight and true joints.

7.18.2.4 Coloured tiles with or without designs shall be uniform and shall be preferably procured from the same batch of manufacture to avoid any differences in the shade.

7.18.2.5 Tiles for the flooring shall be laid over hardened concrete base. The surface of the concrete base shall be cleaned of all loose materials, mortar droppings etc well wetted without allowing any water pools on the surface. The bedding mortar shall then be laid evenly over the surface, tamped to the desired level and allowed to harden for a day. The top surface shall be left rough to provide a good bond for the tiles. For skirting and dado work, the backing mortar shall be roughened using a wire brush.

7.18.2.6 Neat cement slurry using 3.3 kg cement per sq.m of floor area shall be spread over the hardened mortar bed over such an area as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. For skirting and dado work, the back of the tiles shall be smeared with cement slurry for setting on the backing mortar. Fixing of tiles shall be done from the bottom of the wall upwards. The joints shall be in perfect straight lines and as thin as possible but shall not be more than 1mm wide. The surface shall be checked frequently to ensure correct level/required slope. Floor tiles near the walls shall enter skirting/dado to a minimum depth of 10mm. Tiles shall not sound hollow when tapped.

- 7.18.2.7 All the joints shall be cleaned of grey cement with wire brush to a depth of at least 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.
- 7.18.2.8 Specials consisting of coves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

7.19 In-Situ Cement Concrete Floor Topping

7.19.1 Materials

- 7.19.1.1 The mix proportion for the in-situ concrete floor topping shall be 1:2.5:3.5 (one part cement : two and half parts sand : three and half parts coarse aggregates) by volume unless otherwise specified.
- 7.19.1.2 The aggregates shall conform for the requirements of IS:383.
- 7.19.1.3 Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS:2571.
- 7.19.1.4 Grading of the sand shall be within the limits indicated in IS:2571.

7.19.2 Workmanship

- 7.19.2.1 The thickness of the floor topping shall be as specified in the items of work prepared by the Contractor. The minimum thickness of the floor topping shall be 25mm.
- 7.19.2.2 Preparation of base concrete/structural slab before laying the topping shall be as per clause 7.13. The surface shall be rough to provide adequate bond for the topping.
- 7.19.2.3 Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the EMPLOYER. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.
- 7.19.2.4 Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of at least one day. Construction joints shall be plain vertical butt joints.
- 7.19.2.5 Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities and these shall be made good immediately.
- 7.19.2.6 Finishing of the surface by troweling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after

laying, the first trowelling just sufficient to give a level surface shall be carried out avoiding excessive trowelling at this stage. The surface shall be re-trowelled after sometime to close any pores and to scrap off excess water or laitance, which shall not be trowelled back into the topping. Final trowelling shall be done well before the concrete has become too hard but at a time when considerable pressure is required to make any impression on the surface. Sprinkling of dry cement or cement-sand mixture for absorbing moisture shall not be permitted.

7.19.2.7 Immediately after the surface is finished, it shall be protected suitably from rapid drying due to wind/ sunlight. After the surface has hardened sufficiently to prevent any damage to it, the topping shall be kept continuously moist for a minimum period of 10 days.

7.19.2.8 It is preferable to lay the topping on hardened base concrete, as against being laid monolithically with a lesser thickness, since proper levels and slopes with close surface tolerances is achievable in practice, owing to its greater thickness. Further, as this would be laid after all other building operations are over, there will be no risk of any damages or discoloration to the floor finish which are difficult to repair satisfactorily.

7.20 In-Situ Granolithic Concrete Floor Topping

7.20.1 Materials and Workmanship

7.20.1.1 The Requirements of materials and workmanship shall be all as per clause 7.19 for in-situ cement concrete floor topping except that the mix proportion of the concrete shall be 1:1:2 (cement: sand : coarse aggregates) by volume.

7.20.1.2 The minimum thickness of granolithic floor topping on hardened concrete base shall be 40mm.

7.21 Floor Hardener Topping

7.21.1 Materials & Workmanship

7.21.1.1 Floor Hardener topping shall be provided either as integrally finished over the structural slab/grade slab or laid monolithically with the concrete/granolithic floor finish on top of hardened concrete base.

7.21.1.2 Floor hardener of the metallic or non-metallic type suitable for the performance of normal / medium/ heavy duty function of the floor, the quantum of ingredients and the thickness of topping shall be as specified in the respective items of work prepared by the Contractor.

7.21.1.3 For monolithic application with the floor finish/slab the thickness of the layer shall be 15mm. The topping shall be laid within 2 to 3 hours after concrete is laid when it is still plastic but stiffened enough for the workmen to tread over it by placing planks. The surface of the concrete layer shall be kept rough for providing adequate bond for the topping. Laitance shall be removed before placing the topping. The topping shall be screeded and thoroughly compacted to the finished level. Trowelling to a smooth finish shall be carried out as per clause 7.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for at least 10 days.

7.21.1.4 The procedure for mixing the floor hardener topping shall be as per manufacturer's instructions.

7.21.1.5 Surface shall be prevented from any damages due to subsequent building operations by covering with 75 mm thick layer of sand.

7.22 PVC Sheet/Tile Flooring

7.22.1 Materials

- 7.22.1.1 PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS:3462 or homogeneous PVC asbestos tiles conforming to IS:3461.
- 7.22.1.2 The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS. Contractor shall submit the test certificates, if so desired by the EMPLOYER.
- 7.22.1.3 Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark, and batch number.
- 7.22.1.4 The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/tiles.
- 7.22.1.5 The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work prepared by the Contractor.

7.22.2 Workmanship

- 7.22.2.1 PVC Floor covering shall be provided over an under bed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the under bed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS:5318.
- 7.22.2.2 The surface of the under bed shall have trowelled finish without any irregularities, which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.
- 7.22.2.3 PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the under bed until the A/C units have been in operation for at least 7 days. During this period, the temperature range shall be between 20deg.C and 30deg.C and this shall be maintained during the laying operations and also for 48 hours thereafter.
- 7.22.2.4 Layout of the PVC flooring shall be marked with guidelines on the under bed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout.
- 7.22.2.5 The adhesive shall be applied by using a notched trowel to the surface of the under bed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.
- 7.22.2.6 PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that

there is minimum gap between joints. The alignment shall be checked after each row of sheet is completed and trimmed if considered necessary.

- 7.22.2.7 Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slid on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.
- 7.22.2.8 Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.
- 7.22.2.9 A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.
- 7.22.2.10 Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.
- 7.22.2.11 Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

7.23 Acid Resisting Brick/Tiling Work

7.23.1 Materials

- 7.23.1.1 The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS:4457. Acid resistant bricks shall conform to the requirements of IS:4860.
- 7.23.1.2 The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.
- 7.23.1.3 The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS:4832 (Part II). Method of usage shall generally be as per the requirements of IS:4443.

7.23.2 Workmanship

- 7.23.2.1 The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.
- 7.23.2.2 The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS:3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS:1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.
- 7.23.2.3 Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

- 7.23.2.4 For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.
- 7.23.2.5 The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.
- 7.23.2.6 Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

7.24 Epoxy Lining Work

7.24.1 Materials

- 7.24.1.1 The epoxy resin and hardener formulation for laying of jointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS:9197.
- 7.24.1.2 The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:
- a) Hydrochloric acid upto 30% concentration
 - b) Sodium hydroxide upto 50% concentration
 - c) Liquid temperature upto 60deg.C
 - d) Ultraviolet radiation
 - e) Alternate wetting and drying
- 7.24.1.3 Sand shall conform to grading zone III or IV of IS:383.
- 7.24.1.4 The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.
- 7.24.1.5 Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the EMPLOYER.

7.24.2 Workmanship

- 7.24.2.1 The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.
- 7.24.2.2 The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.
- 7.24.2.3 The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The

surfaces shall then be washed with dilute hydrochloric acid and rinsed thoroughly with plenty of water or dilute ammonia solution. The surfaces shall then be allowed to dry. It is essential to ensure that the surfaces are perfectly dry before the commencement of epoxy application.

- 7.24.2.4 Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.
- 7.24.2.5 Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.
- 7.24.2.6 Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

7.25 Water-Proofing

7.25.1 General

- 7.25.1.1 The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Employers Representative.
- 7.25.1.2 The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The brick bat coba shall be covered as specified below.
- 7.25.1.3 The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the EMPLOYER.

7.25.2 Modified Bituminous Membrane

- 7.25.2.1 Modified Bituminous Membrane shall be “SUPER THERMOLAY” 4 mm thick weighing 4 Kg/sqm, manufactured using APP Polymer modified bitumen with a central core of non-woven polyester reinforcement (200 gms/sqm) and with top and bottom layers of thermofusible film (top layer could also be sand finished) made by STP Limited in collaboration with Bitumat Company Limited. “PLYFLEX” of Bitumat Company Limited, Saudi Arabia supplied by STP Limited shall also be acceptable or other equivalent specification.

7.25.3 Waterproofing of Roofs with Lime Concrete

7.25.3.1 Materials

- a) Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25mm and shall generally conform to IS:3068.
- b) Lime shall be class C lime (fat lime) or factory made hydrated lime conforming to IS:712.

7.25.3.2 Workmanship

- 7.25.3.2.1 Lime concrete shall be prepared by thoroughly mixing the brick aggregates inclusive of brick dust obtained during breaking with the slaked lime in the proportions of 2 1/2 (two and a half) parts of brick aggregates to 1 part of slaked lime by volume. Water shall be added just adequate to obtain the desired workability for laying. Washing soap and alum shall be dissolved in the water to be used. The quantity of these materials required per cum of lime concrete shall be 12kg of washing soap and 4kg of alum. Brick aggregates

shall be soaked thoroughly in water for a period of not less than six hours before use in the concrete mix. Lime concrete shall be used in the works within 24 hours after mixing.

- 7.25.3.2.2 The roof surface over which the water-proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS:3067.
- 7.25.3.2.3 The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer.
- 7.25.3.2.4 The average thickness of lime concrete, slope and the finish on top of machine made burnt clay flat terracing tiles conforming to IS:2690 (part I) shall be as specified in the items of work to be prepared by the Contractor. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the items of work prepared by the Contractor, duly considering the traffic the terrace will be subjected to.
- 7.25.3.2.5 The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not be less than 100mm. In case, the thickness is more than 100mm, it shall be laid in layers not exceeding 100mm to 125mm.
- 7.25.3.2.6 Laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards centre and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points.
- 7.25.3.2.6 Lime concrete fillet for a minimum height of 150mm shall be provided all along the junction of the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished on top with provision of clay terracing tiles/cement concrete tiles.
- 7.25.3.2.7 After the lime concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done using wooden THAPIES with rounded edges. The beating will normally have to be carried on for at least seven days until the THAPI makes no impression on the surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column projections.
- 7.25.3.2.8 During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothed with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the EMPLOYER.
 - a) By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 litres of water.
 - b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small pieces and allowed to soak in water), 200 gm of jaggery and 40 litres of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.
- 7.25.3.2.9 The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously.

7.25.3.2.10 Machine made flat terracing tiles shall be of the size and thickness as specified. Tiles shall be soaked in water for at least one hour before laying. Bedding for the tiles shall be 12mm thick in cement mortar 1:3. Tiles shall be laid, open jointed with 4 to 6 mm wide joints, flat on the mortar and lightly pressed and set to plane surface true to slope, using a trowel and wooden straight edge. They shall be laid with their longitudinal lines of joints truly parallel and generally at right angles to the direction of run-off gradient. Transverse joints in alternate rows shall come directly in line with each other. Transverse joints in adjacent courses shall break joints by at least 50 mm. The joints shall be completely filled and flush pointed with cement mortar 1:2 mixed with water proofing compound as per manufacturer's instructions. Curing shall be carried out for a minimum period of seven days.

7.25.3.2.11 Finishing on top with cement concrete tiles or in-situ cement concrete floor topping shall be carried out in similar fashion as described for clay tiles in above paragraph. Tiles to be used shall be supplied after the first machine grinding of the surface.

7.25.4 Waterproofing of Roofs/Terraces etc.
(a) Water proofing of Horizontal Surfaces

7.25.4.1 The waterproofing shall be applied as follows:

7.25.4.2 A coat of Blown Bitumen 85/25 shall be applied at the rate of 1.45 kg/sq.km

7.25.4.3 A roll of Modified Bituminous Membrane shall be unrolled over the primed surface and completely bonded to the substrate by pressing down evenly for the full width of the roll using a wooden roller. Torching shall be done, where recommended by the manufacturer and where directed by the EMPLOYER, as the unrolling progresses.

7.25.4.4 The side overlaps shall be minimum 100 mm whereas the end overlaps shall be minimum 150 mm; both shall be bonded and sealed by flame torching.

7.25.4.5 Care shall be taken that the membrane is lapped with the treatment along the vertical surface and roof gutter treatment for at least 500 mm.

7.25.4.6 The membrane shall be properly overlapped/terminated at all openings, rainwater down takes etc. to ensure that such junctions do not become sources of leakage.

7.25.4.7 Top of membrane finally shall be painted with antiglouse reflective paint.
(b) Waterproofing of Vertical Surfaces at Roof Level and Gutters

7.25.4.8 The Water proofing shall be applied as described in (a) above.

7.25.4.9 Modified Bituminous membrane shall be unrolled and bonded to the substrate after applying a coat of bitumen and by pressing down evenly for the full width of the roll. Light torching shall be done to ensure complete bonding.

7.25.4.10 The membrane shall be overlapped with treatment for the horizontal surface by at least 500 mm.

7.25.4.11 The membrane shall be taken upto a pre-cut chase anchored and sealed.

7.25.5 Khurras and Rainwater Down Pipes

7.25.5.1 Down pipes shall be isolated from RCC work with 6 mm polyethylene foam fixed with adhesive (Araldite) and sealed with silicone sealant prior to laying membrane. A water

proofing flashing composed of one layer of Hessian based self finished felt Type 3 Grade 1 and two layers of aluminium foil of 0.075 mm thickness shall be provided. This flashing shall be carried into the down take pipes for at least 150 mm and sealed with hot bitumen. The Contractor shall closely coordinate the work with the agency providing and fixing the rainwater down take pipes.

7.25.6 Testing

7.25.6.1 The treated area (flat and horizontal only) shall be tested by allowed water to stand on the treated areas to a depth of 150 mm for a minimum period of 72 hours.

7.25.6.2 The treated area (flat and horizontal) shall have continuous slope towards the rainwater outlets and no water shall pond anywhere on the surface.

7.26 Cement Plastering Work

7.26.1 Materials

7.26.1.1 The proportions of the cement mortar for plastering shall be 1:3 (one part of cement to three parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS:1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the EMPLOYER. If so desired by the EMPLOYER sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

7.26.2 Workmanship

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

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

7.26.2.3 All joints in masonry shall be raked as the work proceeds to a depth of 10mm/20mm for brick/stone masonry respectively with a tool made for the purpose when the mortar is still green. The masonry surface to be rendered shall be washed with clean water to remove all dirt, loose materials, etc., Concrete surfaces to be rendered shall be roughened suitably by hacking or bush hammering for proper adhesion of plaster and the surface shall be evenly wetted to provide the correct suction. The masonry surfaces should not be too wet but only damp at the time of plastering. The dampness shall be uniform to get uniform bond between the plaster and the masonry surface.

7.26.2.4 Interior plain faced plaster - This plaster shall be laid in a single coat of 13mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth

surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the EMPLOYER.

- 7.26.2.5 Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in above paragraph.
- 7.26.2.6 Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured for at least two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for at least 7 days.
- 7.26.2.7 Interior plain faced plaster 20mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 2 coats similar to the procedure stipulated in above paragraph.
- 7.26.2.8 Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats. The first coat shall be approximately 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.
- 7.26.2.9 Wherever more than 20mm thick plaster has been specified, which is intended for purposes of providing beading, bands, etc. this work shall be carried out in two or three coats as directed by the EMPLOYER duly satisfying the requirements of curing each coat (rendering/floating) for a minimum period of 2 days and curing the finished work for at least 7 days.
- 7.26.2.10 In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the EMPLOYER.
- 7.26.2.11 Where specified in the Drawings to be prepared by the Contractor prepared by the Contractor, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the Drawings to be prepared by the Contractor prepared by the Contractor.
- 7.26.2.12 Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.
- 7.26.2.13 For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturers instruction while preparing the cement mortar.

- 7.26.2.14 For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.
- 7.26.2.15 Double scaffolding to be used shall be as specified in clause 7.2.2.
- 7.26.2.16 The finished plaster surface shall not show any deviation more than 4mm when checked with a straight edge of 2m length placed against the surface.
- 7.26.2.17 To overcome the possibility of development of cracks in the plastering work following measures shall be adopted.
- a) Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.
 - b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement.
 - c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

7.27 Cement Pointing

7.27.1 Materials

- 7.27.1.1 The cement mortar for pointing shall be in the proportion of 1:3 (one part of cement to three parts of fine sand). Sand shall conform to IS: 1542 and shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by EMPLOYER and if so directed it shall be washed/screened to meet specification requirements.

7.27.2 Workmanship

- 7.27.2.1 Where pointing of joints in masonry work is specified, the joints shall be raked at least 15mm/20mm deep in brick/stone masonry respectively as the work proceeds when the mortar is still green.
- 7.27.2.2 Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and uniform in breadth and the joints shall be raised, flat, sunk or 'V' as may be specified in the respective items of work. No false joints shall be allowed.
- 7.27.2.3 The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the EMPLOYER.

7.28 Water-Proofing Admixtures

- 7.28.1 Water-proofing admixture shall conform to the requirements of IS:2645 and shall be of approved manufacture. The admixture shall not contain calcium chloride. The quantity of the admixture to be used for the works and method of mixing etc. shall be as per manufacturer's instructions and as directed by the EMPLOYER.

7.29 Painting of Concrete, Masonry & Plastered Surfaces

7.29.1 Materials

- 7.29.1.1 Oil bound distemper shall conform to IS:428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.
- 7.29.1.2 Cement paint shall conform to IS:5410. The primer shall be a thinned coat of cement paint.
- 7.29.1.3 Lead free acid, alkali and chlorine resisting paint shall conform to IS:9862.
- 7.29.1.4 Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the EMPLOYER.
- 7.29.1.5 All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the EMPLOYER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

7.29.2 Workmanship

- 7.29.2.1 Contractor shall obtain the approval of the EMPLOYER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.
- 7.29.2.2 Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub- strata.
- 7.29.2.3 The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS:2395.
- 7.29.2.4 Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

7.29.3 White Wash

- 7.29.3.1 The prepared surfaces shall be wetted and the finish applied by brushing. The operation for each coat shall consist of a stroke of the brush first given horizontally from the right and the other from the left and similarly, the subsequent stroke from bottom upwards and the other from top downwards, before the first coat dries. Each coat shall be allowed to dry before the next coat is applied. Minimum of 2 coats shall be applied unless otherwise specified. The dry surface shall present a uniform finish without any brush marks.

7.29.4 Colour Wash

- 7.29.4.1 Colour wash shall be applied in the same way as for white wash. A minimum of 2 coats shall be applied unless otherwise specified. The surface shall present a smooth and uniform finish without any streaks. The finished dry surface shall not show any signs of peeling/powdery and come off readily on the hand when rubbed.

7.29.5 Cement Paint

7.29.5.1 The prepared surfaces shall be wetted to control surface suction and to provide moisture to aid in proper curing of the paint. Cement paint shall be applied with a brush with stiff bristles. The primer coat shall be a thinned coat of cement paint. The quantity of thinner shall be as per manufacturer's instructions. The coats shall be vigorously scrubbed to work the paint into any voids for providing a continuous paint film free from pinholes for effective water proofing in addition to decoration. Cement paint shall be brushed in uniform thickness and the covering capacity for two coats on plastered surfaces shall be 3 to 4 kg/sq.m. A minimum of 2 coats of the same colour shall be applied. At least 24 hours shall be left after the first coat to become sufficiently hard before the second coat is applied. The painted surfaces shall be thoroughly cured by sprinkling with water using a fog spray at least 2 to 3 times a day. Curing shall commence after about 12 hours when the paint hardens. Curing shall be continued for at least 2 days after the application of final coat. The operations for brushing each coat shall be as detailed above.

7.29.6 Oil bound Distemper

7.29.6.1 The prepared surfaces shall be dry and provided with one coat of alkali resistant primer by brushing. The surface shall be finished uniformly without leaving any brush marks and allowed to dry for at least 48 hours. A minimum of two coats of oil bound distemper shall be applied, unless otherwise specified. The first coat shall be of a lighter tint. At least 24 hours shall be left after the first coat to become completely dry before the application of the second coat. Broad, stiff, double bristled distemper brushes shall be used for the work. The operations for brushing each coat shall be as detailed above.

7.29.7 Acid, Alkali Resisting Paint

7.29.7.1 A minimum of 2 coats of acid/alkali resisting paint shall be applied over the prepared dry surfaces by brushing. Primer coat shall be as per manufacturer's instructions.

7.29.8 Plastic Emulsion Paint

7.29.8.1 The prepared surface shall be dry and provided with one coat of primer which shall be a thinned coat of emulsion paint. The quantity of thinner shall be as per manufacturer's instructions. The paint shall be laid on evenly and smoothly by means of crossing and laying off. The crossing and laying off consists of covering the area with paint, brushing the surface hard for the first time over and then brushing alternately in opposite directions two or three times and then finally brushing lightly in a direction at right angles. In this process, no brush marks shall be left after the laying off is finished. The full process of crossing and laying off constitutes one coat. The next coat shall be applied only after the first coat has dried and sufficiently become hard which normally takes about 2 to 3 hours. A minimum of 2 finishing coats of the same colour shall be applied unless otherwise specified. Paint may also be applied using rollers. The surface on finishing shall present a flat velvety smooth finish and uniform in shade without any patches.

7.29.9 Acrylic Emulsion Paint

7.29.9.1 Acrylic emulsion paint shall be applied in the same way as for plastic emulsion paint. A minimum of 2 finishing coats over one coat of primer shall be provided unless otherwise specified.

7.30 Painting & Polishing of Wood Work

7.30.1 Materials

- a) Wood primer shall conform to IS:3536.
- b) Filler shall conform to IS:110.

- c) Varnish shall conform to IS:337.
- d) French polish shall conform to IS:348.
- e) Synthetic enamel paint shall conform to IS:2932.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the EMPLOYER for the brand of manufacture and the colour/shade. All materials shall be brought to the site of works in sealed containers.

7.30.2 Workmanship

- 7.30.2.1 The type of finish to be provided for woodwork of either painting or polishing, the number of coats, etc. shall be as specified in the respective items of work to be prepared by the Contractor.
- 7.30.2.2 Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.
- 7.30.2.3 Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS:2338 (Part I).
- 7.30.2.4 All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothed with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work to be prepared by the Contractor. Any slight irregularities of the surface shall then be made- up by applying an optimum coat of filler conforming to IS:110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the EMPLOYER. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor.
- 7.30.2.5 All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothed with abrasive paper using it in the direction of the grains and dusted off. Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be thoroughly removed. Over this prepared surface, varnish conforming to IS:337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the EMPLOYER. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flattening varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

7.31 Painting of Steel Work

7.31.1 Materials

- a) Red-oxide – zinc chrome primer shall conform to IS:2074.
- b) Synthetic enamel paint shall conform to IS : 2932.
- c) Aluminium paint shall conform to IS:2339.

All the materials shall be of the best quality from an approved manufacturer. Contractor shall obtain prior approval of the EMPLOYER for the brand of manufacture and the colour/shade. All the materials shall be brought to the site in sealed containers.

7.31.2 Workmanship

- 7.31.2.1 Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS:1477 (Part 2).
- 7.31.2.2 The type of paint, number of coats etc. shall be as specified in the respective items of work.
- 7.31.2.3 Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.
- 7.31.2.4 All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS:1477 (Part – I) and as indicated in the item of work.
- 7.31.2.5 It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'.
- 7.31.2.6 After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.
- 7.31.2.7 The first finishing coat of paint shall be applied by brushing and allowed to hard-dry. The gloss from the entire surface shall then be gently removed and the surface dusted off. The second finishing coat shall then be applied by brushing.
- 7.31.2.8 At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the EMPLOYER.

7.32 Flashing

7.32.1 Materials

- 7.32.1.1 Anodised Aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.
- 7.32.1.2 Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

7.32.1.3 Bitumen felt shall be either Hessian base self finished bitumen felt Type-3 Grade I conforming to IS:1322 or glass fibre base self finished felt Type-2 Grade I conforming to IS:7193.

7.32.2 Workmanship

7.32.2.1 The type of the flashing and method of fixing shall be as specified.

7.32.2.2 Flashing shall be of the correct shape and size as indicated in the construction Drawings to be prepared by the Contractor and they shall be properly fixed to ensure their effectiveness.

7.32.2.3 Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.

7.32.2.4 Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/concrete along with cement mortar 1:4 filletting as indicated in the Drawings to be prepared by the Contractor. Curing of the mortar shall be carried out for a minimum period of 4 days.

7.32.2.5 Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 litre/sq.m after the installation.

7.33 Thermal Insulation For Ceiling

Thermal insulation shall be “Thermocole” TF type or similar approved or Resin bonded fibre glass boards.

7.33.1 Fixing

7.33.2 “Thermocole” Boards

7.33.2.1 Soffit of R.C.Slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS:702 shall be applied uniformly over the surface at the rate of 1.5 Kg/m².

7.33.2.2 Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen.

7.33.2.3 The boards shall be further secured with screws, washers and plugs.

7.33.2.4 The joints of the boards shall be sealed with bitumen.

7.33.3 Fibre Glass Boards

7.33.3.1 Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centres with 6mm x 65mm long wood screws. 20 gauge G.I. lacing wire shall be tied to the pegs.

7.33.3.2 ‘Crown’ 200 fibre glass boards 50mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.

7.33.3.3 The insulation boards shall be covered with 20mm – 24 gauge hexagonal G.I. chicken wire mesh, nailed to the timber pegs and 30 gauge aluminium sheets shall be fixed over the chicken wire mesh with 50mm overlap and secured to the timer pegs by screws.

7.33.3.4 If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the framework. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

7.34 Plaster of Paris Board for False Ceiling

7.34.1 Materials

7.34.1.1 Plaster of Paris Boards

- a) The plaster of paris boards to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by EMPLOYER.
- b) The plaster of paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent sulphur trioxide and other requirements as per IS:2547 (Part I) However, its fineness shall be such that the residue, after drying, and sieving on I.S. sieve designation 3.35mm for 5 minutes shall not be more than 1 percent by weight. Initial setting time shall not be less than 13 minutes. The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 Kg per sq.cm.
- c) The plaster of paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizes as shown on the drawings or as directed by EMPLOYER. Wooden forms of height equal to the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet. The edges of the boards shall be truly square. The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non-staining oil to facilitate the easy removal of the board. Plaster of paris shall be evenly spread into the form upto about half the depth and hessian cloth or coir shall be pressed over the plaster of paris layer. The weight of hessian cloth or coir in the board shall be 250 gm per sq.m. The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm. The hessian cloth shall be of an open web texture so as to allow the plaster below and above to intermix with each other and form an integral board. The form shall then be filled with plaster of paris which shall be uniform pressed and then wire cut to an even and smooth surface. The board shall then be allowed to set initially for an hour or so and then removed from the form and allowed to dry and harden for about a week. The board after drying and hardening shall give a ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.
- d) The size of boards shall generally be 600mm x 600 mm x 12 mm thick. Boards shall be kept dry in transit and stored flat in a clean dry place and shall not be exposed to moisture. The boards shall always be carried on edges.

7.34.2 Timber Frame Work

7.34.2.1 Timber for frame work of false ceiling grid and hangers shall be of good quality and well seasoned. It shall have uniform colour, reasonably straight and close grains and shall be free from knots, cracks and sapwood. It shall be treated with approved anti-termite preservative as directed by the EMPLOYER. Extreme care shall be taken so that the preservative treatment does not stain the ceiling boards. In case metal hangers are used, these shall be M.S. flats or bars, having two coats of red oxide zinc chromate paint primer, as shown on drawings or as approved by EMPLOYER.

7.34.3 Metal Frame Work

7.34.3.1 The metal frame work may be made of sections of light metal, such as anodised aluminium, mild steel or as shown on the drawings. The shape of cross-section shall be such as to

facilitate proper suspension and proper fixing of the ceiling boards covering them and shall be structurally sound and rigid.

7.35

Construction

- a) Contractor shall ensure that the frame to support the ceiling is designed for structural strength and the sizes, weight and strength of ceiling boards to be fixed and other loads due to live load, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shown on the drawings. Contractor shall also submit a detailed drawing to show the grid work, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access doors, etc.
- b) Structural design of timber member for the frame shall be in accordance with IS : 883, and metal sections shall be of appropriate size and thickness and shall be of approved manufacture, all as approved by EMPLOYER.
- c) The false ceiling grid work shall be carried out as per the approved drawings or as directed by EMPLOYER. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at 1.2m centre to centre and secondary runners of size 50mm deep x 40 mm wide at 60mm centre to centre perpendicular to the main runners.
- d) The timber grid work shall be suspended with the help of wooden hangers or metal hangers at 1.2m centre to centre in both the directions. Wooden hangers shall be adopted for flat R.C. roof slab structures whereas metal hangers for flat R.C. roof or structural steel floors / tresses. Metal hangers shall be fabricated from mild steel / galvanised flats of 35mm x 6mm size or bars of 10mm dia. Threaded at the lower end and anchored securely in the roof concrete or welded to inserts provided on the underside of slabs, beams etc. All M.S. hangers shall be given two coats of red oxide zinc chromate paint primer. In case the roof work is of A.C. sheeting supported on purlins and trusses, hangers shall be suspended from roof steel work. The arrangement of metal hangers shall be such that the level of false ceiling can be adjusted during fixing of the ceiling frame work. The ceiling frame work shall be secured to hangers by means of washers and nuts. The ends of main runners shall preferably be embedded into the masonry work.
- e) The metal frame work when it is anodised aluminium false ceiling grid system shall consist of aluminium main member of special T-Profile of 38mm x 38mm x 1.5mm thick, interlocking with each other to form frames of various sizes, 600mm x 600 mm or as shown on the drawing. The main members shall be suspended from the roof structures by means of steel hangers as described for timber frame work and supported at the walls by means of anodised aluminium wall angles.
- f) In the case of timber frame work, all the edges of the plaster of paris board shall be fixed to frame members by means of counter sunk and rust less screws of 2.74 mm size, 40mm long at a spacing of 100mm to 150 mm c/c and 12mm from the edge of the board. Holes for screws shall be drilled and screws slightly countersunk into the boards. The boards shall be fixed to wooden framework with a joint clearance of about 3mm. The joints shall always be in perfect line and plane.
- g) In case of aluminium grid system, boards shall be just placed into the frames formed by the main 'T' members and the cross members fitted with the clips for locking boards. Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joint. The boards shall be cut with a saw, if required, to any shape and size.
- h) As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting, Contractor shall fully co-operate with the other agencies entrusted with the above work, who may be working simultaneously. Contractor shall provide necessary openings in the false ceiling work for air-conditioning, lighting and other fixtures. Additional framing, if required, for the above opening shall also be provided at no extra cost to Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by EMPLOYER.

7.35.1 Finishing

- 7.35.1.1 It is essential that false ceiling work should be firm and in perfect line and level and all boards free from distortion, bulge, and other defects. All defective boards and other material shall be removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of EMPLOYER.
- 7.35.1.2 The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints for aluminium frame work shall be of interlocking type so that when the cross member is in place, it cannot be lifted out.
- 7.35.1.3 The countersunk heads of screws and all joints shall be filled with plaster of paris and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50mm wide on either side of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 10mm wide. If metal scrim is used, a stiffer plaster will be necessary to enable the trowelling of the scrim down to the board.

7.35.2 Fire Stopping

- 7.35.2.1 In case of fire protective ceilings, fire resisting barriers at suitable intervals shall be provided. These shall completely close the gap between the false ceiling and soffit of the structural slab. The material of the barrier shall be as indicated by EMPLOYER (Reference may be made to the British Standards Institutions CP 290: Code of Practice for suspended ceiling and lining of dry construction using metal fixing system, for guidance).

7.36 False or Cavity Floor

7.36.1 Frame Work

- 7.36.1.1 The false floor shall consist of a framework of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600mm centre to centre in both directions. The stools shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead. The above framework shall be suitably designed to accommodate 35mm thick, 600mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm dia. anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.
- 7.36.1.2 The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities upto plus or minus 15mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the propheads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

7.36.2 Floor Panels

- 7.36.2.1 The floor panels shall be made of 600mm x 600mm x 35 mm thick medium density unveneered/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cu.m bonded with boiling water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS:3087-specification for wood particle boards (Medium Density)for general purposes.
- 7.36.2.2 The thermal conductivity of the boards shall not exceed 0.12 kCal/hr/sq.m/deg./C/m.

- 7.36.2.3 The panel size given above may be suitably modified near electrical panel/equipment and also to suit room dimensions with panel size not more than 600mm under any circumstances. Exposed 2mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat or primer and two coats of approved fire resistant paint from underside.
- 7.36.2.4 The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 – “Specification for unbacked flexible PVC flooring” and of approved colour and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the on the inner side with stickers for easy identification and reassembly whenever required.
- 7.36.2.5 Suitable backing material shall be provided on the underside of the particle board to prevent warping and / or to cater to specified loading.
- 7.36.2.6 Suitable removable covers shall be provided to serve as outlets for the cables.

7.36.3 Imposed Loading

- 7.36.3.1 The finished floor shall be capable of supporting a uniformly distributed load of 500 to 1000 Kg. per sq.metre of floor area as specified in data sheet. A point load of 450 Kg on 600 sq.mm on any part of the panel or a line load of 725 Kg on 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

7.36.4 Finish

- 7.36.4.1 The finished floor shall be true to lines and levels and present a neat flush surface.

7.36.5 Vendor Drawing

- 7.36.5.1 Vendor shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, vendor shall also submit his calculations for the supporting system with all relevant data assumed, to the EMPLOYER for his approval. Work shall be carried out on approved drawings only.

7.37 Fire Proof Doors

7.37.1 Material and Workmanship

- 7.37.1.1 The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire. The materials, fabrication and erection of fire proof doors shall conform to IS:3614 (Part – I). The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. Sample approval shall also be obtained from testing authority as per the standard IS : 3614 (Part – 2) for the specified degree of fire rating in hours. All fire proof doors shall have specified sizes and conform to the description in the respective items of work.
- 7.37.1.2 Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS:6687) or stainless steel (conforming to IS:304) sheet (18G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wool in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter shall not be less than 35mm for two hour fire rating and 46 mm for four hour fire rating.

7.37.1.3 The shutter with the required insulating material shall be mounted on angle iron frame or the special made frame from zinc coated (16G minimum) weldable steel sheet. The shutter shall be fixed to frame by means of suitable hinges and shall have a three way latching system. All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating. All other accessories like hinges, door lock, hold fasts, etc. shall be provided as approved by TAC (Tariff Advisory Committee). All these accessories shall be compatible with the material used for door and shutter.