

## 04 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 <sup>3</sup>                               |
| (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 <sup>3</sup>                              |
| (iii) | Weight of plain concrete  | : | 24.00 kN/m <sup>3</sup>                              |
| (iv)  | Weight of reinforced concrete   | : | 25.00 kN/m <sup>3</sup>                              |
| (v)   | Weight of brickwork (exclusive of plaster)  | : | 22.00 N/m <sup>2</sup> per mm thickness of brickwork |
| (vi)  | Weight of plaster to masonry surface  | : | 18.00 N/m <sup>2</sup> per mm thickness              |
| (vii) | Weight of granolithic terrazzo finish or rendering screed, etc.   | : | 24.00 N/m <sup>2</sup> 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 <sup>2</sup>  |
|       | (Non-accessible)   | : | 0.75 kN/m <sup>2</sup>  |
| (ii)  | Live load on floors supporting equipment such as pumps, blowers, compressors, valves, etc. | : | 10.00 kN/m <sup>2</sup> |
| (iii) | Live load on all other floors walkways, stairways and platforms.                           | : | 5.00 kN/m <sup>2</sup>  |

In the absence of any suitable provisions for live loads in I.S. Codes or as given above for any particular type of floor or structure, assumptions made must receive the approval of 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.

#### 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.

### 1.6 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 for limit state of collapse as per IS: 3370-2021.
- (ii) liquid depth to be considered up to full supply level and no relief due to soil pressure from other side to be considered for limit state of serviceability as per IS: 3370-2021.
- (iii) structure empty condition (i.e., empty of liquid, any material, etc.) : earth pressure from Finished Ground level with saturation and surcharge pressure wherever applicable, to be considered.
- (iv) partition wall between dry sump and wet sump : to be designed for full liquid depth up to full height of wall for limit state of collapse.
- (v) partition wall between two compartments: to be designed as one compartment empty and other full for both the directions.

- (vi) structures shall be designed for uplift in empty conditions with no live load with the appropriate water table.
- (vii) walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization.
- (viii) walls shall be designed with additional dynamic water loads as per IS:1893-2-2014 with hydrostatic pressure.
- (ix) 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 1.25 shall be ensured against uplift or floatation.

## 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) Special attention is drawn to danger of uplift being caused by the ground water table. All underground structural slab shall be designed for uplift forces due to ground water pressure.
- (v) 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 :
- All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade M 15.
- a) 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 **minimum of M 25 grade**. The structures shall have to be designed as per IS : 3370 (Part I-IV).
  - b) The reinforced concrete for water retaining structures shall have a **minimum cement content of 410 kg/m<sup>3</sup> with a maximum 20 mm size aggregate for M 30 grade concrete.**
  - c) 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.

- d) All buildings shall have a minimum 1 metre wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compacted strata.
- e) Any structure or pipeline crossing below roads shall be designed for Class A of IRC loading.
- f) The bridges & bridge supporting structures shall be designed to safely withstand the loading.
- g) All pipes & conduits laid below the structural plinth & road works shall be embedded in reinforced concrete of grade M15 of minimum thickness 150 mm.
- h) 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.
  - The wall and floor panels shall be poured in sequential order with a minimum time gap of 4 days.
- i) All water retaining structures shall be constructed in Ordinary Portland Cement as per IS specification.
- j) Design of water retaining structure shall be as per limiting crack width as per IS:3370 latest revision.

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

(i) Walls for liquid retaining structures	:	250mm
(ii) Channel / Launder	:	150mm
(iii) Roof slabs for liquid retaining structures (other than flat slabs)	:	150 mm
(iii) Bottom slabs for liquid retaining structures	:	150 mm
(iv) Floor slabs including roof slabs, walkways, canopy slabs	:	100 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

## 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.

## **1.11 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 (Parts1 & 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 minimum in 230 mm thick brick masonry built cement mortar in 1:5. 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 1:5 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 12 mm thick plain faced cement plaster in cement mortar (1:3) 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 two coats 12 mm thick backing coat in cement mortar (1:3) and 8 mm thick finishing coat in cement mortar (1:1). 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 Exterior Weather Coat (waterproof cement based) paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.
7. Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint.
8. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.
9. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.
10. The flooring in all areas except toilets and staircases shall be Marble/Granite/Double charge Vitrified Tiles of approved shade and pattern and placed in cement mortar or to give overall thickness of 50 mm. Half tile skirting shall also be provided in these areas.
11. Toilet areas shall have 450 mm x 450 mm x 25 mm thick polished marble/ Kota stone tiles or **Vitrified Tiles** placed in cement mortar or lime mortar to give an overall thickness of 50 mm. 3.00 mt. high ceramic tile of minimum size 450 mm x 300 mm x 6 mm thick ) dado placed in cement mortar shall also be provided in these areas. In W.C. areas, the flooring and 3000 mm high dado shall be provided with minimum Size 450 mm x 300 mm x 6 mm thick coloured ceramic tiles.
12. All staircases shall have Ave.25 mm thick Kota/marble, Polised/Rough Stone 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.  
**Ladder Design Finalized by RMC.**

13. 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. **(chequered plates thickness finalized by RMC as per Site Condition)** All uncovered openings shall be protected with M.S. hand railing of 40NB (M) or better MOC as specified elsewhere in tender BOQ or specifications/ scope of work.
14. All staircases shall be provided with 40NB (M) galvanised M.S. pipe hand railing for protection or better MOC as specified elsewhere in tender BOQ or specifications/ scope of work.
15. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene **and after carried out China Mosaic tiles Work**. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W downtake inlet points.
16. **For roofing drainage, U-PVC or C-PVC 40/80 Grade/cast iron rainwater down takes with C.I. bell mouth** and C.I. grating at top shall be provided. For roof areas up to 100 sq.m minimum two nos. 100 mm diameter downtake pipes shall be provided. For every additional area of 100 sq.m or part thereof, at least one no. 100 mm dia. downtake pipe shall be provided.
17. 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.
18. Building plinth shall be minimum 600 mm above average finished ground level around building.
19. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building.
20. **All windows and ventilators shall have 25 mm thick marble/Granite stone Double stage or over lapping sills bedded in cement mortar (1:3)**
21. 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 hand railings.
22. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act.
23. All rooms in the buildings shall be provided with appropriate sign boards indicating the function of the rooms involved.
24. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry in the form of EOT / HOT crane shall be provided. Minimum capacity of **2 tonnes** or more as required shall be provided for monorail.

25. 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.
26. Emergency exit doorways with Signboards shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.
27. The side walls of buildings shall, comprise at least 15% ventilated brickwork or louvers. Ventilated brickwork or louvers shall not be used where the ingress of driven rain could affect equipment or stored materials.

#### **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. 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 brick masonry (1:5) of appropriate thickness, topped with 75 mm thick M 15 precast concrete covers and plastered internally in cement mortar (1:4), 20 mm thick.**

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**RCC NP-3 Class Pipe of minimum Dia. 300 mm or above as per Design and Approved by RMC**

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

##### **1.15.2 Foul Drainage**

The foul drainage system shall accept discharge from toilets, washrooms, offices and shall discharge to separate septic tank and further to a soak pit, both of appropriate volumes for individual buildings.

#### **1.16 Cable and Pipework Trenches**

- 1.16.1 Cable and pipework trenches shall generally be constructed in reinforced concrete. However, 500 mm x 500 mm size or smaller trenches, not on fill may be constructed in 350 mm thick brick masonry (1:4). The trenches will be plastered internally with cement mortar (1:4) and externally in cement mortar (1:3).

1.16.2 Trenches within the buildings or Plant areas shall be covered with M.S chequered plates with Thickness suggested by RMC, suitably painted and those outside the buildings shall be covered with M20 precast R.C.C covers. The trenches shall be suitably sloped to drain rain water.

1.16.3 Layout of trenches outside the buildings shall allow space for construction of future trenches where necessary with due consideration for planning for future developments. This aspect shall be brought to the notice of EMPLOYER while planning the works.

### **1.17 Pipes and Ducts**

1.17.1 R.C.C ducts for drainage shall have minimum 1 metre cover while laid under roads. Access shafts of size not less than 600 mm x 1000 mm shall be provided.

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

### **1.18 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 M30 grade reinforced concrete. Chambers shall have removable reinforced concrete covers, as appropriate, approach ladders and valve supports.

### **1.19 Landscaping**

1.19.1 The WTP 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.

### **1.20 Security Fencing and Gates**

1.20.1 Substation shall have internal fencing as per Electricity Board guidelines.

1.20.2 6.0 m wide x Minimum 2.2 m high main steel gates with automatic and manually operating system from Secirity Cabin and 1.5 m wide x 2.2 m high steel wicket gate made out of tubular sections/square bars/flats of welded construction alongwith the locking arrangement and posts to match with security fencing shall be provided at appropriate places. Gates shall be painted with similar synthetic enamel paint.

1.20.3 Chain link fencing with gates around electrical installations shall be provided as per GEB's requirements.

## 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 fourth, 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-raills, 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 Slipes 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  $1\text{m}^3$  or  $0.25\text{m}^3$  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 or **Compactor Machine** 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, struted 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 struted. 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 embedments.
- 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 cementacious 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 use 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 AMC shall not be held responsible for any delay / damage / loss due to deployment of RMC for this project.

The octroi 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 AMC, 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.

### **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	290
M20	360
M25	380
M30	410
M35	425
M40	440

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**

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 self weight, 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	$\pm 0.05$ 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, hessain 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 20 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 :

<b>Use</b>	<b>Grout Thickness</b>	<b>Mix Proportions</b>	<b>W/C Ratio (max)</b>
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 <sup>2</sup> minimum   |
| b)  | Ultimate elongation     | : | 300% minimum                    |
| c)  | Tear resistance         | : | 4.9 N/mm <sup>2</sup> minimum   |
| d)  | Stiffness in flexure    | : | 2.46 N/mm <sup>2</sup> minimum  |
| e)  | Accelerated extraction  |   |                                 |
|     | i) Tensile strength     | : | 10.50 N/mm <sup>2</sup> minimum |
|     | ii) Ultimate elongation | : | 250% minimum                    |
| (f) | Effect of Alkali        | : | 7 days                          |
|     | i) Weight increase      | : | 0.10% maximum                   |
|     | ii) Weight decrease     | : | 0.10% maximum                   |
|     | iii) Hardness change    | : | ± 5 points                      |
| (g) | Effect of Alkali        | : | 28 days                         |
|     | i) Weight increase      | : | 0.40% maximum                   |
|     | ii) Weight decrease     | : | 0.30% maximum                   |
|     | iii) Dimension change   | : | ±1%                             |

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.

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 Maganese 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 (Parts 1 to 3)	Hexagon Head Bolts, Screws and Nuts of product Grade C (Size range M5 to M64)
27. IS : 1367 (All parts)	Technical Supply Conditions for Threaded Fasteners
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 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 Atleast 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) Smoothing 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  $\pm 5$  mm
- (b) In lateral direction  $\pm 5$  mm

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

$\pm 5$  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  $\pm 15$  mm whichever is less
- (b) For columns exceeding 15 metres in height  $\pm 1/1000$  of column height in mm or  $\pm 20$  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  $\pm 10$  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  $\pm 10$  mm

Deviation in any bearing or seating level with respect to true level  $\pm 5$  mm

Deviation in differences in bearing level of a member on adjacent pair of columns both across and along the building  $\pm 10$  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  $\pm 15$  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  $\pm 15$  mm whichever is less

Lateral shift in location of truss from its true vertical position  $\pm 10$  mm

Lateral shift in location of purlin true position  $\pm 5$  mm

Deviation in difference of bearing levels of trusses or beams from the true difference  
i)  $\pm 20$  mm for trusses  
ii) For beams :  
Depth  $< 1800$  mm :  $\pm 6$  mm  
Depth  $> 1800$  mm :  $\pm 10$  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 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 lead primer. 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 end 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 socket 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 to 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 :

<b>Nominal diameter of pipe (mm)</b>	<b>Cement (kg)</b>
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  $\pm 3$  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 (1:3) 15 mm unless otherwise specified.
- 5.14.7.5 Plastering work shall be carried out in two layers, the first layer being 12 mm thick and the second layer being 8 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 off 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 M30 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 M30 grade of concrete used for construction of RCC manhole shall have minimum cement content of 410 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**

### **6.1 Applicable Codes and Client's Requirements**

All the relevant IRC / IS code or as instructed by engineer in charge are applicable for design, Construction methodology and execution work.

Relevant Specification of MoRTH (5<sup>Th</sup> Revision) shall be apply and followed.

All earthworks shall be done according to Employer's Requirements.

#### **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**

#### **(Part A) Flexible Pavement**

##### **6.2.1 Road shall consist of the following:**

- a) Well compacted sub-grade layer.
- b) Providing and laying Granular sub-base (Grade I) of 200 mm thick.
- c) Providing and laying base course of 225 mm thick (WMM).
- 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 50 mm compacted thickness of DBM with VG 30 Bitumen (Dense Bituminous Macadam).
- g) Providing 30 mm compacted thickness of BC with VG 30 Bitumen (Bituminous Macadam).

### **6.3 Materials, Specification**

#### **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.

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

All the Item shall be executed as per MoRTH (5<sup>th</sup> Revision) specification and as specified in relevant IRC/IS code and as directed by engineer in charge.

### **(Part B) C.C Pavement (Road)**

**Road shall consist of the following :**

- a) Well compacted sub-grade layer.
- b) Providing and laying Granular sub-base (Grade I) of 150 mm thick.
- c) Providing and laying 100 mm thick DLC
- d) 125 micron sheet
- e) Providing and laying 200 mm thick PQC in M 30 with necessary Dowelbar, Tie bar ,Groove cutting & filling joint with appropriate sealant as per design requirement

**All the material shall confirm to the relevant IS/IRC Specification or as per MORTH section 1000.**

All the Item shall be executed as per MoRTH (5<sup>th</sup> Revision) specification and as specified in relevant IRC/IS code and as directed by engineer in charge.

### **(Part C) Pre cast interlocking paver block as area development**

Providing & Fixing 60 mm thick Precast Rubber dye/Steel dye inter locking paver block (Pnumetic compressed / mechanically Vibrated) in M 30 garde concrete As per approved design. Paver block should be laid on 35 mm thick sand layer. Sand shall also be used for levelling & joint filling.

It should be laid in proper line & level.

Paver block should be confirming to IS 15658 & IRC SP 63 latest edition.

#### **• V-Wire Underdrain System**

<b>Design Criteria V-Wire Screen under Drain System</b>		
<b>SR NO.</b>	<b><u>DESCRIPTION</u></b>	<b><u>DETAILS</u></b>
1	Rate of filtration	9 to 10 m <sup>3</sup> /hr/m <sup>2</sup> of bed area
2	Sand Depth (Filter media depth)	900 mm minimum
3	Filter box depth	3.25 meter minimum
4	Free Board	500 mm minimum
5	Back wash rate Air	Air- 600 to 900 LPM per square meter of bed area at a pressure of 0.35 kg/cm <sup>2</sup>
6	Back wash rate for water	Water - 400 to 600 LPM per square meter of bed area at a head of 7 meter
7	Under drain system	All welded V-wire screen made from stainless steel grade 304 jacketed on perforated base pipe of PVC or HDPE
8	Direct retention system	V-wire screen are provided with 0.25 to 0.30 mm slot to direct retention of filter media
9	Air distribution system	The system should be designed and provided for uniform air distribution to each lateral
10	Filter media size (Sand)	Effective Size 0.6 to 1 mm (uniform coefficient 1.3 to 1.7)

11	Height of back wash tank floor above the under-drain system.	7 meters minimum (From bottom of tank)
<b><u>Technical specifications of V-Wire Screen under Drain System</u></b>		
<b><u>SR NO.</u></b>	<b><u>ITEM DESCRIPTION</u></b>	<b><u>DETAILS &amp; MATERIAL</u></b>
1	V-wire under drain lateral	V wire Screen made of SS304 fitted on UPVC base pipe
2	Dimensions of the Screen	3.5" dia. V wire Screen
3	V-wire screen material	SS-304
4	Screen slot (aperture) size	300 microns (with standard tolerance as per IS-8110-200)
5	% open area of screen	11%
6	Base pipe of lateral	3-inch Diam. Of UPVC SCH-40
7	End connection of under drain lateral	One end closed with UPVC cap another end is suited to match with Tee connection of manifold
8	Air Header	Made of UPVC SCH-40
9	Tee for manifold with air distribution system	Made of UPVC fittings
10	Air clamp with main header	UPVC saddle with SS304 nuts & bolts
11	End ring of screen	Made from SS304 material
12	Shape of screen	Decagon type
13	Types of V-wire screen	All welded construction- No circumferential joint
14	Type of slot of screen	V-shaped to give required hydraulic function during filtration & back washing.

## **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 scaffoldings 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 - (Part – 20)	Methods for determination of the fire resistance of elements of construction (General Principles)
BS : 476 - (Part – 21)	Methods for determination of the fire resistance of load bearing elements of construction
BS : 476 - (Part – 22)	Methods for determination of the fire resistance of non-load bearing elements of construction
Part – IV - Fire Protection	National Building code of India

## **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  $\pm 3$  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. Incase, 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 transoms and mullions of dimensions as indicated in the construction Drawings to be prepared by the Contractor are generally required to be provided in the half brick partition walls.
- 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  $\pm 5$  mm and maximum variation in height or width of the units shall not be more than  $\pm 3$ 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, solid 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 be laid up at the same time with a true masonry bond between at least 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 at least 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.

#### **7.5A Aerated Light Weight concrete block masonry**

**Masonry work using Aerated Light Weight concrete block having crushing strength not less than 35kg/sq.cm. (As per IS standard) for super structure above plinth level to ALL FLOOR in chemical mortar complete as per technical Specification. (FOR ALL FLOOR)**

**(Note:-Masonry work using Aerated Light Weight concrete block used In Site As Per wall thickness size 300mm , 230 mm or 100mm are Instructed By Site In charge.)**

In general, the work shall be carried out as per the standard specifications of P.W.D. / C.P.W.D. / G.W.S.S.B. relevant drawings and as per the instructions of Engineer-in-Charge. The work shall be carried out as per item description.

The relevant specification shall be followed as per General Technical Specification for Building work Booklet It. No. 6.13(A) P. No. 51. Read autoclaved aerated cement concrete blocks with crushing strength 40 kg/sq.cm instead of common burnt brick having crushing strength 35 kg/sqm. Item shall be carried out at any floor level.

The work shall be carried out as per Indian standard specification IS : 2185 (Part-3) - 1984 for concrete masonry units Part-3 Autoclave cellular (aerated) concrete blocks.

The autoclaved aerated blocks shall be classified in two grades according to their compressive strengths as indicated in Table under:

<b>PHYSICAL PROPERTIES OF AUTOCLAVED AERATED CONCRTE BLOCKS</b>				
<b>Sr. No.</b>	<b>Density in over dry condition</b>	<b>Compressive strength</b>		<b>Thermal conductivity in air dry condition</b>
		<b>Grade-I</b>	<b>Grade-II</b>	
	kg/m <sup>2</sup>	N/mm <sup>2</sup>	N/mm <sup>2</sup>	W.m.k
i	451 to 550	2.0	1.50	0.21
ii	551 to 650	4.0	3.0	0.24
iii	651 to 750	5.0	4.0	0.30
iv	751 to 850	6.0	5.0	0.37
v	851 to 1000	7.0	6.0	0.42

#### **INDIAN STANDARDS:**

Work shall be carried out to Indian Standards and Code of practices. In absence International Standards shall be followed. These shall be latest issue. List given here under is not to be considered as conclusive and is for reference and guidance only. Any discrepancies / conflict noticed shall be directed to the EIC for his direction / approval. However, as a general rule more stringent specification shall take precedence.

IS: 269	Specification for ordinary and low heat Portland cement
IS: 383	Specification for Coarse and fine aggregate from natural sources for concrete
IS:456	Code of practice for plain and reinforced concrete.
IS: 1489	Specification for Portland – Pozzolona cement
IS: 2185	Specification for concrete masonry units hollow and solid cement blocks.
IS: 8112	Specification for ordinary Portland cement grade 43



IS: 9103	Specification for admixtures for concrete.
IS: 13757	Burnt clay fly ash building bricks

## **MATERIALS**

### **Cement**

The cement shall be ordinary Portland cement conforming to IS. Approved branded cement shall be used. It shall be received in bags of 50 kg (or in bulk carriers in case of storage in silos) and each batch shall be accompanied with test certificate of the factory. Also it shall be tested before use to ascertain its strength, setting time, etc. In case cement has been stored for over 6 months from date of manufacturer or for any reasons the stored cement shows signs of deterioration or contamination, it shall be tested as per the direction of the Engineer prior to use in the works. In case blended cement is used, it shall be factory blended only (fly ash only up to 25%)

### **Aggregate**

Aggregate shall conform to IS 383 requirements Coarse aggregate shall be obtained from natural sources such as stone, gravel etc. crushed or uncrushed from identified and approved quarries. Aggregate shall be hard, durable, clean and free from adherent coatings. The seasonal changes shall be well guarded. Grading shall be as indicated in IS 383. Fineness modules of the combined aggregates shall be between 3.6 and 4. Coarse aggregates shall be free from harmful materials such as iron, pyrites, coal, mica, shale or similar laminated material, clay, alkali, soft fragments sea shells, organic impurities etc. Impurities present within acceptable limits shall not adversely affect strength and durability.

### **Fine aggregate:**

Sand shall be well graded, hard, durable, clean and free from adherent coating and organic matter and shall not contain any appreciable amount clay. Sand shall not contain harmful impurities such as iron, pyrites, coal particles, lignite, mica shale or similar laminated material, alkali, and organic impurities in such form or quantities so as to affect the strength or durability of concrete or mortar. The seasonal changes shall be well guarded. Sand shall be invariably washed using screw type sand washing machine only if the silt content is not within the permissible limits. When tested as per IS 2386 part I and II, fine aggregate shall not exceed permissible quantities of deleterious materials as given.

### **Water**

Water used for mixing and curing shall be clean reasonably clear and free from objectionable quantities of shell, silts, alkalis, acids etc.

Water tested shall be in accordance with IS 3025, Maximum permissible limits of deleterious materials in water shall be as given in IS 456.

### **Concrete Work**

Factory made Autoclaved Aerated Concrete block, hydraulically pressed, machine vibrated steam cured only shall allow to be used in the work. The approval of Engineer shall be obtained before used of blocks. Autoclaved Aerated Concrete blocks shall be solid and shall be referred

to by its nominal dimension. The term nominal dimension includes the thickness of the mortar joint. Actual dimensions shall be 10mm short of the nominal dimensions. Blocks shall be made in sizes and shapes to fit different construction needs. It includes stretcher, corner, double corner or pier, jambs, header, bull nose, partition block and concreted floor units.

Nominal dimensions of concrete blocks shall be,

Length	400,	500	or	600 mm
Height	200,	250	or	300 mm
Width	100,	150, 225	or	300 mm

In addition, block shall be manufactured in half length of 200, 250 or 300 mm to correspond to the full length.

Maximum variations in length shall be 5% in length and 3% in width and height. Face shells and webs shall not be less than the values given in there produced table 15 of Annexure.

Grade of concrete for block shall be M10 with maximum water cement ratio of 0.35 for concrete. Concrete shall be mixed in the mechanical mixer. Blocks shall be moulded, lad and compacted with automatic machines only. No hand / manual compaction shall be permitted. Care shall be taken to see that the mix is placed in layers and each layer thoroughly tamped until the whole mould is filled up. Blocks shall be protected until they are sufficiently hardened to permit handling without damage. Naptha based superplasticizer; admixtures of doses prescribed by the manufacturer shall be used. Mixed designed shall be done and established with sufficient trial mixes.

Cured blocks shall be allowed to dry for a period of 30 days before being used. The blocks shall be allowed to complete their initial shrinkage before they are laid in the wall.

All blocks shall be sound free of cracks or other defects. For exposed construction face or faces shall be free of chips, or other imperfections, and the overall dimensions of the blocks shall be in accordance to tolerance as specified.

Blocks shall be considered as per IS if requirements of conditions mentioned in IS 2185 (Part III) are satisfied.

1. The number of blocks with dimensions outside the tolerance limit and/or with visual defects, among those inspected shall not be more than two.
2. Density and compressive strength shall be greater than or equal to the minimum limit specified in table 2 of IS 2185(part I) (table 16 of Annexure)
3. Drying shrinkage shall not exceed 0.1 per cent.
4. Water absorption shall not be more than 10 per cent by mass.

Mandatory laboratory test as per IS 2185 part-III of Aerated Autoclaved Cement Concrete block shall be done at a lot of every 10,000 blocks for each test shown below.

- (1) Block density
- (2) Compressive strength
- (3) Thermal conductivity
- (4) Drying shrinkage

## **MORTAR**

Mortar shall be prepared by using anti-shrinkage compound (as specified by manufacturer of approved chemical) mixing fine graded aggregate with cement in the proportion specified for respective items of work. Mixing of mortar shall be done by mechanical mixers only. Hand mixing may be permitted in specified cases on the written permission of the Engineer-in-charge. Non shrinking compound shall be added to the mortar as per direction of manufacturer.

Mortars shall be specified by proportion. Volumetric mixing shall be based on dry volumes of each ingredient. For convenience, measurement shall correspond to volume of one cement bag i.e. 0.035 cu m. Boxes shall be of size 40 X 35 X 25 cm. These shall be marked as mortar mixing boxes by red paint and shall be used throughout the contract. Hand mixing or mechanical mixing proportion shall be done with the use of these boxes.

Cement mortar shall be prepared by mixing cement, sand and non shrinkage compound in specified proportions. Proportioning shall be carried out as detailed above. Sand shall be added suitably to allow for bulkage if required. Bulkage shall be determined as specified in IS 2386 Part III. Cement and sand added to mixer shall be thoroughly mixed and water shall be added to it gradually. After addition of water the mixer shall run for a minimum of 3 minutes. The mortar mixed shall be consumed within 30 minutes of its mixing.

### **Admixtures**

Additives or admixtures may be added to the cement or concrete mix conforming to the following Indian Standard specifications.

1. IS 9103      Specifications for admixtures for concrete
2. IS 3812      Specifications for fly ash for use as pozzolana and admixture.
3. IS 2645      Specifications for integral water proofing compound.

Other additives or admixtures not being governed by Indian standards shall be tested and checked that the same are not detrimental to durability. Any usage shall only be after the approval of the Engineer.

## **Joint Fillers**

Bituminous impregnated, premoulded joint filler board shall be of approved quality, manufacturer and conform to IS 1838 Part I.

## **Metal reinforcement**

Expanded metal used shall comply IS 412.

## **Delivery / Storage**

Load, unload deliver, store all concrete blocks with due care at site to be free from damage, dirt, intrusion of foreign materials etc.

Store all concrete block units on raised solid platforms.

Protect block from any excess of weather conditions.

## **SCOPE OF WORK**

Provide construct with specified strength, quality Autoclaved Aerated Concrete block masonry or burnt clay fly ash brick masonry conforming to IS Code of Practices, approved method of statement by Engineer, including providing levelling course PCC M20 grade to adjust with full size blocks / bricks, approved mix of mortar, construction and expansion joint filers, metal reinforcement wherever required of type, size and shape, providing special bond adjusting blocks, reinforced patli (course runner beams of concrete M20 required double – legged scaffolds etc. complete).

## **WORKMANSHIP**

Concrete Block shall not be wetted like brick masonry prior to use. In total dry climate top and sides may be slightly moistened to avoid absorption of water from mortar. The column surface and beam bottom shall be prepared properly by hacking to avoid debonding.

Concrete block work shall be laid in English bond. Joints shall not be bigger than 10 mm and will be perfectly horizontal and vertical Joints shall be raked 10 mm deep while mortar is green.

Cut blocks shall not be used . Special solid precast blocks at site shall be cast well in advance to be used as spacers and to adjust breaking of vertical joints.

Cracks in block masonry are due to shrinkage or expansion of blocks or due to load settlement, thermal expansion or changes in moisture content in the structural members enclosing the block walls. The following measures are recommended to prevent formation of cracks.

- a. While curing the block masonry should be lightly sprinkled with water and not made excessively wet.
- b. Expansion joints shall be provided in wall exceeding 30 m in length.
- c. In framed structures, erection of partition and panel walls should be delayed to take care of deformations due to structural loads.
- d. Partition wall should be suitably reinforced in lower courses to strengthen against excessive deflections of floor slabs and should be separated from the ceiling by a layer of resilient material. Joint shall be carried out in plaster or any other finish.

The last layer of block masonry shall be laid by keeping groove of 15mm x 12mm on the external side, which should be filled up with epoxy mortar and Metal.

Where required damp proof course layer shall be laid as specified.

Exposed faces and corners of masonry damaged during construction shall be removed and repaired as acceptable to Engineer.

### **Scaffolding**

Scaffolding independent of block work, double legged single /multiple staging scaffolding shall be provided. It should be tied to block work or structure at suitable intervals in both directions. Two rows of planks shall be provided. all around. Planks shall be at least 50 mm thick and well-tied to scaffolding. Railing to the outside face shall be provided. While erecting scaffolding, the following points must be noted and closely followed:

1. Minimum number of holes in the horizontal direction. Holes shall be formed by omitting header brick.
2. No holes near the skew backs of arches.
3. Scaffolding must be sound and strong and easy to maintain.
4. Holes left must be closed while finishing the plaster.

Raking back shall be carried out at an angle not steeper than 45degrees in case all the block work is not raised together.

The block should be of full height and no cut pieces shall be allowed. PCC levelling course shall be laid to fill up the gap.

### **ITEM INCLUDES**

Items shall include following.

- a. Material including all wastages and labour, for the completion of items as specified including any cent ring, shuttering, curing etc.
- b. Raking out of joints.
- c. Preparing the tops and sides.
- d. Forming and preparing expansion, contraction or construction joints as detailed above or specified in the BOQ or drawing.
- e. Making holes, openings etc. for outlets, embedding down take pipes etc. wherever necessary during construction, and finishing exposed surfaces as per instruction of the Engineer.
- f. Curing and protection as specified.
- g. Making holes, openings, outlets etc. embedding pipes, ends of beams, joists, slabs, trusses, sills etc. whatever required during construction and neatly finishing the exposed surface sand opening as per instructions of the Engineer.
- h. For masonry use of approved non-shrinking compound in cement mortar.

### **Mode of measurement and payment:**

All work having any thickness of wall 100mm, 230mm etc. shall be measured in decimal system and cubical contents shall be worked out to the nearest 0.01 cum. The rate shall be including cost of all labour, materials involved and tools required for completion of Autoclave Aerated Cement Concrete block Masonry work including scaffolding.

The work shall be carried out at any floor level and nothing Extra shall be paid for any lead and lift.

The rate shall for a unit of one cubic meter.

## **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  $\pm 3$  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. 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  $\pm 1.5$ 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 skins 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  $\pm 1.5$ 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  $\pm 10$  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<sup>2</sup>.
- 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  $\pm 3$ 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 underlayer, 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  $\pm 5$ mm. This shall be  $\pm 2$ 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 be 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/mm<sup>2</sup>.
- 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:
- Hydrochloric acid upto 30% concentration
  - Sodium hydroxide upto 50% concentration
  - Liquid temperature upto 60deg.C
  - Ultraviolet radiation
  - 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 smoothened 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.
- By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 litres of water.
  - 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 any where 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**

- 2.29.2.1 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.
- 2.29.2.2 Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub- strata.
- 2.29.2.3 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.
- 2.29.2.4 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 smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified 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 smoothened 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 1 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/m<sup>2</sup>.
- 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 inter-locking 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 confirm 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 confirm 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.



## **8.0 M. S. PIPE, FITTINGS & LOWERING, LAYING AND JOINTING (RAW WATER AND CLEAR WATER PIPELINE WORK)**

- 8.1** This specification covers the general requirements for supply, fabrication, delivery at site laying, stacking at site, jointing, testing and commissioning of all welded M.S pipeline, appurtenances, specials etc. above/below ground, including Civil works required for the same.

### **Applicable codes (M.S. pipes)**

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

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

<b>Sr. No.</b>	<b>Code</b>	<b>Description</b>
1.	IS : 2062-2011	Hot Rolled Medium and High Tensile Structural Steel-Specification
2.	IS : 814	Covered Electrodes for manual Metal Arc Welding of carbon and C-Mn steel.
3.	BS EN 499	Welding Consumables. Covered Electrodes for Manual Metal Arc Welding of Non Alloy and Fine Grain Steel. Classification
4.	AWS : A-5.1	Specification for Mild Steel Covered Arc Welding Electrodes.
5.	IS : 3613	Acceptance Tests for Wire Flux combinations for Submerged – arc Welding.
6.	AWS : A-5.17	Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding. IS : 1377 - Technical Supply Conditions for Threaded Fasteners
7.	IS : 1367	Technical Supply Conditions for Threaded steel Fasteners (Parts 1 to 3).
8.	IS : 2074	Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming- specification
9.	IS : 102	Ready Mixed Paint, Brushing, Red Lead, non-setting, Priming.
10.	IS : 816	Code of practice for use of Metal Arc Welding for General Construction in mild steel.
11.	IS : 4353	Submerged Arc Welding of Mild Steel & Low Alloy Steels – Recommendations.
12.	IS : 817	Code of practice for Training and Testing of Metal Arc Welders.
13.	IS : 1182	Recommended practice for Radiographic examination of Fusion - Welded Butt Joints in steel plants
14.	IS : 2595	Code of Practice for Radiographic Testing.
15.	IS : 3658	Code of Practice for Liquid Penetrate Flaw Detection
16.	IS : 5334	Code of practice for Magnetic Particle Flaw Detection of welds.
17.	ASTM E 94	Guide for Radiographic Testing

18.	ASTM E 709	Guide for Magnetic Particle Examination.
19.	ASTM E 165	Test Method for Liquid Penetrate Examination.
20.	IS : 3600	Methods of Testing Fusion Welded Joints and weld metal in steel (Parts 1 to 9)
21.	IS : 4853	Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints in Steel Pipe
22.	IS : 3589	Seamless or Electrically welded steel pipes for Water Gas and Sewage (168.3 to 2540 Outside Diameter)
23.	IS : 6631	Specification for Steel pipes for Hydraulic Purposes
24.	IS : 7343	Code of practice for ultrasonic Testing of Ferrous Welded Pipes and Tubular Products
25.	IS : 2598	Safety Code for Industrial Radiographic Practice
26.	IS : 5822	Code of Practice for Laying of Electrically Welded steel pipes for water supply
27.	IS : 1608	Metallic material-tensile testing at ambient temperature
28.	IS : 9595	Metal Arc welding of Carbon and Carbon-Manganese Steels – Recommendations
29.	IS : 2825	Code of unfired Pressure Vessels
30.	IS : 5504	Specification for Spiral Welded pipes
31.	IS: 10748	Hot-rolled Steel Strip for Welded Tubes and Pipes - Specification

Manufacturing, Supplying, Delivery, Lowering, Laying, Jointing of MS Pipeline

## 8.2 Scope of Work

Manufacture, supply and delivery of submerged Arc welded M.S Pipe having bevelled ends from plate or coil conforming to IS-3589 and/or IS-5504 with its latest revision / amendment with inside 406 micron thick food grade epoxy coating and outside 3LPE coating conforming to DIN 30670 for the specified thickness & inner diameter of pipe at site with all type of specials, manholes, tees, bends & flanges, lowering, laying and jointing the pipes with welding in prepared trench with required excavation in all strata's, necessary utility crossings, breaking the road surface/ canal / existing structures & reinstating the same, necessary traffic diversion work, refilling around the MS pipeline shall be done by useful selected excavated soil which do not damage the external 3LPE coating (i.e. use of excavated soft/hard rock, pebble etc. shall not be permitted) after completion of work, disposal of surplus excavated stuff, including providing & fixing pipe indicators at every 1 Km distance including hydro testing etc. complete with all taxes, insurance, freight charges, octroi, inspection charges, transportation, etc. complete including all labour, materials and as per specification and to the satisfaction of Engineer-in-charge.

After completion of laying, contractor shall provide L-section of the pipe line and shall give details of latitude and longitude of every air valve, butterfly valves, scour valve, change in direction, crossing, encasings etc.

Measurement for MS pipeline shall be made in meter of actual pipe laid in lines and levels required. Length shall be measured to the nearest 1cm.

### **Standards**

Submerged Arc welded Hot finished mild steel Beveled pipes to be manufactured supplied and delivered under the scope of this contract shall be manufactured in accordance and conforming to IS-3589 and/or IS-5504. Pipes supplied shall be with inside 406 micron epoxy coating as per detailed technical specification and outside 3LPE coating as per DIN-30670,1991 or latest revision / amendments if any.

### **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 marking upon the goods shall indicate the followings.

1. Manufacturer's brand name and / or trade mark.
2. Purchaser's mark as "AMC" be stencilled
3. Diameter, Length and wall thickness.
4. Pipe No., Pipe Designation
5. Date of manufacture
6. Any other important matter that the manufacturer deems fit to be inscribed.

All the MS pipes of diameter up to 2200mm (I.D.) shall be provided with ISI certification mark on each pipe.

### **Packing and Handling**

The materials shall always be packed separately dispatched from manufacturer's works with adequate protective measures to prevent damages and deterioration while in transport or stored at any place. The pack shall always to be so neat and tidy that may withstand any robust and rough handling.

The supplier shall use proper handing instruments / equipments and shall follow to a suitable method of handing of pipes as may be approved by Engineer In-charge, while unloading and stacking materials in the stores.

### **Workmanship**

All pipes with internal epoxy coating and external 3LPE coating shall be finished and shall conform to detail specifications & relevant IS codes.

## Test Certificate

The contractor shall always provide manufacturer's test certificate in accordance with every batch / lot of goods as manufactured and supplied.

## Materials

Steel Plates/H.R. coil

The steel plates for pipes, fittings, specials and stiffeners shall be of mild steel conforming to IS: 2062, Grade-E250 BR or H.R. coil conforming to IS: 10748 grade III.

## Welding Consumable

Such as electrodes, filler rods and wires shall conform to IS: 814, IS: 3613, IS: 6419 and IS: 7280.

## Manufacturing

The mild steel pipes shall be manufactured from H.R. coils conforming to IS-10748 Grade-III or mild steel plate confirming to IS 2062-2011. The pipes are to be fabricated as per terms and conditions as laid down in IS-3589 and/or IS-5504. The pipe shall be manufactured from Fe-410 grade steel.

The steel material viz. MS plate or coils having required thickness (with no negative tolerance) and minimum 1500 mm width with no negative tolerance in trimmed condition having length & width as shown in the schedules of material should have been manufactured and tested under ISI mark scheme or such license under other institution valid for the respective country conforming to IS specification No.IS-2062-2011 Grade- E250 BR for MS plates and IS 10748 Gr.-III for hot rolled steel coils.

The collection and testing of samples will be in accordance with the following Indian Standard and para testing of samples. Imported steel plates shall not be allowed for manufacturing of pipeline.

### Note :

- for MS Plate: IS 2062 is to be read as IS: 2062; Gr. E250 BR
- For H.R. Coil: IS 10748 is to be read as IS:10748 Gr. III

Sr. No.	I.S. No.	Title
1	228	Method of chemical analysis of steel (Second revision)
2	1599:1985	Method for Bend test (Second revision)
3	1608:1995	Mechanical testing of metals- Tensile testing
4.	3803:1984	Steel conversion of elongation value part-I Carbon and loow alloy Steel (Second revision)
5	8910:1978	General Technical delivery requirements for steel and steel product.
6	9595:1996	Metal arc welding of carbon and carbon manganese steels (First revision) - Recommendation

7	1730:1989	Dimension for steel plates, sheets, strips & flats for general engineering purposes (second revision)
8	1852:1985	Rolling & cutting tolerances for Hot re-rolled steel products. (Forth revision)

In addition to above wherever necessary and suggested by inspecting agency, API or other relevant standards will be used for testing and collecting of samples.

Unless otherwise specified, the MS plates supplied under this tender should conform to the applicable requirements of the current addition of the IS specifications No. IS: 2062- 2011 Grade-E250 BR killed Quality or equivalent standard and or IS 10748, Gr. III for hot rolled steel coils for manufacturer of spirally welded pipes.

The permissible variations in dimensions & tolerances applicable in length and width of MS plates should be as per IS specification No 1852:1985 as applicable to rectangular, sheared cut MS plates but no negative tolerance in thickness will be acceptable.

The plates/ HR coil older than 6 months from the date of award of work shall not be allowed to manufacture pipes and these plates/ HR coil shall be free from any cracks, surface flaws, laminations, scares, pits, splits, harmful scratches and other defects.

The MS plates shall be capable of forming operations and should not un-duly loose the specified strength and property during various operations viz. drilling, threading, plugging welding etc. and process adopted for fabrications & erection of pipe line. Also the plates shall be resistant to cleavage, fractures & effect of ageing.

### **Technical Advice**

The contractor shall be fully responsible for proper liaison with the department to evolve satisfactory welding procedure for fabrication & erection of pipe manufactured from the plates / coil supplied by them. The contractor on receipt of a request from the dept. shall without any cost to the dept. arrange to furnish manufacturer's technical advice (with up to date instructions Booklet, technical literature etc. regarding any problem concerning fabrication in particular, suitability of welding, consumables weld grooves, design, heat treatment etc.) such advise shall be rendered till the expiry of contract.

### **Acceptance of Goods**

At the time of delivery of materials, the manufacturer will have to provide test results in accordance with IS specification No. IS-2062-2011 or equivalent standard of the MS plates or IS 10748 for hot rolled steel coils supplied along with the challans. The material will not be accepted without test results of the manufacturer. If the test results of the respective lots will be found satisfactory with respect to relevant IS or equivalent standard specification and with no negative tolerance in thickness only then material will be accepted by the department otherwise rejected.

Thus in case of non-acceptance and return of materials by the department, the department will not be responsible for the cost of materials and it's transportation or

any other cost.

### **Inspection, Sampling & Testing**

To have the quality assurance of the materials, the Engineer-in-charge may arrange inspection of his representative / consultant / third party inspection agency. The material unless inspected, passed and stamped for acceptance shall not be dispatched.

#### **Testing of Samples**

Three samples shall be drawn per heat or from a lot of 500MT of HR coils/MS plate whichever is less jointly as above by the Engineer-in-charge/ his representative and authorized representative of the Contractor. Each sample will be given identification No. and a slip indicating identification No., date of sampling and signature of above representatives should be kept with the samples.

Out of three samples drawn one sample will be sent for testing in accordance with relevant IS specifications by the Inspection team / third party agency to any one of the following laboratories as per testing requirement or any other laboratory as may be decided by the Engineer-in-charge.

1. Gujarat Engineering Research Institute (GERI)
2. State/ Central Govt. laboratory/ Government Engineering College.
3. State/Central Government/ BIS approved laboratory / NABL

Out of remaining two samples, second sample will be kept by the department and third will be kept by the supplier as reference sample. The test result should be obtained within ten (10) days from the date of sampling positively without fail and furnish to the department duly countersigned by the authorized official of Inspection team / third party agency. The test result should indicate physical and chemical properties of the test samples in accordance with relevant IS specifications. The necessary Inspection & samples testing charges will also be borne by the Contractor. In addition to the above whenever necessary and suggested by Engineer-in-charge, API or other relevant standards will be used for testing and collection of samples. The M S plates supplied under this tender should confirm to applicable requirements of the current edition of IS specification No. IS:2062 Grade-E250 BR killed quality and IS10748 for hot rolled steel coils.

The Inspection/ Testing note regarding the testing of the plates/ HR coils shall have to be furnished with all relevant test certificates/ documents to the Engineer-in-charge and acceptance shall be given, if they are manufactured as per the standards.

### **Wall Thickness**

The wall thickness of pipes shall be as per the minimum mentioned in the tender. No negative tolerance will be allowed, only positive tolerance will be allowed.

### **Pipe Ends**

The pipe shall have bevelled ends to an angle of  $30^{\circ} \pm 5^{\circ}$  measured from a line drawn perpendicular to the axis of the pipes. The root face shall be  $1.6 \pm 0.8$  mm. The root face of the bevel may be prepared by hand finishing if required.

### **Length of Pipes**

The random length of pipes shall be 10 to 12 meter. In specific locations, smaller lengths can be accepted as per Engineer-in-charge.

### **Straightness of Pipes**

Finished pipes shall not deviate from straightness by more than 0.2% of the total length checking for straightness shall be carried out using as taut string or wire from end to end along the side of the pipe to measure, the greatest deviation.

### **Testing of Pipes**

The main tests among others to be conducted on each pipe shall be as per IS-3589 and/or IS-5504 with its latest version.

### **Sampling of pipes**

The sampling of pipes shall be as in IS:4711 with latest version/amendment or as directed by the Engineer-in- charge.

### **Condition of Supply**

The pipes with inside epoxy coating & outside 3LPE coating shall be as per specifications.

### **Other Tolerances**

As per IS-3589 and/or IS-5504 with latest version (Except for wall thickness). M.S. Pipes shall be welded either longitudinally or spirally.

Before fabrication of pipes and specials / fittings is commenced, the copies of the mill sheets and the manufacturer's test certificates for plates and other materials required for fabrication shall be submitted by the Contractor to the Engineer In-charge for his approval.

When instructed by the Engineer In-charge, the Contractor shall supply free of charge to the Engineer-in-charge for testing suitable samples of the materials to be used / used in the Works.

### **Inspection**

All materials will be subjected to inspection by the Engineer In-charge, his authorized representative. The inspection charges shall be borne by Contractor. However, in any case of re-inspection due to rejection / rework required of inspected goods or inspection could not be carried out due to non-readiness of material called for inspection etc., the additional charges for inspection will be borne by the contractor

and are required to be paid directly to the inspection agency. All such incidents will be reported to the Engineer-in-charge in writing within a week.

The Contractor shall notify the Engineer In-charge, in advance of the production of materials and fabrication thereof, in order that the Employer may arrange for mill and shop inspection.

The Engineer In-charge may reject any or all materials or work that does not meet with any of the requirements of this specification. The Contractor shall rectify or replace such rejected material/performed work at his own cost, to the satisfaction of the Engineer In-charge.

The Engineer In-charge shall have free access to those parts of all plants or any other premises and sites that are concerned with the furnishing of materials or the performance of work under this specification.

The Contractor shall furnish to the Employer's inspector reasonable facilities and space without charge for inspection, testing and obtaining of any information he desires in respect of the character of material used and the progress and manner of the work.

### **8.3 Fabrication of MS Pipe**

#### **General**

1. The pipes shall be truly cylindrical, and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces, which are to be fixed adjacent to flange adapter with fixed outer diameter, shall not deviate from theoretical one by more than 1 mm. To obtain this accuracy the pipe shall be rolled several times, if necessary, as pipe pieces should be truly cylindrical.

The external longitudinal welding of this pipe shall be ground smooth flush with surface to the satisfaction of the Engineer In-charge, for a length of 200 mm. No extra cost shall be charged by the Contractor for this grinding work.

2. Minor repair by welding or otherwise shall be permitted at the discretion of the Engineer In-charge, but such repairs shall be done only after obtaining the previous permission of the Engineer. Any pipe or part thereof which develops injurious defects during shop welding or other operations shall be rejected.

#### **Fabrication**

Pipe shall be manufactured by continuous process, Spiral Submerged Arc Welding (SAW) facility with on line testing sequentially, dust free environment, X-ray, Ultrasonic testing, adequate Hydraulic testing, etc.

The contractor shall get the MS pipe fabrication at well established, proven, having adequate test facility, having pipe coating facility (inside-epoxy coating & outside –



hot applied 3LPE coating), having valid factory license. The contractor shall propose such manufacturing unit/s for with credentials of manufacturing unit/s approval by the department prior to placement of order. The department shall not be responsible for non acceptance of MS pipes manufactured/ being manufactured in absence of such approval from the department of particular manufacturing unit/s.

In no case manufacturing/ fabrication of MS pipes shall be permitted at site. This manufacturing unit/s should have the following minimum set-up viz.,

1. Continuous Plate bending machines for rolling.
2. SAW (Submerged Arc Welding) machine & Automatic welding machines (suitable for circumferential as well as longitudinal welding)- suitable for 3000 mm Dia pipes.
3. Pipe coating facility (inside-epoxy coating & outside – hot applied 3LPE coating) set-up
4. Hydraulic Testing Machines
5. Travelling gantry or crane of suitable capacity
6. Mobile cranes of suitable capacity for loading/unloading of HR/Plates and Pipes.
7. Lathe for machining of the flanges rings, plates etc.
8. Equipment for abrasive/ shot blasting and applying paint by spray gun.
9. Equipment for cold forming of plates up to 25 mm thick to the required curvature
10. Pipe hydro-testing set-up
11. Testing equipment online and off line such as UT/ DPT/ Chemical & mechanical laboratory for DT & NDT etc.

In addition to above, the details such as company profile, manufacturing experience, order in-hand, client list, quality certifications or other details pertaining to pipes fabrication information as asked by the department.

### **Cutting plates to size**

The plates shall be indented in such length as to have minimum wastage and so as to make the pipe as far as possible with one longitudinal weld joints.

Before cutting, all the edges of the plates shall be cleaned by brushing/grinding on both the sides.

After the plates are cut, the edges shall be made smooth and even by polishing with an electrical or pneumatic grinder to remove all inequalities. Care shall be taken to see that the cut edges of the plate are perfectly straight. Jigs to be used for this purpose shall depend upon the types of cutting machine used. The plates cut to the required shape shall be checked for correctness before they are rolled into pipe drums. If any corrections are required, the Contractor shall do the same by re-cutting, if necessary. If any plate or flat is found to be warped, to have corrugations, the defects shall be removed by putting the plate or flat into a roller press, and no extra payment for this rectification work shall be made. The laminated or heavily corroded plate shall not be used in the manufacturing of the pipe.

## **Rolling of Plates**

The plates cut to the exact size shall be put into a rolling machine to form a pipe of the required diameter. The Contractor shall adjust the rolling machine so as to give a uniform curvature to the pipe throughout its circumference. The curvature obtained shall be checked by the Contractor's foreman during the process of rolling and if proper curvature is not obtained at any place including the ends, the rolling operation shall be repeated at this stage or even after the longitudinal welding of the drum where directed. Heating of plates to obtain the desired curvature shall not be permitted.

## **Tacking the Drums**

The rolled drums shall be kept on an assembly platform for tacking, care being taken to ensure that the tacked drums have their end faces at right angles to the axis of the pipe. While tacking the drum a gap of 2 mm to 4 mm shall be maintained where hand welding is permitted. However, where the welding is to be done on automatic welding machine, there is no need of maintaining such gap depending on the penetration through complete thickness of the welding required. To achieve this objective, clamp spiders, tightening rings and or any other approved gadgets shall be used. Each such drum, before being taken to the assembly platform, shall be numbered on the inside with oil paint, stating the plate thickness as well.

## **Assembly of Drums into Pipes**

The tacked drums shall then be transported to an assembly platform where they shall be tack-welded together to form suitable pipe-lengths. Plate shall be bent in the maximum possible width to reduce the number of circumferential joints.

The longitudinal joints shall be staggered at 90 deg. The drums when tacked together shall have no circumferential gap when the welding is done on automatic welding machine. But when hand welding is adopted, a gap of 2mm to 4mm shall be maintained to obtain a good butt-welded joint.

The assembly shall be truly cylindrical and without any kinks. The faces shall be at right angles to the axis of the cylinder. A suitable arrangement for testing the correctness of the face shall be provided by the Contractor at the assembly platform.

Factory made spirally welded pipes are also permitted.

## **Welding**

All components of a standard shell, either straight or bent etc. shall be welded, by use of automatic arc welding machine by Submerged Arc welding process with alternating current. Manual welding shall not be permitted except for sealing runs/ field weld joints and such other minor works at the discretion of the Engineer In-charge. The strength of the joint shall be at-least equal to that of the parent material.

The contractor shall use radiographic quality electrodes and to be carry-out the welding procedure specification (WPS) and Pre-qualification Requirement (PQR). For welding the contractor shall ensure use with standard current and arc voltage

required for the machine. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer in-charge. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer In-charge shall be obtained. In the case of thin sheets, electric arc welding may not give satisfactory results and gas welding shall be resorted to. Gas welding shall be subject to the same specifications and tests as those for electric welds. Welding should be carried out inside as well as outside. The contractor should engage all qualified welder for field welding at least having of 6G level qualification. The contractor should submit such qualified welders list prior taking up welding work.

All welding shall conform to the requirements of IS 4353 latest version

All longitudinal and circumferential joints shall be double welded butt joints. Field joints shall be from outside, with a sealing weld from inside. End preparation for such welding shall conform to IS:2825.

All circumferential welds involving plates of unequal thickness shall be so kept that the inside surfaces of plates match to provide stream lined joints without alteration in the internal diameter. As far as practicable, welding of dissimilar thickness of shells shall be carried out in the shops.

The welding shall be of the best workmanship free from flaws, burns, etc. and the Contractor shall provide for his own electrodes and equipments, ovens to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall have to undergo for testing. Such testing's shall be organized by the Contractor before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operation shall conform to the requirements of IS:7307 and IS: 7310 (latest) and/or ASME section-IX (latest). Periodical tests as regards their efficiency shall also be taken at intervals of about 6 months and those found inefficient shall be removed from the job. Only those who pass the test shall be posted on the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully checked by X-ray in addition to the regular X-ray inspections. The defects if any shall be set right to the satisfaction of the Engineer In-charge. All such check tests and rectifications of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Site welds shall be done by specially selected welders.

A record shall be maintained showing the names of welders and operators who have worked on each individual joint. Hand welding shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or a pair shall be as far as possible, completed by them in all respects, including sealing run. No helper or other unauthorized person shall be permitted to do any welding whatsoever. In case of infringement of above, the persons shall be punished as directed by the Engineer In-charge.

The welded joint after welding should not become brittle or sensitive to blows and

there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal and is to retain its original ductility. No allowance will be made for thinning of weld and the weld should in no point be less than the nominal thickness of plate.

Upon receipt of the order and prior to the start of fabrication, the Contractor shall submit to the Engineer In-charge for his approval the "welding procedure" he intends to use in the shop work. Similarly, prior to the start of the field welding, procedure for the field welding must be submitted to the Engineer In-charge for his approval. Manual welding shall be adopted only when machine welding is not possible.

### **Ultrasonic Test of Welded Joints**

Minimum 15% of welded length in each pipe (well distributed along the pipe length) at random shall be subjected to ultrasonic test at factory & at field. The acceptance / rejection criteria shall be as per API 5L (American Petroleum Institute). The ultrasonic test shall be conducted as per relevant ASME code. (American Society of Mechanical Engineering) The person who conducts the test shall have certificate as per ISNT or ASNT Level-2. (American Standards and Testing)

### **Destructive Test**

The destructive test of pipe joints on the field shall be carried out as per IS 3600. For every 1 km length of pipeline laid, one destructive test of field joint shall be carried out.

1. The welded joints shall be tested for Tensile test, Bend test & tree-panned plug in accordance with procedure laid down in IS No. 3600 of 1966 and latest version of all part of the code "Code of procedure for testing of fusion welded joints and weld metals in steel".
2. Test pieces shall be taken by the contractor from the welded joints at the position on fabricated pipes pointed out by the Engineer in-charge.
3. The sample so taken shall then be cut to the exact shape and dimensions and machined as described below and handed over to the Engineer-in-charge for testing.

### **Tolerance**

The shell in the completed work shall be substantially round. The difference between maximum and minimum inside diameters at any cross section shall not exceed 1% of the nominal diameter of the cross section under consideration subject to a maximum of 10 mm.

Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2 mm on either side of the plane. Pipe ends shall be bevelled as per IS-3589 and/or IS-5504.

For the shell thickness, no negative tolerances are acceptable.

### **Shop Testing**

After fabrication, but before application of protective coatings all pipes and specials

shall be subjected to a shop hydraulic test. Standard lengths of pipes shall be directly subjected to test and non-standard pipe and elbows can be tested as standard pipe before being cut to size.

The Hydraulic test pressure for individual pipe in the factory shall be as per IS: 3589 (refer latest version).

Prior to testing, the pipe shall be inspected thoroughly and all the apparent defects in welding such as jumps, porosity etc. shall be repaired by gouge and re-welding.

The hydraulic test shall be carried out under cover at the fabrication shop, in the presence of and to the satisfaction of the Engineer In-charge or the inspection agency appointed by the Employer.

For indicating the pressure inside the pipe an accurate pressure gauge of approved make duly tested and calibrated for the accuracy of readings shall be mounted on one of the closures, which close the pipe ends.

The pressures shall be applied gradually by approved means and shall be maintained for at least 5 seconds or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 Kg hand hammer.

The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding after dewatering the pipe. The repaired pipe shall be re-tested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected temporarily. The Contractor shall stack such rejected pipes separately in his yard. The Engineer In-charge shall inspect the same and after taking cuts if necessary, shall determine the nature of repairs to be carried out thereon and shall then decide as to how and where they shall be used. No payment shall be made for handling or carrying out repairs, but, payment for the fabrication and hydraulic testing of the pipe shall be released only after acceptance of the pipe with necessary repairs and subsequent testing etc. are carried out by the Contractor to the satisfaction of the Engineer In-charge. The Engineer In-charge shall be supplied with two copies of the results of all the tests carried out.

### **Submission of Daily Progress Report**

The Contractor shall submit to the Engineer In-charge a daily progress report in the Performa approved by the Engineer In-charge, wherein all the details of the work carried out in the factory shall be fully recorded. Similarly, works done in the various units in the factory shall be separately mentioned. The Contractor shall maintain a register of all the finished materials giving dates of carrying out important operations such as testing, transport, etc. The register shall be presented at least once a week to the Engineer In-charge who shall initial the entries after verification.

### **Transportation of Pipes, Specials, etc.**

All pipes and specials fabricated in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The loading in the factory shall be carried out by means of either a crane, gantry or shear legs, so as not to cause any damage to the finished material. Similarly, while unloading and stacking, great care shall be taken to ensure that the material (pipe & special) is not damaged or dented. The contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer In-charge shall be adopted. The material stacked at site shall be jointly inspected by the Engineer In-charge and the Contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer In-charge before payment is admitted.

Props of approved designs shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props may be removed and re-used for subsequent operations. The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth and subsequent rusting. In order to prevent sagging during transit, savings of steel plates can be utilized by cutting to the required length and tacking the same to the pipe ends, in place of props, if approved by the Engineer In-charge.

As explained in earlier paragraphs, materials such as pipes, tapers, etc. may be transported to the site of laying as soon as the material is finished in all respects with the permission of the Engineer In-charge to avoid congestion in the Contractor's yard. However, materials such as expansion joints, composite bends, 'T' branches and other complicated materials shall be stacked in the Contractor's yard until they are required for laying in the field. In view of this, the work of fabrication of such materials shall be properly synchronized as far as possible with the laying operations.

Fabricated materials such as manhole covers, appurtenances, bolts, nuts, distance pipes, flanges, saddles, collars bypass arrangements etc. shall be transported to the site of laying from the fabrication shop according to the needs of the laying operations only. In regards access roads, the Contractor shall note that access road may lead up to some points on the alignment the Contractor shall have to make his own arrangement for connecting approaches to transport the pipes cross country to the actual site of laying at his own cost. Whatever may be the mode of transport he uses it shall be incumbent on the Contractor to carry and stack the pipes and specials along the alignment as close as possible to the site of laying.

### **Procedure for receiving Steel Pipes**

#### **General**

To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug

plates, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

### **Stacking of pipes, etc. and Inspection**

The Contractor shall keep in each section a responsible representative to take delivery of the pipes, specials and appurtenances, etc. transported from the fabricating stockyard or received from any other work site to the site of laying and to stack along the route on timber skids. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Suitable gaps in the pipes stacked shall be left at intervals to permit access from one side to the other. The pipes, specials, appurtenances so received on site shall be jointly inspected and defects recorded, if any, such as protrusions, grooves, dents, notches, damage to the internal coating etc. shall be pointed out immediately to the Engineer In-charge at the site and in the acknowledgement challans. Such defects shall be rectified or repaired to the satisfaction of the Engineer In-charge entirely at the Contractor's risk and cost.

### **Handling of Pipes, Specials, Appurtenances, etc.**

It is essential to avoid damage to the pipes, fittings and specials, etc. or their coatings at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating.

Great care shall be taken in handling the pipe right from the first operation of manufacture until they are laid and jointed. The Contractor will provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer In-charge. No defective or damaged pipe or special shall be allowed to be used in the work without rectification to the satisfaction of the Engineer In-charge. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer In-charge.

### **Dents**

Whenever any dent, i.e. a significant alteration of the curvature of the pipe shell is noticed, the depth of the dent shall be measured between the lowest point of the dent and the pipe shell curvature line. All dents exceeding 2 percent of the outer diameter of the pipe shall be removed by cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe. The Engineer In-charge

may permit insert patching if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

### **Marking**

The component parts of the pipes shall be carefully marked for identification in the field. The marking shall be on the side, which will be the inside of the pipe after bending.

The marking operation shall be conducted with full size rulers and templates. Only blunt nose punches should be used.

The plates used for fabrication of pipes shall be laid out in such a way that when the shells are completed one set of original identification markings for the material will be plainly visible. In case these markings are unavoidably cut out, they shall be accurately transferred by the Contractor to a location where these markings will be visible on the completed work.

After hydraulic tests on the specials and other items, the number of the shell in the line as it will be erected and the direction of flow shall be stamped in a prominent manner on each piece.

A register shall be maintained in suitable proforma giving the following information for each shell tested:

- i. Serial No.
- ii. Shell No.
- iii. Date of test
- iv. Thickness and specification of steel
- v. Weight of shell tested
- vi. Maximum test pressure
- vii. Details of test performance
- viii. Details of radiographic examination of welds
- ix. Name of Engineer's representative witnessing tests

A copy of these details shall be furnished to the owner at free of cost. No separate payment will be made for these markings and the rates for the items concerned shall be deemed to include the cost of such markings.

## **8.4 Lowering, laying & jointing of pipe**

### **General**

The pipeline shall be buried with minimum cover of 1.5 m at top or as per site condition. However pipeline shall be laid as per detailed Engineering. In case required cover is more than 1.20m, contractor has to laid the pipeline accordingly.

Erection of fabricated shells shall be carried out by the Contractor who shall equip himself, at his cost, with all necessary tools, machinery, labour etc. required for the purpose.



## **Welding**

Except for routine welding of joints, no other work shall be done in the absence of Contractor's engineer, either during the daytime or at night. Chipping shall not be kept in arrears for more than 15 joints.

Saddle pieces shall be fixed in position after checking bolts holes, by means of templates. These works shall be done together with the pipe laying work, if pipeline is to be laid above ground in unavoidable circumstances.

## **Temperature**

The components of the pipeline such as base plates, top plates and pedestals have been so designed that the centres of the plates and pedestals shall coincide at the Mean Temperature (30°).

For this reason, all works such as fixing flanges, base plate etc. in true alignment, and in correct position and tack welding pipes shall be done at the mean temperature.

For ascertaining the temperature, the Contractor shall provide mercury cups and fix them to the pipe shell from outside and shall also provide thermometers of the required type and range. No extra payment shall be made for this.

## **Saddle Supports**

Unless otherwise specified pipeline shall be underground. However at unavoidable reaches it shall be on R.C.C. saddles spaced as per design. The material and construction of R.C.C./Steel structures such as saddles, anchor blocks, crossings etc. associated with the work of pipe line shall conform with the relevant I.S. codes, good engineering practice and as directed by the Engineer In-charge. The pipes to be laid on saddle supports shall be erected at mean temperature. Saddle supports shall either be sliding type or fixed type. For both the types of supports a 10mm thick double plate shall be welded to the part circumference of the pipeline that will make contact with the saddle and another similar plate shall also be embedded in the concrete saddle with necessary arrangement to facilitate welding it to the double plate welded to the pipe, in case of fixed support. In case of sliding support, the pipe shall be allowed to slide freely over the plate embedded in the saddle. Alternatively to achieve fixity, the pipe shall be anchored by providing suitable anchor block. The rate for laying the pipe on saddle support shall include for laying, aligning, tack welding, provision of rigging screws with screw eyes etc., complete.

In addition to above, the pipe shall be held in position on saddles with two numbers 50mm x 8mm thick holding down traps fixed to the saddles with holding down bolts and nuts which shall be paid separately under relevant item of bill of quantities.

## **Erection of Pipes**

The erection shall be true to position, lines and grade as shown in the drawings or as

modified by the Engineer In-charge. The Contractor shall provide at his cost necessary saddles, pads, spider etc., all necessary instruments and other materials and labour required for proper erection of pipes in position and for the Engineer in checking the correctness of the erection.

Alignment of sections at edges to be butt welded shall be such that the maximum offset is not greater than the values given below:

<b>Thickness't' Girth (mm)</b>	<b>Offset in longitudinal joints (mm)</b>	<b>Offset in Joints (mm)</b>
Up to 12	0.25 t	0.25 t
12 to 20	3 mm	0.25 t
20 to 40	3 mm	5 mm
40 to 50	3 mm	1/8 t
Over 50	Lesser of 0.0625 t or 10 mm	Lesser of 0.125 t or 20 mm

The best of welders as selected from their work in the Contractor's workshop shall be selected for in-situ welding of the pipes . The relevant provision under welding such as qualification standard for welding procedures, tests on welder's work and removal of defects etc., shall also apply to in-situ welding.

## **Specials**

### **General**

Specials, such as tees, Y-pieces, bends (single or composite), tapers, etc. shall necessarily be in steel and shall be manufactured as per standards and tested and laid in the same manner as the pipes. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have at least the same strength as the pipeline to which they are to be jointed.

### **Bends**

- Bends shall be fabricated taking into account the vertical and horizontal angles for each case.
- The bends shall have welded joints and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.
- Bends shall be designed with suitable deflection angle between segments.
- When the point of intersection of a horizontal angle coincides with that of a vertical angle, or when these points can be made to coincide, a single combined or compound bend shall be used, designed to accommodate both the angles. The combined bend should have a pipe angle equal to the developed angle, arrived at from appropriate formula.
- All joints in bends shall be thermally stress relieved as specified.
- Details of thrust collars anchor bolts, holding down straps, saddle plates should be furnished together with full specifications in Contractor's fabrication drawing.

### **Manholes**

- Manholes of 600 mm dia shall be provided at locations generally 2.5 km

- apart, with additional manholes at both the sides of butterfly valves. Manholes in the pipeline shall be placed in suitable position in the top quadrant.
- b. The Contractor shall fabricate different parts of manhole in conformity with relevant IS Specification, well established practices and as directed by the Engineer In-charge.
  - c. The manhole shall be provided with MS blank flange on top. The required MS nut, bolts & rubber packing shall be fixed of standard quality for fixing of flange.

### **Closing or Make up sections**

Closing or make up sections shall be furnished at appropriate locations on the line to permit field adjustments in pipeline length to compensate for shrinkage in field welded joints, differences between actual and theoretical lengths and discrepancies in measurements.

### **Heads**

Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance should be made in the length of the pipe section receiving the test head for the welding and removal of the head and preparation of the plate edges for the final weld after testing.

The rate quoted for the hydraulic test shall be deemed to cover the cost of such installations.

### **Walkways, Stairs, Ladders, Hand Rails etc.**

Walkways, stairs, rungs, ladders, hand rails, etc. shall be provided as shown in the drawings and/or as directed by the Engineer In-charge. They shall conform to well established design and construction for each accessory concerned.

### **Flanges**

Flanges shall be provided at the end of pipes or special where, butterfly, air valve, scour valve, sluice valves, blank flanges, tapers, etc. have to be introduced. The flanges received from the manufacturers will have necessary boltholes drilled. The Contractor shall assemble the flanges in the exact position by marginal cutting, if necessary, so as to get the desired position of the valves, etc. either vertical or horizontal and shall then fully weld the flanges from both sides in such a way that no part of the welding protrudes beyond the face of the flanges. In case the welding protrudes beyond the flanges and if the Engineer orders that such protrusions shall be removed, the Contractor shall file or chip them off. If required and when ordered by the Engineer In-charge, the Contractor shall provide and weld gusset stiffeners, as directed on site. The drilling pattern shall be matching with the drilling pattern of flanges of valves.

### **Blank Flanges**

Blank flanges shall be provided at all ends left unattended for the temporary closure

of work and also for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closures, non-pressure blank flanges consisting of mild steel plates, tack welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer's requirements shall be provided.

### **Stiffener Rings**

The Contractor shall provide stiffener rings wherever required by design. The Contractor shall weld the same to the pipes with one circumferential run on each side.

All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

### **Field Hydraulic Test**

The pressure test shall be conducted as per IS-3589 (latest revision). A leakage equivalent to 0.267 litre per mm of pipe dia. per kilometre of pipeline per day for testing at working pressure applied is permissible. Any leakage beyond that specified herein above shall be rectified to the satisfaction of the Engineer In-charge.

Water shall not spout, ooze or sweat either through joints-welded or bolted or the body of the pipe. If any leakage noticed shall be repaired by the Contractor, which shall include coating and repairing of the damaged portion. Repairs and replacements and further testing including the cost of the plates and other raw materials shall be carried out by the Contractor at his own cost. If any leakages are observed during the defects liability period due to defective workmanship or material supplied by the Contractor, he shall repair the same to the entire satisfaction of the Employer, at his own cost.

After completion of field hydraulic test as specified above and if no leakage is found in the entire pipeline / joints and all welded portion, then this may be considered as field hydraulic test.

### **Progress in laying**

The contractor shall submit a detailed bar chart for manufacturing and laying of the pipeline. While preparing this bar chart, the contractor shall plan all activities such that the laying of pipes shall closely follow the manufacturing schedule and no pipes shall remain stacked in factory or at site for a period more than one month.

### **Lowering and Jointing**

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged and, if necessary, additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the coating of pipe is not damaged in any way during the lowering and assembling. After the pipe is lowered into the trench, it shall be laid in correct line and level by using the leveling instruments, sight rails, theodolite, etc. Care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4mm. If

necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends in perfect contact and alignment. It may also be necessary to use jacks for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work.

On completion of the pipe jointing and external protection, the trench and the welding pits shall be cleaned. The welding pit shall be filled and compacted in 150mm layers with the bedding material.

Backfilling shall be carried out as detailed here under.

Providing Steel Props inside the Pipeline (Dia. 1200 mm and above).

It is necessary that the roundness of the pipes is maintained circular. To achieve the same, steel adjustable screw type props of screw or similar approved make consisting of minimum six (three on each side) legs shall be fixed inside the pipe. The deflection of the pipe should be limited to 1% of the average diameter. In no case shall the limit be exceeded, even under the full load, in case of pipes laid underground. The design and drawings of the props that the Contractor intends to use should be got approved by the Engineer In-charge before starting the work. While laying the pipes underground, the Contractor shall provide this propping arrangement from inside to maintain circularity. These props shall be fixed vertically and at intervals of not more than 1.8 metres or as directed by the Engineer In-charge. In case the Engineer In-charge finds it necessary, they will have to be fixed in any position. The props should be kept in position at least for three days after the encasing of the pipe in that section is completed or till refilling is done to the full height of fill over the pipe in case the pipes are not encased. The props shall be removed only after obtaining permission from the Engineer In-charge. The height of earth fill over the pipe top shall normally be such as to avoid floatation under submerged conditions and to have a minimum earth cushion of about 1.20 metres over the pipe whichever is greater. It is also necessary that, in case of buried pipe, adequate side supports from the backfilled materials is developed to keep the diametrical deflection within the specified limits. Backfilling of the excavated trenches, particularly below the pipe and along the sides shall, therefore, have to be done with proper care and compaction as desired. No extra payment will be made for the above work.

### **Precautions against Floatation**

When the pipeline laid underground or above ground in a long narrow cutting gets

submerged in water collected in the trench of cutting it is subjected to an uplift pressure due to buoyancy and is likely to float if completely or partly empty. In the design of pipelines, provision is to be made to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc. Factor of safety for calculations for check against floating shall be taken as 1.2.

In the case of works extending over one or more monsoon seasons, however, special care and precautions are necessary during the progress of work on this account. The Contractor shall close down pipe laying operations well in time for the monsoon. The work of providing blocks, refilling the earth to the required level, compacting the same, etc. shall always be done as soon as the pipeline in the cutting has been laid.

The Contractor shall see that the water shall not be allowed to accumulate in open trenches. Where work is in an incomplete stage, precautionary work, such as blank-flanging in the open ends of the pipeline and filling the pipeline with water etc. shall be taken up as directed by the Engineer In-charge.

Such works shall be to the Contractor's account and no separate payment shall be made for the same. The Contractor's rate for pipe laying shall be deemed to include such precautionary measures against floatation.

Protection of the pipeline against floatation during the Contract Period shall be the responsibility of the Contractor. Should any section of the pipeline float due to his negligence, etc. the entire cost of laying it again to the correct line and level shall be to his account.

Electric and telephone line, gas line, cable and pole if required to be shifted, necessary charges for shifting to be paid to GEB/AEC/other department shall be paid by the contractor to the concern department.

Manhole chamber and all other structure required to be constructed on road are to be designed for "AA" class loading and same shall be got approved from Engineer-in-charge.

All necessary actions required for diversion of the traffic on State high way, or any other routes are to arrange by the contractor at his own cost as per the requirement of the traffic rules and approval from concerned competent authority.

During the execution of work any damage occurred to the private / Govt. property is to be reimbursed by the contractor to the owner.

### **Back filling of trenches**

On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline. If the Engineer considers that the Contractor is not

complying with any of the foregoing requirements, he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trenches. Backfilling shall be carried out from bottom of pipe to 30 cm. above top of pipe with useful excavated soil which do not damage the external 3LPE coating. In case of any damage to external coating (of pipe/joint/specials etc.), the damages shall be rectified by the contractor at no extra cost. In case of failure in attending satisfactory repairs, entire pipe/specials shall be replaced with new one at no extra cost. Only soft earth of good quality free from stones cinders, ashes, slag, refuse, rubbish, vegetable or organic material, lumpy or frozen materials, boulders, rocks or stone or other material which in opinion of Engineer in-charge is unsuitable or deleterious. Filling from bottom of pipe line upto centreline shall be done in layers not exceeding 225mm and compacted to 80 percent of the maximum dry density by hand compaction as per part VII of IS:2720. Filling from centre line of the pipe to a level 300mm above the top of pipe shall be done by hand or approved mechanical methods in layer of 225mm as per IS 3114. Care shall be taken during backfilling, not to injure or disturb the pipes, joints or coating. Filling shall be carried out simultaneously on both sides of the pipes so that unequal pressure does not occur. Walking or working on the completed pipeline unless the trench has been filled to height of at least 30 cm over the top of the pipe except as may be necessary for tamping etc., during backfilling work.

Soil of excavated stuff which is to be used for refilling / backfilling work shall be got tested for all chemical tests including  $\text{SO}_3$  % , sulphate as  $\text{SO}_3$  2:1 water soil extract as per I.S. 456:2000.

No swelling soils shall be used for backfilling work.

Alignment passing through cultivable land, top layer of back filling should be restored to original condition. Any change in above shall be approved by the engineer-in-charge. Engineer-in-charge may change the requirements of back filling, and method of back filling etc.

The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place. No extra payment will be made for material brought from outside. Backfill material shall be properly consolidated by watering and ramming, taking due care so that no damage is caused to the pipes.

To prevent buckling of pipe shell diameters 1200 mm and above, pipes shall be strutted from inside while the work of refilling is in progress, for which no separate payment shall be made.

Strutting shall be done by means of strong spiders having at least 6 arms which shall be sufficiently stiff to resist all deformation. Spiders shall be provided at a maximum interval of 4 m.

If suitable material for back filling is not available from excavated stuff, it shall be brought from borrow area for which no extra payment shall be made.

The Engineer shall, at all times, have powers to decide which portion of the excavated materials shall be for filling and in which portion of the site and in what manner it shall be so used.

If any material remains as surplus it shall be disposed off as directed by the Engineer In-charge, which includes loading, unloading, transporting and spreading as directed. Contractor has to make his own arrangement for disposal of surplus earth. Contractor has to identify and arrange for dumping zone to dispose of the excess excavated stuff. No extra payment for such arrangement shall be paid. If the Contractor fails to remove the earth from site within 7 days after the period specified in a written notice, the Engineer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refilling is not available from excavation the Contractor shall bring selected material/sand of approved quality as directed by the Engineer In-charge. No extra payment will be made for material brought from outside.

No mechanical plant other than approved compacting equipment shall run over or operate within the trench until backfilling has reached its final level or the approval of the Engineer In-charge has been obtained.

**Subsidence in filling in:** Should any subsidence take place either in the filling of the trenches or near about it up to completion of the Contract Works. The Contractor shall make good the same at his own cost or the Engineer may make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer In-charge may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

### **Distance indicators and Markings**

The Contractor shall supply and fix indicators at all points of change of direction, at all valves and at every one kilometre intervals along the buried pipe line. Indicators shall consist of 10 cm x 10 cm pre-cast concrete posts 1.25 metre long, set 0.75 metre into the ground and painted white above ground level. The description shall be written in blue at one face of the pre-cast post.

In case of the pipeline laid above ground details such as chainage, Invert levels of pipe, appurtenance number, pedestal / saddle number, culvert number, anchor / thrust block number etc., shall be suitably marked either on the pipeline or the supporting structure etc., in distinct colour. The Contractor shall include the cost of this in his rates for the other items.

### **Thrust Block and Anchor Block**

RCC thrust blocks of adequate size and shape in required grade shown in the drawing



shall be provided on bend for anchorage as per design requirement to transmit the hydraulic thrust / force to the ground, spreading over a sufficient area, depending upon the type of soil met with.

Thrust blocks shall be provided for both horizontal and vertical bends wherever required in the pipeline to effectively transfer the hydrostatic thrust developed to the surrounding ground.

#### **Encasing Pipeline**

Encasing of pipeline with the reinforced concrete of desired grade as shown in the drawing shall be done as per design requirement wherever adequate cover on pipeline is not available as per site condition. Encasing of pipeline shall also be done for all the nallah crossing/River crossing/minor road crossings as per indicative drawing and to the design requirement and as directed by the Engineer In-charge.

#### **Mile Stone Payment Breakup for (Providing, Supplying, Lowering, Laying, Testing & Commissioning of M.S. Pipe)**

<b>No.</b>	<b>Items</b>	<b>Payment breakup</b>
<b>1.</b>	On Receipt of pipes on site of work in good condition	70 %
<b>2.</b>	On Satisfactory lowering, laying & jointing	20 %
<b>3.</b>	On Satisfactory hydraulic testing	5 %
<b>4.</b>	On Satisfactory commissioning & completion of work	5%

## **9.0 M. S. PIPE INLINING AND OUT COATING (PIPELINE WORK)**

Specification for Solvent free food grade liquid epoxy inlining Providing & applying internal coating to MS pipe with solvent free food grade epoxy having dry film thickness of 406 microns including scrapping the surface of the pipe.

### **General**

Buried steel pipeline shall be coated internally, with a single coat two part solvent free high build liquid epoxy lining as per AWWA C210-07 suitable for potable water application and shall be approved by NSF International Standard NSF/ANSI-61 2004 or by water regulations advisory scheme (WRAS), UK or Central food research Institute, Mysore as per standards BS 6920 UK. The Contractor shall perform all work in accordance with these specifications and the latest pipeline coating practices, and shall complete the work in all respects to the full satisfaction of the Owner / Owner's Representative. The entire coating operation starting from cleaning and surface preparation till coating shall be performed under the supervision of skilled personnel who are well conversant with the work. Pipes which have been cleaned and primed, or cleaned, primed and coated, without having been inspected and approved shall be rejected.

This specification is not intended to be all inclusive and the use of guidelines set forth here does not relieve the Contractor of his responsibility for the quality and performance of the applied coating system, and to supply coating material capable of performing its intended service.

All steel special sections, connections fittings and field joints to be used for underground steel pipeline shall be internally coated with same liquid epoxy.

### **Reference Standards**

The following standards (latest revision) referenced below are a part of this specification. In case of conflict between this specification and the referenced standards, this specification shall apply

- i. ANSI/AWWA C210 - Standard for Liquid Epoxy Coating Systems for the Interior & Exterior of Steel Water Pipelines.
- ii. NSF/ANSI 61 – Standard for Drinking Water System Components-Health Effects.
- iii. ANSI /ASTM D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
- iv. ANSI/ASTM D3359 - Standard Test Method for Measuring Adhesion by Tape Test.
- v. ANSI/ASTM D3363 - Standard Test Method for Film Hardness by Pencil Test.
- vi. ANSI/ASTM D4417 - Standard Test Method for Field Measurement of Surface Profile of Blast Cleaned Steel.
- vii. ANSI/ASTM D4541 - Standard Test Method for Pull-Off Strength

of Coatings Using Portable Adhesion Testers.

- viii. ANSI/ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness
- ix. ANSI/ASTM D5000 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser
- x. SSPC-PA 2 - Measurement of Dry Paint Thickness with Magnetic Gauges
- xi. SSPC-SP 1 - Solvent Cleaning
- xii. SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning

### General

Protective lining shall consist of a coating system consisting of 100% solids epoxy comprising of resin & hardener mixed in a proportion as recommended by the manufacturer.

The mixed epoxy shall be applied to abrasive blasted steel surface in the coating plant using plural hot airless spray machine with extended boom to apply the lining to a smooth finish without any drip or sag. The epoxy shall also be capable of application by spray/brush at field joint locations and repair of damages to the spray/brush applied epoxy.

## 9.1 Internal Lining System

The internal epoxy lining shall consist of chemically cured resin (epoxy) & hardener (curing agent), mixed in the ratio as recommended by the manufacturer and applied to a dry film thickness (DFT) of minimum 406μ. Physical properties of the internal lining shall be as follows.

**Table : Physical Property of Internal Lining**

Property	Requirement	Test Method / Reference
Long term contact with potable water	No effects for human consumption as certified by NSF International	NSF / ANSI -61
Thickness (applied min)	406μ	SSPC-PA 2
Thickness deviation (min)	- 0 / + 200μ	SSPC-PA 2
Dielectric strength (min)	450 V/mil (15 V/μm)	ASTM D149
Hardness Shore D	85 (min)	ASTM D2240
Adhesion to Steel (min)	800 psi	ASTM D4541
Tabor Abrasion	1560 cycles / mil	ASTM D4060
Compressive strength	70 MPa	ASTM C109

## **Coating Application**

### **General**

All internal epoxy lining work for main pipeline shall be done in coating plant using two component airless plural spray machine. For internals of bends, short section of pipes, tees, fittings etc., internal epoxy will be manually spray applied either in the coating plant or in the field using suitable two component airless plural spray machine.

Internal field joint coating shall be spray/ brush applied. The internal epoxy lining shall be applied only on blasted steel surface.

### **Pipe preparation**

#### **Metal surface condition**

Internal surface of the pipe shall be free from mud, mill scale, mill lacquer, wax, oil, grease, or any other foreign material. Before blast cleaning, surfaces shall be inspected and pre-cleaned according to SSPC-SP 1 to remove oil, grease, and loosely adhering deposits. Visible oil and grease spots shall be removed using a solvent. Only solvents that do not leave a residue shall be used. Preheating to remove oil, grease, and mill scale may be used provided that all pipe is preheated in a uniform manner to avoid distortion.

After drying and removing all loosely adhering foreign materials, the pipe surface shall be cleaned by blasting with grit or steel shots to achieve a surface preparation at least equal to SA 2.5 that specified in BS 7079/ISO 8501-1:2007. The blast anchor pattern or profile depth shall be 2 mils to 3 mils (50  $\mu\text{m}$  to 75  $\mu\text{m}$ ) measured in accordance with ASTM D-4417 and/or ISO 8503-4.

For consistent surface finish, a stabilized working mix shall be maintained in abrasive recycling blasting machines by frequent small additions of new grit, shot infrequent large additions shall be avoided. The abrasive working mix, abrasive recycling blasting machines shall be maintained clean of contaminants by continuous effective operation of blasting machine scalping and air-wash separators.

The cleaned interior pipe surface shall be inspected for adequate surface preparation. Surface imperfections, such as slivers, scabs, burrs, weld spatter, and gouges, shall be removed by hand filing or grinding if necessary to prevent holidays.

Blast-cleaned pipe surfaces shall be protected from conditions of high humidity, rainfall, or surface moisture. No pipe shall be allowed to flash rust before coating. To ensure a dry pipe surface at the time of liquid epoxy application, the minimum steel substrate temperature shall be 10°C and at least 3°C above the dew point.

## **Coating Application**

- **Main Pipe Line –**

- a. Application temperature**

The temperature of the mixed coating material and of the pipe at the time of application shall be not lower than 10°C. Preheating of the coating material by using in line heaters to heat the coating material may be used to facilitate the application. Heating shall conform to the recommendations of the epoxy coating manufacturer.

- b. Application of epoxy**

The epoxy shall be applied directly to the abrasive roughened steel surface pipe using a hot plural component airless spray equipment, with all necessary ancillary equipment like spraying boom etc, in accordance with the epoxy coating manufacturer's recommendations. Pipe will be rotated at a suitable speed and the boom of the spray machine carrying the spray gun will travel inside the pipe at a pre- determined speed to ensure that thickness of minimum 406 microns is achieved in one single spray application. Alternatively, fixed boom & spray machine with moving pipe with predetermined speed to achieve minimum thickness of 406 micron in a single spray is also accepted.

- c. Curing**

After application of epoxy, curing of the epoxy shall be natural air convection. Typical dry time of the epoxy at ambient temperature of 25-40°C shall be between one hour to three hours. Shore D hardness of the epoxy after 10 hours shall be > 65.

- d. Internal coating cutback**

Internal coating cutback on either side of the pipe shall be 75 mm +/- 25 mm.

### **Internal Coating of Field Joints**

After the main pipes have been welded in the trench, internal epoxy coating shall be applied on the inside of the pipeline at the girth welds using brush/spray application. Internal epoxy for field joint coating shall be supplied by the same manufacturer and shall be NSF approved. The epoxy shall be supplied in small cans of appropriate size required per joint with applicator pad.

The internal surface of the field joint shall be inspected and weld spatter or slag shall be removed by grinding.

The internal surface shall then be manually blasted to remove rust / contamination etc. The resin & hardener will be mixed and the coating applied to a minimum thickness of 406µ. The internal field joint coating shall overlap the factory applied main line internal coating by 50mm on either side.

## **Material acceptance, inspection and testing**

### **Material acceptance**

Proposed internal epoxy lining materials shall be approved by the Owner / Owner's representative. Test certificate from independent third party test laboratory shall be submitted conforming compliance to the physical properties as listed in Table 3.1 (Clause no 3.8.4) No deviation to the physical properties shall be acceptable.

When the material is supplied, acceptance of the material shall be based on submission of certificate of conformance of the internal epoxy to this specification along with manufacturing acceptance test certificates for various lots as per manufacturer's quality assurance and quality control requirements.

### **Coating application inspection**

The entire internal lining operation by the Contractor will be supervised by qualified experts from the manufacturer. The credentials of the manufacturer's expert shall be approved by the Owner / Owner's representative. All coating work will be done in the presence of the Owner / Owner's representative.

### **Thickness**

Thickness of the coating system shall be checked in accordance with SSPC-PA 2. Thickness shall be in accordance with the values given in the Table. Out of 25 Nos. of pipes, one pipe shall be tested for the thickness at two selected places.

### **Holiday testing:**

The completed pipe shall be subjected to holiday detection tests which shall be carried out to the satisfaction of the Engineer In-charge. The applied voltage shall be those appropriate to the coating under test as recommended by the coating material manufacturer.

### **Pull Off Adhesion**

The pull off adhesion of the internal epoxy lining to steel shall be checked in accordance with ASTM D-4541. The average value below the limits stated in the Table shall constitute a failure of the system to meet the adhesion requirement. Out of 25 Nos. of pipes, one pipe shall be tested for the pull off adhesion test at two selected places.

### **Field procedures**

At all times during construction of the pipeline, the Contractor shall use caution to prevent damage to the internal lining on the inside of the pipe. No metal tools or heavy objects shall be permitted to unnecessarily contact the finished coating. Workmen shall not be permitted to walk on the internal coating except

when necessary. In these cases, they shall wear shoes with rubber or composition soles and heels or other suitable footwear that will not damage the coating. Any damage to the pipe or the protective coating from any cause during the installation of the pipeline shall be repaired.

### **Coating repair in field**

All holidays visually or electrically discovered either at the coating plant or in the field shall be repaired by applying the same liquid epoxy coating using brush. The minimum over-lap at the damaged area shall be 100 mm all around. The repaired area shall be tested with a holiday detector as per specifications after the repair is completed. The thickness of the coating at the repair area shall be minimum 406 $\mu$ .

### **Epoxy Coating for Internal Surface of Pipes and Specials**

The epoxy coating shall be solvent-less, liquid epoxy coating of at least 406 microns thickness, for the interior surface of steel pipe lines & conforming to IS-3589 and/or IS-5504. Epoxy paint to be used for this work shall be suitable to local environmental conditions / ambient conditions.

### **General**

All steel pipes and fittings outside the pumping station shall be internally lined with a spray applied solvent free epoxy approved for contact with potable water under the United Kingdom Water Regulations Advisory Scheme authorized for use under Regulation 31 (4)(a) of the water supply (Water Quality) Regulations 2000 for contact with potable water. The applicable specifications for the coating system shall be suitable to potable water at elevated ambient / air temperature tested as per BS – 6920. AWWA C210 is referred standard for coating application as per Sec. 4.4. Surface preparation application condition, post treatment of coated surface to be as per manufacturer's specifications.

Paint – NSF standard 61 – NACE RP – 01 – 75. paint should be suitable for long time storing or potable water in the pipeline.

### **Materials & Workmanship**

The coating system shall be factory lined and the lining shall be suitable for application in an environment with black bulb temperature up to 85°C.

All steel pipes shall be lined at the factory. Pipes welded on site shall be lined on site to the same standards as for pipes.

Pipe ends – coating shall be held back in from the ends of pipe sections to be jointed by field welding.

Detailed proposals of the lining method, materials and apparatus to be used for both factory and site application shall be submitted to and approved by the Engineer

In- charge before work starts. Storage and application shall be accordance with recommendations of the coating manufacturer, but as a minimum:

- a. A visual examination of the surface to be coated shall be carried out and any slivers or similar deposits removed.
- b. Prior to blasting all oil and grease shall be removed from the surface to be coated.
- c. Preparation of steel surfaces for both factory and site application shall be to a minimum of SA 2.5 in accordance with BS 7079/ ISO 8501-1:2007 specifications /or as per client specifications and roughness should 50-75 micron.
- d. The surface to be coated shall be dry, clean and free from foreign material and coating shall take place before any surface rusting and at least within 4 hours of blasting.
- e. Surface preparation and coating shall not be carried out when the relative humidity exceeds 85% or when the surface to be coated is less than 3 deg C above the dew point.
- f. The coating shall have a minimum mean dry film thickness of 406 microns.
- g. Coatings shall be used within the pot life specified by the manufacturer.
- h. The materials to be used for the work of each batch, test certificate shall be reviewed.
- i. Paint shall be applied by brush / air-less or conventional spray method.

Pipe linings shall be inspected on site and damaged, defective or otherwise unsatisfactory linings may be condemned. All defective areas shall be made good to the satisfaction of the Engineer In-charge.

### **Inspection and Testing:**

It will be detailed in the contractor's Quality Plan and will be undertaken as minimum to the following:

- a. Visual Inspection of blasted profile on every pipe to be coated.
- b. Visual inspection of finished coating on every pipe.
- c. Measurement of coating thickness at four points on each pipe.
- d. The completed pipe shall be subjected to holiday detection tests which shall be carried out to the satisfaction of the Engineer In-charge. The applied voltage shall be those appropriate to the coating under test as recommended by the coating material manufacturer.
- e. The adhesion test as per clause no. 5.1.6 of AWWA-C-210.07 shall be carried out on one pipe per lot of every 10 pipes. Two parallel knife cuts about 100 mm long and 20 mm apart shall be made through the coating. If necessary, the test knife may be heated to make the cut. The painted surface between two cuts shall be lifted off the pipe with a stiff blade. If the paint film does not pill-off, more than the width of the cut, the bond shall be deemed to be satisfactory. If the width of the peel exceeds the width of the cut, two additional tests shall be made on the same pipe at two different locations. The painted surface shall be accepted if both the tests are satisfactory. If the results of either of the tests are un-satisfactory, the painting work of pipeline shall be rejected. Adhesion test shall be performed on 1 pipe out of 10 pipes. If the adhesion test fails for one pipe,



then this test shall be performed on all the remaining 9 pipes of that particular lot.

- f. Prior to acceptance and application of the material, the Epoxy coating material shall be submitted by the contractor & shall be tested in an independent third party / vendor's test laboratory designated by the purchaser, in presence of client / consultant and the results shall be in accordance with the specified standards. The frequency of the test shall be minimum 1 sample in every 10000 litres or per batch of the coating material. Tests like: Specific Gravity, Hardness (shore – D), Adhesion to steel, Tabor abrasion, pull-off adhesion tests, will be carried out. Rejection: If the sample of coating material does not comply with the standard, the coating material represented by such a sample shall be rejected.
- g. The pull-off adhesion of the internal epoxy lining to steel shall be checked in accordance with the ASTM D – 4541.
- h. All holidays visually or electrically discovered either at the coating plant or in the field shall be repaired by applying the same liquid epoxy coating using the brush. The minimum over-lap at the damaged area shall be 100 mm all around. The repaired area shall be tested with a holiday detector as per specification after the repair is completed. The thickness of the coating at the repair area shall be minimum 406 micron.

## **Preservation, Marking and Shipping Preservation**

### **Preservation**

The bare ends of each pipe shall be painted outside with a removable varnish as temporary corrosion protection during transportation.

Contractor to ensure proper protection at bevel ends of each pipe.

### **Marking**

In addition to the marking required by API 5L, the specification MO1 “Steel Pipes for Mainlines and other applicable project specifications”, the Pipe Coating Contractor's unique coating number shall be marked to the internal surface or the pipe with synthetic resin paint.

Further marking details like colour coding etc. shall be agreed upon with the Engineer In- charge. The marking shall have at least a distance of 150mm to the pipe end.

### **Shipping**

Shipping and Loading preparation shall be in accordance with API Specification 5L or otherwise stated in the contract documents.

### **Documentation**

#### **Pre-Production Documentation**

The Contractor shall submit the following documents to the Engineer In-charge

for approval prior to commencing pipe coating work. Work shall not commence until these procedures have been reviewed and approved by the Engineer In-charge.

- a. The manufacturer's trade name and data sheets for all proposed coating materials. This includes cleaning and abrasive blasting consumables.
- b. Procedure for identifying or maintaining the identification of each coated item.
- c. Handling procedure.
- d. Stacking procedure.
- e. Materials control and traceability procedure for the batches of coating materials.
- f. Materials control and traceability procedure (pipe and coating materials).
- g. Procedure for steel surface preparation including materials, cleaning, inspection, verification of cleanliness and surface profile.
- h. Coating application procedures.
- i. The results of the batch tests for batches to be used for pre-qualification tests.
- j. Details of testing methods including instrument types and copies or current calibration certificates.
- k. Details of inspection methods for bare and coated pipe.
- l. Full test results from the coating Procedure Qualification Test (PQT).
- m. Repair procedure and results or tests on demonstration of repairs.
- n. Project specific Quality Plan.

### **Production Records**

A daily log containing the following data shall be maintained and be available for inspection by the Engineer In-charge during and/or after production. Data shall be recorded against the pipe unique identification number.

- a. Bare pipe inspection data
- b. Ambient temperature (every 4 hours)
- c. Humidity (every 4 hours)
- d. Coating progress (no. of items coated. Including item serial numbers)
- e. Blast pipe surface amplitude
- f. Tests for cleanliness of blast surface
- g. Test for cleanliness or blast medium
- h. Film thickness measurements
- i. Average, maximum and minimum coating thickness during each shift
- j. Details of any coating repairs
- k. The unique identification number of all items that are stripped for recoating – 'RP'
- l. Pipe coating test results

This log shall be available to the Engineer In-charge throughout all coating operations

### **Release Documentation**

The Contractor shall submit to the Engineer In-charge the following documentation in hard copy and softcopy (format to be agreed upon with the Engineer In-charge) with each batch of pipes released:

- a. Mill certificates for line pipe
- b. Unique pipe identification numbers
- c. Unique coating identification number (if different)
- d. Pipe length
- e. Length of the coated portion of each pipe and total coated lengths of all pipes.
- f. Reductions in length due to use in tests, damage or repairs, recorded against pipe unique identification number
- g. Date of coating
- h. Batch numbers of coating materials used

This shall be followed within two weeks by the following:

- a. Manufacturer's certificates for each batch of coating materials
- b. Certification / calibration certificates for all testing and coating equipment
- c. Inspection and test records, results, and other documentation of all materials and coating tests

All reports shall be signed by the Pipe Coating Contractor to signify compliance with the requirements of this specification.

## **9.2 SPECIFICATIONS FOR OUTSIDE 3 LPE COATING**

### **1. SCOPE**

This Specification defines the minimum requirements for the application of three-layer polyethylene coating to the external surface of steel pipes and internal surface of steel pipes with solvent free liquid epoxy lining for water transmission pipe line.

For the factory applied coating the system shall comprise of a layer of fusion bonded epoxy (FBE), overlaid with adhesive with an outer layer for high density polyethylene (HDPE) and internally lined with a air less spray applied solvent free epoxy.

### **2. CODES AND STANDARDS**

ANSI/AWWA C213	Standard for Fusion-bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
ASTM D149	Standard test method for dielectric breakdown voltage and dielectric strength of solid electrical insulating materials at commercial power frequencies.
ASTM D257	Test methods for dc resistance or conductance of insulating materials.

ASTM D570	Standard test method for water absorption of plastics
ASTM D638	Standard test method for tensile properties of plastics
ASTM D746	Standard test method for brittleness temperature of plastics and elastomers by impact.
ASTM D790	Standard test method for flexural properties of unreinforced and reinforced plastics and electrical insulating materials.
ASTM D1238	Standard test method for melt flow rates of thermoplastics by extrusion plastometer.
ASTM D1505	Standard test method for Density of plastics by the Density-Gradient Technique.
ASTM D1525	Standard test method for Vicat softening temperature of plastics.
ASTM D1531	Standard test methods for relative permittivity (dielectric constant) and dissipation factor by fluid displacement procedures.
ASTM D1603	Standard test method for carbon black in define plastics
ASTM D1928	Standard practice for preparation of compression-molded polyethylene test sheets and test specimens.
ASTM D2240	Standard test method for rubber property – durometer hardness.
ASTM D3417	Standard test method for enthalpies of fusion and crystallization of polymers by differential scanning calorimetry (dsc)
ASTM D4703	Standard test practice for compression Molding Thermoplastic Materials into Test Specimen, Plaques or Sheets.
ASTM F372	Standard test method for water vapor transmission rate of flexible barrier materials using an infrared detection technique
AWWA C 200-97	Steel water pipe line
ASTM G8	Standard test method for CathodicDisbonding of pipeline Coatings.
CAN/CSA Z 245:1	Internal fusion bond epoxy coating / lining of steel pipes.
DIN 30670	Polyethylene Coatings of Steel pipes and Fittings – Requirements and Testing.

DIN EN ISO 9001 2000 Quality management systems – Requirements

- DIN EN ISO 8501-1 Preparation of steel substrates before application of paints and related products – Visual assessment of surface cleanliness – Part 1 : Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings.
- DIN EN ISO 8502-2 Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 2 : Laboratory determination of chloride on cleaned surfaces.
- DIN EN ISO 8502-3 Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 3 : Assessment of dust on steel surfaces prepared for painting (pressure- sensitive tape method)
- DIN EN ISO 8502-4 Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 4 : Guidance on the estimation of the probability of condensation prior to paint application.
- DIN EN ISO 8502-9 Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 9 : Field method for the conductometric determination of water-soluble salts.
- DIN EN ISO 8503-1 Preparation of steel surfaces before application of paints and related products. Method for the grading of surface profile of abrasively blast cleaned steel using a comparator (1995)
- DIN EN ISO 8503-1 Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast-cleaned steel substrates – Part 1 : Specifications and definitions for ISO surface profile comparators for the assessment of abrasive blast cleaned surfaces.
- DIN EN ISO 8503-2 Preparation of steel substrates before application of paints and related products – Surface roughness characteristics of blast-cleaned steel substrates – Part 2 : Method for the grading of surface profile of abrasive blast-cleaned steel – comparator procedure.
- ISO 8502-5 Preparation of steel substrates before application of paints and related products – Tests for the assessment of surface cleanliness – Part 5 : Measurement of chloride on steel surfaces prepared for painting (ion detection tube method)

NACE RP0490	Holiday Detection of Fusion-Bonded Epoxy External Pipeline Coatings of 250 to 760mm (10 to 30 mils)
NACE RP-01-75	Recommended practice : control of International corrosion in steel pipe line system.
SIS 05-5900	Preparation of steel substrates before application of paints and related products – visual assessment of surface cleanliness – PT 1 : rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous.

### **3. HANDLING OF COATING MATERIALS**

#### **a) General**

Materials shall be brought from vendor shall be handled and stored in accordance with the material manufacture's recommendations, which shall be available for review by the Engineer at the Pipe Coating Contractor's premises.

Materials shall be stored in temperature controlled environment until required for use.

Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected unless otherwise agreed with the Engineer.

As a minimum, all packages of the coating materials shall be marked with the following data:

- i) Name of manufacturer
- ii) Complete material identification – trade name, chemical name and
- iii) type of product details
- iv) Batch number
- i) Date of manufacture
- ii) Place of manufacture
- vii) Shelf life/expiry date (if appropriate)
- viii) Health and safety, and environmental instructions ix) Hazard Warnings
- x) Storage instructions
  
- xi) Quantity
- xii) Manufacturing Standard

Any material not labeled with the above information shall not be used

#### **b) Abrasive Grit**

The abrasive shall be steel grit, also in combination with steel shot of the required grade to achieve the specified surface profile. The use of sand is not permitted.

Blasting abrasives shall be kept dry, clean and free from contamination. When recovered metallic grit systems are used, a stabilized working mix of blast cleaning material shall be established. This mix shall be maintained throughout the entire course of the production, by frequent small additions from fresh or cleaned stock at a rate sufficient to refurnish consumption. Blasting and other dust producing areas shall be kept separate from coating application areas. The surface cleaning shall be degree of cleanliness as per SA 21/2 & ISO 8502-3.

#### **c) FBE Powder**

The FBE powder selected shall be suitable for use at the design temperatures in the proposed environment and be suitable for a three layer polyethylene coating system. The FBE shall be endorsed by the Pipe Coating contractor of the adhesive and Polyethylene as being compatible with these products under the specified service conditions.

Each batch of FBE shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specifications;

- i) Gel Time
- ii) Moisture content
- ii) Particle size distribution
- iii) Density
- iv) Infrared Scan
- vi) Thermal analysis

#### **d) Adhesive**

The adhesive selected shall be completely suitable for use at the design temperatures in the proposed environment and be suitable for a three layer polyethylene coating system.

Each batch of adhesive shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specifications:

- i) Adhesion
- ii) Density
- iii) Melt flow index

#### **e) Polyethylene**

The polyethylene selected shall be or high density and shall be completely suitable for use at the design temperatures in the described environment. The polyethylene shall be

suitable for a three-layer polyethylene can be stabilized against UV-rays before or after granulating the material

Each polyethylene batch shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specification:

#### **4. PROPERTIES OF COATING MATERIAL**

##### **a) Properties of Epoxy Powder and Adhesive**

MANUFACTURER shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirement and properties of coating system as specified and shall submit a compatibility certificate in this regard from the manufacturer of materials. In absence of such certificate, compatibility test shall be conducted by the contractor by contractor at his own cost. In addition, the Manufacturer shall also furnish Infra-red Scan for each batch of epoxy powder. The coating materials Supplier shall issue test certificates as per EN 10204 for each batch of materials supplied to MANUFACTURER and the same shall be submitted to PURCHASER for approval prior to their use. Epoxy powder properties shall be as per CSA Z245.20.98 (latest revision). The colour of epoxy powder shall be either green or dark red or any other colour approved by COMPANY except grey colour. Copolymer grafted adhesive shall have the following properties.

<b>Sr.No.</b>	<b>Properties</b>	<b>Unit</b>	<b>Requirement</b>	<b>Test Method</b>
a.	Melt Flow Rate (at 190 <sup>0</sup> C/216 kg)	g/10 minutes	1.0 min	ASTM D 1238
b.	Vicat Softening Point	<sup>0</sup> C	100 min	ASTM D 1525
c.	Specific Gravity	-	0.926 min	ASTM D 792



## b) Properties of Polyethylene Compound

Sr.No.	Properties	Unit	Requirement	Test Method
a.	Tensile Strength @ + 25 <sup>0</sup> C	N/mm <sup>2</sup>	17 min	ASTM D638
b.	Melt Flow Rate (190 <sup>0</sup> C / 2.16 kg)	g/10 minute	0.25	ASTM D 1238 or DIN
c.	Specific Gravity + 25 <sup>0</sup> C MDPE HDPE	-	0.926 min.0.941 min.	ASTM D 792
d.	Hardness @ + 25 <sup>0</sup> C	Shore D	50 min.	ASTM D 2240
e.	Water Absorptions, 24 hours @ + 25 <sup>0</sup> C	%	0.05 mz.	ASTM D 570
f.	Volume Resisitivity @ + 25 <sup>0</sup> C	Ohm-cm	10 <sup>15</sup> min.	ASTM D 257
g.	Dielectric withstand, 1000 Volt/sec rise @ + 25 <sup>0</sup> C	Volts/mm	30,000 min.	ASTM D 149
h.	Vicat Softening Point	<sup>0</sup> C	110 min.	ASTM D 1525
i.	Elongation	%	600 min.	ASTM D 638
j.	Oxidative Induction Time in Oxygen at 220 <sup>0</sup> C, Aluminum pan, no screen	Minutes	10 min.	ASTM D 3895
k.	Environmental Stress Crack Resistance (ESCR) (for F50)-Medium Density Condition "C"-High Density, Condition "B"	Hours	300300	ASTM D 1693
l.	Carbon Black Content	%	2 min.	ASTM D 1603

In addition to vendor's certificate, the MANUFACTURER shall draw samples from each batch of epoxy, adhesive and polyethylene in the presence of PURCHASER and the test for the following properties at the coating yard at least one week prior to its use, to establish compliance with the Manufacturer's test certificates.

- (A) Epoxy Powder: Gel Time, Cure Time, Moisture content, Thermal Characteristics (Tg1, Tg2, ΔH)
- (B) Adhesive: Specific gravity, Melt Flow Rate, Vicat Softening Point
- (C) Polyethylene: Melt Flow Rat, Specific Gravity, Vicat Softening Point, Moisture content, Oxidative Induction Time.

In Case of the failure of any of the above tests in a batch, that batch of material shall be tested for all other tests required including the tests which failed. If all tests pass, the batch shall be accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.

MANFUCATURER shall ensure that all coating materials are properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use.

### c) Properties of coating System

Sr.No.	Properties	Unit	Requirement	Test Method
a.	Bond Strength (using Type 2 test assembly i.e. Dynamometer) - @ 20+/- 5 <sup>0</sup> C@ 65 +/- 5 <sup>0</sup> C	Kg/cm	8.0 min5.0 min	DIN 30670
b.	Impact Strength (30 impacts on body along the length. No breakdown allowed when tested at 25 kV)	Joules/ mm of coating thickness	7 min	DIN 30670
c.	Indentation Hardness - @ 23 +/- 2 <sup>0</sup> C - @ 70 +/- 2 <sup>0</sup> C	mm	0.2 max0.3 max	DIN 30670
d.	Elongation at Failure	%	300 min	DIN 30670
e.	Coating Resistivity (*)	Ohm-m <sup>2</sup>	10 <sup>8</sup> min.	DIN 30670
f.	Heat Ageing (*)	-	Melt Flow rate shall not deviate by more than	DIN 30670
g.	Light Ageing (*)	-	35% of original value Melt flow rate shall not deviate by more than 35% of original value.	DIN 30670
h.	Cathodic Disbondment- @ + 65 <sup>0</sup> after 30 days . @ + 65 <sup>0</sup> after 48 hrs	Minimum radius of disbondment (**)	15 max7 max	ASTM G42
i.	Degree of Cure of Epoxy - Percentage Cure, ΔH - ΔTg	% <sup>0</sup> C	95+3/-2	CSA Z 245.20 – 98 (***)

- (\*) Test carried out in an independent laboratory of national / international recognition of PE top coat is also acceptable.
- (\*\*) Disbondment shall be equivalent circle radius of total unsealed area as per ASTM G 42.
- (\*\*\*) Temperature to which the test specimens are to be heated during cyclic heating shall however be as per the recommendations of epoxy powder manufacturer.

## **5. ACCEPTANCE OF PIPE MATERIALS**

### **a) Identification and Tracking**

Upon receipt at the coating factory, the Pipe Coating Contractor shall record the following pipe information:

The unique pipe identification number, measured length, and measured weight (both to be found stenciled in paint on one end of the pipe).

This data shall be used as a basis for monitoring pipe from the time of receipt until the delivery of coated pipe.

The Pipe Coating Contractor shall identify (or maintain identification of) every coated item, by using a weatherproof mark on the inside of the pipe and on the outside of the coated item. The pipe identification shall be the unique pipe identification number (the number required by the applicable pipes specification). The pipe coating contractor may use additional tracking numbers at his discretion but these shall relate simply to the unique pipe number in the QC documentation.

Pipe tracking shall be carried out in accordance with approved procedures.

### **b) Preliminary Inspection**

The Pipe Coating Contractor shall carry out visual inspection of all pipes.

The Pipe Coating Contractor shall record all external damage on pipes against the unique item serial number. This damage shall be brought to the attention of the Engineer and the Pipe shall not be coated without prior release by Engineer.

Bevel protectors at each end of every pipe joint shall not be removed unless showing signs of damage or if removal is required to facilitate surface preparation, or they would be damaged by coating operations. If the protectors are removed the conditions of the bevel shall be recorded against the pipe serial number and any damage shall be brought to the attention of the Engineer.

### **c) Damage to Pipe and Pipe Ends and Repair**

No repair work shall proceed until a written procedure has been prepared by the Pipe Coating Contractor and approved by the Engineer.

Minor damage to pipe and pipe ends/bevels, identified either at time of receipt or after abrasive blasting shall be repaired by grinding. The number of such damages shall be not more than 3 per pipe. Repair by grinding on the pipe or pipe ends/ bevels outside diameter shall not reduce the wall thickness to less than the minimum requirements of the line pipe specification, when measured using ultrasonic thickness measurement equipment.

All other damage to pipe ends/bevels shall be advised to the Engineer for review. Subject to Engineer's approval, these defects may be repaired by removal of damaged pipe material and re-beveling. No welding on the pipe surface shall be allowed.

Pipe identification numbers shall be preserved during repair. Any reduction in pipe lengths shall be recorded in the relevant forms and files.

## **6. PIPE PREPARATION PRIOR TO COATING APPLICATION**

### **a) Cleaning of Pipes**

All surface contaminants such as oil, grease, tar, salt, or other contaminants on the pipe shall be removed by solvent cleaning followed by steam or hot bath cleaning, in accordance with a procedure approved by the Engineer.

Following the steam or hot bath cleaning the pipe shall be tested for salt and chloride contamination in accordance with the requirements of DIN EN ISO 8502-2, ISO 8502-5 or DIN EN ISO 8502-9.

The removal of hydrocarbon contamination shall be confirmed by a water spray test, where a fine spray is applied to the surface and uniform wetting confirms the removal. This check shall be performed before and after blasting, as a pre-qualification test and as a minimum, once per 100 items during production, or when necessary.

Items found to be contaminated shall be cleaned as above and re-blasted if testing after blasting establishes that salt, chloride or hydrocarbon contamination is still present. The remainder of the batch concerned shall all be checked individually.

All water used for rinsing or cleaning purposes shall be potable with less than 200 ppm total dissolved solids and 50 ppm chlorides.

### **b) Abrasive Blasting**

Blasting and other dust producing areas shall be separate from coating application areas.

After cleaning and prior to abrasive blasting the pipe lengths shall be free from moisture, dust, grease and free from other foreign materials.

Abrasive and dust, which entered the inside of the pipe during blasting operation, shall be removed by suitable means.

Weld joints, sharp-edge projections, weld spatter and slag etc. shall be dressed prior to blast cleaning.

Using dry blasting techniques only, the exterior surface of the pipe joints shall be abrasively cleaned to remove all mill scale, and other impurities from the surface.

No blast cleaning shall take place when the prevailing relative humidity is higher than 85 percent unless pipe is preheated to at least 3° C above the dew point.

Twice per shift, samples of the abrasives mixture shall be removed from the hopper and checked for hydrocarbon contamination. The sample shall be placed in a beaker to which de-ionized water is added. The beaker shall then be sealed and shaken vigorously. Once the grit has settled the surface of the water shall be examined for signs of hydrocarbon contamination. If any signs are found all the abrasive in the hopper shall be rejected and not re-used.

Additionally, abrasive materials shall be checked at least once per shift to ensure that only uncontaminated angular grit with an acceptable size distribution is used. As a minimum the following shall be carried out.

- Correct abrasive size distribution shall be carried out by sieve analysis.
- Placing a sample of abrasive on a clean, dry sheet of absorbent paper to determine water contamination.

The surface of the pipes shall be blasted until a finish of Grade 2.5 to DIN EN ISO 8501-1 is attained. The surface profile shall be between 50 to 100 microns, measured in accordance with DIN EN ISO 8503-2. Profile measurements shall be made with a Keane Tator Profile Comparator, Testex Press –O-Film or other Engineer approved method suitable for the abrasive being used.

Following abrasive blasting, the surface shall not be contaminated with dirt, dust, metal particles, hydrocarbons, water, chlorides, sulphates or any other foreign matter, which would be detrimental to the coating.

Prior to the coating application, the exterior surface shall be thoroughly inspected under adequate lighting. Any damage such as surface imperfections, slivers, scabs, burrs, gouges, or sharp edged defects, shall be repaired in accordance with this specification. Pipes that have damage repaired by grinding and have ground areas greater than 50 mm diameter shall be re-blasted to meet the requirements. After grinding or mechanical repairs the wall thickness shall be ultrasonically examined and compared with the minimum requirements of the applicable code / standard.

Any dust or loose residue that has accumulated during blasting and/ or grinding operations shall be removed by the use of clean compressed air or by vacuum extraction. Alternative methods for removing dust and lint shall require approval of the Engineer.

The elapsed time between the start of blasting and the heating of pipe shall be indicated in the application procedure submitted by the Pipe Coating Contractor and shall be reflected on his plant scheme.

The total elapsed time between the start of blasting of any pipe and the heating of that pipe to the specified temperature shall not exceed the following time-humidity table:

<b>Relative Humidity</b>	<b>Elapsed Time</b>
85%	0.5 hrs.
80%	1.0 hrs.
70%	2.0 hrs.
60%	2.0 hrs.

Any pipe surface not processed within the above time-humidity table shall be completely re-cleaned and re-blasted before coating. The maximum time limit between blasting and coating for humidity below 60% shall be 4 hours.

## **7. APPLICATION OF COATING**

### **a) General**

The application of the coating shall be in accordance with the material manufacturer recommendations and the procedure outlined below.

The Pipe Coating Contractor shall perform coating procedure qualification testing (PQT) prior to commencing production or on his own risk at the start of production in accordance with these specifications.

Prior to start-up of the coating process the powder application and recovery systems shall be thoroughly cleaned to remove any powder other than that is use, minimum once per day and the collected powder shall be disposed of.

## **b) FBE Layer**

The FBE shall be applied to a minimum thickness of 200 microns.

The pipe shall be uniformly preheated in accordance with the FBE manufacturer's instructions. This temperature shall have been confirmed during PQT. The surface temperature shall not exceed 260 deg C in accordance with AWWA C213.

Pipe temperature shall be checked periodically using pyrometer. The pyrometer shall be checked for error not less than every four hours against a calibrated temperature measuring instrument.

The coating shall be applied by electrostatic spray with the pipe at earth potential and the epoxy powder charged to high potential.

The use of reclaimed FBE powder is only permitted if the reclaimed powder is screened to remove foreign or deleterious material before being reintroduced into the powder application system.

The clean reclaimed powder up to a maximum of 20% shall be introduced back into the fresh virgin material by means of proportional weight.

During application, the beveled ends and pipe bore shall be protected against mechanical damage and from contamination with coating material.

## **c) Adhesive Layer**

The adhesive shall be applied to a thickness of 200 microns.

The adhesive layer shall be applied before gel time of the FBE has expired. Application of the adhesive shall not be permitted after the FBE has fully cured. The Pipe Coating Contractor shall establish to the satisfaction of the Engineer that the adhesive is applied within gel time window of the FBE and at the temperature recommended by the adhesive manufacturer. The Pipe Coating Contractor shall state the proposed minimum and maximum time interval between FBE and adhesive applications at the proposed pre-heat temperature.

## **d) Polyethylene Layer/Cutback**

The polyethylene layer shall be applied to a minimum thickness as per DIN 30670 over the pipe body and to a minimum of 90% body thickness over the production welds.

A polyethylene layer cutback of 100mm (+10/-10mm) shall be provided at pipe ends.

Pipe DN	Standard thickness on body	On welds
$\geq$ DN 800 & higher	3.2 mm	3.0mm

The polyethylene shall be applied over the adhesive within the time limits established during pre-production testing.

The coating shall be cooled to below 60 deg C before handling.

The ends of the coating shall be chamfered and beveled to 30 to 45 deg

Immediately after the coating is fully cured, pipe identification marks shall be re-applied on the coated pipe using a method approved by Engineer.

## **8. INSPECTION, TESTING AND CERTIFICATION**

### **8.1. General**

In order to demonstrate that the manufacturer's proposed coating procedure is capable of meeting the specification, the Pipe Coating Contractor shall undertake coating procedure qualification testing (PQT) prior to commencing production, or at his own risk at the start of production. The pipe coating Contractor shall also be required to test the finished coating during production to demonstrate continued compliance with this specification. Details of all inspections and testing shall be fully documented in accordance with this section.

All states of the surface preparation, coating and testing shall be subject to 100% inspection by the Pipe Coating Contractor. The Engineer shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection supervision work

### **8.2. Coating Procedure Qualification Testing (PQT)**

Prior to commencing or at the start of full production five pipe joints of each diameter coated with FBE only and five pipe joints of each diameter with the full coating system shall be selected for PQT. All coating shall be in accordance with the coating procedure specifications and shall be witnessed by the Engineer or its representative.

The produced pipes will not be released until the successful results of the PQT can be provided. In case of long-term tests the PQT report shall be updated once the results can be provided. Any failure in meeting the specified acceptance criteria for the PQT will result in rejection of the coated pipes. Engineer shall approve any remedial action, repairs or re-use.



The test methods for all tests required for PQT on the FBE and the complete coating system shall be performed in the same manner as the production tests described in this specification.

Pipes selected for PQT testing shall pass all the criteria containing before production commences.

Any change in the coating material or coating procedure shall require re-qualification.

If any of the tests fails to meet the minimum acceptance criteria defined in this specification, then the pre-qualification pipes shall be rejected. Further pipes may be prepared and coated using revised procedures and further tests performed. Once acceptable results are obtained and approved by Engineer, the Pipe Coating Contractor's quality plan and procedures shall be revised, and submitted to the Engineer for approval. All items coated using the rejected procedures shall be striped and recoated to the revised procedures.

### 8.3. PQT Inspection and Test Summary

Inspection and testing summary for procedure qualification test (PQT) for three layer coating system for each pipe diameter:

Property	Acceptable Values	Frequency of Tests
<u>On Arrival</u> Pipe Damage	Minor damage/grinding <3 per	Each Pipe
<u>After Cleaning</u> Chloride Oil Salt	2 mg/cm <sup>2</sup> No contamination 3 mg/cm <sup>2</sup>	Each Pipe
After Abrasive Blasting	Sa 2.5 to ISO 8501	Each Pipe
<input type="checkbox"/> Cleanliness	50 – 100 um	Each Pipe
<input type="checkbox"/> Profile	No contamination	Each Pipe
<input type="checkbox"/> Visual Inspection	No surface defects	Each Pipe
<input type="checkbox"/> Holidays	No holidays	Each Pipe
<input type="checkbox"/> Thickness	Min/Max see as specified	10 per pipe
<input type="checkbox"/> Adhesion	As specified	2 per pipe
<u>Holidays</u> <u>Visual Inspection</u> Coating Bare steel at pipe ends Production FBE PE cut	No surface defects 120+10/-0 mm width 10 to 40 mm width, Chamfered 150 + 10/-10 mm bevel 30° to 45°	Each Pipe Each Pipe Each Pipe Each Pipe

Property	Acceptable Values	Frequency of Tests
<u>Adhesion</u> <input type="checkbox"/> Peel Test	> 100 N/cm at 20 <sup>0</sup> C +5 <sup>0</sup> > 50 N/cm at 50 <sup>0</sup> C +5 <sup>0</sup>	2 per Pipe 2 per Pipe
<u>Impact Resistance</u>	As specified	1 per pipe
<u>% Elongation at Failure</u>	As specified	2 per pipe
<u>Cathodicdisbondment</u>	As specified	2 per pipe
<u>DIN 30670</u>	As specified	1 per pipe

#### 8.4. Production Testing

Production testing shall be performed at the frequency shown below:

property	Acceptable Values	Frequency of Tests
<u>On Arrival</u> <input type="checkbox"/> Pipe Damage	Minor damage/grinding <3 Per Pipe	Each Pipe
<u>After Cleaning</u> Chloride Oil Salt	2 mg/cm <sup>2</sup> No contamination 3 mg/cm <sup>2</sup>	Each Pipe
After Abrasive Blasting Cleanliness Profile Contaminatio n Pipe	ISO-Sa 50 – 100 um No contamination As specified	Each Pipe 20 Each Pipe 20
<u>FBE Layer</u> <input type="checkbox"/> Visual Inspection <input type="checkbox"/> Holidays <input type="checkbox"/> Thickness	No surface defects No holidays Min/Max see As specified As specified	One pipe per day and one pipe when FBE batch changes
<u>Coating Thickness</u> (minimum)	As specified	Each Pipe
<u>Holidays</u>	No holidays	Each Pipe

property	Acceptable Values	Frequency of Tests
<u>Visual Inspection</u> Coating Bare steel at pipe ends Production FBE PE cut backs	No surface defects 120+10/-0 mm width 10 to 40 mm width, Chamfered 150 + 10/-10 mm bevel 30° to 0°	Each Pipe Each Pipe Each Pipe Each Pipe
<u>Adhesion</u> Peel Test	> 100 N/cm at 20° C +5°	1 Pipe per 25 2 per Pipe
<u>Cathodic Disbondment at Room</u>	As specified	First pipe, last pipe and at intervals of every 500 pipes

The frequency of tests shown in the table above will be for normal production operations. This frequency of tests is subject to change at the discretion of the Engineer as a result of change of materials or consistent poor production performance.

#### **a) Holiday Detection**

##### FBE Layer:

The FBE coating shall be 100 % holiday tested with a pulse type DC holiday detector equipped with audible signaling device. The test shall be carried out in accordance with NACE RP0490 or equivalent.

##### Final Coating:

Each fully coated pipe shall be inspected for holidays over 100 percent of its coated surface using a high voltage DC detector.

The detector shall be a type, which maintains complete contact with the coating. It may be either constant or pulsed voltage type. If constant voltage type, holiday detection shall be carried out on a dry coating. The operating voltage between electrode and pipe shall be checked at least twice per working shift, and shall be maintained at 10 kilovolt/mm of coating thickness.

The Pipe Coating Contractor shall demonstrate to the Engineer that the setting of the detector is satisfactory for detecting pinhole defects. This setting shall be checked once every two hours. The correct travel speed shall be determined by consistent detection of an artificial pinhole made in a good coating sample but shall not exceed 300 mm/s.

All holidays and other defects shall be marked for subsequent repair and re-testing. On retesting, no holidays shall be permitted in the final coating.

The number of holidays for each pipe length shall be recorded. Coated pipe having holidays in excess of 1 per 1 square meter shall be stripped and re-coated.

If there is an excess occurrence of holidays on successive pipes, the Pipe Coating Contractor shall immediately stop the coating operation to determine the cause and remedy it.

#### **b) Adhesion ( Peel) Test**

##### FBE Layer:

With a sharp narrow bladed knife, two incisions (approximately 13 mm long) shall be made, in the form of an X. through to the metal substrate. At the intersection of the X. an attempt shall be made to force the lining from the steel substrate with the knife point. The point of the knife shall be inserted horizontally i.e., the flat of the blade under the lining at the point of intersection of the X such that the blade point is on the metal surface. Using a levering action, the flat point shall be forced away from the steel in an attempt to pry off the coating. Refusal of the lining to disbond from the substrate shall be recorded as a pass. A pass shall also be recorded where the lining fails cohesively. Partial or complete adhesive failure between the lining and the substrate shall be recorded as a failure. Disbondment at the point of the intersection is common due to the action of marking the 'X' cut. Therefore for 1 mm away from the tip of the intersection any disbandment shall be ignored.

##### Final Coating:

The adhesion for the complete coating shall be determined in accordance with the requirements for bond strength in DIN 30670. The relevant test temperature and acceptance criteria for these tests shall be as specified. Automatic chart recording equipment shall be used and the average peeling force shall be recorded.

The failure mode shall be recorded. The failure should occur at the adhesive/polyethylene interface or adhesive/FBE interface or cohesively in the polyethylene layer. If failure should occur at the FBE/steel interface this will be considered a total failure of the system.

#### **c) Impact Test**

A sample or coated pipe shall be impact tested in accordance with the procedures and acceptance criteria of DIN 30670.

#### **d) Resistance to Indentation Test (Indentation Hardness)**

Once per shift (and when the FBE or polyethylene batch is changed), the indentation hardness of two coated samples shall be measured (at  $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$  and  $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ) in accordance with DIN 30670 Indentation depth shall not exceed 0.2mm at  $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$  or 0.3mm at  $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$ .

#### **e) Percentage Elongation at Failure**

This test shall be conducted in accordance with DIN 30670 on each of the full system pre-qualification pipes, but at least the coating of three pipes shall be tested for elongation at failure, from which five test pieces shall be taken. The percentage elongation at failure shall be at least 200%.- on each of the full system pre-qualification pipes, 2 samples per pipe to the requirements of DIN 30670.

#### **f) Other DIN 30670 Tests**

The Pipe Coating Contractor shall demonstrate, for the same system to be applied for this order, attainment of DIN 30670 requirements for Coating Resistivity, to Thermal Ageing and Light Ageing as required by DIN 30670. .

#### **g) Cathodic Disbondment Test**

Cathodic Disbondment testing shall be conducted:

as a pre-qualification test - 48 hours duration at  $65 \pm 2^{\circ}\text{C}$

as a pre-qualification test - 28 days duration at  $23 \pm 2^{\circ}\text{C}$

as a production test - 48 hours duration, at the frequency of one test per 50D coated pipes at  $65 \pm 2^{\circ}\text{C}$

The test requirements shall be in accordance with ASTM G 8.

The final unsealed diameter (including the initial holiday diameter of 6.35 mm) shall not exceed 15 mm. This shall apply to both, the 28 day test at  $23 \pm 2^{\circ}\text{C}$  and the 2 days test at  $65 \pm 2^{\circ}\text{C}$ .

The Pipe Coating Contractor may propose alternative cathodic disbondment test standards provided the essential requirements of this specification are retained. Any such alternatives shall be submitted to the Engineer for review and approval.

Every 24 hours the applied voltage and current flow shall be recorded. Any drift from the specified voltage setting shall be corrected.

#### **h) Destructive Tests**

A sufficient length of production pipe shall be cold cut to provide the required number of samples for conducting the coating destructive tests listed in this specification.

Items that fail individual tests and that cannot be repaired shall be rejected. Subject to the approval of Engineer, the rejected coating shall be stripped and the joint shall be re- blasted and coated in the manner specified for new pipe in this specification.

Where a test relates to a quantity of coated items, e.g. 1 per 50 items or 1 per 100 items etc., the quantity or items represented by the item tested (e.g. 50 or 100) shall be considered to be a batch.

If a test on an item in a batch fails then this item shall be rejected and two further items shall be randomly selected from the batch for repeat testing. If either of these tests fails then the whole batch shall be quarantined for review by Engineer. The cause of failure shall be established and reported to the Engineer and if deemed necessary by the Engineer the coating procedure shall be amended and re-qualified. The Engineer will decide whether the whole batch is rejected and sent for re-blasting and re-coating or whether acceptance may be on the basis of acceptable tests carried out on individual items.

### **i) Coating Repairs**

The Pipe Coating Contractor shall submit detailed coating repair procedures for approval by Engineer. These shall include procedures for repair or 'pin-hole', 'small area' and 'large area' defects. The minimum and maximum areas for which each type of repair is applicable shall be stated taking into consideration the below mentioned requirements.

The maximum number of coating defects allowable, before a joint of pipe shall be classed as rejected and recoated, shall not exceed 1 per 1 square meter (exclusive of damage caused by testing).

#### **□ Repair areas of sizes < 5 mm<sup>2</sup>**

Pinhole damage shall be repaired by cleaning with an emery cloth followed by application of a two (2) pack epoxy repay repair kit or an approved hot melt mastic smoothed flush with the polyethylene surface. If the mastic is used, it shall be spread with the aid of a hot air or a propane torch.

#### **□ Repair areas of sizes > 5 mm<sup>2</sup> up to < 250 mm<sup>2</sup>**

The area shall be cleaned with solvent and abraded with an emery cloth to ensure that the surrounding polyethylene is well bonded, the surface shall be roughened for a distance of at least 25 mm beyond the damage area. Approved hot melt mastic shall be applied to the damage area and smoothed flush. The mastic and surrounding area shall be warmed with hot air or propane torch until the surrounding polyethylene has a slight sheen. An approved polyethylene patch material shall be applied overlapping the damage but not overlapping the pre-braided areas. Torch heat and smoothing pressure shall be applied to fuse the patch and ensure that no blisters are formed.

#### **□ Repair areas of sizes 250 mm<sup>2</sup> up to 625 mm<sup>2</sup>**

Heat shrink-wrapping pipe sleeves shall be used for repair according to the following procedure:

Thoroughly clean the area to be coated

Bevel the extremities of the mill-coating with a rasp

Pre-heat the area to be coated to a temperature of approximately 700C. Install the sleeve over the area to be coated

Warm the shrink sleeve to a temperature above 150OC with a propane torch or a warm-air ring.

□ **Repair areas of sizes exceeding 625 mm<sup>2</sup>**

No single defect shall exceed an area of 625 mm<sup>2</sup>. Pipes with a coating defect exceeding 625 mm<sup>2</sup> shall be cause for rejection and shall be subsequently rejected and recoated. All rejections shall be recorded.

Repairs shall provide a finished coating equal in effectiveness to that of the parent coating. The limit of the repair area shall be revised.

Each repaired area shall be holiday inspected in accordance as specified.

The Pipe Coating Contractor shall submit coating stripping procedure for pipes rejected for coating quality. The rejected coating may be stripped by heating in an oven. Under these circumstances, the temperature of the pipe joint shall not be allowed to rise above 400<sup>0</sup> C.

## **9. HANDLING, TRANSPORT AND STORAGE RULES**

The Manufacturer shall be responsible for any damage occurring to the pipes from unloading to reloading on the relevant transportation means.

The Manufacturer shall consequently:

- inspect the bare pipes upon delivery to check that they have suffered no previous damage,
- take all necessary precautionary measures to prevent any deterioration during the following operations:
- handling,
- transfer to storage yards.
- storage,
- loading of pipes for shipment.

All repairs and inspections shall be at the Manufacturer's expense.

### **a) Handling**

The pipes shall be handled without causing damage to the pipe bevels and coating.

Direct contact steel or hamp slings or with any material whose shape or nature may deteriorate the pipe coating shall be strictly prohibited. Polyamide slings or hooks fitted with thermoplastic protection may be used.

Use of electromagnetic device is recommended.

**b) transfer to storage yard**

During transport of pipes to the storage yard of the Manufacturer, the latter shall take all their required measures to avoid pipe and coating damage.

**c) Storage yard of the Manufacturer**

Stockpiling of coated pipes shall be made so as to avoid any deterioration of coating. Coated pipes, when non concrete weight coated, shall be protected against ultraviolet rays action in particular.

**d) Pipe loading for shipment**

When loading the coated pipes for shipment, the Manufacturer shall take all necessary measures to avoid the deterioration of pipes and coating during handling and transport.

**e) End caps**

If the bare pipes have been delivered to the Manufacturer with end caps, these end caps or new ones) should be fitted again on the pipe ends after coating if required in the CONTRACT.

**f) REPAIR OF COATING**

MANUFACTURER shall submit to PURCHASER, its methods and materials proposed to be used for executing a coating repair and shall receive approval from PURCHASER prior to use. In open storage the repair materials must be able to withstand a temperature of at least (+) 800C without impairing its serviceability and properties. MANUFACTURER shall furnish manufacturer's test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specification.

All repair material will be of Class C.70 as specified in the relevant DIN Standard.

All pipe coating plan, shall have sound external with no holiday or porosity on 100% of the surface.



Defects, repairs and acceptability criteria shall be as follows:

- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 cm<sup>2</sup> or linear damage (cut) of less than 3 mm shall be repaired by stick using material of same quality.
- Damages caused to coating by handling such as scratches, cuts, dents, gouges, not picked up during holiday test, having a total reduced thickness on damaged portion not less than 2 mm and an area not exceeding 20 cm<sup>2</sup> shall be rebuilt as per approved method and without exposing to bare metal.
- Defects of size exceeding the above and mentioned area of or holidays of width less than 300 mm shall be repaired as per approved method by exposing the bare metal surface.
- Defect exceeding the above and in number not exceeding 2 per pipe and their length not exceeding 500 mm shall be repaired as per approved method.
- Pipes with bigger damage shall be stripped and recoated.
- In case of coating defect close to coating cut back, MANUFACTURER shall remove the coating throughout the entire circumference of the pipe down to the steel surface and increase the coating cut back length. Now, if the coating cut back exceeds by 30 mm than the specified cut back length, then the coating shall be repaired as per approved method thereby making up the coating cut back length as per specification.

In case the defect exceeds 70 mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.

Irrespective of type of repair, the maximum number of repair of coating shall be as follows:

- Holiday repair of size  $\leq 100$  cm<sup>2</sup> attributable to process of coating application shall be maximum one number per pipe.
- In addition to the above, defects to be repaired as per approved method shall be maximum 2 (two) per pipe.

Defects exceeding the above limits shall cause pipe coating rejection, stripping and recoating. The above is exclusive of the repairs warranted due to testing as this specification.

All repairs carried out to the coating for whatever reason shall be to the account to MANUFACTURER.

Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the PURCHASER. In any case the MANUFACTURER shall establish his material, methods and procedure of repair that

result in an acceptable quality of product by testing and shall receive approval from PURCHASER prior to use.

Testing of repairs shall be in the same form as testing coating. All repairs shall result in a coating thickness no less than the parent coating thickness. MANUFACTURER shall test repairs to coating as and when required as and when required by PURCHASER.

### **Field Joint Coating : Heat Shrink Sleeve (Hss)**

#### **Scope**

- This specification establishes the minimum requirements of materials, equipment and Installation of field joint anti-corrosion coating of buried onshore pipelines factory coated with three layer polyethylene coating, by heat shrink wraparound sleeves conforming to EN 12068.
- External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection modified/replaced by this specification, all the requirements of EN 12068 shall remain fully applicable and complied with.
- This specification shall be read in conjunction with the conditions of all specifications and documents included in the Contract between Company and Contractor. Unless specified otherwise, all sections of this specification shall apply to all specifications referred in this specification.
- After Sand blasting of Welded joint, Dust contamination test should be checked by Engineer/TPIA as 1 joint per 10 joints and after completion of Heat shrinkable sleeve of welded joint, Peel test should be done as 1 joint per 10 Joints.
- Holiday Test done at field for pipe end and field joint coating shall be done as per instruction of Engineer-in-Charge.

#### **Reference Documents**

Reference has also been made to the latest edition (edition enforce at the time of issue of enquiry) of the following standards, codes and specifications:

a)	ISO 8502-3	Preparation of Steel Substrates before Application of Paints and Related Products Part 3 Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
b)	ISO 8503-1	Part 1 Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces
c)	ISO 8503-4	Part 4: Methods for calibration of ISO surface profile Comparator and for the determination of surface profile

d)	SIS 055900	Pictorial Surface Preparation Standard for Painting Steel Surfaces
e)	SSPC-SP1	Steel Structure Painting Council
f)	ASTM D149	Standard Test Method for Dielectric Breakdown Voltage & Dielectric Strength of Solid Electrical Insulating
g)	ASTM D257	Standard Test Methods for DC Resistance or conductance of Insulating Materials
h)	ASTM D570	Standard Test Methods for Water Absorption of

- In case of conflict between the requirements of this specification and that of above referred Documents, the requirements of this specification shall govern.
- The CONTRACTOR shall be familiar with the requirements of these documents and shall make them readily available at the site to all personnel concerned with carrying out the works specified in this specification.

### Materials And Equipment

- Field joint anti-corrosion coating material shall be heat shrinkable wraparound sleeve suitable for a maximum operating temperature of (+) 60°C (max. T) and shall conform to designation EN 12068-C-HT-60 UV. In addition, the field joint anti-corrosion coating shall comply the requirements

### Heat shrinkable wraparound sleeves:

- Heat shrinkable wraparound sleeve shall consist of radiation cross-linked, thermally stabilized, ultraviolet resistant semi-rigid polyolefin backing with a uniform thickness of high shear strength thermoplastic/co-polymer hot melt adhesive. The joint coating system shall consist of a solvent free epoxy primer applied to the pipe surface prior to sleeve application. The backing shall be provided with suitable means (thermo-chrome paint, dimple, or other means) to indicate the desired heat during shrinking in field is attained. The sleeve shall be supplied in pre-cut sizes to suit the pipe diameter and the requirements of overlap.
- The total thickness of heat shrinkable wraparound sleeve shall be as follows:

Pipe size (specified outside diameter)	Thickness	
	On Pipe Body	On Weld Bead
	Min	Min.
	2.5	2.0
	3.3	2.6

- The heat shrink wraparound sleeve shall have the required adhesive properties when applied on various commercial pipe-coating materials. The pre-heat and application temperatures required for the application of the shrink sleeve shall not cause loss of functional properties of the pipe coating.

### Functional Requirements of Field Joint Coating

**Properties of the PE backing shall be as follows**

Sr.	Properties	Unit	Requirement	Test Method Std.
a.	Tensile Strength @	N/mm <sup>2</sup>		ISO 527-3
b.	Ultimate Elongation @	%		ISO 527-3
c.	Dielectric withstand with 1000	kV		ASTM D149
d.	Water absorption @ +25° C for 24 hours	%		ISO 62
e.	Electrical Volume	Ohm-cm	15	ASTM D257

- Functional Properties of Joint Coating System (As supplied)
- As applied field joint coating system shall comply the requirements of DIN EN 12068, corresponding to designation EN 12068 C HT 60 UV, except as modified below:
- Cathodic Disbondment Resistance at Tmax i.e. 60°C shall be 10mm when tested as per Annexure K of EN 12068. Test shall be carried out at (+) 60°C.
- Peel Strength shall be as follows:

Peel Strength		Unit	Requirement for Mech. Resistance	Test Method
Inner to Inner (+) Outer to Inner	@23° C	N/mm	1.5	Annex B of DIN EN 12068
	@Tmax	N/mm	0.3	
Outer to Outer	@23° C	N/mm	1.5	
	@Tmax	N/mm	0.3	
To Pipe Surface	@23° C	N/mm	5.0	Annex C of DIN EN 12068
	@Tmax	N/mm	1.0	
To Factory Coating	@23° C	N/mm	5.0	
	@Tmax	N/mm	1.0	

- Contractor shall obtain prior approval from Employer regarding the Manufacturer of the joint coating material and the specific grade of the joint coating system. Complete technical details along with test certificates complying with the requirements and shall be submitted to Employer for this purpose. The Contractor shall furnish test certificates from an independent DIN recognized/approved laboratory for all the properties required for the specified EN designation of field joint coating and the requirements of this specification

**Cut back**

- Cut back length of the precoated pipes shall be 150mm ±10mm
- Field joint coating system shall be of suitable width considering an overlap to the factory coated pipe coating by minimum 50 mm on each side 3LPE coated pipes.

**Application Procedure**

## General

- The application procedure shall be in accordance with manufacturer's instructions and the minimum requirements specified below whichever are the most stringent and shall be expert shall supervise the application and shall be available at site upon request during qualification of application procedure and during construction at contractor's cost.
- Operators for coating application shall be given necessary instructions and training before start of work, by the Contractor. To verify and qualify the application procedures, all coating applied during the qualification test, shall be removed for destructive testing as detailed subsequently in this specification. Contractor shall only utilize those operators who have been approved/pre-qualified by the field joint coating manufacturer.
- Oil, grease and salt shall be removed from steel surface by wiping with rags soaked with suitable solvents such as naphtha or benzene. Kerosene shall not be used for this purpose. Solvent cleaning procedure according to SSPC-SP1 shall be followed.
- Each field joint shall be blast cleaned using a closed cycle blasting unit or an open expendable blasting equipment. With the first equipment type, steel or chilled shot and iron grit shall be used and Garnet material with the second one (in case the authority having jurisdiction have no objection, the contractor may adopt sand blasting instead of garnet material). During blast cleaning the pipe surface temperature shall be simultaneously more than 50C and more than 30C above ambient Dew Point, while the ambient Relative Humidity shall not be greater than 85%. Prior to surface cleaning the surfaces shall be completely dry. The surface shall be cleaned to a grade Sa 2½ in accordance with Swedish Standard SIS-055900 with a roughness profile of 50-70 microns. Surface roughness profile shall be measured using an approved profile comparator in accordance with ISO 8503-1 and shall be calibrated prior to the start of the work in accordance with ISO 8503 or ISO 8503-4. The blast cleanliness shall be checked on every joint and the roughness profile shall be checked 1 every 10 joints.
- Dust, grit or foreign matter shall be removed from the cleaned surface by an industrial vacuum cleaner. The dust contamination allowed shall be of a rating max 2 as per ISO 8502-3. The frequency of checking for dust contamination shall be 1 every 10 joints.
- Blast cleaned field joint shall be coated with 2-4 hours according to the conditions below:  
Relative Humidity (RH) >80% - 2 hours  
Relative Humidity (RH) 70-80% - 3 hours  
Relative Humidity (RH) <70% - 4 hours
- Pipes delayed beyond this point or pipes showing any visible rust stain, shall be blast cleaned again.
- The field joint surface shall be inspected immediately after blast cleaning and any feature of the steel surface such as weld spatter, scabs, laminations or other imperfections considered injurious to the coating integrity, made visible during blast cleaning, shall be reported to the Company Representative and on permission from Company

Representative, such defects shall be removed by filling or grinding. Pipes affected in this manner shall be then re-blasted cleaned if the defective area is larger than 50mm in diameter.

- The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areas of the line pipe coating shall be cleaned and abraded, to expose a clean uniform fresh surface of uncontaminated factory applied coating.
- All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.
- Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

#### **Application Procedure for Heat Shrink Wraparound/Sleeves**

**In addition to the requirements stated above, following shall be complied with:**

- The wraparound sleeve shall be of a size such that a minimum overlap of 50mm is ensured (after shrinking) on both sides of the yard applied corrosion coating of pipes.
- In the cases where carrier pipe is installed by direct boring/jacking, the overlap on the mill coating for the leading edges of the joints shall be minimum 200mm. When this extra overlap is achieved by providing an additional patch of heat shrink tape/wraparound, it shall be applied in such a manner that the square edge of the patch on the joint coating is in the direction opposite to the direction of boring/jacking.
- Before centering the wraparound sleeve, the bare steel surface shall be preheated either with a torch moved back and forth over the surface or by induction heating. The minimum pre-heat temperature shall be as recommended by manufacturer and shall be checked by means of contact type temperature-recording thermometer (Digital Pyrometer with flat probe type contact). Temperature indicating crayons shall not be used. Pre-heat temperature shall be checked on every joint. Care shall be taken to ensure that the entire circumference of the pipe is heated evenly. Temperature measuring instruments shall be calibrated immediately before the start of the works and thereafter at intervals recommended by the manufacturer of the instrument.
- Upon pre-heating, the pipe surface shall be applied with two pack epoxy primer of wet to cover the exposed bare metal of the welded field joint and 10mm min. onto the adjacent pipe coating if recommended by the manufacturer. The wet film thickness of the primer shall be checked on every joint with a wet film thickness gauge prior to installation of sleeve. Thickness gauge shall be calibrated once per shift.

- Immediately after application of epoxy primer, the wraparound sleeve shall be entirely wrapped around the pipe when the epoxy is still wet. Sleeve shall be positioned such that edge of the undergoing layer facing upward and an overlap of min. 50mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.
- A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the center of the sleeve and heat circumferentially around the pipe. Continue heating from the center towards one end of the sleeve until recovery is completed. In a similar manner, heat and shrink the remaining side. Shrinking has been completed when the adhesive begins to ooze at the sleeve edges all around the circumference.
- The complete shrinking of the entire sleeves shall be obtained without undue heating of the existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. The installed sleeve shall not be disturbed until the adhesive has solidified.
- The joint coating application shall be done under supervision of the manufacturer's personnel during the field trial demonstration and testing work. Presence of manufacturer's representative is a mandatory requirement and bidders are required to furnish specific commitment to this. Minimum 50 (fifty) field joint coating to be carried and environment protection methodology demonstrated at the time of field trial shall be strictly followed during the entire work.

### **Repairs**

- If a field joint is detected to be unacceptable after testing as per relevant QA section of this specification the Contractor shall, at his own cost:
- Determine the cause of the faulty results of the field coating. Mobilize the expert of manufacturer, if required.
- Test to the complete satisfaction of Company, already completed field coatings.
- Stop the field coating works until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Company.
- Contractor shall replace all joint coating found or expected to be unacceptable as per relevant section of this specification.
- Contractor shall, at his own cost, repair all areas where the coating has been removed for testing by the Company.
- After the coating work on welded joints and repairs to the coating have been completed the coating as a whole shall be tested with a spark-tester before lowering or jacking the pipeline.

- Employer shall be entitled to check the coating on buried pipelines or parts of pipelines are established, the Contractor shall be responsible for excavation at such points, repairing the coating, spark testing and backfilling the excavations without extra charge.

#### **Documentation**

- Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material.
- Complete information as per DIN EN 12068 along with descriptive technical catalogues.
- Test certificates and results of previously conducted tests, for all properties listed.
- Reference list of previous supplies, in last 5 years, of the similar material indicating the project details such as diameter, quantity, operating temperature, year of supply, project name, contact person and feedback on performance.
- Once the employer's approval has been given and change in material or manufacturer shall be notified to Employer, whose approval in writing of all changes shall be obtained before the materials are manufactured.
- Prior to shipment of materials from the manufacturer's works, Contractor shall furnish the following documents:
- Test certificates/results as per Manufacturer's quality control procedure for each batch of material.
- Specific application instructions with pictorial illustrations.
- Specific storage and handling instructions.
- All documents shall be in English language only.



## **10.0 LAYING OF PIPES AND FITTINGS / SPECIALS (PIPELINE WORK)**

### **10.1 SCOPE**

- 10.1.1 The specification covers the requirements for laying of pipes below ground.

### **10.2 APPLICABLE CODES**

- 10.2.1 The laying of pipes and fittings / specials shall comply with all currently statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred to. In all cases, the latest revision of the standards / codes shall be referred to. If requirements of this specification conflict with the requirements of the standards / codes, this specification shall govern.

#### **10.2.2 Codes of Practice**

- a) IS : 783 - Code of practice for laying of concrete pipes.
- b) IS : 3114 - Code of practice for laying of cast iron pipes
- c) IS : 3764 - Safety code for excavation work
- d) IS : 4127 - Code of practice for laying of glazed stoneware pipes
- e) IS : 5822 - Code of practice for laying of electrically welded steel pipes for water supply
- f) IS : 6530 - Code of practice for laying of asbestos cement pressure pipes

### **10.3 CARTING AND HANDLING**

- 10.3.1 The pipes and other materials required shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by the Engineer-in-charge. The Contractor shall be responsible for the safety of pipes and fittings / specials in transit, loading / unloading. Every care shall be exercised in handling pipes to avoid damage. While unloading, the pipes and fittings / specials shall not be thrown down from the truck on to hard surfaces. They shall be unloaded on timber skids with steadying ropes or by any other approve means. Padding shall be provided between coated pies, fittings /specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings / specials along concrete and similar pavement with hard surfaces shall be prohibited.
- 10.3.2 New Pipes can be brought to site only after the mandatory tests (i.e. cube tests, three edge bearing tests, hydrostatic tests, water absorption test etc.) are completed and **necessary test certificates from the manufacturer are produced alongwith each delivery of batch of pipes.**

## 10.4 STORAGE

- 10.4.1 Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m.
- 10.4.2 Fittings/specials shall be stacked under cover and separated from pipes.
- 10.4.3 Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

## 10.5 LAYING

### 10.5.1 Excavation

- 10.5.1.1 Before excavating the trench the alignment of pipeline shall be approved by the Engineer-in-charge. The excavation of trenches and pits for manholes / chambers shall be carried out in accordance with the specification of earthwork in excavation and backfilling and shall be done such that it does not get far ahead of the laying operation as approved by the Engineer-in-charge.
- 10.5.1.2 To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regards to safety provisions shall be observed.
- 10.5.1.3 Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of the timber securely fixed in the ground not more than 3 m. apart and they shall not be less than 75 mm in diameter or less than 1.2 m. above surface of the ground. There shall be two rails, one near the top of the post and the other about 450 mm above the ground and each shall be from 50 mm to 70 mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m. high shall be formed where required by the Engineer-in-charge for further protection.
- 10.5.1.4 The road metal and also the rubble packing shall first be stripped off for the whole width of the trench / pit and separately deposited in such place or places as may be determined by the Engineer-in-charge.

- 10.5.1.5 During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes covers etc. and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service organisations or otherwise as the Engineer-in-charge may direct.
- 10.5.1.6 Contractor shall take into account additional excavation if any as the Engineer-in-charge may require in order to locate the position of water pipes, drains, sewers etc. or any other works which may be met with, in or about the excavation of trenches/pits while quoting the rates for excavation of trenches/pits while quoting the rates for excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as the Engineer-in-charge may direct, and shall be protected by the Contractor from damage during the progress of the work. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipe line of water, gas, sewage etc.
- 10.5.1.7 If the work for which the excavation has been made is not completed by the expected date of the setting of monsoon as stipulated in “Data Sheet-I” or the setting in of rain whichever is earlier, or before the day fixed by Engineer-in-charge for filling in any excavation on account of any festival or special occasion, Contractor shall backfill such excavation and consolidate the filling.
- 10.5.1.8 Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than that specified in “Data Sheet-I”. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of the Engineer-in-charge. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches / pits shall be saturated with water well rammed wherever the Engineer-in-charge may consider it necessary to do so.
- 10.5.1.9 Wherever a socket or collar of pipe or fitting / special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all around the socket in order to make the joint, and the grip shall be maintained clear until the joint has been approved by Engineer-in-charge.
- 10.5.1.10 When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60 cm in depth and 90 cm in length shall be made at joints in order to facilitate welding.

10.5.1.11 The excess excavated material shall be carried away from site of works to a place up to a distance as directed by the Engineer-in-charge. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by the Engineer-in-charge and any claim or dispute shall not be entertained in this respect.

#### 10.5.2 Dewatering

10.5.2.1 During the excavation, if subsoil water is met with, Contractor shall have to provide necessary equipment and labourers for dewatering the trenches/pits by bailing out water; if pumping out subsoil water is found to be necessary, Contractor shall provide sufficient number of pumps for the same. In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient. Contractor shall also make necessary arrangement for the disposal of drained water nearby storm water drain or in a pit if allowed by Owner/Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, Contractor shall take necessary permission from the local authorities.

#### 10.5.3 Special, foundation in poor soil

10.5.3.1 Where the bottom of the trench and subgrade is found to consist of material which is unstable to such a degree that in the opinion of the Engineer-in-charge, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings and as instructed by Engineer-in-charge shall be constructed.

#### 10.5.4 Wooden shoring

10.5.4.1 Contractor shall suitably design polling bards, waling and struts to meet different soil conditions that might be encountered in excavating trenches/pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from the Engineer-in-charge. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

10.5.4.2 The Engineer-in-charge may order portions of shoring to be left in the trenches/pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas-mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations.

Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

### **10.5.5 Steel Plate Shoring**

- 10.5.5.1 Where the subsoil conditions are expected to be of a soft and unstable character in trench / pit excavation, the normal method of timbering may prove sufficient to avoid subsidence of the adjoining road surface and other services. In such circumstances contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc. as per the instructions, manner and method directed by Owner / Engineer. Contractor shall supply, pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the specifications

### **10.5.6 Boning staves and sight rails**

- 10.5.6.1 In laying the pipes and fittings/specials the centre for each manhole /chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances therefrom to be well clear of all intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipelines. The sight rail shall not in any case be more than 30 m apart, intermediate rails shall be put up if directed by Engineer-in-charge.
- 10.5.6.2 Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of metres and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top edge of the cross piece must be fixed below the top edge of the tee head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of pipe etc. as the case may be.
- 10.5.6.3 The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The centre line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the centre lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line sight from rail to rail.
- 10.5.6.4 The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.
- 10.5.6.5 For the pipes converging to a manhole / chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 m. of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point.

- 10.5.6.6 The posts and rails shall in not case be removed until the trench is excavated, the pipes are laid and the Engineer-in-charge gives permission to proceed with the backfilling.

### **10.5.7 Bedding**

- 10.5.7.1 The type of bedding for pipes shall be as per relevant item.

### **10.5.8 Laying of pipes and fittings**

- 10.5.8.1 All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches and approved and measured by the Engineer-in-charge. Pipes and fittings / specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings / specials shall be made by Contractor. In no case pipes and fittings / specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings / specials shall be used to lift and lower the coated pipes and fittings / specials. The pipes and fittings / specials shall be inspected for pipes and fittings / specials shall be inspected for defects and be rung with light hammer preferably while suspended to detect cracks. If doubt persists, further conformation shall be done by pouring a little kerosene / dye on the inside of the pipe at the suspected spot. No sign of kerosene / dye should appear on the outside surface. Pipes and fittings / specials damaged during lowering or aligning shall be rejected by the Engineer-in-charge.
- 10.5.8.2 All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centred in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings / specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings / specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by Engineer-in-charge. During the period that the plug is on the contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2.5% . In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

- 10.5.8.3 The cutting of pipe for inserting valves, fittings or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe-cutting machine shall be used.

**10.5.9 Thrust block**

- 10.5.9.1 Thrust blocks shall be provided, to counteract hydraulic thrust, at places wherever directed by owner / engineer and as per relevant drawing.

**10.5.10 Jointing**

- 10.5.10.1 Jointing for pipes and fittings / specials shall be done in accordance with the relevant specifications depending upon the type of pipes being used.

**10.5.11 Testing and Commissioning**

- 10.5.11.1 Testing and commissioning of pipes shall be done in accordance with the relevant specifications.

**10.5.12 Backfilling**

- 10.5.12.1 Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Backfilling shall be done in layers not exceeding 15 cm. Each layer shall be consolidated by water into, ramming, care being taken to avoid damage to the pipeline. In case of mild steel pipes / specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

**10.5.13 Reinstatement of Road / Footpath**

- 10.5.13.1 Reinstatement of road / footpath shall be done as per the requirements of local authorities and the relevant specifications after completion of work.

**10.5.14 Clearing of site**

- 10.5.14.1 All surplus materials, and all tools and temporary structures shall be removed from the site as directed by Engineer-in-charge and the construction site left clean to the satisfaction of Engineer-in-charge.

**10.6 MEASUREMENT**

- 10.6.1 The measurement for excavation in trenches shall be done in following manner and will be paid accordingly.

- i) Length : As per the actual length of pipes and fittings / specials laid at work site.
- ii) Width and cross sections : As per Drawing.
- iii) Depth : Average depth of trench from ground level to bottom of bedding.

10.6.2 Excavation of asphalt road and reinstatement of road shall be measured on per square meter basis and the length and width at top of trench shall be considered same as those mentioned for excavation of trench.

10.6.3 Shoring (open / close) shall be measured on the square meter basis of the actual area of trenches shored.

10.6.4 The measurement for removal of excess excavated material upto a specified distance shall be as per the relevant items (s) in the schedule of Quantities and Rates and shall be measured on cubic meter basis. In case of soil 30% deduction shall be done to take account for voids where as it will be 40% in case in case of rubble.

10.6.5 Measurement for pipes and fittings / specials shall be in accordance with the relevant clause(s) of specification for particular type of pipes.

#### **10.6.6 Notes**

10.6.6.1 Fencing provided along the sides of trenches and pits shall not be paid for separately and contractor shall take into account the costs of such works and quote accordingly.

10.6.6.2 In case of the metal packing or dressed stones not being deposited as specified or being mixed up with excavated materials and not available for the reinstatement of road / pavement, the cost of the new metal packing or dressed stones requires shall be charged to Contractor by Engineer-in-charge.

10.6.6.3 Service lines if damaged during excavation shall be made good either by Contractor or by other agency as Engineer-in-charge may decide and wholly in either case at the expense of Contractor.

10.6.6.4 Contractor shall not be paid any additional compensation for excess excavation over what is specified as well as for any remedial measures that are specified.

10.6.6.5 The excess excavated material shall be carried away from site of works as specified, failing which in view of public safety and traffic convenience the Engineer-in-charge may carry out the work by any other agency at Contractor's risk and cost.

10.6.6.6 Portion of shoring left in the excavated trenches or pits shall be measured and paid separately, if instructed by Engineer-in-charge to do so.



## **11.0 VALVES AND VALVE CHAMBER (PIPELINE WORK)**

### **11.1 SLUICE VALVE:**

#### **11.1.1 GENERAL:**

Cast Iron Sluice Valves shall be manufactured strictly in accordance with and conforming to Indian standard specification IS : 14846 – 2000 or its latest amendment.

The valves are intended to be used in vertical / horizontal position. Valve shall be rising / non rising spindle type as specified having pressure rating PN 1.0 in general or higher as required as per application as specified in these specifications and free from sharp projections which are likely to catch and hold stringy materials. Bolts and nuts shall conform to IS 1363: 1967 and IS 4218: 1967. Over all dimension like, face to face distance, height of valve etc shall conform to IS 14846.

#### **11.1.2 FEATURES OF CONSTRUCTION:**

##### **BODY & BONNET**

Body & Bonnet shall be designed so as to withstand the rated test pressure as specified in IS: 14846. Bodies of the valve shall be fitted with seat rings securely fixed in machined recesses by proper engineering practice.

Reasonable clearances shall be provided behind the rear faces of the flanges on body and bonnet to provide free access to use spanners for assembling & dismantling. Rear side of valve flanges shall be machined or spot faced for proper seating of bolt head, washer and nut.

Valves shall have Gun metal drain plug of required size as per IS to facilitate drain of trapped water from the valve body.

##### **FLANGES**

Valve flange faces shall be parallel to each other and shall be at right angle to the valve centerline. The flanges and their dimensions of drilling shall be in accordance with the requirements of IS 1538, Table IV & VI. The rear side of the flanges shall be machined or shall have spot face to provide proper tightening of Nut & Bolts..

##### **STUFFING BOX**

The gland and stuffing box which come in contact with spindle shall be provided with bushing of minimum 3 mm thickness and of material as specified in IS-14846 or specified in specific requirement of this specification as anti frictional device. The minimum inside dimensions of the stuffing box shall be in accordance with IS 14846.

Valve shall be provided with back seat bush to facilitate repacking of valves in pressurised condition without disturbing the pump operation.

## **WEDGES**

The Valves shall be with equal tapered solid CI wedge made in one piece. Valves shall have perfect machined and pressed Wedge seat rings securely fixed in to machined recesses. The wedge seat ring shall ride high on the body seat ring to allow for wear, when shut. The minimum wear travel shall be 25 % of the face width of the seat rings as specified in IS.

## **SEAT RINGS**

The dimensions of the body seat rings and wedge seat rings shall conform to IS 14846. The wedge seat rings & body seat rings shall be securely riveted over and above sufficient hydraulic press fittings.

## **GUIDES & LUGS**

All valves shall be provided with the guides and lugs to guide the wedge through its full travel in body. The channel and shoe arrangement shall be secured by non – protruding rigid rivets of non ferrous metals. The clearance between lugs and guides for different sizes of sluice valves shall be as specified in IS 14846.

## **STEM & WEDGE NUT**

Valve Stem shall have a machine cut, single start trapezoidal threads of such length that the wedge can be raised to a position so as to ensure full flow passage through the valve's bore. In fully closed position of the valve the stem shall remain in full contact with wedge nut for its entire length with at least 10 mm projection. The length of the stem particularly below the collar shall be kept accordingly. The dimensions of stem and wedge nut shall be in accordance with IS : 14846.

The stem of valve shall be so screwed as to close the valves when the cap, hand wheel or crank handle is rotated in clockwise direction. The direction of closing shall be marked on the Cap / hand wheel.

Wherever extended spindle is provided, the valve shall also be provided with suitable headstock.

Rising Spindle Sluice Valve shall be with the Yoke and Yoke Sleeve (Spindle Nut) placed in the Yoke, in such a way that the axial movement of the Yoke Sleeve is avoided in the yoke along direction of spindle axis and but it can not rotate. Integrally formed end of the Spindle shall be locked in Wedge and Rotation of the yoke sleeve shall Open / Close the wedge responding to direction of rotation. The design shall offer minimum operating torque to operate the valve.

The ball type thrust bearing may be provided above and below the collar of the yoke sleeve to minimize the operating torque as per manufacturer design. The spindle threads shall be engaged in the operator drive sleeve for the rising spindle sluice valve offered with gear box and / or electric actuator.

## **GEARS**

Gears shall be of suitable design (IS 2535: 1978) and workmanship, so as to ensure satisfactory working of sluice valve.

## **ACCESSORIES:**

1. Valves above 300 mm size shall be provided with Repacking arrangement as per IS 14846.
2. The Valves 600 mm & above size shall have channel and shoe arrangement as per IS 14846.
3. The Valves 450 mm size & above shall have spur / bevel gear arrangement as per IS 14846.
4. All Valves shall have valve's OPEN / CLOSE indicator arrangement as per IS 14846.

### **11.1.3 MARKING:**

The following information shall be embossed on each valve body:

- ISI Certification Mark.
- The manufacturer's name or Trade Mark.
- Pressure Rating of valve.
- The size of valve in mm.
- Heat number of cast.

#### 11.1.4 DATA SHEET FOR CAST IRON SLUICE VALVE

SR. NO.	PARTICULARS		DESCRIPTION
1.0	Make		Pl. furnish detail
2.0	Manufacturing Standard		IS : 14846 – 2000 or latest rev.
3.0	Size and quantity		Pl furnish detail
4.0	Fluid / Specific gravity		Sewage / 1.02
5.0	Pressure Rating		PN : 1.0
6.0	Stem		Non Rising Spindle
7.0	Ends		Flanged, flat faced as per IS-1538 having off center bolt holes
8.0	Bonnet		Bolted
9.0	Disc.		Solid wedge
10.0	Operation		Hand wheel operated
11.0	Seat	Body	Renewable
		Disc	Renewable
12.0	Direction of Closing		Clockwise
13.0	Repacking /Back Seat Bush Arrangement		Required (above 300 mm size)
14.0	Channel & Shoe Arrangement		Required (600mm & above size)
15.0	Gear Box arrangement		Required for manually operated valves ( 450 mm & above size)
16.0	By-pass arrangement		Not Required
17.0	Body / bonnet		C.I. IS 210 GR FG 260
18.0	Disc		C.I. IS 210 GR FG 260
19.0	Stem		S.S. AISI – 304 (M)
20.0	Body seat		S.S. AISI – 304 (M)
21.0	Yoke		C.I. IS 210 GR FG 260
22.0	Disc seat		S.S. BS 970 Gr 304 (M)
23.0	Yoke sleeve/Stem nut		Bronze IS 318 GR LTB2
24.0	Shoe & Channel Linings		S.S. BS 970 Gr 304 S16
25.0	Stuffing box		C.I. IS 210 GR FG 260
26.0	Stuffing Box Bush		Bronze IS 318 GR LTB2
27.0	Gland		C.I. IS 210 GR FG 260
28.0	Gland Packing		Greasy Jute Packing
29.0	Bolts, studs & nuts		Carbon Steel IS 1367 Class 4.6/4
30.0	Hand wheel /Cap		CI
31.0	Shell test		15 Kg / Cm <sup>2</sup>
32.0	Seat test		10Kg / Cm <sup>2</sup>

NOTE:01. Manufacturer / supplier shall submit separate data sheet for each duty.

02. For components (marked-M) material certificates shall be furnished

#### **11.1.5 Vendor List**

The Vendor for Valve shall be as per Vendor list given in Mechanical Specification.

#### **11.1.6 Testing**

Defects noted during test and operation of sluice valve shall be refitted by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

#### **11.1.7 Fixing of Valves**

Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. The arrangement of housing the valves with chambers and stable and firm foundations. The chamber and top roof cover with removable lid shall be provided so that it shall be possible to remove or replace or recondition the valves seats and to remove the parts without removing the valves from the pipe work. For this suitable flange adapters may be provide

Valves used on pipeline shall be straight through type and non chokable. Each valve or its operation equipment shall bear an approved name plate stating its function. All operation spindles, gears and head stocks shall be provided with adequate points for lubrications.

The tightening of nut and bolts shall be done smoothly in such a way that no excessive strain occurs on any one side. The nuts shall be tightened on diametrically opposite site at a time.

#### **11.1.8 Information Required**

Following documents/drawings shall be submitted by Bidder alongwith the quotation.

Preliminary outline dimensional drawings.

Typical cross section drawings.

Supplier's data sheet showing valve size, pressure rating, test pressures, list of tests to be conducted etc.

#### **11.1.9 Scope**

The rate of item covers cost of supply of valves with ISI mark along with all jointing materials and all labours for overhauling, lowering, laying, jointing with main pipe including all jointing materials like nuts bolts, rubber packing, and testing etc. The cost shall also includes all taxes, duties, insurance etc. complete.

### **11.1.10 Payment**

Payment shall be on number basis of the completed item.

## **11.2 VALVE CHAMBERS**

The valves chambers consists the following items for construction.

- a) Excavation
- b) P.C.C. M-15 (1:2:4) for RCC valve chamber
- c) R.C.C. M-30
- d) Providing and fixing TMT Fe-500 bar reinforcement for RCC work
- e) Interior plain faced 15 mm thick cement plaster 1:3 for valve chamber
- f) Providing and fixing fiber reinforced seat and heavy duty cover in line and level in CC 1:2:4
- g) Providing and fixing PVC steps for valve chambers.

### **a) Excavation :**

The excavation for chambers will be carried out as per the general technical specifications laid down under section “D-1”, “Work in Trench Excavation and Back Filling”. The excavation shall be carried out in all sorts of strata of soil and rock. The rate includes shoring, strutting and dewatering for which no extra payment will be made. The measurement shall be carried in length, Breadth and depth. The excess excavation carried out by the contractor will be filled with approved material for which no extra payment will be made. The excavation will be paid on cubic meter basis.

- b) P.C.C. 1:2:4 for foundation levelling course plain cement concrete proportion 1:2:4 shall be “Nominal Mix Concrete”. The general technical specification as laid down for Nominal Mix Concrete in section D-6, Concrete Works shall apply to the item also. P.C.C. 1:2:4 is to be carried out for levelling course of the chamber after excavation is carried out. P.C.C. 1:2:4 will be carried out as per dimension length, breadth and thickness given in drawings. No extra payment will be made for the concrete of larger dimensions executed than shown in the drawings.

The payment will be made on cubic meter of concrete carried out.

### **c) R.C.C. M-30 for base slab, pedestal walls and slabs**

R.C.C. M-30 for different components of chambers shall be “Mix Design” and the technical specifications as laid down under section D-6” concrete works for mix design shall also apply to this item. The necessary tests for mix – design shall be carried out by contractor as directed by engineer in charge. The mix design for the concrete will be carried out by contractor at his cost. The payment will be made on cubic meter of concrete carried out.

### **d) Reinforcement – TMT bars**

The reinforcement shall be TMT bar reinforcement for different components like walls, base slab and top slab of the chamber.

The general technical specifications as laid down under section D-6, "Concrete Works" sub head materials – Reinforcement specification for TMT bars reinforcement shall apply to this item also. The TMT bars shall be paid on weight basis i.e. MT and the weight will be arrived at using the standard weight per meter length of bar of each diameter.

**e) Cement plaster 15 mm thick in C. M 1: 3**

The cement plaster 15 mm thick in CM 1:3 is to be applied to inside of walls fully and from ground level to top of the manhole / chambers on outside.

**Materials**

The proportions of the cement mortar for plastering 15 mm thick shall be 1:3 (one part of cement to three parts of sand) unless otherwise specified under the respective items of work. 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 grading of sand for plastering shall conform to IS : 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the ENGINEER. If so desired by the ENGINEER Sand shall be screened and washed to meet the specification requirements. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and removed forthwith from the site. Droppings of plaster shall not be re-used under any circumstances.

**Workmanship**

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

Plastering operations shall not be commenced until installation of all fittings and fixtures in manhole /chambers are complete

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 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.

Interior and exterior plain faced plaster this plaster shall be laid in single coat of 15 mm thickness. The mortar shall be dashed against the prepared surface with a trowel. The dashing of the coat shall be done using a strong whipping motion at right angles to the face of the wall or it may be applied with a plaster machine. The coat shall be trowelled hard and tight forcing it to surface depressions to obtain a permanent bond and finished to smooth surface. Interior plaster shall be carried out on jambs, lintel and sill faces, etc. as shown in the drawing and as directed by the Engineer. Rate quoted for plaster work shall be deemed to include for plastering of all these surfaces.

Wherever more than 20mm thick plaster been specified, which is intended for purposes of providing beading, bands, etc. This work shall be carried out in two or three coats as directed by the ENGINEER duly satisfying the requirements of curing each coat (rendering /floating) for a minimum period of 2 days and curing the finished work for atleast 7 days.

Where specified in the drawings, rectangular grooves of the dimensions indicated shall be provided in external 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.

Curing of plaster shall be started as soon as the applied plaster has hardened sufficiently so as not to be damaged when watered. Curing shall be done by continuously applying water in a fine spray and shall be carried out for atleast 7 days.

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

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

Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.

#### Measurement

Measurement for plastering work shall be in sq. m. correct to two places of decimal. Unless a separate item is provided for grooves, mouldings etc., these works are deemed to be included in the unit rates quoted for plastering work.

#### **f) Heavy duty fibre cover with frame**

The item includes providing and fixing heavy duty fibre reinforced seat and cover of approved quality and capacity. The same shall be fixed in line and level in C. C. 1:2:4 and will be finished smooth as directed by Engineer – in



– charge. The payment will be made on number basis. The rates includes transportation loading and unloading of the FRC Cover.

**g) Providing and fixing PVC steps in chamber in line and levels etc. complete.**

The steps will be plastic moulded reinforced steps with 10mm TOR steel bar with plastic polyproclene material (vergin) in concrete or masonry valve chamber. The same shall be fixed at 35 cm. C/C and 35 cm staggered or as approved by Engineer in charge. The payment will be made on number basis.

### **11.3 DI RESILIENT (SOFT) SEATED GLANDLESS SLUICE VALVES**

#### **11.3.1 SPECIFICATION:-**

- (1) All Ductile Iron resilient seated sluice valves shall be manufactured strictly in accordance with and conforming to Indian Standard specification IS:14846/ BS:5163/ AWWA C 509 Or its latest amendments and detailed specification of AMC
- (2) The valves intended to be used in water supply systems up to 70°C in vertical/ horizontal position. All the sluice valves shall be Double flanged of non-rising spindle type and shall be of PN1.0 type.
- (3) The Material of Construction for different components, parts of sluice valves shall conform to requirements given in table below:

<b>Sr.</b>	<b>Components</b>	<b>Material</b>	<b>Ref. to IS No.</b>	<b>Grade or Designation</b>
1	Body and Bonnet	Ductile iron/ SG Iron	GGG-50/40 or 1865	500/7 or 400/15
2	Stem	Stainless steel	AISI 304 / 316	
3	Stem sealing	NBR wiper ring		NBR O-rings
4	Wedge	Ductile iron/ SG Iron	GGG-50/40 or 1865	500/7 or 400/15, core fully encapsulated with EPDM rubber with integral wedge nut
5	Bonnet bolts	Stainless steel	AISI 420	Sealed with hot melt
6	Bonnet gasket	EPDM rubber	WRAS or DVGW approved	EUW-70
7	Wedge Nut	Aluminum Bronze		
8	Coating	Electro statically applied epoxy powder coating	DIN 30677-2 or GSK guide lines	Internally and externally RAL Blue colour

#### **11.3.2 Manufacturing:-**

- a) Dimensions of each part of the valve shall conform to IS:14846-2000/ BS:5163 / AWWA C 509 or Manufacturer's standard
- b) The valve shall be glandless and pocket less for smooth flow of water.
- c) The valve shall be easy in operation having negligible head loss and it shall be maintenance free.
- d) Resilient wedge with double sealing points provides absolute water tightness.
- e) Ductile Iron wedge core is fully vulcanized with EPDM rubber on all sides.
- f) The valve shall be open anticlockwise.
- g) The flange of the valve shall conform to IS:1538-1993/ BS EN:1092-2 table-9 or its latest amendments.
- h) Hand wheel:-All valve shall be provided with hand wheels as per required size. The direction of closing shall be indicated on the top of the hand wheel.
- i) The supplier shall submit a detailed G.A. drawing which is to be approved by the AMC after awarding the work. The valves shall be manufactured and supplied according to this approved drawing.

### **11.3.3 Testing:-**

The DI Sluice Valve shall be tested according to IS:14846-2000/ as per approved drawings in presence of representatives of AMC or / and AMC appointed TPI consultant. Representative of AMC or / and AMC appointed Third Party Inspection Consultant [TPI] may visit/inspect the worksite at any stage of manufacturing for inspection/testing and may reject any material which does not conform to the specified requirement. The supplier shall give at least 15 days notice period for the inspection/testing of the material. All the charges towards testing/ inspection including traveling charges of AMC representatives shall be borne by the manufacturer. T.P.I. Charges shall be borne by AMC

All valves shall be provided with enclosed greased packed spur gear box (for 400 mm dia. and above size). The valves shall be vertically operated by removable key from top accordingly the design of the shaft and Gear box shall be done. The gear box essentially be of worm and worm wheel design, self locking type with or without additional Spur gear arrangement to ensure that the effort on hand wheel is limited to 180 N pull and Push. The gear box shall be invariably of Master gear/Auma/Limitorque/ Ameya/ Transpower/BEL-Bombay Engg. Lt/Safex/New-Tech/Perfect Engg. only with operating torque as per AWWAC-504 rating.

### **MARKING:-**

The following information shall be cast/punched/painted on each valve body in raised letters.

- (a) The manufacturer's name or trade mark.
- (b) The nominal pressure of valve.
- (c) The size and serial number of valve.

- (d) Year of manufacturing.
- (e) Heat number of cast.
- (f) AMC/ or any other mark.

**Packing:**

All valves shall be supplied with the wedge close Valve of small diameter may be packed in wooden case parts liable to injury in transit shall be wrapped with wood-wool or similar material as a protection.

**Vendor List**

The Vendor for Valve shall be as per Vendor list given in Mechanical Specification.

Mode of Measurement and payment:

The rate shall be paid in Nos. basis.

**11.4 Butterfly Valves with ISI mark IS-13095/BS:5155 with PN 1.0 - Gear operated**

SCOPE – Fabricated valve will not be considered.

This standard cover double flanged and wafer type of metal seated, resilient seated cast iron, ductile iron, and carbon steel and lined butterfly valves for general purpose. Valves covered under this standard are manually, pneumatically, hydraulically or electrically operated.

It covers valves of nominal pressure designations up to and including 4 Mpa. and class 300 with ends flanged in accordance with appropriate table of I.S 6418 : 1971 ‘Cast iron and malleable cast iron flanges for general engineering purpose’ or wafer type valves with bodies designed to be accommodate between pipe work flanges in accordance with appropriate table of IS 6418 : 1971 or IS 6392 : 1971 ‘steel pipe flanges’ in nominal size DN 40 to DN 2000. It also covers valves up to class 300 and flanges as per the pressure/temperature ratings given in IS 13159 ( Part 1) : 1991 ‘steel pipe flanges and flanged fittings : part I dimensions’ and IS 6418 : 1971 ‘cast iron and malleable cast iron flanges for general engineering purposes’.

**11.4.1 REFERENCE**

The Indian standards are necessary adjuncts to this standard.

**11.4.2 TERMINOLOGY AND DEFINITIONS**

Terminology and definition covered in IS 4854 (Part3) : 1974 are generally applicable.

### **11.4.3 VALVE END CONNECTIONS**

Double flanged valves

A valve having flanged ends for connection to pipe flanges by individual bolting.

### **11.4.4 SERVICE APPLICATIONS**

Valves shall be suitable for one or more of the following applications.

- (a) Tight shut off - A valve having no visible leakage on the disc in closed position under test conditions.
- (b) Regulating - A valve intended for regulating purpose and which may have a clearance between the disc and the body in close position.
- (c) Low leakage - A valve which has specified maximum leakage rate on the disc in the closed position.

Vacuum Condition

Where valve are to be used under vacuum conditions, purchaser shall mention specifically and the detailed design provision shall be mutually agreed between the purchaser and the manufacturer.

### **11.4.5 NOMINAL SIZES**

The range of nominal valve size (DN) in mm shall be as follows:

40, 50, 65, 80, 100, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 750, 800, 900, 1000, 1200, 1400, 1600, 1800 and 2000

### **11.4.6 NOMINAL PRESSURES**

Valve shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (Mpa) at 20 °C temperature as follows:  
PN 0.25, PN0.6, PN1.0, PN 1.6, PN 1.25 and PN4.0

The class designation for valves specified by nominal pipe size shall be class 125, class 150 and class 300.

### **11.4.7 PRESSURE / TEMPERATURE RATINGS**

Maximum permissible gauge working pressure and operating temperatures shall be in accordance with IS 6418 : 1971 and IS 13159 ( Part I ) : 1991 except that restriction on temperature may be placed by the manufacturer on valves in accordance with this standard by reason of valve type, trim materials or other

factors. However, all valves shall be suitable for continuous use at their PN designation within the temperature range of  $-10^{\circ}\text{C}$  to  $65^{\circ}\text{C}$ .

#### 11.4.8 BODY ENDS

##### Double Flanged Body Ends

The dimensions of flanged body ends and drillings shall be in accordance with the requirement given in Annex B. Flanges as per any other specific requirements of the purchaser may also be given as agreed to between the manufacturer and the purchaser or as per I.S. 13159 ( part I ) : 1991.

Flanges shall be at right angles to the axis of the bore and concentric with the bore. Flanges shall be drilled unless otherwise specified and bolt holes shall be off centers. Tapped by the design of the valve

##### Wafer Body Ends

Body ends shall be capable of being fitted between the pipe flanges complying with the requirements of annex B flange drilling.

The joint faces shall be at right angles to the axis of the bore and concentric with the bore.

Holes may be provided, where required by the design, for the passage of the bolts securing the flanges and the valve. Where through bolting is not practicable due to the presence of valve shaft, bearing housing, tapped holes may be provided for individual bolting of each flange.

#### 11.4.9 FACE TO FACE DIMENSIONS

Face to face dimensions of double flanged and wafer types of valve shall be as per Table 1.

Face to face dimensions given in Table 1 are exclusive of the sealing gaskets at both ends.

The manufacturer shall ensure that adequate space will be available between valve flanges for bolting when flanged valve with short body face to face to face or wafer long face to face are manufacture

Tolerance on face to face dimension in Table 1 shall be as follow

Face to face dimension of Unlined valve MM		Tolerance MM
Over	Up to and Including	
0	250	$\pm 2$
250	500	$\pm 3$
500	800	$\pm 4$
800	100	$\pm 5$

1000                      2400                       $\pm 6$

#### 11.4.10 BODIES

Bodies end ports shall be circular and the numerical valves of the diameter shall be as close as possible to the valve of DN.

#### 11.4.11 DISC AND SHAFT

The disc and shaft shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The shaft may be of one piece design or in two pieces separately attached to the disc. Any means of attachment between the shaft and the disc shall be such as to preclude components becoming loose in service.

#### 11.4.12 SEATING AND LININGS

Non-integral seating, and lining shall be used, and their means of attachment shall be such as to preclude their becoming loose in service.

#### 11.4.13 BEARINGS

The bearings shall be suitable for the maximum loads imposed by the shaft during testing and in service.

For valves DN 350 and above, a bearing shall be provided to take the axial thrust, spring retaining clips (circlips) shall not be used as thrust bearing.

Suitable sealing shall be provided for the shaft where it passes outside the pressure containing enclosure.

#### 11.4.14 MATERIAL OF CONSTRUCTION

This standard is based on materials specified in I.S.S. Unless otherwise agreed, the materials shall be of a grade equivalent to those given in I.S.S. or superior. Other material may be used as per agreement between the manufacturer and the purchaser. The material of construction shall be as per table given below

Sr. No.	Part Component	Pressure Rating (1 Bar + 1 atmosphere)
1.	Manufacturing / design std	BS:5155, IS:13095, AWWA C-504
2.	Pressure rating	PN-1.0, PN-1.6, PN-2.5
3.	Flanged ends	IS:1538 or optional
4.	Body and disc material	DI to GGG-40/50 or grade as per /IS:1865
5.	Body Seat	Nickel weld overlay micro finished
6.	Trims	Stainless steel
7.	Disc Seal	EPDM / Nitrile rubber
8.	Special features	<ul style="list-style-type: none"> <li>Epoxy power or liquid quoted inside and outside for protection from corrosion</li> <li>Integral seat</li> <li>Low torque</li> </ul>

		• High performance gear box
		High rating PN-4.0 on request

The material of construction of Gear Box for valves shall be as per table given below

Sr. No.	Description	Materials
1.	Gear Case & Cover	Cast Steel ASTM A 216 Gr. WCB or S.G Iron to IS 1865 Gr. 400/15
2.	Sector Gear	I. / S.G.I. IS 1865 Gr. 600/3
3.	Worm / Shaft, spur Gear /pinion /shaft	BS 970 EN 19 / EN 24
4.	Fastners / Dowels	SS 316 / SS 304
5.	O – Rings	Nitrile Rubber with Shore hardness of $65 \pm 5$
6.	Bearing for shaft	Ball / Roller bearing.

#### 11.4.15 OPERATION

##### Manual Operation

All valves shall be capable of operated at a differential pressure across the disc as marked on the valve. Lever, worms gear / travelling nut type or any other suitable type of operator can be use

##### Direction

Unless otherwise, specified manually operated valves shall be closed by turning hand wheel or lever in a clockwise direction when facing the hand wheel or lever. The design of lever when fitted shall be such that the lever may only be assembled to the valve so that it is parallel to the direction of flow when the valve is open.

All gear travelling nut operators shall be provided with suitable stops to prevent movement of the shaft beyond the limit corresponding to the fully closed position of the disc.

All gear travelling nut operators shall be packed with grease for life time operation. Gear / travelling nut operators shall be totally enclosed and weather proof for general application. For special applications such as marine, submerged service etc. the purchaser may specify special en-closer.

All gear / travelling nut operators shall be self locking type. All leaver operated valve shall be capable of being locked at least three intermediate position.

The operating hand-wheels shall be marked 'CLOSE' or 'SHUT' to indicate the direction of closer.

The operator shall be provided with arrangement to indicate the disc position.

#### 11.4.16 TESTING

All valves shall hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint or other similar treatment unless otherwise agreed between the purchaser and the manufacturer. There shall be no air entrapped within the part of the valves subjected to test pressure.

##### Performance Testing

Each valve shall be shop operated from fully closed to fully open position and reverse, under no pressure and no flow condition to demonstrate that the complete assembly is workable.

##### Body Test

Completely assembled valve shall be tested as follows:

‘The body ends shall be blanked so that the valve is subjected to the full pressure in all directions include by the test pressure wafer valves may be tested in any suitable manner agreed between the purchaser and the manufacturer. The valve disc shall be in slightly open position and pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of this test shall be as in Table 3 below in Para 17.3.

##### Seat Test

The seating surface of the valve shall be cleaned unless a surface treatment forms an integral part of the design or the use of a temporary surface treatment has been agreed between the manufacturer and the purchaser to avoid the possibility of damage under the condition of the test.

NOMINAL DIA MM	MINIMUM TEST DURATION IN MINUTES	
	BODY TEST	SEAT TEST WHEN APPLICABLE
Up to and including 50	0.25	0.25
65 to 150	1.00	1.00
200 to 300	2.00	2.00
350 to 1000	5.00	2.00
1200 to 2000	5.00	3.00

Each valve shall be shop tested for leaks in close position. The test shall be conducted with the body flanges in a horizontal position. Pressure shall be applied to the upstream end of the valve, the downstream being open to atmosphere. The duration of test shall be as per Table above. There shall be no indication of leakage past the valve disc during test and valves shall be drop tight. Seat test shall be carried out in both the direction of valve if agreed between the manufacturer and the purchaser. The seat pressure applied on upstream side shall be equivalent to 1.1 times the maximum permissible working pressure at 20 °C and shall be applied with water.



For regulating type valves seat test shall not be applicable.

#### **Disc Strength Test**

The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure at 20 0 C With disc in closed position, hydro test pressure shall be applied to the lower face of the disc for duration as per table-3. There shall be no damage to the valve disc nor shall any part of valve or disc be permanently deformed by the test. The purpose of this test is to provide evidence of the adequacy and structural integrity of disc and body. Any leakage past the seat shall not be the criteria for rejection of the valve (Sampling test sample as per IS 2500). For regulating type valves, disc strength shall not be applicable.

Maximum permissible leakage shall be as given in Table in para 18.0.

#### **11.4.17 TEST CERTIFICATES**

When specified by the purchaser, 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.

<b>VALVE TYPE</b>	<b>LEAKAGE RATE</b>
Tight shut-of	No visible leakage for duration of test
Low leakage	0.1 mm <sup>2</sup> /s X DN (sec 5)
Regulating	Not specific Outside the scope of this standard

#### **11.4.18 INSPECTION**

The purchaser or his authorized representative shall have access to the manufacturer's works at all reasonable times to inspect assembled valve at factory. The bidder has to make necessary arrangements for testing facilities of the valves as per the relevant IS at factory.

#### **11.4.19 WITNESSING OF TESTS**

When the purchaser desires to witness the tests, this shall be specifically agreed in advance.

#### **11.4.20 MARKING**

Marking shall be cast integral on the body or on a plate securely attached to the body. The markings shall be in accordance with I.S. 9866: 1981.

#### **11.4.21 PREPARTION FOR DISPATCH**

- (a) Valve shall be complete in all respect when dispatche Each valve shall be drained, cleaned, prepared and suitable protected with 2 coats of red oxide on unmachined surfaces and rust preventive coats on machined and flanged surfaces for dispatch in such a way as to minimize the possibility of damage and deterioration during transit and storage. Painting other than specified on the finished valve shall be as per the agreement between the manufacturer and the purchaser.
- (b) Disc shall be unseated when dispatched, but care shall be taken to ensure that there is no risk of damage to the disc.
- (c) When specified, the body ends shall be suitably sealed to exclude foreign matter during transit and storage.
- (d) Components shipped unattached shall be adequately protected and identified to permit correct field assembly.

#### **11.4.22 MODE OF PAYMENT**

The payment will be made on No. basis.

### **11.5 TAMPER PROOF DOUBLE ACTING KINETIC AIR VALVES**

Tamper proof double acting Kinetic Air Valves are to be supplied which shall be designed as per IS 14845 / AWWA C512-92 standards.

#### **11.5.1 GENERAL**

The double air valves shall have two ball chambers, having one outlet of large capacity for admission and release of bulk volume of air during emptying and filling of the main and another having small outlet for escape of smaller quantities of entrapped air. This type of air valves shall be of flanged type with full conformation with IS:1538.

The ball sealed orifice always remains open while air is exhausting and is immediately closed when water rises in the chamber, lift the ball and seals the orifice. It shall also ensure that there are no recesses or pockets, sheltering, escaping air for the large orifice (low pressure) valve to drop into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball to blown into when the valve is open. Turbulent air at the time of filling of pipe shall not circulate in such cavities and cause the ball blown into the discharging air streams, blowing the valve shut prematurely.

The cone angle of the lower pressure chamber shall be such that even at the critical velocity of air escape at 300 m/sec. The total impact force on the ebonite covered ball is less than the suction force on the angular area between the ball and the cone. The design of the valve should be such as to allow maximum free air discharge at various pressure differentials. The tenderer shall submit with the tender full set of curves showing discharge of free set of curves showing discharge of free air valves pressure differential for all sizes of valves offered by him.

Under no circumstances shall be large orifice ball blow shut prematurely.

The low pressure cover shall be massive and designed to withstand full operating thrust in working conditions.

Air valve shall be design to prevent premature closure prior to all air having been discharge from the line. The orifice shall be positively sealed in the close position but float ( Ball) shall only be raised by the liquid and not by mixer of air and liquid. The sealing shall be design to prevent the floats sticking after long period in the close position.

All branched outlets including outlets for Air valves will be with compensation pads (Dia of Main / For branch Dia ratio greater than 3). Diameter of compensation pad will not be less than 1.75 times the O. of the branched outlet. Plate thickness for pads will be same that of the main.

For outlets with above ratio less than three, then the joints will be of plate reinforcement type.

All branched outlets including air valve tee's will be provided with one ½" BSP coupling duly plugged for measurement of pressure in due course. The closing plug will be in Stainless Steel (AISI 304 or equivalent) with Hex. Head and will be provided with copper washer for sealing.

The neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

The valve body, the orifice cover, cowl of the air valves shall be made of cast iron of grade 2 of IS:210.

Where tenderer considers necessary a suitable drain plug shall be provided

### **11.5.2 HIGH PRESSURE ORIFICE**

The high pressure orifice and the high pressure chamber shall be so designed that the orifice is effectively sealed in working conditions by "EPDM" coated float.

The material of the orifice shall be gunmetal. The orifice shall be of size not less than 3 mm and tapering to 100 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be carefully chosen to avoid damage to the float surface. The orifice shall be protected by a suitable plug of stainless steel.

### **11.5.3 VALVE FLANGES**

All valve flanges shall be designed to withstand the stresses to which they would be subjected under hydraulic tests. Flanges shall be machined flat. The flanges shall be drilled in accordance with IS:1538 (part – I to XXII) – 1976 (specifications for C. I. Fittings for pressure pipes for water etc.)

#### **11.5.4 COATING**

The casting shall be such that it shall not impart any taste or smell to water. The coating shall be smooth, glossy and tenacious, sufficiently hard so as not to flow when posed to a temperature of 770 C and not so brittle at a temperature of 150 C as to chip off when scratched lightly with the point of penknife.

Alternatively, two coats of black Japan conforming to type 8 of IS 341-1971 (Or latest edition) or paint conforming to type – 2 of IS 158-1969 (OR latest edition) shall be applied.

#### **11.5.5 TAMPER PROOF AIR RELEASE VALVES**

The bidder has to supply tamper proof Air Release Valves.  
The valves shall be

- (i) 100% tamper proof
- (ii) Zero water leakage
- (iii) Unaffected by strong air flow
- (iv) Maintenance free

The tamper proof air release valve shall have following:

- (i) Double orifice & double float.
- (ii) Stainless steel large & small float.
- (iii) Stainless steel guiding stem for large float shall give 100% perfect closing.
- (iv) Aerodynamic bucket design for maximum airflow & which should restrict entry of foreign material.
- (v) Integral vent welded to inverted cap made of MS should restrict tampering of Air Release Valve large orifice.
- (vi) Small orifice automatic valve vertically assembled should discharge small quantity of dissolved air / air pockets automatically.
- (vii) Design shall be as per AWWA C512-92 standards.
- (viii) Air Release Tamper Proof Valves shall be tested as per IS 14845 – 2000.

**11.5.6 MATERIAL OF CONSTRUCTION OF KINETIC AIR VALVES**

Sr. No.	Kinetic Air Valves	Material Description PN 10, PN 16 / PN 25
1	Body	Ductile Iron DIN 1693-GG40/ Spheroidal Graphite Iron IS 1865 Gr 400/15
2	Float (Large)	Stainless Steel : ISI – 304 / 316 / 316L
3	Nozzle	Gun Metal : IS 318 LB2 / GM + Neoprene Rubber
4	Gasket	Rubber : Neoprene
5	Cover	Carbon Steel : Plate
6	Fasteners	Carbon Steel : IS 1363

**11.5.7 TESTING**

The air valves shall be tested as per IS 14845 – 2000. The air valves shall withstand 1.5 times the working pressure. The joints and air valve shall be water tight. During test if the joints of air valve are found leaking or the air valve is found not functioning properly then the same shall be got rectified or replaced by the contractor to the satisfaction of Engineer-in-charge.

**Vendor List**

The Vendor for Valve shall be as per Vendor list given in Mechanical Specification.

**11.5.8 MODE OF PAYMENT**

The payment will be made on No. basis.

**11.5.9 Fixing of Valves :** All type of valves shall be lowered and fixed in proper position and right to the plumb and flange joints with the sets of tail pieces shall be carried out perfectly water type. Nut, bolts, rubber insertion etc. required shall be got approved by the Engineer in charge of AMC.

## **12.0 SPECIFICATIONS FOR PILE FOUNDATION WORKS**

### **12.1 General :**

- 1 These specifications cover reinforced cement concrete driven / bored cast in situ piles including all related items of work like sand filling in the holes left after casting the piles, chipping off a small length at the top, load test on a single and/or groups of piles, taking cores for ascertaining strength of concrete in pile etc. The relevant clauses of the specifications for concrete plain and reinforced as per relevant IS codes, fall within the scope of these specifications.

#### **2 Extent of Contractor's services :**

The work to be provided for by the contractor, unless otherwise specified, shall include but not be limited to the followings :-

- (a) Furnish all labor, supervision, services, materials, piling equipment, tools, plants, transportation etc. required for the work for pile foundations conforming to the detailed drawings or as may be specified, including all surveying and setting out arrangements necessary for fixing correct locations of piles etc.
- (b) The identification plan showing the proposed sequence of piling will be prepared on the basis of plan furnished by the engineer and get the same approved from the competent authority before commencing pile work.
- (c) Submit in prescribed form detailed daily report of piling work done giving all information as required by the Engineer – in – charge.
- (d) Furnish details of the pile driving boring and casting equipment giving all salient dimensions and loads.
- (e) Carry out tests to the satisfaction of the Engineer-in-charge including casting and dismantling test caps if done and submit the test results in prescribed data sheet as given under Appendix – D in pursuance to provision under Clause 7.13.2 of IS. 2911 (Part I/Sec 2) 1979.
- (f) Make necessary earthwork and approaches for movement of the equipment for execution specified, and cleaning up the works area etc.
- (g) Provide all necessary work mentioned under the “Technical Specifications for concrete, plain and reinforced: as per relevant IS codes as may be applicable.

### **3 Work provided by others :**

No work under these specifications, will be provided by any agency other than the contractor unless specifically mentioned otherwise elsewhere in the contract.

### **4 Codes and specifications applicable :**

The following Indian standard codes and specifications, unless otherwise specified herein, shall be applicable.

- i) IS : 269 - Specifications for ordinary and low heat port land cement.
- ii) IS : 432 - (All parts) Specifications for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement.
- iii) IS : 455 - Specifications for portland and reinforced concrete.
- iv) IS : 456 - Code of practice for plain and reinforced concrete.
- v) IS : 2720 - Method of tests for soil (Part – I)
- vi) IS : 2911 - Code of practice for design and construction of pile foundations part I (all sections) concrete piles.
- vii) IS : 3385 - Code of practice for management of civil engineering works part I pile foundation.
- viii) IS : 5121 - Safety code for piling and other deep foundations.

Other IS codes pertaining to the items of piling work and not listed above shall also deem to come under the purview of this clause. The provision of special conditions of contract those specified on the execution drawings or other specifications issued in writing by Engineer-in-charge shall also form part of these specifications.

All codes and standards referred to in these specifications shall be of the latest version. Where IS codes are not available, a reference to British Standards / Codes will be made.

### **5 Conformity with designs :**

The contractor will prepare check list in approved Performa which will be called “Pile Installation Card. At each important stage of the work as decided by the Engineer-in-charge for correctness and conformity with the design, specifications and drawings, before allowing the next phase of the work to

Commence. These intermediate checks and approval by the Engineer – in-charge will not, however absolve the contractor from his total responsibility to execute the work as per the specifications and drawings and to remove and / or rectify all work which is defective or inaccurate.

**6 Soil Data :**

The information as to the bore hole log details and soil investigation report, are given in good faith and for general guidance only. The client will not be responsible for any discrepancy or inaccuracies therein and shall not entertain any claim whatsoever from the contractor on the basis if the same.

**7 Other Data :**

Nothing contained in this contract documents or these specifications shall relieve the contractor from the responsibility of obtaining the approval from the Engineer-in-charge, the pile installation procedure to be followed by him. During the execution of the work, should any error or inconsistencies appear in any of his contract documents, the contractors shall not proceed with the work before obtaining instructions / clarifications from the Engineer-in- charger.

**8 Site Inspection :**

The contractor is directed to inspect the site and satisfy himself about the working conditions, availability of approach, facilities of water, power utility services etc. and he shall be deemed to be aware of all the site conditions in so far as the requirements of carrying out pile foundations is concerned.

**12.2 Materials :**

**1 General :**

All materials whether incorporated in the works or used temporarily for executing will be of the best approved quality conforming to the latest Indian Standard Specifications.

**2 Concrete & Reinforcement :**

The relevant clauses in the specifications for concrete, plain and reinforced, enclosed are applicable. If no specific specifications are enclosed, the relevant IS Codes are deemed to form part of this specifications.

**3 Drilling Mud (Bentonite) :**

**(a) General :**

For soft soils if required drilling mud (bentonite) will be used. The specification of the same are as under.

Drilling mud corresponding to basic properties given under appendix A under Clause – 4.3 of Part I – IS –2911 Sec – 2 shall be used to keep



The sides of the bore holes established Mud shall have THIXOTROPIC Properties i.e. gel forming property. The drilling mud shall have such properties as to permit the formation of filter cake on the sides of the bore holes, the thickness of which would depend on the nature of the subsoil deposit. Sodium based bentonite have ideal properties suitable for use as drilling mud.

**(b) Specification / Properties**

The suspension used for pilling work shall satisfy the following requirements.

Fresh sodium based bentonite shall have :

- (a) The liquid limit of bentonite when tested in accordance with IS 2720 (Part V) shall be more than 300 percent and less than 450 percent.
- (b) The PH value of 5% bentonite suspension shall be between 8 & 11.5%.
- (c) The free water standing after 24 hours of 10% suspension of 100 cc be only a thin veil of water.
- (d) Sand content of bentonite powder to be not more than 7 percent.
- (e) The Marsh viscosity of 5% suspension when tested by Marsh cone should be around 37 seconds.
- (f) The 10 minute gel strength of fresh 5% bentonite to be between 10 to 75 Kg. Sq.m.
- (g) The density of the bentonite solution should be above 1.11.

**(c) Reuse :**

During boring operations fresh suspension gets contaminated with bored soil and gradually becomes heavy. This contaminated bentonite may be reused depending upon the manner of boring, type of strata encountered and the specific gravity of the contaminated bentonite. It is essential to check the specific gravity of the bentonite in the bore holes before concreting. The contaminated bentonite may be collected in a suitable receptacle and allow the heavier practices to settle and the slurry washed before reuse.

**(d) Disposal :**

The drilling mud shall be suitably disposed off without causing any nuisance to the surrounding area in a manner to be approved by the Engineer-in-charge.

**4 Storage of Materials :**

The relevant clause pertaining to storage of materials under specification for concrete plain, reinforced and prestressed as per relevant IS Codes will apply.

### **12.3**

#### **Installation :**

All Installation requirements for bored pile shall be accordance with IS : 2911 (part I) sec-2 and as supplemented or modified herein or by other best possible standards to the satisfaction of the Engineer-in-charge where the specific requirements mentioned in this section of the specification wherever not covered fully in all aspects.

#### **1. General :**

The tenderer is supplied with details of bore hole log or any other data indicating the probable nature of the soil strata expected at the site. All piles will have to be bored / driven to the required founding level as shown on the drawings or as may be decided by the Engineer-in-charge.

#### **2. Type of pile :**

##### **(i) Type**

All piles shall be driven or bored cast-in-situ concrete piles reinforced as per design requirements.

For any type of pile adopted and in spite of different methods of installations, concreting, etc. the load carrying capacity of single and group of piles shall not be less than the design loads indicated on the drawings.

##### **(ii) Diameter :**

The casing / boring shall be of such diameter as to give the necessary specified nominal diameter of the concrete pile. In general, the measurement of the diameter of the pile shall be as follows :-

- (a) For cast in situ bored piles, employing temporary casing withdrawn during the placing of the concrete, the nominal diameter shall be the outside diameter of the temporary casing.
- (b) For cast in situ bored piles with permanent liner, the nominal diameter shall be the inside diameter of the permanent casing left in place.
- (c) For partly lined or unlined bored cast in situ piles using drilling mud, the nominal diameter shall be the inside diameter of the guide liner (temporary or permanent)
- (d) The size of the cutting tool shall not be less than the diameter of the pile by more than 75 mm.
- (e) The contractor may however be required to demonstrate to the Engineer-in-charge, if so called for by him, that the diameter of

the bore hole for its full length is not less than the nominal diameter specified and this may be done by lowering a guide ring having a diameter equal to the nominal diameter of the pile into the bore hole before concreting the pile or lowering the reinforcement cage.

**3. Identification of Pile :**

A plan showing clearly the designation of all piles by identification system shall be filled with the Engineer-in-charge before installation of piles is started, if so desired by the Engineer-in-charge.

**4. Piling Sequence :**

The piles shall be installed in such a sequence that the carrying capacity of previously installed piles is not reduced or there is no appreciable upheaval of ground causing unusual soil resistance to rest of the pile driving or the soil is not flowing laterally during driving operation. The Engineer-in-charge shall decide on the sequence of the groups of piles that the contractor shall undertake for construction and the contractor shall have to follow this sequence.

**12.4 Workmanship & Construction of Piles :**

**(a) General :**

- (1) Piles shall be constructed by acceptable method which leaves their strength unimpaired and which develops and retains the required bearing resistance. Equipment and the method of construction of the pile shall be such that the pile is installed in its proper position alignment and truly vertical.
- (2) Piles construction shall be carried out by using standard bored piling process. Piles shall be cased with mild steel liner of required thickness which shall be provided up to depth shown on the detailed working drawing supplied by the Engineer-in-charge.
- (3) For uncased piling for boring beyond the depth of M. S. casing shall be done using bentonite slurry to prevent the subsoil from caving. This shall be of approved quality and standards as prescribed under detailed specification for pile foundation work given in the document. The boring shall start from the level as indicated in the drawings.
- (4) Further, for all types of bored piles including the use of open-end casing, the tenderer shall submit, in view of sub-soil water being present in the bore hole, particulars of concrete placement method so as to reduce to a minimum, the contact of fresh concrete with ground water. It is imperative that the bore hole shall exclude any subsoil material before placement of reinforcement and concrete inside the casing or bore hole. Details of the concrete placing equipment and/or any other process intended to be used by the tenderer for such conditions, shall be fully described.
- (5) The reinforcements of the pile should project out, above the top level of the pile by a minimum length of 600 mm or as specified, to be later or

- bent and embedded in the pile cap concrete.
- (6) Concrete shall be placed and compacted at least up to 300 MM above the cut-off level and the ground level shall be filled up with sand so that the next pile does not move out of place during construction.
  - (7) To construct the pile cap, the ground will be excavated to expose the top portion of the piles, which will be dismantled neatly up to the cut-off level, removing all cracked, loose and unsound concrete. The top surfaces of the piles will be kept rough and treated by keeping wet and application of Neat cement coat, before concreting of pile cap to ensure bond with the pile cap concrete in which they will be ultimately embedded.
  - (8) In case, the casing is directed to be removed, care shall be taken to ensure that there is no gap left in the concrete of the pile and that the reinforcement are not displaced.

## 12.5

### Quality control :

The contractor shall maintain quality control for all items of work including materials and every stage as may be directed by the Engineer, to ensure compliance with contract specifications and shall maintain and submit to the Engineer, records of the same. The quality control requirements stipulated under the specifications for “Concrete Reinforced and Plain” will apply wherever relevant. In addition, the requirements will include but not be limited to the following:

- |                        |   |   |
|------------------------|---|---|
| (a) Location & Plumb   | : | Control survey for accuracy in plan and check for verticality.  |
| (b) Driving            | : | Correlation of weight of hammer, length of strokes, number of strokes per minute and rate of penetration.   |
| (c) Boring             | : | Prevention of any cave-in of subsoil.   |
| (d) Casting of piles   | : | Check inside casing or boring as the case may be, reinforcement cage, concrete mix, placing, consolidation. |
| (e) Inspection of pile | : | Taking core for ascertaining homogeneous and compactness of concrete.                                       |
| (f) Load tests         | : | As prescribed under these documents if any.   |

## **12.6 Concrete in Piles :**

### **(a) General :**

This shall conform to the specifications for cement concrete- plain and reinforced as per relevant IS codes to the extent it has been referred to or applicable for this purpose. The concrete shall be as per design mix specified & of approved quality. The entire depth of the pile shall be concreted in one operation without stoppage. All concreting operation for piles shall be carried out during day time only. Exposed portions of piles shall be cured for at least 10 days from the date of casting. When installing the piles in groups, sufficient time shall be allowed for freshly poured concrete in pile to set before installing adjacent piles. The Engineer-in-consultation with the contractor shall determine the installation sequence and time schedule to ensure that freshly concreted piles are not damaged due to installation of adjacent piles.

### **(b) Materials :**

Unless otherwise called for on the drawings or in the bills of quantities, the concrete shall be of grade M-30 and shall have a cement content not less than 410 Kg/Cu.m. for concrete.

Cement shall be ordinary port land cement conforming to I.S. : 269 unless specified otherwise. Maximum size of aggregate shall be 20 mm.

### **(c) Volume check :**

Concreting shall start as soon as possible after driving is closed and pile tube or completion of boring. Concrete shall be so placed as to fill the entire volume of the hole without segregation and formation of voids caused by faulty consolidation or entrapped air. The volume of concrete placed shall be observed in the initially cast piles and the average figure obtained shall be used to check whether there is undue deviation in concrete consumption and if so the same shall be brought to the notice of the Engineer without further work on piling.

### **(d) Consistency :**

Where the concrete is cast in place in an open-end tube, its consistency shall be suitable to the method of compaction employed in the formation of piles. If necessary concrete shall be as dry as possible to minimize shrinkage and the possibility of cement being washed down by flow is withdrawn. plasticising agents may be used by the contractor to improve the workability but the Engineer may be furnished with proof that the proposed plasticising agent has no adverse effects on the hardened concrete of reinforcement. Care shall be taken against segregation of concrete while passing through the reinforcement cage, and against inflow of soil and water during withdrawal of the tube, if such method is adopted by maintaining sufficient head of concrete inside the tube. The extraction of casing shall not cause any shearing or necking of the poured concrete thereby reducing the capacity of the piles.

If it becomes necessary to place concrete through water, this should be done with special equipment and necessary precaution in conforming with contractor's specification as may be got approved by the Engineer. As per Clause 6.3.4 of IS 2911 (Part I /sec 2) slump of concrete shall range between 100 to 180 mm. depending on the manner of concreting.

**(e) Testing :**

At least one test shall be made for every 15 m<sup>3</sup> of concrete and not less than six cubes shall be cast on each day of concreting of piles. Three of the six cubes constituting one test shall be tested on the 7<sup>th</sup> day from casting the cubes and the remaining three cubes shall be tested on the 28<sup>th</sup> day after casing. Tests of all cubes shall be carried out in presence of Engineer-in-charge or his representative.

**(f) Acceptance**

The Engineer reserves the right to reject any pile of deficient concrete strength. Such rejected piles shall be replaced by the contractor at his own cost who shall also bear the additional cost of widening the pile cap resulting from the grouping if the piles as result of replacement of piles. The Engineer also reserve the right to order a change in the mix design and/or water cement ratio to obtain the specified strength of workability if so considered necessary during execution.

**12.7 Reinforcement in Piles**

Reinforcement conforming to IS : 432 , IS : 1139 or IS : 1786 grade suitable for cement concrete as per IS specifications for reinforcement concrete for general building work shall be applicable for this specification to the extent it has been referred to or acceptable.

Reinforcement used in cast in situ piles shall be made up into cages sufficiently well wired or span welded to withstand handling without damage. The bars shall be so spaced as not to offer obstruction in placing concrete. Care shall be taken to preserve correct cover and alignment of reinforcement throughout the operation of placing the concrete. Any distortion or displacement of reinforcement during the compaction of concrete or while extracting the tube, shall be avoided.

Joints in longitudinal reinforcement bars, if unavoidable, shall be made by lapping and the laps shall be tack welded to prevent distortions of the reinforcement cage. The lap length of longitudinal bars beyond the pile cut-off level shall be as shown on the drawings.

Unless otherwise specified in the drawings, the lateral reinforcement shall consist of a helix made from 8 mm. dia. bars at a pitch of 150 mm. through out the length of the reinforcement cage.

Concrete cover over all reinforcement including lateral helical reinforcement shall be 50 mm. unless otherwise specified or shown on the drawings.

Care shall be taken to preserve the correct cover and alignment of reinforcement free from any twist, throughout the whole operation of placing the reinforcement in the bore hole and placing the concrete.

## **12.8 Dowels :**

The contractor shall provide necessary dowels is as directed by the Engineer if so required.

### **1. Inspection**

For cast in situ, bored, piles, the contractor shall get the bore hole inspected by the Engineer in charge for proper plumb, location, compaction of founding surface, pressure of water and other requisites. The diameter of the hole may also be checked in the case of bentonite slurry bored pile by lowering a guide ring through the depth of the hole. The depth of the bore hole shall be measured by means of a chain to which a plumb bob weighing not less than 250 gm. Is attached. The contractor shall provide all the equipment required for the above inspection and he shall co-ordinate this work with the Engineer in charge. Concreting shall start only after the Engineer has approved the bore hole. All facilities, equipment and labor required for inspection by the Engineer mentioned above shall be provided by the Contractor promptly and free of cost.

### **2. Record of Installation of Piles :**

A joint record shall be maintained by the contractor in a Performa approved by the Engineer, of the entire penetration for every pile and the behavior of such pile during its entire process of construction as per IS 2711 (part I) Section 2. These records shall be submitted to the Engineer-in-charge regularly as the job progresses. Any sudden change in the rate of penetration which can not be ascribed to the nature of the ground or any deviation from the designed location, alignment or load carrying capacity of any pile or any upheaval or subsidence noticed on any pile driven under this contract or already existing, during construction of other piles, shall be promptly reported to the Engineer-in-charge and adequate corrective measures shall be taken free of any charge as may be decided by the Engineer-in-charge. The records of such additional borings or other subsurface information that were obtained during the process of installation shall also be filed with the Engineer in charge.

### **3. Pile capacity, quality and tolerances**

#### **(a) Working load on piles**

General specifications of pile foundations and its details are given in the tender for general information.

The capacity of the piles in place shall be verified by conducting “Routine Load Tests” on working pile as describe hereinafter.

For bored piles, the characteristics, thickness and inclination of the subsoil strata under laying the pile points shall be taken into account for estimating the extent of settlement of the pile due to consolidation of the soil below, while evaluating the allowable load on pile.

The contractor shall submit his findings on the allowable carrying capacity of a single pile from the load test. This shall then be reviewed by the Engineer and the allowable carrying capacity of each pile and group piles shall be decided by him in consultation with the contractor. The decision of the Engineer in charge regarding the allowable load on the piles shall be final.

The layout and number of piles and the size and details of the pile caps may have to be revised if the decided allowable loads on each single pile in a group differ from the above value and the contractor shall have to do the work according to the revised design and drawings at no extra cost or expenses to the client.

If the load test results indicate that the piles, already constructed are deficient in load carrying capacity, such deficiencies shall be made good by the contractor in the manner as may be approved by the Engineer, at no extra cost to the client.

**(b) Quality :**

The contractors shall guarantee the full cross section of the pile for its entire length and also guarantee against the occurrence of necking or wasting, bulging, spilling of pile sheaft concrete and similar defects which will impair the strength and durability of the pile.

**(c) Tolerances :**

The pile shall be installed truly vertically as per the detailed design required within the following permissible tolerances. The position of the pile at the level of the bottom of the pile cap shall not vary more than 75 mm in any direction from the positions specified in the drawings. The alignment shall not vary by more than 2% (about 1 degree) from the vertical axis or the specified batter. The above two allowances, however, shall not be cumulative.

**(d) Defective Piles**

Piles that are defective or where the deviation in alignment of the tube or base is more than that tolerance specified, shall be pulled out or left in place as per the directions of the Engineer in charge. Additional pile shall be driven to replace them and/or the pile cap shall be redesigned and built at no extra cost to the client. In case the pile / casing can not be removed. It shall be cut as may be directed by the Engineer in charge. Voids resulting from rejected borings or extraction of the pile or casing shall be filled with gravel or sand



unless other piles are installed in such voids. The contractor shall also not be paid for any expenses incurred by him, in extracting and rejected pile / casing and refilling if so required.

#### **4. Idle period**

The phasing of construction and movement of plant shall be done as may be directed by the Engineer. The phasing may involve some extra movement of the plant or some idle period during test pile operation etc., but the contractor will not be entitled for any claim due to this reason and all rates quoted by him shall include the same. However, during the testing of piles and other holdups, pile driving operation may be allowed on other piles, if considered acceptable and if so decided by the Engineer in charge with a view to minimise idle time. If due to change in loading elevation of any other alternations, modifications become be entitled to any claim whatsoever, for such modifications in the pile layout, during the progress of work including claims for any idle labor or tools and plant on that account.

### **12.9 Testing acceptance Criteria :**

#### **1. Static Load Test**

##### **(i) General**

In order to determine the carrying capacity of pile, static load tests shall be undertaken by the contractor on single pile as indicated on drawings. Piles to be tested shall be cast in situ at least 30 days before loading. Before any load test is made, the proposed arrangement of the structure and kentledge to be used in making the load test shall have to be approved by the Engineer in charge. All load tests shall be made under the supervision of the Engineer in charge. All responsibility for conducting the test safety and properly shall rest with the contractor.

##### **(ii) Preparation of pile head for test**

The pile head shall be chipped off carefully till sound concrete is met with and the reinforcement shall either be cut off for initial test or bent sideways and the top shall be capped by means of a suitable RCC cap. A bearing plate may be embedded on the top to receive the loading jack.

#### **Procedure for Load Testing**

- (a) The test shall be carried out by applying a series of vertical load increments on the pile. The load increments shall be equal to about 20% of the estimated working load on the pile.
- (b) The test load may be applied by means of hydraulic jack with pressure gauges, with remote pumps acting against rolled steel joists or suitable load frame obtaining reaction reached from :

- (i) Kentledge heavier than the required test load, placed on a platform supported clear of test pile. Any existing structure of suitable construction may be used as a kentledge. The center of gravity of the kentledge shall generally be on the axis of the pile and the load applied by the jack shall also be concentric with the pile axis.  
OR
  - (ii) Tension piles or suitable anchors. The center to center distance between the test piles and the anchor piles shall be a minimum of five times the diameter of the test pile. Working piles shall not be used as anchor piles.
- (c) The reaction to be made available for the tests shall be at least 25% more than the final test load proposed to be applied.
  - (d) The settlement shall be recorded at least with three dial gauges for single piles and four dial gauges for group of test piles and positioned at equal distances along the periphery of the pile and held normally by datum bars resting on immovable supporters at least 5 x D (subject to a maximum 2.5 m) away from the test pile periphery where D is the diameter of the test pile shaft.
  - (e) Each stage of loading shall be maintained till the rate of movement of the pile top is less than 0.1 mm per hour in sandy soils and 0.02 mm per hour in clayey soils for this purpose, the soil met with at the tip of the pile shall be considered. The estimated safe working load in the pile shall be kept in position for at least 24 hours and during this period settlement regarding shall be recorded every hour.
  - (f) Each stage of application of the load increment shall be smooth and free from jerks. Time and settlement observations shall be made at the commencement and completion of the load increment. Settlement observations shall be made when each increment of load had been maintained for at least 15 minutes.
  - (g) The loading shall continue for the specified load for the type of test in question or failure of the pile should this occur earlier.
  - (h) After the proposed working load had been applied and from each increment thereafter, the test shall remain in place until there is no settlement in two hours period. The total test load shall remain in place until settlement does not exceed ½ of a millimeter in 48 hours.
  - (i) The total test load shall be removed in decrements not exceeding 1/5 of the total test load. The rebound shall be

Recorded after each decrement is effected and the final rebound shall be recorded, 24 hours after the entire test load had been removed.

- (j) A complete record in triplicate shall be filed with the Engineer or the loads and readings obtained, duly verified and countersigned by the Engineer.

**(iii) Costs**

The tested piles will be used as usual foundation piles if it is a routine test. Tenderer shall include cost of all materials, accessories and labor including construction of pile top loading platform and dismantling the same, for the load test.

**(iv) Acceptance Criteria**

**(I) For Initial Load Tests**

- (a) Two thirds of the final load at which the total settlement attains a value of 12 mm unless it is specified that a total settlement different from 12 mm is permissible in any given case taking into consideration the nature and type of the structure. In the latter case, the load corresponding to the actual total permissible settlement of the pile head shall be the safe load.
- (b) Fifty percent of the final load at which the total settlement equals 10% of the diameter of the pile.

**(II) The safe load on a group of piles shall be the least of the following**

- (a) Final load at which a total settlement attains a value of 25 mm unless a total settlement, different from 25 mm is acceptable for a given case on the basis of type and nature of the structure.
- (b) Two thirds of the final load at which the total settlement is 40 mm.

**2. For Routine Load Tests**

The two pile tests shall be considered as successful, provided that –

- (a) The total settlement at the full test load of 1.5 times the proposed design load for the pile is not more than 12 mm.
- (b) The net settlement on removal of entire test load is not more than 6 mm.
- (c) Load settlement curve shall not indicate failure of the pile within the above range of settlement.

The cost of testing of two piles shall be borne by contractor and no payment shall be made.

### **3. Cyclic Load Test**

Cyclic load test may have to be carried on the test pile if directed by the Engineer. This load test shall be carried out as per Cl. 6.3 of IS : 2911 with procedure laid down in Appendix A in the said IS : 2911 (Part IV) 1985. Loading shall be continued till, there is no marked progressive settlement of the pile. The rate for such item shall be decided as may be mutually agreed upon with the Engineer in charge.

### **4. Lateral Load Test**

#### **(i) Procedure for Load Test**

- (a) This test shall be conducted as far as possible at the cut off level of the piles. In case of pile groups the test shall be conducted after providing caps such that the required conditions of actual use fulfilled.
- (b) The test may be conducted by introducing a hydraulic jack, with gauge between two piles or pile groups under test or the reaction may be suitably obtained otherwise these tests may also be done by applying lateral pull, by a suitable set up. If it is conducted by jack located between two piles or groups, the full load imposed by the jack shall be taken as the lateral resistance of each pile or group. The loading should be applied in increments of about 20% of the estimated safe load.
- (c) After applying each increment of load, the next increment of load shall be applied after the rate of settlement of mm. in sandy soil and 0.02 mm. per hour in clayey soil or two hours time whichever is earlier.
- (d) Displacements shall be measured by using at least two dial gauges spaced at 30 cm. and kept horizontally one above the other on each pile. Where it is not possible to locate one of the dial gauges in the line of jack axis, then the two dial gauges may be kept at a distance of 30 cm. at a suitable location from similar triangles.

#### **(ii) Acceptance Criteria**

The safe lateral load on a pile shall be taken as the least of the following:

- (a) Fifty percent of the final load at which total displacement increases to 12 mm.
- (b) The load at which the displacement is equal to 5 mm.
- (c) Load corresponding to any other displacement specified and dictated by performance requirement.

**5. Pull out test :**

Pull out tests may be carried out in special cases, if required to determine friction and ensure that the construction method and equipment used by the contractor produces sound piles of desired depth and specifications.

**(i) Procedure for pull out test :**

- (a) Uplift force on the piles may preferably be applied hydraulic jacks with calibrated gauges and using suitable set up approved by the Engineer.
- (b) The test pile shall have adequate steel reinforcement to withstand pulling loads. Additional reinforcement may be provided in the pile for this purpose.
- (c) Pull out loads shall be applied without shock by suitable mechanical means, in stages of 2 ½ tonnes until a peak value of frictional resistance is reached. A graph of pull out force and corresponding rise of pile top shall be plotted.

**(ii) Acceptance Criteria :**

For initial load, tests, the load applied shall be two times the estimated safe load on the pile. The safe load shall be taken as the least of the following :

- (a) One half the load at which the displacement is 12 mm. or corresponding to a specified displacement.
- (b) One half the load at which the load displacement curve shows a clear break.

Routine test load shall be carried out to 1.5 time the allowable load, pull out load in the pile or the load corresponding to 12 mm. pull whichever is earlier.

**(iii) Defective Piles :**

In case it is observed that the piles cast are not sound and there is doubt about compactness of concrete, reduction in diameter, exposure of steel, undesirable information or any other flaws which the Engineer in charge considered improper, the contractor shall modify or improve his method of construction and ensure by casting and constructing further piles at his own cost before he is permitted to go ahead with the construction.

6. Low strain pile integrity test : On RC bored foundation piles using pile integrity tester equipment manufactured by pile dynamics inc. of USA or TNO of Netherland or equivalent that confirms to ASTM D5882 shall be conducted.

7. High strain dynamic pile test : High strain dynamic pile testing shall be as per ASTM-D4945-1989.

**8. Pile cut off, Excavation & clean up :**

**(i) Pile cut off**

- (a) All piles shall be concreted to a level 150 mm. to 450 mm. above the specified pile cut off elevation which shall be 8 cm. above the bottom of the pile cap. For piles cast by tremie method, in bentonite stabilized bore holes, this level of concreting above pile cut off elevation shall be not less than 600 mm.
- (b) Before casting the pile cap, this excess concrete shall be cut off up to pile cut off elevation. In case sound concrete is not met with at such elevation, the piles shall be cut to such elevation where sound concrete is met.
- (c) Piles shall be cut off at level and true to elevation shown or specified on the drawings. Care shall be taken not to damage the reinforcement or the concrete below cut off elevation during such stripping operations.
- (d) Where stripping has been done to a level lower than the specified cut off elevation to obtain dense and sound concrete, the contractor shall build up the pile up to cut off elevation at his own cost.

**(ii) Excavation**

- (a) Excavation by the Contractor for pile cut off shall be done to the depth specified on the drawings. These excavations shall be coordinated with the Engineer - in – charge so that they will remain open for a minimum possible time and the pile cap concrete is placed as soon as possible thereafter.
- (b) Any additional excavation carried out due to pile stripping being required to be carried out below the cut off elevation to obtain dense concrete and the back filling of all such excavation shall be done by the Contractor at his own cost.

**(iii) Clean up**

- (a) Upon completion of the piling work, all casing equipment, construction tools, protective coverings and debris resulting from the piling operations shall be removed from the works site with the permission of the Engineer - in – charge
- (b) All excavated material and left over drilling mud shall be disposed off, as may directed by the Engineer - in – charge , away from the site and the cost of all such cleanup operations shall be included by the Contractor in his rates for piling work and no separate payment will be made for the same.

9. **Rates and Measurements :**

1. **Rates**

The rate for the item of installation of piles shall include the cost of all materials consumed in the work or incidental to it as well as testing of materials, including the cost of plants and equipment, labour, supervision, transport, taxes, insurance, royalties and revenue expenses, securities and safety measures, approaches, power, fuel, lubricants, services, preliminary and enabling works, camps, stores etc. and overheads and profits etc. complete.

Separate items and rates have been provided for Empty boring, concrete and reinforcement steel work.

2. **Measurements**

- (a) For the purpose of measurements and payments, the length of the pile shall be measured from the tip of the pile to the bottom of the pile cap for each diameter of the pipe installed in position as per these specifications. The 8 cm. length of pile tip projecting into the pile cap shall not be measured and also shall not be deducted from the quantity of the pile cap concrete. The rate shall be based on the assumption that the boring of the pile is done by means of a normal bailer through soft soil such as clay, silt, sand, soft and hard murrum, gravel and boulders not more than 150 mm. in diameter or a mixture thereof. The rate shall include the cost of providing and placing concrete of specified proportions or strength as specified and shall be in cubic meters.
- (b) Measurement of length for payment will be done by letting down a tape with a heavy weight attached at the end, through the hole left by driving, before the reinforcement cage is lowered and concreting commences. The additional depth driven and covered with the show or any other materials like aggregates or concrete will not be considered for payment. Payment will be made for the specified depth below the cut off level as measured as per above procedure, whichever is less.
- (c) Empty boring through overburden and through soils of all types between the tip of piles and the bottom of pile cap shall be paid per meter for empty bore.
- (d) Reinforcement placed in the pile shall be paid for separately for the actual quantity of reinforcement placed in the pile exclusive of wastage, avoidable, overlaps, couplings, and welded joints spaces bars and annealed steel wire for binding as stipulated in the relevant specification for reinforcement.
- (e) Payment for load tests shall be made only for those tests ordered by the Engineer and the payment shall be made only for the completed load test provided the pile tested passes the load test, otherwise the cost shall be borne by the Contractor.