

- Name of Work -

**EPC Contract for Providing Irrigation Water
Facility to Filling Kelamul Village Tank by Lifting
Water from KLBMC at Ch.8.20 km of Taluka
Kadana, Dist. Mahisagar.**

Tender Document

VOLUME II – [A]

Technical Specifications for Civil Works

Government of Gujarat
Narmada Water Resources, Water Supply
& Kalpsar Department

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LIST OF ABBREVIATION

Acronym	Description
CC	Cement concrete
MSA	Maximum size of aggregate
IS	Indian standard
KN	Kilo newton
MORTH	Ministry of road transportation and highway
WBS	Water bond macadam
PI	Plasticity index
RCC	Reinforcement cement concrete
GSB	Gradual sub base
PCC	Plain cement concrete
GI	Galvanized iron
HP	Horse power
LED	Light emitting diode
OFC	Optical fiber cable
FID	Fuse instantons detonator
OPC	Ordinary Portland cement
TMT	Thero mechanically bar
ISA	Indian standard angle
HSFG	High strength friction grip
RSJ	Rolled steel joints
MS	Mild steel
HDPE	High density poly ethylene
ROU	Right of unit
ROW	Right of width
NOC	Non-objection certificate
NH	National highway
SH	State highway

1. DESIGN CRITERIA FOR STRUCTURAL DESIGN

1.1 INTRODUCTION

This document forms the engineering design basis for structural design. The content of these documents is to form the guidelines for engineering design of structures and to provide information about other disciplines concerned.

This is technical specification summarizes the concept and relevant IS codes (Latest Version) to be followed for buildings and water retaining structures.

1.2 GEO-TECHNICAL INVESTIGATION

The contractor shall be responsible for the geo-technical exploratory survey to obtain accurate information about soil condition at the site.

The depth, thickness, extent, composition of each stratum and the depth of ground water shall be determined. Provide a geo-technical report based on survey data which includes boring logs, field and laboratory test results, interpretation of data, building foundation and earthwork recommendations.

1.3 BASIC ENGINEERING DATA: DATUM AND SITE LEVELS

1. Finished Ground Level (FGL) = High Flood Level (HFL) + 0.15m (minimum)
2. Plinth height (minimum):
 - a. Pump House = FGL + 0.70 m
 - b. Staff Quarters = FGL + 0.50 m

1.4 LIST OF DESIGN CODES AND STANDARDS

All designs shall be based on the latest International or Indian Standard (IS) Specifications or Codes of Practice. The design standards adopted shall follow the best 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 the Engineer-in-charge. In case of any variation or contradiction between provision Indian standards or code and the specification given with the submitted tender document, the provision given in the tender document shall be followed.

1.4.1 FOUNDATION ENGINEERING

IS 1080	Design and construction of shallow foundation in soils (Other than raft, ring, and shell)
IS 6403	Determination of bearing capacity of shallow foundations.
IS 8009	Part I & Part II Calculation of settlements of foundations
IS 2950	1981 Code of practice for design and construction of raft foundations (Part-1)

- IS 2974 Code of practice for design and construction of machine foundations (part 1 to 4)
- IS: 13301 Guidelines for vibration isolation for machine foundations

1.4.2 LOADING STANDARD CODES AND DESIGN AIDS

- IS 456 - 2000 Code of Practice for plain and reinforced concrete.
- IS 875- 1987 Code of Practice for design loads for buildings and structures.
 Part I - dead loads.
 Part II - Live loads.
 Part III - Wind loads
 Part V - Special Loads and Load combinations
- IS 3370 Code of Practice for concrete structures for the storage of liquids.
 Part I - General Requirement (2009)
 Part II - Reinforced concrete structures (2009)
 Part III - Pre-stressed concrete structures (1967)
 Part IV - Design tables (1967)
- IS 1893(Part-4) - 2005 Criteria for Earthquake Resistance Design of Structure
- IS 1893 - 2002 Criteria for earthquake resistant design of structures Part-1 General Provision and Buildings
- IS 4326 Earthquake design and construction of buildings - Code of Practice.
- IS 13920-1993 Ductile detailing of Reinforced Concrete Structures subjected to Seismic forces - Code of practice
 (reaffirmed 1998)
- IS 13920:1993 Ductile detailing of Reinforced Concrete Structures subjected to Seismic forces - Code of practice
 (reaffirmed 1998 - Edition 1.2 (2002-03))
- IS 1911 Schedule of unit weights of building materials

1.4.3 REINFORCEMENT

- IS 1786-2008 Specification for High strength deformed steel bars and wires for concrete reinforcement

- IS 2502 Bending and fixing of bars for concrete reinforcement
- IS 5525 Recommendations for detailing of reinforcement in reinforced concrete works.

1.4.4 BRICKWORK AND HOLLOW BLOCK

- IS-1077 Common burnt clay building bricks-specification
- IS-2212 Code of practice for Brick work
- IS -2185 Specification for Cement Masonry units (Part I - Hollow and solid concrete blocks. Part-II Hollow and solid light weight concrete blocks)

1.4.5 CEMENT AND FINE & COARSE AGGREGATES

- IS-455 Portland slag cement
- IS-1489 Part 1 Portland Pozzolana Cement (PPC) fly ash based
- IS-1489 Part 2 PPC Calcined clay based
- IS-8112 43 grade Ordinary Portland Cement
- IS-12330 Specification for Sulphate Resisting Portland Cement
- IS-12269 Specification for 53 grade ordinary Portland cement
- IS-383 Specification for Coarse and Fine aggregates from natural sources for concrete

1.4.6 ALL STRUCTURAL STEEL DESIGN SHALL GENERALLY CONFORM TO THE FOLLOWING PUBLICATIONS OF THE INDIAN STANDARDS INSTITUTION

- IS 152062- Hot rolled low medium and high tensile structural steel
2006
- IS 800 Code of practice for General Construction in Steel
- IS 816 Code of practice for use of manual metal arc welding for general construction in mild steel

1.4.7 MISCELLANEOUS

- IS: 1172 Code of basic requirements for water supply, drainage and sanitation
- IS: 1742 Code of Practice for building drainage
- IS: 3067 Code of Practice for general design details and preparatory works for damp proofing and water proofing of buildings
- SP: 16 Design Aids for reinforced concrete to IS: 456 - 1978

SP 20	Handbook on masonry design and construction
SP 22	Explanatory handbooks on codes for earthquake engineering
SP: 24	Explanatory handbook on Indian Standard Code of Practice for plain and reinforced concrete
SP: 25	Handbook on causes and prevention of cracks in buildings
SP: 34	Handbook of concrete reinforcement & detailing
IRC: 6 (2000)	Standard specification and core practice for road bridges section-ii load and stresses.
IRC: 37	Guidelines for the design of flexible pavements
IRC: 73	Geometric design standards for Rural (Non-Urban) Highways.

1.5 METHOD OF ANALYSIS

All structures shall be analyzed by the linear elastic theory to calculate internal actions produced by design load. It can be analyzed by STAAD-PRO software or excel spread-sheet. The design shall be carried out for the worst/governing combination. Load calculation and Design document shall be prepared in Excel.

1.6 METHOD OF DESIGN

Design shall be carried out as per following: RCC footings: Limit state method of design
RCC columns: Limit state method of design

RCC beams and slabs: Limit state method of design

Retaining wall: Working stress method of design with limiting crack width of 0.2 mm as per IS 456 – 2000

RCC water retaining structures: Working Stress method design method with crack width limited to 0.1 mm.

Also provide the seismic design calculation of RCC Water retaining structures as per IS: 1893 (Part - II, 2014).

Steel Structure: Limit State/Working stress Method Design

1.7 DESIGN BASES

- a. Foundation shall be designed to carry all the loads from equipment or super structure, which they support in accordance with the relevant codes.
- b. Net safe bearing capacity of soil & Ground water table: As per geo-technical report
- c. Type of foundation.
- d. For buildings and structures: As per geo-technical report

- e. Allowable increase in soil bearing capacity in event of storm(wind) 25%, Earthquake 25%, factor of safety as per IS 1904 against overturning 1.5, Sliding 1.5, and buoyancy 1.2.
- f. As a general rule following features will be adopted, unless decided otherwise in a specific or exceptional case:
- g. Top of footing will be horizontal and flat/Trapezoidal as case.
- h. Minimum depth of foundation is considered as per latest geotechnical report for various locations of the proposed structure.
- i. Foundation plinth for structural columns and equipment supports shall extend not less than 5 mm from the edge of base plate.
- j. The clear distance between a standard mild-steel anchor bolt or anchor sleeve and the face of the foundation shall be not less than 75 mm.
- k. Minimum thickness of lean concrete layer shall be 100 mm for building and 150 mm for water retaining structure, also extend 75 mm beyond the foundation edge.
- l. For heavier loads and restricted settlements pile foundation may be considered as an alternative as per IS 2911.
- m. Wherever columns are very near pedestals of footing are considered combined to take care of unbalance loading. Sufficient reinforcement is provided to take care of unbalancing load. Centre of footing and combined loading is match to nullify eccentricity in load.
- n. Where stresses due to wind (or seismic) and temperature are combined with those due to other loads, the allowable stresses in concrete and reinforcement steel may be increased by 33.33% in case of working stress design. However, steels having definite yield stress, stress limited to yield stress, for steels without definite yield point, the stress will be limited to 80 percentage of ultimate strength or 0.2 percent proof stress whichever is smaller. (IS 456 – 2000)
- o. All building shall have a minimum 1.0 wide, 100 mm thick plinth protection paving in M15 grade concrete or stone slabs/tiles with 230 mm thick and 600 mm height wall with suitable PCC. All plinth protection shall be supported on well compacted strata

1.8 DESIGN CONDITIONS FOR UNDERGROUND OR PARTLY UNDERGROUND LIQUID RETAINING STRUCTURES

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

- a. Water depth to be considered up to full height of wall and no relief due to soil pressure from the other side to be considered.
- b. RCC water retaining structures like storage tanks shall be leak proof and designed by working stress method.
- c. Structure empty condition (i.e., empty of liquid, any material, etc.): full earth pressure with saturation and surcharge pressure wherever applicable, to be considered.
- d. Partition wall between dry sump and wet sump: to be designed for full water depth up to full height of wall.

- e. Partition wall between two compartments: to be designed as one compartment empty and the other full for both the directions.
- f. Structures shall be designed for uplift in empty conditions with no live load with the water table as per Geotechnical report or high flood level or finished ground level, whichever is maximum. No reduction factor for the uplift forces shall be considered. Use of pressure relief valves to reduce uplift pressure due to ground water table shall not be allowed.
- g. Walls shall be designed under operating conditions to resist earthquake forces from earth pressure mobilization and dynamic water loads.
- h. Underground or partially underground structures shall also be checked against stresses developed due to any combination of full and empty compartments with appropriate ground/uplift pressures from below to base slab. A minimum factor of 1.2 shall be ensured against uplift or floatation and due to other loads shall be 1.5.
- i. Soil bearing capacity is to be considered as per soil investigation report.
- j. The design life of all structures and buildings shall be 60 years.

1.9 DESIGNED 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, Equipment load, Piping Anchor and Restraint loads, Crane, Monorail & Elevator loads, Earth Pressure load, Hydrostatic Pressure load, stresses due to temperature changes, shrinkage and creep in materials, dynamic loads, impact load and other specific loads.

A. DEAD LOAD

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

a. MATERIAL WEIGHT/ DENSITIES

Weight of water	:	10 kN/m ³
Weight of soil	:	As per field test results
Weight of Plain concrete	:	24.00 kN/m ³
Weight of reinforced concrete	:	25.00 kN/m ³
Weight of brickwork (exclusive of Plaster)	:	22.00 N/m ² per mm thickness of brickwork
Weight of plaster to masonry surface	:	20.40 N/m ² per mm thickness
Weight of granolithic terrazzo	:	24.00 N/m ² per mm of thickness rendering screed, etc.

finish		
Weight of Filling in Sunk Slab etc.	:	20 kN/m ³
Weight of ceiling plaster 6/8 mm thick	:	20 kN/m ³
Light weight concrete with aggregates as Perlite etc.	:	10 kN/m ³
Rubble Masonry	:	22.00 KN/m ³
Electrical Panel Load, Instrumentation Panel Load, Battery backup Load etc.	:	As per Actual Panel Loads
Note: Openings (doors, windows, ventilators etc.) in the masonry are ignored.		

b. SLABS

Floor Finished on working floors	:	1.5 kN/m ²
Floor Finish on Terrace with water proofing	:	2.0 kN/m ²
Filling in sunk slabs	:	Weight density x thickness of filling
Self-weight	:	Weight density x thickness of slab

c. BEAMS

Self-weight	:	Weight density x width x total depth
Brick masonry	:	Weight density x wall thickness x wall height

B. LIVE LOAD

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

i	Live load on roofs (accessible) (Non-accessible)	1.50 kN/m ² 0.75 kN/m ²
ii	Live load on floors supporting Equipment such as Pumps, blowers, Compressors, valves, etc. or as required by equipment supplier	10.00 kN/m ²

	whichever is greater.	
iii	Live load on all other floors Walkways, stairways and platforms.	5.00 kN/m ²
iv	Live load on all residential floors	3 kN/m ²
v	Live load on Toilets	2.5 kN/m ²

Live load reduction shall be in accordance with the provisions of IS: 875 and IS: 1893 in case of seismic analysis.

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

C. WIND LOAD

Wind loads shall be as per IS: 875.

In design of structures, wind force on equipment supported on frame including all fixtures, piping, staircases, ladders, handrails etc. shall also be considered.

D. EARTHQUAKE LOAD

This shall be computed as per IS: 1893 (latest version). An importance factor appropriate to the type of structure shall be considered for design of all the structures.

For all structures and buildings Response Spectrum Method of design shall be used. The importance factor for all buildings and structures shall be taken as per IS 1893.

E. 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.

F. EARTH PRESSURE LOAD

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

In addition to earth pressure a minimum surcharge load of 20 kN/m² shall also be considered for the design of all underground structures or railway load (in case the railway track is located nearby) whichever is critical.

The underground structures shall be subjected to sub surface water pressure. Calculations shall be based on the weight of the soil plus full hydrostatic pressure. The full upward pressure of water below base raft shall be taken over the entire area.

G. HYDRO STATIC PRESSURE LOAD

Ground water level for calculation shall be considered as per Geotechnical report (submitted by the contractor) or high flood level or at Finished Ground Level whichever is maximum.

H. TEMPERATURE LOAD

Expansion and contraction due to changes of temperature of materials of a structure shall be considered and adequate provisions shall be made for the effects produced (as per provision in relevant IS codes). Suitable expansion joints shall be provided in the longitudinal direction wherever necessary. The maximum distance of the expansion joint shall be as per the provisions of IS: 800 and IS: 456 for steel and concrete structures respectively.

Coefficient of thermal expansion of steel shall be taken as per IS: 800. Coefficient of thermal expansion for concrete shall be taken as per IS: 456.

I. VIBRATION LOADS

Vibration Loads shall mean the vibration forces caused by heavy vibrating equipment or machinery and dynamic forces caused by fluids in the normal operation.

Frames, structures and foundations for machinery or equipment causing vibration shall be designed to limit vibrations to an acceptable level.

It shall be designed such that whether they are independent or part of the building, it shall not only safely carry the loads for such items but also prevent resonance. Natural frequencies of frames, structure and foundations must differ by more than 20% from that of the machinery under operating condition.

Static and dynamic loads of major equipment will be based on the manufacturer's data of the specified equipment and will be designed in design in addition to live load.

1. ROTATING (CENTRIFUGAL) TYPE

i	Vertical direction	0.5 times the weight of equipment or machinery
ii	Horizontal direction	
a	Along direction of Rotation (Perpendicular to centre line)	0.25 times the weight of Equipment or machinery of shaft
b	Along direction of shaft axis	0.1 times the weight of equipment or machinery

2. RECIPROCATING TYPE

i	Vertical direction	0.5 times the weight of equipment or machinery
ii	Horizontal direction	
a	Along direction of Reciprocating Motion	0.25 times the weight of Equipment or machinery of shaft
b	Along direction	0.1 times the weight of equipment or machinery

	Perpendicular Reciprocating motion	
--	------------------------------------	--

These horizontal loads shall be considered to be acting at shaft centerline.

J. LOAD COMBINATION

Load combination for checking of bearing capacity of soil and design of steel structures concrete and RCC members (working stress)

- a. $DL + 1.0 LL$
- b. $DL \pm 1.0 WL (1.0 EQ)$
- c. $DL + 1.0 LL \pm 1.0 WL (1.0 EQ)$

Load combination for design of RCC structures and Steel Structures (Limit state)

- a. $1.5 DL + 1.5 LL$
- b. $1.5 DL \pm 1.5 WL (1.5 EQ)$
- c. $0.9 DL + 1.5 WL/EQ$ shall be used for stability against overturning is critical.
- d. $1.2 DL + 1.2 LL + 1.2 WL (1.2 EQ)$

Load combination for water retaining structures (working stress method)

- a. $1.0 DL + 1.0 \text{ Earth Pressure} + 1.0 \text{ Surcharge pressure}$
- b. $1.0 DL + 1.0 \text{ Water pressure}$
- c. $1.0 DL + 1.0 LL + 1.0 WL + 1.0 \text{ Earth Pressure} + 1.0 \text{ Surcharge Pressure}$
- d. $1.0 DL + 1.0 LL + 1.0 WL + 1.0 \text{ Water Pressure}$

$DL = \text{Dead load}$, $LL = \text{Live Load}$, $WL = \text{Wind Load}$, $EQ = \text{Earthquake Load}$

Appropriate factor of live load shall be taken as per IS:1893 for seismic load calculation. The load combinations giving the most critical conditions on foundations, structures or individual members shall be taken in to account.

1.10 MINIMUM COVER TO MAIN REINFORCEMENT

The minimum clear cover to reinforcement in all R.C.C. structures shall be as per IS: 456 / IS: 3370 (Part —II), except as mentioned for following:

The following minimum clear cover shall be provided for R.C.C (non-Water retaining) works.

A. Slab (Roof & Floors, Canopies, Chhajas, Lintels, Waist Slab in stair etc.)	25 mm
B. Beams	40 mm
C. Plinth beams	40 mm
D. Columns, pedestals	40 mm

E.	Dry pits / retaining walls	
1.	Face in contact with earth	50 mm
2.	Free face	50 mm
F.	RCC Water / Liquid retaining structures	
1.	Face in contact with liquid	50 mm
2.	Away from liquid but in contact with earth	50 mm
G.	RCC Foundation	
1.	Sides and top	50 mm
2.	Bottom	60 mm

Cover shall be increased when surfaces of concrete members are exposed to the action of harmful chemicals (as in case of concrete in contact with earth faces contaminated with such chemicals, acid vapour, saline atmosphere, sulphureous smoke (as in case of steam operated railways) etc. and such increase of cover may be between 15 mm to 40 mm beyond the figures given above, as specified by the engineer-in-charge.

Cover blocks of different and necessary sizes shall be used as and when required for providing the adequate and specified cover to the reinforcement. Such cover blocks shall be made so in advance and properly cured to take the load of reinforcement. Cover Blocks shall be made of same grade of concrete as of structure.

A. MINIMUM DIAMETER OF BAR

Main steel in foundation	10 mm
Main steel in column	12 mm
Main steel in beam	12 mm
Main steel in slab	10 mm
Stirrups & Ties	08 mm
Main steel in wall & Wall footing	10 mm
Main steel for water retaining structure	10 mm

B. MINIMUM THICKNES OF PCC

For all RCC buildings foundation	100 mm thick
For Brick masonry wall foundation	100 mm thick
For all water retaining structures	150 mm thick

C. MINIMUM PERCENTAGE OF STEEL

For buildings	As per IS: 456-2000
For liquid retaining structure	As per IS: 3370- 2009 (Part-2)

(For thickness more than or equal to 150 mm, reinforcement may be provided on both faces)

1.11 MINIMUM THICKNESS OF STRUCTURAL MEMBERS

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

Civil Member	Width (mm)
Walls for water retaining structures	225
Walls of launders	150
Base slab of launders	125
Roof slabs for water retaining structures	125
Bottom slabs for water retaining structures	225
Floor slabs including roof slabs, walkways canopy slabs	125
Walls of cables/pipe trenches, underground pits etc.	125
Column footings	300
Parapets, Chhajjas	100
Precast trench cover	75
Beam	230 (Width) 300 (Depth)

1.12 SPACING OF REINFORCEMENT

Minimum distance between two parallel main reinforcement bars shall place as per relevant Indian Standards (Latest Version).

In locations where reinforcement is congested, grouping of bars by touching one another may be permitted provided the requirements of minimum horizontal distance as specified above are complied with and provided further that development length is adequately increased.

1.13 MATERIAL SPECIFICATION

Footings of building - M 25 (F_{ck} - 25 N/mm²)

Super structure of Pump house - M 25 (F_{ck} - 25 N/mm²)

Super structure for other building - M 20 (F_{ck} - 20 N/mm²)

Raft foundation - M 30 for water retaining structure (F_{ck} - 30 N/mm²)

Water retaining structure (Sump etc.) - M 30 (F_{ck} - 30 N/mm²)

PCC for column footings - 1:2:4

PCC for wall footings and plinth beams - 1:2:4

Reinforcement - Thermo-mechanically treated (TMT) minimum require Fe 500 (500 N/mm²) confirming to IS: 1786-1985.

1.14 JOINTS

Movement joints such as expansion joints, complete contraction joints, partial contraction joints and sliding joints shall be provided and designed to suit the structure as per relevant IS specification. 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.

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.

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 water stops of 225 mm width shall be used for walls and base slabs.

Expansion joints for non-liquid retaining structures shall be provided as per IS 3414. Expansion joint if required shall be furnished in detailed drawings.

1.15 NOMINAL STRIPING TIME (BASED ON IS: 456)

In normal circumstances, (generally where temperatures are above 20°C) and where Ordinary Portland Cement (OPC) is used, forms may generally be removed after expiry of following periods:

Sr. No.	Civil Member	Width (mm)
A	Vertical formwork to columns, walls, beams	18-24 hours
B	Soffit formwork to slabs (Props to be re-fixed immediately after removal of formwork)	3 Days
C	Soffit formwork to beams (Props to be re-fixed immediately after removal of formwork)	7 Days
D	Props to slabs:	
	Spanning up to 4.5 m.	7 Days
	Spanning over 4.5 m.	14 Days
E	Props to beams and arches:	
	Spanning up to 6 m.	14 Days
	Spanning over 6 m.	21 Days

1.16 CURING OF DIFFERENT CONCRETE ITEMS

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition by ponding or by covering with a layer of sacking, canvas, hessians or similar material and kept constantly wet for at least seven days from the date of placing concrete. The period of curing shall not be less than 14 days for concrete exposed to dry and hot weather conditions.

For, other items the curing shall be done as follows:

- a. Brickwork- at least for 14 days

- b. Plaster work - at least for 14 days
- c. Sand faced plaster - at least for 14 days
- d. Tiles or stone flooring and dado - at least for 14 days.

1.17 SPECIAL CONSIDERATION FOR STEEL STRUCTURES

A. STEEL STAIRS

All steel staircase shall normally clear width (back-to-back of stringer) of 1000 mm and maximum inclination with horizontal of 35° 75'. However, in case of space restriction, minimum clear width up to 750 mm and slope up to 45° may be provided with prior approval. The vertical height between successive landings shall not be exceeded 2.75m. Channels (MC 150 mm) shall be provided as stair stringers. Treads shall be minimum 250 mm wide made of Chequered plate / grating, with suitable nosing and spaced equally so as to restrict the rise to maximum 150 mm.

B. STEEL LADDERS

Ladders shall be provided to platforms, walkways, instruments and equipment's that do not require frequent access. Ladders shall preferably be vertical and its angle with vertical shall not exceed 5°. Ladders shall be minimum 450 mm clear width with 20 mm dia. MS rungs spaced at 300 mm (maximum)

Ladders of more than 4.5 m height shall be provided with fixed spiral staircase.

C. PLATFORMS AND WALKWAYS

All steel platforms above grade shall be constructed with kick plates at edge of platform to prevent tools or materials from falling off. It shall consist of 8 mm thick steel plate projecting 100 mm above the platform surface. Kick plate shall be painted with the same type of coating as the material to which it is attached.

D. SPECIAL CONSIDERATION FOR BRICK / BLOCK MASONRY

All Masonry works shall be designed in accordance with IS: 1597, IS: 1905, IS: 2212, IS: 4326 and other relevant IS codes as applicable. Structural design of Brick / Block Masonry shall be in accordance with criteria specified by section 4 of National Building Code of India Part IV.

All Masonry walls for buildings shall be raised on plinth beams.

Bricks shall be of minimum compressive strength of 35 kg/cm² conforming to IS: 1077. Brick masonry shall generally be in cement mortar 1:6 (1 cement: 6 sand) by weight. However, 115 mm thick masonry shall be constructed in cement mortar 1:4 by volume using metal boxes. 100 mm cement concrete layer with 2 nos. of 10 mm diameter bar shall be provided if height of wall exceeded 2.0 m at location as decided by Engineer-in-charge.

E. GROUTING

Non-shrink flow able grout shall be used for under pinning work below base plate of columns. Non-shrink cum plasticizer admixture shall be added in the grout. For grouting of base of

machine foundation high strength ready mixed non-shrink flow able grout shall be used.

Crushing strength of the grout shall generally be one grade higher than the base concrete. Minimum grade of grout shall be M 25.

Nominal thickness of grouting shall be at least 50mm for columns and pedestals of major equipment. For secondary posts, stair and ladder base, etc. grouting shall not be less than 25mm thick.

1.18 SOIL BEARING CAPACITY

The contractor has to access soil bearing capacity as per relevant IS code at construction site at his own cost and design the structures on the base of soil report received after investigation. The soil investigation report has to be submitted to Engineer-In-Charge for verification.

2. TECHNICAL SPECIFICATION OF CIVIL WORKS

2.1 MATERIAL

- a. All materials to be used shall conform to the relevant specifications as per the latest version of Indian Standard, unless otherwise stated in the detailed specifications of items of work.
- b. Wherever a reference to any Indian Standard appears in the specification, it shall be taken to mean as a reference to the latest version of the standard.
- c. Test for material shall be invariably carried out by the contractor, when the same are specified in the specifications. Tests shall also have to be carried out, even though the same are not specifically mentioned in the specifications but in the opinion of the Engineer-In-Charge, the same are required to be carried out.
- d. No collection of materials shall be made before it is got approved from the Engineer- In- Charge.
- e. Collection of approved materials shall be done at site of work in a systematic manner. Materials shall be stored in such a manner as to prevent deterioration or intrusions of foreign matter and to ensure the preservation of their quality and fitness for the work.
- f. Materials, if rejected by the Engineer-in-Charge, shall be immediately removed from the site of work. If they are not removed within Twenty-Four hours of receiving such intimation, Engineer-In- Charge may get the same removed at contractor's cost. The Engineer-In-Charge shall dispose-off such materials in a manner as he chooses and the contractor shall not be entitled to any compensation for the cost of such materials.
- g. Construction with defective material:
- h. Approval to the samples of various materials given by the Engineer-In-Charge will not absolve the contractor from the responsibility of replacing the defective material brought on site or materials used in the work found defective at a later date. The contractor shall have no claim to any payment or compensation whatsoever on account of any such materials rejected by the Engineer-In-Charge.
- i. The contractor shall be responsible for observing the laws, rules and regulations imposed under the "Mineral Acts" and such other laws and rules prescribed by Government from time to time.
- j. All standards, specifications, codes of practices referred to herein shall be the latest version including all applicable official amendments and revisions.
- k. The contractor is hereby instructed to note that:
 - All the excess excavated stuff (including soil, soft and hard murrum, rock debris, soft and hard rock etc.) got available from the excavation of all the components like- approach channel, sump/ forebay, pump house, pipe-line, other crossings, structures, chambers etc.
 - All the materials obtained from dismantling of approaches and other structures etc.

Disposal of all the materials mentioned in above (a) and (b) shall be the responsibility and liability of the contractor. The contractor shall have to dispose of the same from the site with all leads without any extra cost claim. The contractor shall have to arrange for identification and acquisition of dumping zone/s. All the cost and consequences in this regard shall be borne by the

contractor. The contractor has to contact/ approach Mining and Geology Department of Government for disposal of above-mentioned materials. All necessary royalty payment shall also be borne by the contractor. The contractor shall have to maintain all records in this regard and any theft of materials shall be the responsibility of contractor.

2.1.1 WATER

Water shall not be salty or brackish and shall be clean, reasonably clear and free from objectionable quantities of silt and traces of oil and injurious alkalis, salts, organic matter and other deleterious material, which will either weaken the mortar or concrete or cause efflorescence or attack the steel in R.C.C. Container for transport, storage and handling of water shall be clean. Water shall conform to the standards specified in I.S. 456-2000.

If required by the Engineer-In-Charge it shall be tested by comparison with distilled water. Comparison shall be made by means of standard cement tests for soundness, time of setting and mortar strength as specified in I.S. 269-1976. Any indication of unsoundness, change in time of setting by 30 minutes or more or decrease of more than 10 percent in strength of mortar prepared with water sample when compared with the results obtained with mortar prepared with distilled water shall be sufficient cause for rejection of water under test.

Water for curing mortar, concrete or masonry should not be too acidic or too alkaline. It shall be free of elements, which significantly affect the hydration reaction or otherwise interfere with the hardening of mortar or concrete during curing or those which produce objectionable stains or other unsightly deposits on concrete or mortar surfaces.

Hard and bitter water shall not be used for curing.

Potable water shall generally be found suitable for curing mortar or concrete.

Permissible Limit for Solids

	Tested as per	Permissible Limit Max.
Organic	IS: 3025	200 mg/lit
Inorganic	IS: 3025	3000 mg/lit
Sulphate (as SO ₃)	IS: 3025	400 mg/lit
Chlorides (as Cl)	IS: 3025	2000 mg/lit for concrete work not containing embedded steel and 500 mg/lit for pre-stressed /reinforced concrete work.
Suspended Matter	IS: 3025	2000 mg/lit

2.1.2 CEMENT

- a. Cement shall be procured only from approved manufacturer /Supplier/Distributor and shall be subject to prior approval of the Engineer-in-charge.
 - All cement used for the work shall be ordinary Portland cement (OPC) of 53 grade only. Ordinary Portland cement shall comply with the requirements of the latest version of IS: 269.
 - Cement older than 3 months from the manufacturing week shall not be allowed.

- b. Cement shall be of approved make as per vendor list.

2.1.3 WHITE CEMENT

The white cement shall confirm to I.S. 8042-1978.

2.1.4 SAND

Sand shall consist of natural sand, crushed stone sand or crushed gravel sand or combination of any of these. The sand shall be clean, well graded, strong, durable and gritty particles free from injurious amounts of dust, clay, Kankar nodules, soft or flaky particles, shale, alkali, salts, organic matter, loam, mica or other deleterious substances and shall be got approved from the Engineer-in-charge. The sand shall not contain more than 3% of silt as determined by field tests. If necessary, the sand shall be washed to make it clean. The source of sand shall also be got approval from Engineer-in-Charge.

FM OF SAND USED FOR DIFFERENT WORK

Sr No.	Type of Work	IS Code	FM Range
1	For Cement concrete	IS 383 zone-I & II	2.20 to 3.5
2	For Masonry	IS 2116, Table:1	1.50 to 2.50
3	For plaster	IS 1542	1.20 to 2.20
4	For sand bedding below pipe (as require)	IS 383 zone-I & II	2.11 to 4.00

2.1.5 STONE GRIT

- a. Grit shall be consisted of machined crushed stone and shall be hard, strong, tough, dense, durable, clean, of proper gradation and free from skin or coating likely to prevent proper adhesion of mortar. Grit shall generally be cubical in shape and as far as possible flaky elongated pieces shall be avoided. It shall generally comply with the provisions of I.S. 383-1970. Grit shall be obtained from source. The grit shall have no deleterious reaction with cement. The source of sand shall also be got approval from Engineer-in-Charge.
- b. The grit shall conform to the following gradation as per sieve analysis:

I.S. Sieve Designation	% By Weight passing sieve	I.S. Sieve Designation	% By Weight passing sieve
12.50 mm	100	4.75 mm	0 - 20
10.00 mm	85 -100	2.36 mm	0 - 5

- c. The crushing strength of grit will be such as to allow the concrete in which it is used to build-up the specified strength of concrete.
- d. The necessary tests for grit shall be carried out as per the requirements of I.S. 2386 (Parts I to VIII) 1963, as per instructions of the Engineer-in-charge. The necessity of test will be decided by the Engineering-in-charge.

2.1.6 CEMENT MORTAR

- a. Water, Cement & Sand shall conform to specification of respective items specified in this document.
- b. Proportion of Mix: Cement and sand shall be mixed to specified proportions, sand and cement being measured by measuring boxes. The proportion of cement shall be by weight if cement will be used in a mixer of 1 bag capacity. The mortar may be hand mixed or machine mixed as directed by Engineer-in-charge.
- c. Preparation of Mortar: In hand mixed/machine mixed mortar, cement and sand in the specified proportions shall be thoroughly mixed dry on a clean impervious platform by turning over at least 3 times or more till a homogeneous mixture of uniform colour is obtained. Mixing platform shall be so arranged that no deleterious extraneous material shall get mixed with mortar or mortar shall flow out. While mixing, the water shall be gradually added and thoroughly mixed to form a stiff plastic mass of uniform colour so that each particle of sand shall be completely covered with a film of wet cement. The water cement ratio shall be adopted as directed.
- d. The mortar so prepared shall be used within 30 minutes of adding water. Only such quantity of mortar shall be prepared as can be used within 30 minutes.

2.1.7 STONE COARSE AGGREGATE FOR NOMINAL MIX CONCRETE

- a. Coarse aggregate shall be of machine crushed stone and shall be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.
- b. The aggregate shall generally be cubical in shape. Unless special stones of particular quarries are mentioned aggregates shall be machine crushed. Aggregate shall have no deleterious reaction with cement. The size of the coarse aggregate for plain cement concrete and ordinary reinforced cement concrete shall generally be as per the table given below. However, in case of reinforced cement concrete the maximum limit may be restricted to 5 mm less than the minimum lateral clear distance between bars or 5 mm less than the cover whichever is smaller.

IS Sieve Designation	Percentage Passing (by weight) for nominal size of				
	40 mm	20 mm	16 mm	12.5 mm	10 mm
80 mm	-	-	-	-	-
63 mm	100	-	-	-	-
40 mm	85 - 100	100	-	-	-
20 mm	0 - 20	85 - 100	100	-	-
16 mm	-	-	85 - 100	100	-
12.5 mm	-	-	-	85 - 100	100
10 mm	0 - 5	0 - 20	0 - 30	0 - 45	85 - 100
4.75 mm	-	0 - 5	0 - 5	0 - 10	0 - 20
2.36 mm	-	-	-	-	0 - 5

- c. The gradation test shall be carried out regularly as per relevant IS and for every change of source of materials. The necessary tests indicated in IS: 383-1970 and IS: 456-2000 shall have to be carried out to ensure the acceptability. The aggregates shall be stored separately and handled in such a manner as to prevent the intermixing of different aggregates. If the aggregates are covered with dust, they shall be washed with water to make them clean.

2.1.8 COARSE AGGREGATE

- a. Aggregate for Design Mix Concrete: Coarse aggregate shall be of machine crushed stone and shall be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.
- b. The aggregates shall generally be cubical in shape, unless special stones of particular quarries are mentioned, aggregates shall be machine crushed from the best, or equivalent hard stones as approved. Aggregate shall have no deleterious reaction with cement.
- c. The necessary tests indicated in IS: 383-1970 and IS: 456-2000 shall have to be carried out to ensure the acceptability of the material.
- d. If aggregate is covered with dust, it shall be washed with water to make it clean.
- e. The test shall be carried out regularly as per IS and as directed by Engineer-in-charge.

2.1.9 BRICKS

- a. The bricks shall be hand or machine molded and made from suitable soils and kiln burnt. They shall be free from cracks and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour. The bricks shall be molded with a frog of 100 mm x 40 mm and 10 mm to 20 mm deep on one of its flat sides. The bricks shall not break when dropped on the ground from a height of 600 mm.
- b. The size of modular bricks shall be 190 mm x 90 mm x 90 mm.
- c. The size of conventional bricks shall be 225 mm x 110 mm x 75 mm.
- d. Only bricks of one standard size shall be used on one work. The following tolerances shall be permitted in the conventional size adopted in a particular work.

Length : 3.00 mm

Width : 1.50 mm

Height : 1.50 mm

- e. The crushing strength of the bricks shall not be less than 35 Kg/sq.cm. The average water absorption shall not be more than 20% by weight. Necessary tests for crushing strength and water absorption etc. shall be carried out as per IS: 3495 (Part I to IV) - 1976.
- f. Normally the locally manufactured conventional brick is available. So, the contractor shall get approved make and size of brick from Engineer-in-charge.

2.1.10 MILD STEEL BARS

- a. Mild steel bars reinforcement for R.C.C. work shall conform to IS: 432 (Part-II)-1966 and

shall be of tested quality. It shall also comply with the relevant part of IS: 456-2000.

- b. All the reinforcement bars shall be clean and free from dirt, paint, grease, mill scale or loose or thick rust at the time of placing.
- c. The bar shall be measured correct up to 10 mm length and weight as specified below:

mm	Kg/Rmt.	mm	Kg/Rmt.
6	0.22	20	2.47
8	0.395	22	2.98
10	0.62	25	3.85
12	0.89	28	4.83
14	1.21	32	6.31
16	1.58	36	7.99
18	2.0	40	9.86

2.1.11 HIGH STRENGTH DEFORMED THERMO MECHANICALLY TREATED (TMT) BARS

- a. High strength deformed Thermo Mechanically Treated (T.M.T.) bars shall be as per IS: 1786 (latest) of grade minimum of Fe 500.
- b. Other provision and requirements shall conform to specification of Mild Steel Bars.
- c. Reinforcing steel shall not be stored directly on the ground. These shall be stored under cover and shall be protected from rusting, oil grease and distortions as directed by the Engineer-in-charge.
- d. No re-rolled material will be allowed and accepted. Contractor shall submit the manufacturer's test certificate along with the gate pass no., lorry no. with each truck load consignment.
- e. Frequency of tests shall be as per IS: 1786, table-5. Steel not conforming the specifications shall be rejected and removed from the site immediately.
- f. Pitted and defective rods shall not be used. All the reinforcement shall be ISI marked.

Elongation percent on gauge length is $5.65 \times A1/2$

- Where A is the cross-sectional areas of the test piece.

Mild steel is not recommended for the use in structures located in earthquake zone, subjected to severe damage and for structures subjected to dynamic loading (other than wind loading) such as railway and highway bridges.

Welding of reinforcement bars covered in this specification shall be done in accordance with the requirements of IS: 2751.

Sr. No	Property	Fe 500
1	0.2 Per cent Proof stress/ yield stress, (Min.in N/mm ²)	500.0

2	Elongation, percent Min. on gauge length $5.65 A^{1/2}$, where 'A' is the cross-sectional area of the test piece.	12.0
3	Tensile strength (Minimum).	8% more than the actual 0.2% proof stress / yield stress but not less than 565.0 N/mm^2
4	Total elongation at maximum force, percent Minimum on gauge length $5.65 A^{1/2}$, Where 'A' is the cross-sectional area of the test piece.	–

Tests: Selection and preparation of Test sample. All the tests' pieces shall be selected by the Engineer – in- Charge or his authorized representative either-

a) From cutting of bars

Or

b) If he so desires, from any bar after it has been cut to the required or specified size and the test piece taken from and any part of it.

In neither case, the test pieces shall be detached from the bar or coil except in the presence of the Engineer-In-Charge or his authorized representative.

The test pieces obtained in accordance with as above shall be full sections of the bars as rolled and subsequently cold worked and shall be subjected to physical tests without any further modifications. No deduction in size by machining or otherwise shall be permissible. No test pieces shall be enacted or otherwise subject to heat treatment. Any straightening which a test piece may require shall be done cold.

Tensile Test: 0.2% proof stress and percentage elongation. This shall be done as per IS: 1608, read in conjunction with IS: 226.

RE- test: This shall be done as per IS: 1786.

Re-bend test: This shall be done as per IS: 1786.

CHEMICAL COMPOSITION OF REINFORCEMENT BARS SHALL BE AS PER TABLE

Sr No.	Constituent	Maximum Per cent (Fe 500)
1	Carbon	0.30
2	Sulphur	0.055
3	Phosphorus	0.055
4	Sulphur and Phosphorus	0.105

Thermo Mechanically treated reinforcement bars:

- There is no BIS code for TMT bars. The available code BIS: 1786 pertains to HSD Bars. Therefore, there should be no stipulation that TMT bars should conform to relevant BIS code.
- The TMT bars are being produced under valid license from either of the firms namely Tempcore, Thermex Evcon Turbo & Turbo Quench. These firms have acquired patents and are giving licenses to various producers to produce TMT Bars.

- c) The TMT bars shall conform to IS: 1786 pertaining to Fe 500 minimum grade of steel as specified.
- d) In design and construction of reinforced concrete building in seismic zone III and above, steel reinforcement of Grade Fe 500 shall be used. However, high strength deformed steel bars, produced by thermo-mechanical treatment process of grade Fe 500 having elongation more than 14.5. % And conform to other requirements of Fe 500 respectively of IS:1786 may also be used for reinforcement. In future, latest provision of IS:456 and IS:13920 or any other relevant code as modified from time to time shall be applicable.

- **STACKING AND STORAGE**

Steel for reinforcement shall be stored in such a way as to prevent distorting and corrosion. Care shall be taken to protect the reinforcement from exposure to saline atmosphere during storage, fabrication and use. It may be achieved by treating the surface of reinforcement with cement wash or by suitable methods. Bars of different classifications, sizes and lengths shall be stored separately to facilitate issue in such sizes and lengths to cause minimum wastage in cutting from standard length.

- **IDENTIFICATION**

Care shall also be taken to properly identify these bars at site. The staff shall be specially trained for looking for identification marks on these bars given by the manufacturers which are generally given colour code. It will be advisable to see that only one type/grade of bars are brought to site and used in the project after conducting tests for each lot.

2.1.12 CORROSION RESISTANCE STEEL (HYSD CRS)

CRS HYSD FE 500 reinforcing bars shall conform to IS: 1786 (2008).

2.1.13 MILD STEEL BINDING WIRE

- a. The mild steel wire shall be of 1.63 mm or 1.22 mm (16 or 18 gauge) diameter and shall conform to IS: 280-1972.
- b. The use of black wire will be permitted for binding reinforcement bars. It shall be free from rust, oil, paint, grease, loose mill scale or any other undesirable coating, which may prevent adhesion of cement mortar.

2.1.14 FUSION BONDED EPOXY COATING REINFORCING BARS

Fusion bonded epoxy coating reinforcing bars for RCC work shall conform to IS: 13620 & shall be of tested quality. The thickness of Fusion Bonded Epoxy Coating shall be 200 to 250 microns. If this is required, contractor shall be done at his risk and cost.

2.1.15 STRUCTURAL STEEL

- a. All structural steel shall conform to IS: 226 -1965. The steel shall be free from the defects mentioned in IS: 226 -1975 and shall has a smooth finish. The material shall be free from loose mill scale, rust pits or other defects affecting the strength and durability. Rivet bars

- shall conform to IS: 1148 -1973.
- b. When the steel is supplied by the contractor, test certificates of the manufacturers shall be obtained according to IS: 226-1975 and other relevant Indian Standards.
 - c. If tests are required for the same, shall be performed by contractor at his cost as instructed by Engineer-in-Charge.

2.1.16 SHUTTERING

- a. The shuttering shall be either of wooden planking of 30mm minimum thickness with steel lining or of heavy steel plates stiffened by heavy steel angles. The shuttering shall be supported on battens and beams and props of vertical bellies properly cross braked together so as to make the centering rigid. In places of balli props, bricks pillar of adequate section built in mud mortar may be used.
- b. The form work shall be sufficiently strong and shall have camber, so that it assumes correct shape after deposition of the concrete and shall be able to resist forces caused by vibration of concrete, live load of men working with it and other incidental loads associated with it. The shuttering shall have smooth and even surface and its joints shall not permit leakage of cement grout.
- c. If at any stage of work during or after placing concrete in the structure, the form work sags or bulges out beyond the required shape of the structure, the concrete shall be removed and work shall be re-done with fresh concrete with adequately rigid formwork. The complete form work shall be got inspected by and approved from the Engineer - in- charge, before the reinforcement bars are placed in position.
- d. The props shall consist of bullies having 100mm minimum diameter measured at mid length and 80mm at thin end and shall be placed as per design requirement. These shall rest squarely on wooden sole plates 40 mm thick and minimum bearing area of 0 – 10 m² laid on sufficiently hard base.
- e. Double wedges shall further be provided between the sole plate and wooden props so as to facilitate tightening and easing of shuttering without jerking the concrete.
- f. As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided.
- g. Specially for the structures such as (Pumping station & Panel Room) the steel shuttering with MS. Probes shall only be used. In case of steel shuttering either soap solution or raw linseed oil shall be applied after thoroughly cleaning the surface. Under no circumstances black or burnt oil shall be permitted.
- h. The shuttering for beams and slabs shall have camber of 4mm per meter (1 in 250) or as directed by the Engineer-In-Charge so as to offset the subsequent deflection. For cantilevers, the camber at free end shall be 1/50th of the projected length or as directed by the Engineer-in-charge.

2.1.17 TEAK WOOD

- a. The teak wood shall conform to IS: 4021 as required for the item to be executed. When the

kind of wood is not specifically mentioned: good Indian teak wood as approved shall be used.

- b. Teak wood shall generally be free from large, loose, dead or cluster knots, flaws, warps, twists, shakes, bends or any other defects. It shall generally be uniform in substance and of straight fibers as far as possible. It shall be free from rot, decay, harmful fungi and other defects of harmful nature, which will affect the strength, durability or its usefulness for the purpose for which it is required. The colour shall be uniform as far as possible. Any effort like painting, using any adhesive or resinous materials made to hide the defects shall render the pieces liable to rejection by the Engineer-in-charge.
- c. All scantlings, planks etc. shall be sawn in straight lines and planes in the direction of grains and have uniform thickness.
- d. The tolerances in the dimensions shall be allowed at the rate of 1.5 mm per face to be planed.
- e. First Class Teak Wood: First class teak wood shall have no individual hard and sound knots more than 6 sq. cm. in size and the aggregate area of such knots shall not be more than 1% of area of piece. The timber shall be closed grained.
- f. Second Class Teak Wood: No individual hard and sound knots shall be more than 15 sq. cm. in size and aggregate area of such knots shall not exceed 2% of the area of piece.
- g. If tests are required for the same, shall be perform by contractor at his cost as instructed by Engineer-in-Charge.

2.1.18 ROLLING SHUTTERS

- a. The rolling shutters shall conform to I.S. 6248-1979. Rolling shutters shall be supplied of specified type with accessories. The size of the rolling shutters shall be specified in the drawings. The shutters shall be constructed with interlocking lath sections formed from cold rolled steel strips not less than 0.9 mm thick and 80 mm wide for shutters less than 3.5 m width, not less than 1.25 mm thick and 80 mm wide for shutters of 3.5m in width and above unless otherwise specified.
- b. Guide channels shall be of mild steel deep channel section and of rolled pressed or built up (fabricated) joint-less construction. The thickness of sheet used shall not be less than 3.15 mm.
- c. Hood covers shall be made of M.S. sheets not less than 0.92 mm thick. For shutters having width
- d. 3.5 m and above, the thickness of M.S. sheet for the hood covers shall be not less than 1.25 mm.
- e. The spring shall be of best quality and shall be manufactured from tested high tensile spring steel wire or strip of adequate strength to balance the shutters in position. The spring pipe shaft etc. shall be supported on strong M.S. or malleable C.I. Brackets. The brackets shall be fixed on the or under the lintel as specified with raw plugs and screws bolts etc.
- f. The rolling shutters shall be of self-rolling type up to 8 Sq.m. clear area without ball bearing and up to 12 Sq.m. clear area with ball bearing. If the rolling shutters are of larger area than gear operated type shutters shall be used.

- g. The locking arrangement shall be provided at the bottom of shutter at both ends. The shutters shall be opened from outside.
- h. The shutters shall be completed with door suspension, shafts, locking arrangements, pulling hooks, handles and other accessories.

2.1.19 GLASS

All glass shall be of the best quality, free from specks, bubbles, smokes, veins, air holes blisters and other defects. The kind of glass to be used shall be as mentioned in the item or specification or in the special provisions or as shown in detailed drawings. Thickness of glass panes shall be 4 mm. The specifications for different kinds of glass shall be as under;

a. SHEET GLASS

In the absence of any specified thickness or weight in the item or detailed specifications of the item of work, sheet glass shall be weighing 7.5 Kg/Sq.m. for panes up to 600 mm x 600 mm.

For panes larger than 600 mm x 600 mm and up to 800 mm x 800 mm, glass weighing not less than 8.75 Kg/Sq.m. shall be used. For bigger panes up to 900 mm x 900 mm, glass weighing not less than 11.25 Kg/Sq.m. shall be used.

Sheet glass shall be patent flattened glass of best quality and for glassing and framing purposes shall conform to IS: 2835-1960. Sheet glass of the specified colours shall be used, if so shown on detailed drawings or so specified. For important buildings and for panes with any dimensions over 900 mm, plate glass of specified thickness shall be used.

b. PLATE GLASS

When plate glass is specified, it shall be 'Polished Patent Plate Glass' of best quality. It shall have both the surface ground flats and parallel and polished to obtain clear undisturbed vision and reflection. The plate glass shall be of the thickness mentioned in the item or as shown in the detailed drawing or as specified. In the absence of any specified thickness, the thickness of plate glass to be supplied shall be 6 mm and a tolerance of 0.20 mm shall be admissible.

c. OBSCURED GLASS

This type of glass transmits light so that vision is partially or almost completely obscured. Glass shall be plain rolled, figured, ribbed or fluted, or frosted glass as may be specified as required. The thickness and type of glass shall be as per details on drawings or as specified or as directed.

d. WIRED GLASS

Glass shall be with wire netting embedded in a sheet of plane glass. Electrically welded 13 mm Georgian square mesh shall be used. Thickness of glass shall not be less than 6 mm, wired glass shall be of type and thickness as specified. The type of glass to be used shall be as per design drawing or as decided by the Engineer-in-charge.

2.1.20 FIXTURES & FASTENINGS

a. General

The fixtures and fastenings that is butt, hinges, tee and strap hinges, sliding door bolts, tower bolts, door latch, bath-room latch, handles, door stoppers, casement window fasteners, casement stays and ventilator catch shall be made of the metal as specified in the item or its specifications.

They shall be of stainless steel or as approved by Engineer-in-charge.

The fixtures shall be heavy or medium type. The fixtures and fastenings shall be smooth finished and shall be such as will ensure ease of operation.

The samples of fixtures and fastenings shall be got approved as regards quality and shape before providing them in position.

Brass and anodized aluminium fixtures and fastenings shall be bright finished.

b. Holdfasts

Holdfasts shall be made from mild steel flat 30 cm length and one end of the holdfasts shall be bent at right angle and two nos. of 6 mm. dia. holes shall be made in it for fixing it to the frame with screws. At the other end, the holdfast shall be forked and bent at right angles in opposite directions.

c. Butt Hinges

Railway standard heavy type butt hinges shall be as approved. Tee and strap hinges shall be manufactured from M.S. sheet.

d. Sliding Door Bolts (Aldros)

The aldros as specified in the item shall be used and shall be got approved.

e. Tower Bolts (Barrel Type)

Tower bolts as specified in the item shall be used and shall be got approved.

f. Door Latch

The size of door latch shall be taken as the length of latch.

g. Bathroom Latch

Bathroom latch shall be similar to tower bolt.

h. Handle

The size of the handles shall be determined by the inside grip length of the handles. Handles shall have a base plate of length 50 mm more than the size of the handle.

i. Door Stoppers

Door stoppers shall be either floor door stopper type or door catch type. Floor stopper shall be of overall size as specified and shall have a rubber cushion.

j. Door Catch

Door catch shall be fixed at a height of about 900 mm from the floor level such that one part of the catch is fitted on the inside of the shutter and other part is fixed in the wall with necessary wooden plug arrangements for appropriate fixity. The catch shall be fixed 20mm inside the face of the door for easy operation of catch.

k. Wooden Door Stop with Hinge

Wooden door stop of size 100 mm x 60 mm x 40 mm shall be fixed on the door frame with a hinge of 75 mm size and at a height of 900 mm from the floor level. The wooden door stop shall be provided with 3 coats of approved oil paint.

l. Casement Window Fastener

Casement window fastener for single lead window shutter shall be left or right-handed as directed.

m. Casement Stays (Straight Peg Stay)

The stays shall be made from a channel section having three holes at appropriate positions so that the window can be opened either fully or partially as directed. Size of the stay shall be 250mm to 300mm as directed.

n. Ventilator Catch

The pattern and shape of the catch shall be as approved.

o. Pivot

The base and socket plate shall be made from minimum 3 mm thick plate and projected pivot shall not be less than 12 mm dia. and 12 mm length and shall be firmly riveted to the base plate in case of iron pivot and in single piece base in the case of brass pivot.

2.1.21 PAINTS

a. Oil Paints

Oil paints shall be from reputed manufacture and of the specified colour and shade and as approved by Engineer-in-charge. The ready mixed paints shall only be used.

However, if ready mixed paint or specified shade or tint is not available, white ready mixed paint

with approved strainer will be allowed. In such a case, the contractor shall ensure that the shade of the paint so allowed shall be uniform.

All the paints shall need with the following general requirements;

Paint shall not show excessive setting in a freshly opened full can and shall easily be re-dispersed with paddle to a smooth homogeneous state. The paint shall show no curdling, livening, caking or colour separation and shall be free from lumps and skins.

The paint as received shall brush easily, possess good levelling properties and show no running or sagging tendencies.

The paint shall not skin within 48 hours in three quarters filled closed container.

The paint shall dry to a smooth uniform finish free from roughness, grit unevenness and other imperfections.

Ready mixed paint shall be used exactly as received from the manufacturers and generally according to their instructions and without any admixtures whatsoever.

b. Enamel Paints

The enamel paint shall satisfy the general requirements as mentioned in specification of oil paints. Enamel paints shall conform to I.S. 2933-1975.

2.1.22 ROUGH KOTA STONE

- a. The Kota stones shall be hard, even, sound and regular in shape and generally uniform in colour conforming to IS 1123. The colour of the stone shall generally be green. Brown colored stones shall not be allowed for use. They shall be without any soft veins, cracks or flaws.
- b. The size of the stones to be used for flooring shall be size 600 mm x 600 mm and/or size 600mm x 450mm as directed. However, smaller sizes will be allowed to be used to the extent of maintaining the required pattern. Thickness shall not be less than 18 mm.
- c. Tolerance of minus 30mm on account of chisel dressing of edges shall be permitted for length as well as breadth. Tolerance in thickness shall be plus 3 mm.
- d. The edges of stones shall be truly chiseled and table rubbed with coarse sand before paving. All angles and edges of the stone shall be true, square and free from chipping and the surface shall be true and plain.
- e. When machine cut edges are specified, the exposed edges and the edges at joints shall be machine cut. The thickness of the exposed machine cut edges shall be uniform.

2.1.23 POLISHED KOTA STONES

Polish Kota stone shall have the same specifications as per rough kota stone except as mentioned below.

The stone shall have machine polished smooth surface. When brought on site, the stones shall be single polished or double polished depending upon its use. The stones for paving shall generally be single polished. The stones to be used for dedo, skirting, platforms sink, veneering, sills, steps, etc. where machine polishing after the stones are fixed in situ is not possible shall be double polished.

2.1.24 GALVANISED IRON PIPES AND FITTINGS

Galvanized iron pipe shall be of the medium duty type and of required diameter and shall comply with IS: 1239-1979. The specified diameter of the pipes shall refer to the inside diameter of the bore. Clamps screw and all galvanized iron fittings shall be of the standard 'A' or equivalent make.

2.1.25 CAST IRON PIPES AND FITTINGS

All soil, waste, vent and anti-siphonage pipes and fittings shall conform to I.S. 1729-1964. The pipes shall have spigot and socket ends with head on spigot end. The pipes and fittings shall be true to shape, smooth, cylindrical their inner and outer surfaces being as nearly as practicable concentric. They shall be sound and nicely cast and shall be free from cracks, laps, pin holes or other imperfections and shall be neatly dressed and carefully fettled.

The end of pipes and fittings shall be reasonably square to their axis.

The sand cast iron pipes shall be of the diameter as specified in the description and shall be in length of 1.5 m, 1.8 m & 2.0 m including socket ends of the pipe unless shorter length are either specified or required at junction etc. The pipes and fittings shall be supplied without ears unless specified or directed otherwise.

Tolerances: The standard weights and thickness of pipes shall be as shown in the table below. A tolerance up to minus 10% may however be allowed against these standard weights.

Sr No.	Nominal Dia of Bore	Overall Thickness	Weight of pipe excluding bars		
			1.5 m long	1.8 m long	2.0 m long
1	75.0	5.0	12.83 Kg	16.52 Kg	18.37 Kg
2	100.0	5.0	18.14 Kg	21.67 Kg	24.15 Kg

A tolerance up to minus 15% in thickness and 20 mm. in length will be allowed. For fittings tolerance in lengths shall be plus 25 mm. and minus 10 mm.

The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions specified for the corresponding sizes of straight pipes. The tolerance in weights and thickness shall be the same as for straight pipes.

2.1.26 BITUMEN FELT FOR WATER PROOFING AND DAMP PROOFING

Bitumen felt shall be on the fiber bases and shall be of type 2; self-finished felt graded and shall conform to I.S. 1322-1970.

2.1.27 SELECTED EARTH

- a. The selected earth / material shall be that obtained from excavated material or shall have to be brought from outside as indicated in the item. If item does not indicate anything, the selected earth shall have to be brought from outside.
- b. The selected earth shall be good yellow soil and shall be got approved from the Engineer-in-charge. In no case black cotton soil or similar expansive and shrinkable soil shall be used. It shall be clean and free from all rubbish and perishable materials, stones or brick bats. The clods shall be broken to a size of 50mm or less. Contractor shall make his own arrangements at his own costs for land for borrowing selected earth. The stacking of materials shall be done as directed by the Engineer-In-Charge in such a way as not to interfere with any constructional activities and in proper stacks.
- c. When excavated material is to be used, only selected stuff got approved from the Engineer-In- Charge shall be used. It shall be stacked separately and shall comply with all the requirements of selected earth mentioned above.

2.1.28 GLAZED STONEWARE PIPE AND FITTINGS

The pipes and fittings shall be of best quality and as approved by the Engineer-in charge. The pipe shall be of best quality manufactured from stone-ware of fire clay, salt glazed thoroughly burnt through whole thickness, of a close even texture, free from air blows, fire blisters, cracks and other imperfections, which affect the serviceability. The inner and outer surfaces shall be smooth and perfectly glazed. The pipe shall be capable to withstand pressure of 1.5m head without showing signs of leakage. The thickness of the wall shall not be less than (1/12) th of the internal dia. The depth of socket shall not be less than 38mm. The socket shall be sufficiently large to allow a joint of 6 mm. around the pipe.

2.1.29 WATER STOPPER

225 mm wide 5-6 mm thick, PVC ribbed stopper as approved by Engineer-in-charge. The sample of water stopper shall be got approval from Engineer-In-Charge before procurement. The same shall get it tested before use.

2.1.30 HAND RAILING

Providing and fixing 38 mm dia. G.I. pipe (Class-B) railing in three rows 1150 mm high for the

openings, platforms, stairs & around the sump area etc. including two coats of approved chlorinated rubber paint etc. complete.

Hand railing shall be with 25 mm of GI pipe in three rows with 25mm of GI pipe upright at a spacing not more than 1.85 m and of 1.15 m clear height. Hand railing shall be provided all around platforms, Approach Bridge, staircase and walkways & Sump etc. The GI railing shall be as per approved drawing.

2.1.31 CEMENT PAINT (WATER PROOFING PAINT)

The cement Paint shall be (conforming to IS: 5410) of approved brand and manufacture such as Asian paints, Nerolec paints & Dulux paints or any other brand as approved by Engineer-in-charge. The cement Paint shall be brought to the site of work by the contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in-Charge. The empty containers shall not be removed from the site of work till the relevant item of the work has been completed and permission obtained from the Engineer-in-Charge.

2.1.32 WATER PROOFING PLASTER

The cement mortar shall consist of two parts of fine river sand free from any dust and other organic matter and one part of approved quality of cement. The mortar shall be properly mixed on watertight platform. The mortar shall be used within half an hour after mixing. The water proofing materials weighting 1.5 kg of powder in one bag of cement shall be added.

The plaster shall be applied in uniform thickness of 20 mm and shall be properly smoothened with wooden & finished with cement finishing of required. The curing shall be done at least for week by sprinkling the water over the wall. The wall shall be tested for water proofness. The rate includes the cost of water proofing materials. The test for water proofness shall be carried out by the contractor at his own cost filling the water by contractor and it shall be checked out that there is no percolation of water from the wall. Payment shall be made per sq. m. of plaster done.

2.1.33 AIR VALVES DOUBLE ACTING FLANGED / SCREWED TYPE (FOR HDPE PIPE)

The double acting air valve shall be supplied and carted by the contractor as per relevant latest IS. The rate shall include loading, unloading and stacking at site.

The materials shall be carted to store or site of work including all freight, loading, unloading including all taxes, insurance, including necessary jointing materials such as G.I. Nipple, saddle pieces shall be brought by the contractor for fixing of air valve.

A suitable hole shall be drilled on the pipeline. The pipeline shall be of any type such as HDPE,

AC, PVC or CI pipes. A clamp shall be got prepared with a nipple welded on it. The clamp shall be fixed on pipe with bolts and nuts in such a way that the part of nipple fixed in the clamp shall remain in the hole drilled in pipe. The rubber packing shall be provided between the clamps and the pipe. White zinc spun yarn shall be used for fixing the nipple of air valve.

Bolt holes shall be drilled according to centre lines. Bolt heads and nuts shall be hexagonal and shall conform to IS: 1363 (specification for black hexagonal bolts, nuts and lock nuts and black hexagonal screws).

The neoprene seat ring shall be held security in place under the low-pressure cover by jointing support ring to prevent it from sagging when the ball is not soaking the orifice.

2.1.34 JOINTING MATERIAL

Jointing material shall be brought by contractor with all necessary joint rings, nuts, bolts, and washers for completing the joints on all the flanges of valve supplied under this contract including these flanges which will be jointed to pipe system. The lengths of bolts shall be assumed to be suitable for jointing material supported under the contract shall be inclusive of rates.

Joint rings shall be of flat section at least 3 mm thick. They shall be of rubber in accordance with IS: 638 – 1965 or its latest edition (specifications for rubber and insertion jointing) of hardness proven in practice so as form a water tight joint and use of jointing paste shall not be allowed.

2.2 CODE OF PRACTICE

1. The method of the execution of the items shall conform to the relevant specifications as per the latest version of the Indian Standard unless specified otherwise and as far as is applicable.
2. Wherever a reference to any Indian Standard appears in the code, it shall be taken to mean as a reference to the latest version of the standard.
3. Work Tests shall invariably be got carried out by the contractor, when the same are specified in standard Code. Tests shall also have to be carried out, even though the same may not have been specifically mentioned in the standard Code, if in the opinion of the Engineer-In-Charge, they are required to be carried out.
4. All moulds, equipment's etc. required for preparing specimens for tests shall be kept in sufficient numbers and in good state as directed by the Engineer-In-Charge on the site of work.
5. Specimen for tests shall be sent to the laboratory along with the representative of department in time and the results there of shall be promptly obtained and reported to the Engineer-In-Charge.
6. Satisfactory test results shall not absolve the contractor from dismantling and re-doing any work revealed to be defective at a later date. The contractor shall have no claim for any payment or compensation whatsoever on account of replacement of such defective work. Contractor shall take all precautions and care during dismantling and re-doing the work to

ensure that any other work, so far executed does not get damage or affected.

8. The work shall be carried out in true line and level and in conformity with the detailed drawings and specified patterns.
9. All work shall be carried out in a workman-like manner and as per the best techniques for the particular item.
10. All tools, templates, equipment etc. for correct execution of the work as well as for checking lines, levels, alignments of the works during execution shall be kept in sufficient numbers on the site of work.
11. All installations pertaining to water supply and drainage lines fixtures as well as and sanitary fittings shall be deemed to be completed only after giving satisfactory test by the Contractors.
12. Scaffolding shall be provided by the Contractor at his own cost for such of the items for the execution of which is essential. Design of scaffolding and its approval should be obtained from Engineer-in-charge.

2.3 CIVIL AND BUILDING WORKS

The design criteria for structural design of civil structures shall be as given in Section–1 of this Volume.

2.3.1 MATERIALS IN GENERAL

The term “materials” shall mean all materials, goods and articles of every kind whether RAW, processed or manufactured and equipment and plant of every kind to be supplied by the contractor for incorporation in the works.

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

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

As soon as practicable after receiving the order to commence the works, the contractor shall inform Engineer-In-Charge 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 Engineer-In-Charge which may be withheld until samples have been submitted and satisfactorily tested. The contractor shall thereafter keep Engineer-In-Charge informed of orders for and delivery dates of all materials.

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.

2.3.2 SAMPLES AND TESTS OF MATERIALS

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

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

The contractor shall give Engineer-In-Charge 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 Engineer-in-charge. Representative of Engineer-In-Charge may 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 Engineer-In-Charge to carry out such a test on a mutually agreed date in his presence. The contractor shall in any case submit to Engineer-In-Charge representative within seven days of every test such number of certified copies (minimum six) of the test results as Engineer-In-Charge may require. The representative of contractor shall have to remain present during testing at any place. It is compulsory to present the contractor at the time of testing. In absence of representative of contractor, test shall be carried out by the department and results shall have to accept by the contractor.

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

The provisions of this clause shall also apply fully to materials supplied under any nominated sub-contract.

2.3.3 STANDARDS

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

Where the relevant standard provides for the furnishing of a certificate to Engineer-in-charge, 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 Engineer-in-charge. The specifications, standards and codes listed below are considered to be part of this Bid specification. All standards, specifications, codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions.

A. MATERIAL

IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 428	Washable Distemper-specification

IS: 432	Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (Parts 1 & 2)
IS: 458	Pre-cast concrete pipes (with and without reinforcement)-Specification
IS: 650	Specification for standard sand for testing of cement
IS: 651	Specification for salt glazed stoneware pipe and fittings
IS: 777	Glazed earthenware tiles
IS: 808	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	Timber paneled and glazed shutters (Parts 1 & 2)
IS: 1038	Specification for steel doors, windows and ventilators
IS: 1077	Common burnt clay building bricks-Specification
IS: 1398	Specification for packing paper, water proof, and bitumen laminated
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	Rolling and cutting tolerances for hot rolled steel products
IS: 1948	Specification for aluminium doors, windows and ventilators
IS: 1977	Low Tensile structural steels - specification
IS: 2062	Steel for general structural purposes - Specification
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 waterproofing compounds for cement mortar and concrete
IS: 2750	Specification for steel scaffoldings
IS: 2835	Flat transparent sheet glass
IS: 3384	Specification for bitumen primer for use in waterproofing and damp roofing
IS: 3502	Steel Chequered plates - Specification
IS: 4021	Timber door, window and ventilator frames- Specification
IS: 4350	Specification for concrete porous pipes for under drainage
IS: 4351	Steel door frames- Specification

IS: 4990	Specification for plywood for concrete shuttering work
IS: 9862	Ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water and chlorine resisting
IS 10262	Guidelines for concrete mix design proportioning
IS 12269	Specification for 53 grade ordinary Portland cement
IS: 12330	Specification for sulphate resisting Portland cement
IS: 12709	Specification for Glass fiber 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 radio graphic 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 41)
IS: 3025	Methods for sampling and test (physical and chemical) for water and waste water (Parts 1 to 63)
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	Door shutters - Methods of Tests (Parts 1 to 16)
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 buildings & structures (Parts 1 to 5)
IS: 1081	Code of practice for fixing and glazing of metal (steel and aluminium) doors, windows and ventilators
IS: 1172	Code of 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
IS: 2394	Code of practice for application of lime plaster finish
IS: 2395	Code of practice for painting, concrete, masonry and plaster surfaces (Parts 1&2)
IS: 2470	Code of practice for installation of septic tanks (Parts 1 & 2)
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement
IS: 2571	Code of practice for laying in situ cement concrete flooring
IS: 2595	Code of practice for radiographic testing
IS: 2751	Code of 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 to 4)
- IS: 13920 Ductile detailing of reinforcement concrete structure subjected to seismic forces - code of practice
- IS: 4326 Code of practice for Earthquake Resistant Design and Construction of Buildings
- IS: 4353 Submerged arc welding of mild steel and low alloy steels - Recommendation
- IS: 5329 Code of practice for sanitary pipe work above ground for buildings
- IS: 5334 Magnetic particle flaw detection of welds - Code of practice
- IS: 5822 Code of practice for laying of welded steel pipes for water supply
- IS: 7215 Tolerances for fabrication of steel structures
- IS: 9595 Metal welding of carbon and carbon manganese steels - Recommendations
- 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

2.3.4 ORIENTATION

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 pipe work. Underground services requiring to be relocated in order to accommodate the proposed site layout shall, with the approval of Engineer-in-charge, be relocated by the contractor with no extra cost.

2.3.5 BUILDINGS AND STRUCTURES

All the building and structure works shall generally comply with the following Engineer-In-Charge requirements unless otherwise specified elsewhere.

1. All external walls shall be in 230 mm thick brick masonry built in cement mortar in 1:6 by volume.
2. All internal partition walls shall be built in cement mortar 1:4 by volume.
 - a. Finishes to concrete liquid retaining structures (for details, refer clause 2.5.16 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 2.5.16 of this volume) shall be:

F1 - Buried

F1 - Exposed, where plastering is specified F2- Exposed

3. All internal masonry surfaces finish shall have 15 mm thick cement plaster in cement mortar (1:3) by volume with cement finish on top. Internal surface of fore-bay/sump and suction area shall have 15mm thick cement plaster in CM (1:3) by volume.
4. All external masonry surfaces shall have 20 mm thick sand faced cement plaster in two coats. The first coat shall be approximately 12 mm thick in C.M. 1:3 by volume and finishing coat shall be 8 mm thick in C.M. 1:1. by volume
5. All external surfaces above ground level shall have two coats of weather proof exterior emulsion APEX type paint of approved quality and shade.
6. Internal Room areas, walls and ceilings, shall have two coats of oil bound distemper.
7. Toilet floor slab shall be filled with PCC 1:2:4 by volume and provided with waterproofing as per the specifications. All terraces shall be provided with China mosaic as per specifications.
8. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.
9. The toilet facilities for Pump house /Panel room building shall include at least:
 - a. 2 Nos. Water closets with European type W.C. pan minimum 580 mm long with integral size "P" or "S" trap including jointing the trap with soil pipe in cement mortar 1:1
 - b. 2 Nos. Urinals of sizes 600 mm x 400 mm x 300 mm flat back type in colour porcelain separated by a marble partition of size 680 mm x 300 mm. (12 mm thick)
 - c. 2 Nos. wash basins of size 550 mm x 400 mm in colour porcelain with inlet, and outlet arrangements.
 - d. 2 Nos. mirror of size 450 mm x 600 mm wall mounted type fitted over wash basins.
 - e. 2 Nos. plastic liquid soap bottles
 - f. 2 Nos. chromium plated brass towel rods minimum 750 mm long.
 - g. All stopcocks, valves and pillar cocks shall be heavy duty chromium plated brass.
 - h. All fittings such as 'P' or 'S' traps, floor traps, pipes, down take pipes etc.
 - i. The sewage from toilet blocks shall be led to a septic tank.
 - j. Pipes to be 'C' class concealed plumbing.
10. All staircases shall have 25 mm thick Kota stone flooring. 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 Engineer-In-Charge to access areas not frequently visited.
11. All floor cut outs and cable ducts, etc. shall be covered with pre-cast concrete covers in outdoor areas and mild steel chequered plates of adequate thickness in indoor areas. All uncovered openings shall be protected with M.S. hand railing of 38 NB (M).
 12. All staircases shall be provided with 25 NB (M) M.S. pipe hand railing for vertical support and 25 NB M.S. railing for horizontal support including painting.
 13. The reinforced concrete roofs shall be made water proof by application of China mosaic flooring. The finished roof surface shall have adequate slope to drain quickly the rain water to rain water down take inlet points.
 14. For roofing drainage, down take PVC pipe of ISI mark of suitable diameter of 6 Kg/cm² pressure use with necessary specials shall be provided. For roof areas up to 100 Sq. m. minimum two nos. of 100 mm diameter down take PVC pipes shall be provided. For every additional area of 100 Sq. m. or part thereof, at least one no. 100 mm dia. down take PVC pipe shall be provided.
 15. 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.
 16. All doors, windows, rolling shutters shall have lintels above. Chajjas protection to lintels on external walls shall be such as to prevent the rainwater splashing into the building.
 17. All concrete channels and ducts used for conveying water 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.
 18. Kerbs to be provided below the hand railing on the catwalks / pathways should be as per relevant sections of Factory Act.
 19. All rooms in the buildings shall be provided with appropriate signboards indicating the function of the rooms involved.
 20. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry in the form of EOT crane of suitable capacity with monorail shall be provided.
 21. The design of buildings shall be suitable for the climatic conditions existing on site. Buildings shall as far as be possible permit the entry of natural light.
 22. 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.
 23. The side walls of buildings shall comprise at least 15% ventilated brickwork or louvers. Ventiladed brickwork or louvers shall not be used where the ingress of driven rain could affect equipment or stored materials.
 24. All the building shall be provided with overhead PVC water tank of 3000 lit capacity with all the necessary outlets - inlet connection, underground sump of minimum 5000-liter capacity suitable domestic type motor pump set etc. complete.

25. All the doors shall be made from flush door shutters solid core constructions flush door shutters solid core constructions with approved granite base frame of first class hardwood with cross band and face veneer or plywood face / laminated face panels including anodized aluminium butt hinges with necessary screws (B) Non-decorative type and block board core anodized aluminium butt hinges in flush door shutters (2) 35 mm thick further extra for using bright finished M.S piano hinges or a nickel plated piano hinges. All the windows Providing and fixing fully glazed aluminium window partly fixed and partly sliding shutter with frame section 63.5 x 38.1 x 1.02 mm weighing 0.547 kg/Rmt. Shutter section 40 mm x 18 mm x 1.55 mm weighing 0.547 kg/ Rmt. Bottom , top and vertical channel section 61.85 31.75 x 1.20 mm weighing 0.695 kg / Rmt extruded aluminium colour anodized section frame with sliding shutter with 5 mm thick transparent bronze colour tinted float glass panel of Modi guard or equivalent make with power coated aluminium fitting & fixtures and transparent silicon sealant glass fixing to frame as detail including PVC - T in frame, silicon based lining handles locks, two nos. PVC gasket, screws aluminium joints special runners etc. complete. All windows and ventilators shall be provided with pigeon grill.
26. Pest control treatment shall be applied to all building / structure at foundation plinth.
27. Sanitary arrangement shall be provided to all building/structure with required capacity septic tank – soak pit etc.
28. All building such as pump house/ panel building, panel room, staff quarter shall have a minimum 1.0 m wide, 100 mm thick plinth protection as per clause 1.7 (o) of this volume.

2.3.5.1 STAFF QUARTERS

The Eight dwelling units are to be constructed in R.C.C frame structure at head work as per B.O.Q.

The minimum size of accommodation for each dwelling unit is given in the related tender drawings.

Passage & stair case etc. and other requirement shall be provided in each dwelling unit as per drawing.

Cooking sandwich platform in Z black granite top 60 cm wide, and length shall be provided as per kitchen size on Kota stone wall.

M.S fan clamps as directed by Engineer in charge.

S.S. Kitchen sinks of size 600 mm X 450 mm X 150 mm.

Wash basin – 550 mm, 400 mm with chromium plated bottle trap. & M.I. fisher Union as directed by Engineer in charge.

Pillar tap as directed by Engineer in charge.

Brass screw down bib tap polished bright- 15 cm as directed by Engineer in charge. European type W.C. with flushing cistern / tank as directed by Engineer in charge.

Light points including 15 ampere point as directed by Engineer in charge.

- Bell points as directed by Engineer in charge.
- Fan points as directed by Engineer in charge.

- Telephone point as directed by Engineer in charge.
- Cable TV point as directed by Engineer in charge.
- AC Point as directed by Engineer in charge.

The P.V.C. water tank of I.S.I mark of capacity 4000 liters with required UPVC/GI. 'B' class pipe for inlet, outlet, overflow etc. to be provide as per site requirement for W.S. arrangement necessary sanitary arrangement is to be provided with septic tank, soak pit etc.

Contractor shall prepare and maintain a dwelling unit in staff quarter as rest house with all necessary arrangement as directed by Engineer in Charge.

The quantities of above and any other requirements shall be confirmed by contractor with Engineer in charge and shall have to execute them without any extra cost.

2.3.5.2 PUMP HOUSE / PANEL ROOM

The R.C.C frame structure near U/G sump is to be constructed.

The minimum size of Pump house/ panel room, Office room with false ceiling, battery room with separate toilets facility for ladies & gents shall be as per the tender drawings. The rolling shutter shall be provided in pump house, one on inner face of wall & other on outer face of wall. One rolling shutter shall be provided with Pigeon grill of suitable Size. Necessary water supply, sanitary arrangement and lightening arrestor shall also be provided.

The following allied facilities shall to be provided.

1. False ceiling / member of Wooden frame of minimum size (7 cm x 7 cm) shall be provided & fixed at minimum 1.0 m distance from c/c on both ways for frame, in PLC / Office room (4.6 m x 4.7 m). The fiber insulation board lining shall be fixed as directed in PLC / office room. (The detailed specification of ceiling with fiber Insulating Building Boards – shall be as per Tender)
2. Providing & fitting (include Installing for refrigerant piping, cabling & drain piping beyond standard length for duct able A .C machine 18 gauge hard drawn copper pipe including necessary fitting) 5starsplit Air conditioner of approve make with rated approved make split air conditioning unit consisting of condensing unit with fan motor , hermetically sealed rotary compressor with accessories etc. duly connected separately erected evaporating unit and blower motor with its accessories by means of proper insulated copper tubing suitable for (cost include MS stand, Gas Charging & Internal Copper Wiring & remote control) of 2 ton capacity with all allied work in P.L.C./ Office room.
3. On both side of panel room stair case arrangement shall be provided. M.S ladder with hand railing shall be provided for access from pump house to panel room.
4. Lightening arrestor shall be provided over the building as per requirement.

2.3.6 ROADWAYS & PATHWAYS, GATE & ECOLOGICAL DEVELOPMENT

The gate made out of M.S. section of minimum size shown in the indicative drawing shall be provided at the entry point. The pumping station plot shall be developed to give good

environment, includes lawn area, shrubs partitions and no. of trees requirement. The lawn area shall be protected with shrubs all around. The pumping station plot shall be protected with brick masonry wall (230 mm) with minimum height of 2000 mm above F.G.L. with 50 x 50 x 6 mm size angles of 0.6 m height, anchored in the wall at 2.50 to 3.0 m intervals. The barbed wire fencing shall be done in three horizontal lines. In addition to this retaining wall shall be design and constructed to protect the pumping station from erosion with masonry wall and wire fencing above the retaining wall.

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 minimum 5 m wide with 0.50 m wide shoulder on either side as shown in the indicative drawing. 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.

Rates for road included following:

1. Required excavation with proper slope & camber
2. Well compacted W.M.M of 200 mm thick of aggregate up to size of 45 mm.
3. 150 mm thick - PCC M10 (1:3:6)
4. 150mm thick - C.C with M 30 Grade with reinforcement of minimum Fe 500 grade – minimum 8 mm diameter.
5. 0.5 wide shoulder with suitable paver block with anchor line.

Aggregates shall be of approved quality as per description in material section.

2.3.6.1 GRANULAR SUB-BASE

This work shall consist of laying and compacting well-graded material on prepared sub grade. The material shall be laid in one or more layers as sub-base or lower sub base and upper sub-base (termed as sub-base hereinafter) as necessary according to lines, grades and cross- sections shown on the drawings or as directed by the Engineer-in-charge.

The material to be used for the work shall be natural sand, murrum, gravel, crushed stone, or combination thereof depending upon the grading required. The material shall be free from organic or other deleterious constituents.

Moisture content of loose material shall be checked in accordance with IS: 2720 (Part 2) and suitably adjusted by sprinkling additional water from a truck mounted or trailer mounted water tank and suitable for applying water uniformly and at controlled quantities to variable widths of surface or other means approved by the Engineer-in-charge. So that, at the time of compaction, it is from 1 percent above to 2 percent below the optimum moisture content corresponding to IS: 2720 (Part 8). While adding water, due allowance shall be made for evaporation losses. After water has been added, the material shall be processed by mechanical or other approved means like disc harrows, rotavators until the layer is uniformly wet.

Immediately thereafter, rolling shall start. If the thickness of the compacted layer does not exceed

100 mm, a smooth wheeled roller of 80 to 100 KN weight may be used. For a compacted single layer up to 200 mm, the compaction shall be done with the help of vibratory roller of minimum 80 to 100 KN static weight with plain drum or pad foot drum or heavy pneumatic tyred roller of minimum 200 to 300 KN weight having a minimum tyre pressure of 0.7 KN/m² or equivalent capacity roller capable of achieving the required compaction. Rolling shall commence at the lower edge and proceed towards the upper edge longitudinally for portions having unidirectional cross fall and super elevation and shall commence at the edges and progress towards the centre for portions having cross fall on both sides.

Rolling shall be continued till the density achieved is at least 90% of the maximum dry density for the material determined as per IS: 2720 (Part 8). The surface of any layer of material on completion of compaction shall be well closed, free from movement under compaction equipment and from compaction planes, ridges, cracks or loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of layer and re- compacted. The surface finish of construction shall conform to the requirements of section 902 of MORTH specifications for Road and Bridge Works (III Revision).

Control on the quality of materials and works shall be exercised by the Engineer-In-Charge in accordance with section 900 of MORTH specifications for Road and Bridge Works (III Revision).

2.3.6.2 WATER BOUND MACADAM SUB-BAS/ BASE

This work shall consist of clean, crushed aggregates mechanically interlocked by rolling and bonding together with screening, binding material where necessary and water laid on a properly prepared sub-grade/sub-base/base or existing pavement, as the case may be and finished in accordance with the requirements of these specifications and in close conformity with the lines, grades, cross-sections and thickness as per approved plans or as directed by the Engineer-in-charge.

It is, however, not desirable to lay water bound macadam on an existing thin black topped surface without providing adequate drainage facility for water that would get cumulated at the interface of existing bituminous surface and water bound macadam.

1. MATERIALS

a. COARSE AGGREGATES

Coarse aggregates shall be machined crushed stone of suitable quality. The aggregates shall conform to the physical requirements set forth in below Table 2.1. The type and size range of the aggregate shall be specified in the contract or shall be as specified directed by the Engineer-in-charge. If the water absorption value of the coarse aggregate is greater than 2%, the soundness test shall be carried out on the material delivered to site as per IS: 2386 (Part 5).

b. CRUSHED OR BROKEN STONE

The crushed or broken stone shall be hard, durable and free from excess flat, elongated, soft and disintegrated particles, dirt and other deleterious material.

Table - Physical requirement of coarse aggregates for water bound macadam

Sr. No	Test	Test Method	Requirements
1	* Los Angeles Abrasion Value Or ** Aggregate Impact value	IS:2386 (Part -4) IS:2386 (Part-4) or IS:5640**	40 % (Max.) 30 % (Max.)
2	Combined Flakiness and Elongation Indices (total)***	IS:2386 (Part-1)	30 % (Max.)

*Aggregate may satisfy requirements of either of the two tests.

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

***The requirement of flakiness index and elongation index shall be enforced only in the case of crushed broken stone and crushed slag.

c. GRADING REQUIREMENT OF COARSE AGGREGATES

The coarse aggregates shall conform to one of the grading given in following table as specified provided. However, the use of grading No. 1 shall be restricted to sub-base courses only.

Table - Grading requirement of coarse aggregate

Grading No.	Size Range	IS Sieve Designation	Per cent by weight passing
1.	90 mm to 45 mm	125 mm 90 mm 63 mm 45 mm 22.5 mm	100 90 - 100 25- 60 0 - 15 0 – 5
2.	63 mm to 45 mm	90 mm 63 mm 53 mm 45 mm 22.5 mm	100 90 - 100 25- 75 0 - 15 0 – 5
3.	53 mm to 22.4 mm	63 mm 53 mm 45 mm 22.5 mm 11.2 mm	100 95 - 100 65 - 90 0 - 10 0 – 5

d. SCREENINGS

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

Screenings shall conform to the grading set forth in table. The consolidated details of quantity of screenings required for various grades of stone aggregates are given in table. The table also gives the quantities of materials (loose) required for 10 m² for sub- base/base compacted thickness of 100/ 75 mm.

Table - Grading for screenings

Grading Classification	Size of Screenings	IS Sieve Designation	Percent by weight passing the IS Sieve
A	13.2 mm	13.2 mm	100
		11.2 mm	95 - 100
		5.6 mm	15 - 35
		180 microns	0 – 10
B	11.2 mm	11.2 mm	100
		5.6 mm	90 - 100
		180 microns	15 – 35

approximate quantities of coarse aggregates and screenings required for 100/75 mm compacted thickness of water bound macadam (wbm) sub-base/ base course for 10m² area.

Table - Approximate Quantities of Coarse aggregates and screening for WBM

Classification	Size Range	Compacted thickness	Loose qty.	Stone Screening		Crushable Type such as Murrum or Gravel	
				Grading Classification & size	For. WBM Sub Base and Base Course	Grading Classification & size	Loose Qty.
Grading 1	90 mm to 45 mm	100 mm	1.21 to 1.43 m ³	Type A 13.2 mm	0.27 to 0.30 m ³	Not Uniform	0.30 to 0.32 m ³
Grading 2	63 mm to 45 mm	75 mm	0.91 to 1.07 m ³	Type A 13.2 mm	0.12 to 0.15 m ³	-do-	0.22 to 0.24 m ³

-do-	-do-	-do-	-do-	Type A 11.2 mm	0.20 to 0.22 m ³	-do-	-do-
Grading 3	53 mm to 22.4 mm	75 mm	-do-	-do-	0.18 to 0.21 m ³	-do-	-do-

e. BINDING MATERIAL

Binding material to be used for water bound macadam as a filler material meant for preventing raveling, shall comprise of a suitable material approved by the Engineer In-charge having a Plasticity Index (PI) value of less than 6 as determined in accordance with IS: 2720 (Part-5).

The quantity of binding material where it is to be used will depend on the type of screenings. Generally, the quantity required for 75 mm compacted thickness of water bound macadam will be 0.06 - 0.09 m³/10 m² and 0.08 - 0.10 m³/10 m² for 100 mm compacted thickness.

The above-mentioned quantities should be taken as a guide only, for estimation of quantities of construction etc.

Application of binding materials may not be necessary when the screenings used are of crushable type such as murrum or gravel.

2. CONSTRUCTION OPERATIONS

a. PREPARATION OF BASE

The surface of the sub grade/sub-base/base to receive the water bound macadam course shall be prepared to the specified lines and cross fall (camber) and made free of dust and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained, if necessary, by sprinkling water. Any sub-base/base/surface irregularities, where predominant, shall be made good by providing appropriate type of profile corrective course (levelling course).

As far as possible, laying water bound macadam course over an existing thick bituminous layer may be avoided as it will cause problems of internal drainage of the pavement at the interface of two courses. It is desirable to completely pick out the existing thin bituminous wearing course where water bound macadam is proposed to be laid over it. However, where the intensity of rain is low and the interface drainage facility is efficient, water bound macadam can be laid over the existing thin bituminous surface by cutting 50 mm x 50 mm furrows at an angle of 45°s to the centre line of the pavement at 1 m intervals in the existing road. The directions and depth of furrows shall be such that they provide adequate bondage and also serve to drain water to the existing granular base course beneath the existing thin bituminous surface.

b. INVERTED CHOKE

If water bound macadam is to be laid directly over the sub-grade, without any other intervening pavement course, a 25 mm course of screenings (Grading B) or coarse sand shall be spread on

the prepared sub-grade before application of the aggregates is taken up. In case of a fine sand or silty or clayey sub-grade, it is advisable to lay 100 mm insulating layer of screening or coarse sand on top of fine-grained soil, the gradation of which will depend upon whether it is intended to act as a drainage layer as well. As a preferred alternative to inverted choke, appropriate geosynthetics performing functions of separation and drainage may be used over the prepared sub grade as directed by the Engineer-in-charge.

c. SPREADING COARSE AGGREGATES

The coarse aggregates shall be spread uniformly and evenly upon the prepared subgrade/sub-base/base to proper profile by using templates placed across the road about 6m apart in such quantities that the thickness of each compacted layer is not more than 100 mm for Grading 1 and 75 mm for Grading 2 and 3. Wherever possible, approved mechanical devices such as aggregate spreader shall be used to spread the aggregates uniformly so as to minimize the need for manual rectification afterwards. Aggregates placed at locations which are inaccessible to the spreading equipment, may be spread in one of more layers by any approved means so as to achieve the specified results.

The spreading shall be done from stockpiles along the side of the roadway or directly from vehicles. No segregation of large or fine aggregates shall be allowed and the coarse aggregate as spread shall be uniform gradation with no pockets of fine material.

The surface of the aggregates spread shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregates as may be required. The surface shall be checked frequently with a straight edge while spreading and rolling so as to ensure a finished surface as per approved Drawings.

The coarse aggregates shall not normally be spread more than 3 days in advance of the subsequent construction operations.

d. ROLLING

Immediately following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of 80 to 100 KN capacity or tandem or vibratory rollers of 80 to 100 KN static weights. The type of roller to be used shall be approved by the Engineer- In-Charge based on trial run.

Except on super-elevated portions where the rolling shall proceed from inner edge to the outer, rolling shall begin from the edges gradually progressing towards the centre. First the edge/edges shall be compacted with roller running forward and backward. The roller shall then move inward parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one-half widths.

Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. However, where screenings are not to be applied, as in the case of crushed aggregates like brick metal, laterite and kankar, compaction shall be continued until the aggregates are thoroughly keyed. During rolling, slight sprinkling of water may be done, if necessary. Rolling shall not be done when the sub-grade is soft or yielding or when it causes a wave-like motion in the sub-grade or sub- base course.

The rolled surface shall be checked transversely and longitudinally, with templates and any irregularities corrected by loosening the surface, adding or removing necessary amount of aggregates and re-rolling until the entire surface conform to desired cross fall (camber) and grade. In no case, the use of screenings shall be permitted to make up depressions.

Material which gets crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates.

It shall be ensured that shoulders are built up simultaneously along with water bound macadam courses.

e. APPLICATION OF SCREENINGS

After the coarse aggregate has been rolled, screenings to completely fill the interstices shall be applied gradually over the surface. These shall not be damp or wet at the time of application. Dry rolling shall be done while the screenings are being spread so that vibrations of the roller cause them to settle into the voids of the coarse aggregate. The screenings shall not be dumped in piles but be spread uniformly in successive thin layers either by the spreading motions of hand shovels or by mechanical spreaders or directly from tipper with suitable grit spreading arrangement. Tipper operating for spreading the screenings shall be so driven as not to disturb the coarse aggregate.

The screenings shall be applied at a slow and uniform rate (in three or more applications) so as to ensure filling of all voids. This shall be accompanied by dry rolling and brooming with mechanical brooms, hand brooms or both. In no case shall the screenings be applied so fast and thick as to form cakes or ridges on the surface in such a manner as would prevent filling of voids or prevent the direct bearing of the roller on the coarse aggregate. These operations shall continue until no more screenings can be forced into the voids of the coarse aggregate.

The spreading, rolling, and brooming of screenings shall be carried out in only such lengths of the road which could be completed within one day's operation.

f. SPRINKLING OF WATER AND GROUTING

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

In case of lime treated soil sub-base, construction of water bound macadam on top of it can cause excessive water to flow down to the lime treated sub-base before it has picked up enough strength (is still "green") and thus cause damage to the sub-base layer. The laying of water bound macadam layer in such cases shall be done after the sub-base attains adequate strength, as directed by the Engineer-in-charge.

g. APPLICATION OF BINDING MATERIAL

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

h. SETTING AND DRYING

After the final compaction of water bound macadam course, the pavement shall be allowed to dry overnight. Next morning hungry spots shall be filled with screenings or binding material as directed, lightly sprinkled with water if necessary and rolled. No traffic shall be allowed on the road until the macadam has set. The Engineer-In- Charge shall have the discretion to stop hauling traffic from using the completed water bound macadam course, if in his opinion it would cause excessive damage to the surface.

The compacted water bound macadam course should be allowed to completely dry and set before the next pavement course is laid over it.

i. SURFACE FINISH AND QUALITY CONTROL OF WORK

The surface finish of construction shall conform to the requirements of Section 902 of MORTH specifications for Road and Bridge Works (III Revision).

Control on the quality of materials and works shall be exercised by the Engineer-In- charge in accordance with Section 900 of MORTH specifications for Road and Bridge Works (III Revision).

The water bound macadam work shall not be carried out when the atmospheric temperature is less than Zero degree centigrade in the shade.

3. RECONSTRUCTION OF DEFECTIVE MACADAM

The finished surface of water bound macadam shall conform to the tolerance of surface regularity as prescribed in Section 902 of MORTH specifications for Road and Bridge Works (III Revision). However, where the surface irregularity of the course exceeds the tolerances or where the course is otherwise defective due to sub grade soil mixing with the aggregates, the course to its full thickness shall be scarified over the affected area, reshaped with added material or removed and replaced with fresh material as applicable and re-compacted. In no case shall depressions be filled up with screenings or binding material.

2.3.6.3 CEMENT CONCRETE PAVEMENT

On completion of GSB & WBM, 150 mm thick layer of CC (M-30) with PCC as per drawing

shall be laid in uniform layers. The specification of CC (M-30) shall be as per detail furnished in this volume. For proper compaction, vibrator shall be used to obtain required density. The adequate curing shall be done to cement concrete by spreading water etc complete for minimum 14 days.

2.3.7 SITE DRAINAGE

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

2.3.7.1 STORM WATER DRAINAGE

Storm water drains adjacent to the existing and proposed roads (under this Contract) and as per site requirement shall be sized for a rainfall intensity of 30 mm/hr, allowing for 100% runoff. Drains adjacent to roads shall be as per drawing. The normal size of the drain is minimum 320 x 400 mm in depth. Depth varies as per longitudinal slope of drain. The drain portion shall be topped with suitable RCC precast slab wherever approach is required.

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

The rate includes cost of required excavation, PCC, Brick Masonry, Cement Plaster, wall and base & RCC M20 at top of appropriate thickness. The detailed specifications of excavation, PCC shall be as per detailed specifications described this volume.

2.3.7.2 FOUL DRAINAGE

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

2.3.8 CABLE AND PIPE WORK TRENCHES

Cable and pipe work 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) by weight. The trenches will be plastered internally with cement mortar (1:3) by volume and externally in cement mortar (1:3) by volume.

Trenches within the buildings or Plant areas shall be covered with M.S chequered plates, suitably painted and those outside the buildings shall be covered with M20 pre-cast R.C.C covers. The trenches shall be suitably sloped to drain rainwater.

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 Engineer-In-Charge while planning the works.

2.3.9 PIPES AND DUCTS

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

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

2.3.10 PUMP ROOM / PANEL ROOM

Mural elevation for aesthetic front at entry of Pump House/Panel to be provided by contractor & same shall be got approved from the department.

2.3.11 BEAUTIFICATION, SITE GRADING ETC.

The work includes site clearance for plot area of sub head work which includes cost of jungle cutting, tree cutting removal of existing miscellaneous structure if any. Debris if any is to be removed and dispersed off as directed.

The contractor has to level the plot by excavating the higher portion and filling earth in depressions areas. The filling in depressed portion is to be done in layers, which is to be well compacted.

The contractor has to develop in part of plot area for gardening / beautification. is to be developed as garden in which required mixture of earth and sludge is to be provided and dumped in garden portion. Manure is also to be applied on land of garden portion of good quantity.

Contractor has to plant minimum 400 m permanent hedges in the plot. The work also includes digging of trenches 60 cm wide and 45 cm deep refilling the executed earth mixed with farm yard manure supplied at the rate of 4.65 cm per 100 m and supplying and planting hedge plants 2 rows at 30 cm apart. There will grow fruit trees in open area where gardening is not possible.

The flowering plants and shrubs of minimum 3 m x 3 m area shall be developed at minimum 20 locations in the plot area as per directed by Engineer-in-charge.

In garden turfing lawns with fine grassing including plunging, dressing including breaking clods, removal of rubbish, dressing, supplying doab grass root at 10 cm apart including supplying and spreading of farm yard manure at rate of 0.60 cm per 100Sq.m.

The contractor has to provide internal road minimum 5 m wide to connect each unit of head work from C.C. main road by interlocking concrete block 60 mm thick with grade of concrete M 20 pneumatic compressed by mechanically pressed including 75 mm sand layer for levelling and filling the joint with curb of C.C. block on both face of the internal road as directed and approved by Engineer-in-charge.

The contractor has to be providing appropriate lighting arrangement with decorative pole which cover all the portion of pumping station in the plot area.

2.4 EARTHWORKS

This specification covers the general requirements of earthwork in excavation in different soil/ rock / materials necessary for the construction of the works including structures, roadway, side drains, pipe lines in accordance with requirements of these specifications and the lines, grades and cross-section shown in the drawings or as directed by the Engineer-in-charge. This Specification also includes site grading, filling in foundations, plinths, trenches and approach

ramps, conveyance and disposal of surplus soil or stacking them properly as shown on the drawings or as directed by the Engineer-In-Charge and all operations covered within the intent and purpose of this specification.

2.4.1 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.

Code no	Description
IS 783 - 1985	Code of practice for laying of concrete pipes
IS 3764 - 1992	Code of Safety for Excavation work
IS 2720	Methods of test for soils
(Part-1) - 1983	Part 1 Preparation of dry soil samples for various tests.
(Part-2) -1973	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) -1992	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 cohesion less 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 tests (Hilf Method).

2.4.2 GENERAL

The contractor shall furnish all tools, plant, instruments, qualified supervisory personnel, labour,

materials, any temporary works, consumables, any and everything necessary, whether or not such items are specifically stated herein for completion of the work in accordance with the Employer's Requirements.

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

Necessary trial pits shall be carried out manually at required interval prior to start the trench excavation to locate service like water pipeline, drainage line, electric cable, telephone cable etc. with no extra cost.

Contractor shall take care of existing underground OFC, telephone, cables etc. and shall excavate the site carefully and if any loss and damage occur to the underground cables, pipes etc. shall be rectified by the contractor at his cost. Any legal liability and financial liability for the same shall be responsibility of the contractor.

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. The trench of excavation shall be carried out as per drawing given with the tender document and longitudinal section which is to be prepared and got approved from the Engineer-in-charge.

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

Top soil shall be stock piled separately for later re-use.

In case of Asphalt carpet cutting, the base course materials and sill coat material shall be staked separately away from the earth and metal.

2.4.3 CLEARING

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

All service cable materials required to be transported and stock at site as directed by the Engineer-in-charge.

2.4.4 EXCAVATION

All excavation work shall be carried out by mechanical equipment unless, in the opinion of Engineer-in-charge, the work involved requires it to be carried out by manual methods. Trial pit

shall be excavated manually.

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 Engineer-in-charge. 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 Engineer-in-charge. The final excavation should be carried out just prior to laying the blinding course.

To facilitate the permanent works, the contractor may excavate and also backfill later, outside the lines shown on the drawings provided by the contractor as agreed with the Engineer-in-charge. 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, up to the required elevation at no cost to the employer.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Engineer-In-Charge shall be obtained by the contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval shall not in any way relieve the contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips. Should slips occur, the slipped material shall be removed and the slope dressed to a modified stable slope.

2.4.5 ROCK

2.4.5.1 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 m³ or 0.25 m 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.

Before classification of material as rock, the contractor shall demonstrate to the satisfaction of the Engineer-In-Charge 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.

Material shall not be classified as rock unless the Engineer-In-Charge 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 Engineer-In-Charge to enable the extent of the rock excavation to be determined.

All excavated material shall be stacked properly as directed by the Engineer-in-charge.

2.4.5.2 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 Engineer-in-charge, 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 Engineer-In-Charge at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and number of explosives used shall be progressively and suitably reduced.

The use of explosive material shall only be permitted after written permission from the Engineer-In-Charge and other competent authorities. For the works to be executed in close proximity of the reservoir, habitants and other important structure, only controlled blasting shall be permitted. The contractor shall get approved the details methodology and blasting operation plan from the Engineer-in-charge.

The contractor shall obtain a valid blasting license from the authorities concerned. The contractor shall produce such license whenever demanded by the Engineer-In-Charge for its verification. 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 a way as possible from the area to be blasted. Engineer-in-charge's prior approval shall be taken for the location proposed for the magazine. The Department shall not take any responsibility whatsoever in connection with the storage of explosives on site or of any accident etc. in connection therewith. All operations of the contractor in which or for which explosives are used shall be at his own risk and upon his sole responsibility. In no case shall blasting be allowed closer than 30 m 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. In such case light and control blasting shall be done without disturbing or endanger the stability, safety of formation and public properties nearby work and material shall be removed by means of chiseling.

For blasting operations, the following points shall be observed.

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.

Before any blasting is carried out, contractor shall intimate Engineer-In-Charge 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.

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.

The blasting of rock near any existing buildings, equipment's 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 were directed by Engineer-in-charge; a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.

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.

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.

Contractor shall preferably detonate the explosives electrically.

The explosives shall be exploded by means of a primer which shall be fired by detonating a fuse instantaneous detonator (FID) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.

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.

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.

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 over break limit of 75 mm shall be filled up as instructed by Engineer-in-charge, with concrete of strength not less than M-15. Stopping in rock excavation shall be done by hand trimming.

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 observation 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.

2.4.6 STRIPPING LOOSE ROCK

All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Engineer-in-charge, to fall or otherwise endanger the workmen, equipment 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.

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

2.4.7 FILL, BACK FILLING AND SITE GRADING

2.4.7.1 GENERAL

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

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the Engineer In- charge.

2.4.7.2 MATERIAL

To the extent available, selected surplus soil from excavations shall be used as backfill. Backfill material shall be free from lumps, organic or other foreign material. All lumps of earth shall be broken or removed. Where excavated material is mostly rock, the boulders shall be broken into pieces not larger than 150 mm size, mixed with properly graded fine material consisting of murrum or earth to fill the voids and the mixture used for filling.

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

2.4.7.3 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 the Engineer-in-charge. Earth shall be ram with approved mechanical compaction machines. Usually, no manual compaction shall be allowed unless the Engineer-In-Charge is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to a proper profile to the approval of the Engineer In-charge.

2.4.7.4 PLINTH FILLING

Plinth filling shall be carried out with approved material as described here in before in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The Engineer-In-Charge may, however, permit manual compaction by hand tampers where he is satisfied that the 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.

Compaction of the plinth fill shall be carried out by means of rammer / plate compactor suitable mechanical equipment with sprinkling of water if required.

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

The 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.

At some locations/areas, it may not be possible to use rollers because of space restrictions, etc.

2.4.7.5 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.

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 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 up to centerline shall be done in layers not exceeding 225 mm and compacted to 85 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 300 mm above the top of pipe shall be done by hand or approved mechanical methods in layer of 225 mm as per the requirements of I.S. 3114:1994.

2.4.8 GENERAL SITE GRADING

Site grading shall be carried out as indicated in the drawings and/or as directed by the Engineer-in-charge. Excavation shall be carried out as specified in the employer's requirements. Filling and compaction shall be carried out as specified under Clause 2.4.7 and elsewhere unless otherwise indicated below.

The fill has to be compacted and it shall be placed in layers not exceeding 225 mm and levelled uniformly and compacted as indicated in Clause 2.4.7 before the next layer is deposited.

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

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height

has been completed. This shall hold good for embankments as well. The fill will be considered as incomplete if the desired compaction has not been obtained.

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

If so specified, the rock as obtained from excavation may be used for filling and levelling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50cm 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 compacted with watering suitable roller. Not less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

2.4.9 FIELD DENSITY

The compaction, under the plant road area at Pumping Station shall comply with minimum 90% compaction by Standard Proctor at moisture content differing not more than 4% from the optimum moisture content. The contractor shall demonstrate adequately by field and laboratory test that the specified density has been obtained. In other areas the soil should be backfilled and compacted suitably as specified by the Engineer-in-charge.

2.4.10 TIMBER SHORING

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 Engineer-in-charge. 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 m spacing, strutted with ballies or as approved by the Engineer-in-charge.

The length of the ballie struts shall depend on the width of the trench or pit. If the soil is very soft and loose, the boards shall be placed horizontally against each side of the excavation and supported by vertical walling, which in turn shall be suitably strutted. The lowest boards supporting the sides shall be taken into the ground and no portion of the vertical side of the trench or pit shall remain exposed, so as to render the earth liable to slip out.

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 Engineer-in-charge. It shall be the responsibility of the contractor to take all necessary steps to prevent the sides of excavations, trenches, pits, etc. from collapsing.

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 Engineer-in-charge.

The withdrawal of the timber shoring shall be done carefully to prevent the collapse of the pit or

trench. It shall be started at one end and preceded systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber shoring / strutting.

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 spacing shall be subject to the approval of the Engineer-in-charge. In all other respects, the employer's requirements for close timbering shall apply to open timbering.

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.

2.4.11 DEWATERING

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 program. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Engineer-in-charge. But in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

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

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

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

The contractor shall arrange for necessary temporary works/diversion works/ coffer dam at his own cost enabling excavation for construction of approach channel and where pipe crosses river / nalla.

2.4.12 RAIN WATER DRAINAGE

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

2.5 CONCRETE

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

2.5.1 APPLICABLE CODES

2.5.1.1 MATERIALS

IS: 12269	Specification for 53 grade ordinary Portland cement
IS: 12330	Specification for sulphate resisting 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 wires for concrete reinforcement. (Part 1 and 2)
IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
IS: 1566	Specification for hard-drawn steel wire fabric for concrete reinforcement
IS: 9103	Specification for admixtures for concrete
IS: 2645	Specification for integral waterproofing compounds for cement mortar and concrete
IS: 4990	Specification for plywood for concrete shuttering work.

2.5.1.2 MATERIAL TESTING

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

2.5.1.3 MATERIAL STORAGE

IS: 4082 Recommendations on stacking and storing of construction materials and components at site.

2.5.1.4 CONCRETE MIX DESIGN

IS: 10262 recommended guidelines for concrete mix design.

SP: 23 (S&T) Handbook on Concrete Mixes

2.5.1.5 CONCRETE TESTING

IS: 1199 Method of sampling and analysis of concrete.

IS: 516 Method of test for strength of concrete.

IS: 9013 Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.

IS: 8142 Method of test for determining setting time of concrete by penetration resistance.

IS: 9284 Method of test for abrasion resistance of concrete.

IS: 2770 Methods of testing bond in reinforced concrete.

2.5.1.6 EQUIPMENT'S

IS: 1791 General requirement for batch type concrete mixers

IS: 2438 Specification for roller pan mixer

IS: 4925 Specification for concrete batching and mixing plant

IS: 5892 Specification for concrete transit mixer and agitator

IS: 7242 Specification for concrete spreaders

IS: 2505 Concrete vibrators - Immersion type - General requirements

IS: 2506 General Requirements for concrete vibrators, screed board type

IS: 2514 Specification for concrete vibrating tables

IS: 4656 Specification for form vibrators for concrete

IS: 11993 Code of practice for use of screed board concrete vibrators

IS: 7251 Specification for concrete finishers

IS: 2722 Specification for portable swing weighs batchers for concrete (single and double bucket type)

IS: 2750 Specification for steel scaffoldings

2.5.1.7 CODES OF PRACTICE

Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.

IS: 456	Code of practice for plain and reinforced concrete.
IS: 457	Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
IS: 3370	Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
IS: 3935	Code of practice for composite construction.
IS: 2204	Code of practice for construction of reinforced concrete shell roof.
IS: 2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS: 2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS: 3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS: 3414	Code of practice for design and installation of joints in buildings.
IS: 4326	Code of practice for earthquake resistant design and construction of building.
IS: 4014	Code of practice for steel tubular scaffolding (Parts 1 & 2)
IS: 2571	Code of practice for laying in-situ cements concrete flooring.
IS: 7861	Code of practice for extreme weather concreting: Part 1 Recommended practice for hot weather concreting.

2.5.1.8 CONSTRUCTION SAFETY

IS: 3696	Safety code for scaffolds and ladders. (Parts 1 & 2)
IS: 7969	Safety code for handling and storage of building materials.
IS: 8989	Safety code for erection of concrete framed structures.

2.5.2 GENERAL

The Engineer-In-Charge shall have the right at all times to inspect all operations including the sources of materials, procurement, layout and storage of materials, concrete batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer-In-Charge approval obtained, prior to starting of concrete work. This shall, however, not relieve the contractor from any of his responsibilities. All materials which do not conform to the specifications shall be rejected.

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

2.5.3 MATERIALS

2.5.3.1 CEMENT

Unless otherwise called for by the Engineer-in-charge, cement shall be ordinary Portland Cement (OPC) of grade 53 conforming to IS: 269.

2.5.3.2 AGGREGATES (GENERAL)

Aggregates shall consist of naturally occurring stones (crushed or uncrushed) 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 allowed and used.

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

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.

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.5. The maximum size of coarse aggregate shall be of 40 mm, but in no case greater than 1/4 of the minimum thickness of the member and also not more than the minimum cover specified.

2.5.3.3 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.

2.5.3.4 REINFORCEMENT

All reinforcement steel shall be of minimum TMT-Fe 500 grade confirming to IS: 1786.

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.

2.5.3.5 ADMIXTURES

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

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

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.

Wastage-

No extra payment shall become payable to the contractor on any account for wastage of cement and steel and other materials.

2.5.4 SAMPLES AND TESTS

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

Manufacturer's test certificate shall be furnished for each batch of cement / steel to the Engineer-in-charge. Samples shall also be got tested by the contractor at his cost in a laboratory approved by the Engineer-in-charge. Engineer-In-Charge 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.

Sampling and testing shall be as per IS: 2386 (part 1 to 4) under the supervision of the Engineer-in-charge.

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

The contractor shall furnish manufacturer's test certificates and technical literature for the admixture proposed to be used. If directed, the admixture shall be got tested by the contractor at his own cost in a laboratory approved by the Engineer-in-charge.

2.5.5 STORING OF MATERIALS

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.

The contractor shall 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 weather proof shed with a raised water proof floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Cement bags shall be stacked as per IS: 4082 – 1996, clause – 4.0. Storage arrangement shall be as approved by the Engineer-in-charge. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

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.

The Contractor shall make his own arrangements for storing water at site in tanks to prevent contamination.

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground water. Each type and size of bar shall be stacked separately.

2.5.6 CONCRETE

2.5.6.1 GENERAL

Concrete grade shall be as designated on drawings. In concrete grade M15, M20, M25, M30, etc. the number represents the specified characteristic compressive strength of 150 mm cube at 28 days, expressed in N/sq.mm as per IS-456. Concrete in the works shall be "DESIGN MIX CONCRETE" or "NOMINAL MIX CONCRETE". All concrete works of grade M5, M7.5, M10 and M15 shall be NOMINAL MIX CONCRETE whereas all other grades, M20 and above, shall be DESIGN MIX CONCRETE.

2.5.6.2 DESIGN MIX CONCRETE

A.MIX DESIGN & TESTING

For Design Mix Concrete, the mix shall be designed according to IS: 10262 and SP: 23 to provide the grade of concrete having the required workability and characteristic strength not less than appropriate values given in IS:456. The design mix shall be cohesive and does not segregate and should result in a dense and durable concrete and also capable of giving the finish as specified. For water 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. The maximum size of coarse aggregate shall not exceed 40 MSA.

The minimum cement content for Design Mix Concrete shall be as per IS: 456-2000 as given below.

Table 5 - Minimum cement content for design mix concrete

Exposure	Minimum Grade of concrete	Minimum cement content for Kg/m ³ as per IS 456-2000	Minimum Grade of concrete	Minimum cement content for Kg/m ³
	Plain concrete		Reinforced concrete	
Mild			M 20	300
Moderate	M 15	240	M 25	300
Sever	M 20	250	M 30	320
Very sever	M 20	260	M 35	340
Extreme	M 30	280	M 40	360

However, the minimum cement level for design concrete mix shall be as mentioned below as finalized by the employer.

Table 6 - Minimum cement content Level for design mix concrete

Sr No.	Grade	Maximum size of aggregate	Minimum Cement Kg/m ³
1	M – 15	20 MSA	300
		40 MSA	280
2	M – 20	20 MSA	360
		40 MSA	330
3	M – 25	20 MSA	380
		40 MSA	360
4	M- 30	20 MSA	410
5	M- 35	20 MSA	425

The minimum cement content stipulated in TABLE - 6 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. However, if required cement level as per mix design is less than as mentioned in Table-2, then recovery of Rs 5.23 per kg of cement (As Per Sor R&B SOR Mahisagar 2024-25, item no. M143) shall be made from the contractor bill. But in any case, the cement level shall not be less than as mentioned in TABLE – 5 above.

It shall be the contractor's sole responsibility to carry out the mix designs at GERI / Government approved laboratory as directed by Engineer-in-charge. He shall furnish the results to the Engineer-In-Charge at-least 10 days before concreting operations. In case of emergency and urgency, mix design based on 7 days results may be adopted for execution of concrete at all risk and cost of contractor. However, 28 days mix design results shall be binding to the contractor. For this approval and permissions of Engineer-In-Charge should be obtained. "Complete calculations as mentioned in IS: 10262 along with detail of trial mix, strength results and final selected mix." The strength requirements of the concrete mixes ascertained on 150 mm X 150 mm X 150 mm cubes tested as per IS:516 shall comply with the requirements of IS- 456.

Contractor has to carry out new Concrete Mix Design of M20 grade and above at the end of every monsoon at his cost.

Characteristic Compressive Strength Compliance Requirement (Table 11: IS 456).

Specified Grade	Mean of the Group of 4 Non-Overlapping Consecutive Test Results in N/mm ²	Individual Test Results in N/mm ²
(1)	(2)	(3)

M 15	$\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest } 0.5 \text{ N/mm}^2)$ or $\geq f_{ck} + 3 \text{ N/mm}^2$, whichever is greater	$\geq f_{ck} - 3 \text{ N/mm}^2$
M 20 or above	$\geq f_{ck} + 0.825 \times \text{established standard deviation (rounded off to nearest } 0.5 \text{ N/mm}^2)$ or $\geq f_{ck} + 4 \text{ N/mm}^2$, whichever is greater	$\geq f_{ck} - 4 \text{ N/mm}^2$

NOTE - In the absence of established value of standard deviation, the values given in Table 8 of IS: 456 may be assumed and attempt should be made to obtain results of 30 samples as early as possible to establish the value of standard deviation.

"After Finalization of the mix one trial batch shall be produced using such mix and shall be got tested for workability and strength characteristic under direct supervision of Engineer-In-Charge or his representative

A range of slumps which shall generally be used for various types of construction is given below as per table of IS: 456 shown below:

However, the slump shall be as per approved Mix design and requirement of workability.

Placing Condition	Degree of workability	Slump (mm)
(1)	(2)	(3)
Blinding concrete; Shallow sections; Pavements using pavers	Very Low	See Note No. 1
Mass concrete; Lightly reinforced Sections in slabs, Beams, walls, columns; Floors; Hand placed pavements; Canal lining; Strip footings.	Low	25 - 75
Heavily reinforced Sections in slabs, Beams, walls, columns; Slip form work; Pumped concrete	Medium	50-100 75-100
Trench fill; In-situ piling Tremie concrete	High Very High	100-150 See Note No. 2

NOTE: For most of the placing conditions internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness bars and thickness of sections. For termite concrete, vibrators are not required to be used.

"The mix design shall submit well in advance to Engineer-In-Charge or his representative as per

details given in IS: 10262 along with details of trial mixes with and without use of admixture and test results of cubes as specified in relevant IS"

NOTE-1: In the "very low" category of workability where strict control is necessary, i.e., Pavement quality concrete, measurement of workability by determination of compacting factor will be more appropriate than slump (see IS 1199) and a value of compacting factor of 0.75 to 0.80 is suggested.

NOTE-2: In the "very high" category of workability, measurement of workability by determination of flow will be appropriate (see IS 9103).

B. BATCHING & MIXING OF CONCRETE

The batching mixing plant shall be portable; semi-automatic for isolated small and miscellaneous work if approved by Engineer-in-charge, concrete shall be carried out using ordinary mixer with weigh batch facility.

Proportions of aggregates and cement as decided by the concrete mix design shall be by weight. These proportions shall be maintained during subsequent concrete ingredients batching by means of batching plant capable of controlling the weights within 1% of the desired value including correctly controlling the water delivery to the drum. Calibration certificate of batching plant shall be provided before starting concreting and it shall be calibrated from time to time as per instruction of Engineer- In-Charge or his representative. For small quantity of concrete works, the contractor may produce the concrete by manual weigh batcher or mechanically operated batch mixers complying with IS: 1791, and in consultation of Engineer-in-charge.

Amount of water added shall be such as to produce dense concrete of required consistency, specified strength and satisfactory workability and shall be so adjusted to account for moisture content in the aggregates. Water-cement ratio specified for use by the Engineer-In-Charge shall be maintained. The mixer shall be cleaned out after completion of concrete work day to day. For accurate addition of water, a water tank of suitable capacity with gauging/measuring facility shall be provided near the mixer.

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

2.5.6.3 NOMINAL MIX CONCRETE

A. 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 9 of IS: 456. However, it will be the contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

Proportions for Nominal Mix Concrete (Table-9, IS 456).

Grade of concrete	Total Quantity of Dry Aggregates by Mass per 50kg of Cement, to be Taken as the Sum of the Individual Masses of Fine and Coarse Aggregates, kg, Max	Proportion of fine Aggregate to Coarse Aggregate (by Mass)	Quantity of Water per 50 kg of Cement, Max in Liter
(1)	(2)	(3)	(4)
M 5	800	Generally, 1:2 but subject to an upper limit of 1:1½ and lower limit of 1:2 ½	60
M 7.5	625		45
M 10	480		34
M 15	330		32
M 20	250		30

NOTE- The proportion of the fine to coarse aggregates should be adjusted from upper limit to lower limit progressively as the grading of fine aggregates becomes finer and the maximum size of coarse aggregate becomes larger. Graded coarse aggregate shall be used.

Example

For an average grading of fine aggregate (that is, Zone II of Table 4 of IS 383), the proportions shall be 1:1 ½, 1:2 and 1:2 ½ for maximum size of aggregates 10mm, 20mm and 40mm respectively.

B. NOMINAL MIX CONCRETE

Based on the adopted nominal mixes, cement and aggregates shall be measured by on volumetric basis.

2.5.7 FORMWORK

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

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

Formwork shall be designed to fulfil the following requirements:

- 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.
- Made of suitable materials.
- Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.
- Capable of withstanding without deflection under 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.

The formwork may be of timber with steel lining or steel depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of the Engineer-in-charge. Joints between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete using seals if necessary.

The faces of formwork coming in contact with concrete shall be cleaned and two coats of approved moulds 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. No extra cost shall be paid to the contractor for these works.

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

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

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

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

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

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

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

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

Formwork showing excessive distortion, during any stage of construction shall be re-positioned 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.

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;
- g. Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

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 Engineer-in-charge. 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.

2.5.8 REINFORCEMENT WORKMANSHIP

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.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings / schedules or as directed by Engineer-in-charge.

Re-bending or straightening incorrectly bent bars shall not be done without the approval of the Engineer-in-charge.

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 Engineer-In-Charge 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. Binding wire shall be 16-gauge soft annealed wires. Ends of the binding wire shall be bent away from the concrete surface and in no case encroach into the concrete cover.

Substitution of reinforcement, laps/splices not shown on drawing shall be subject to Engineer-In-Charge approval.

2.5.9 TOLERANCES

Tolerance for formwork and concrete dimensions shall be as per IS: 456 unless specified otherwise.

Tolerances specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

The formwork shall be designed and constructed to the shapes, lines and dimensions shown on the drawings within the tolerances given below:

	Reference - Clause 11 of IS: 456	
(a)	Deviation from specified dimensions of Cross-section of columns and beams	- 6 mm + 12 mm
(b)	Deviations from dimensions of footings (Tolerances apply to concrete dimensions Only, not to positioning of vertical Reinforcing steel or dowels)	
1	Dimension in plan	- 12 mm + 50 mm
2	Eccentricity 0.02 times the width of the footing in the direction of deviation but not more than 50 mm	
3	Thickness	± 0.05 times the specified thickness

2.5.10 PREPARATION PRIOR TO CONCRETE PLACEMENT

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

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

2.5.11 TRANSPORTING, PLACING AND COMPACTING CONCRETE

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

In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be re-handled 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 1.0 m.

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

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

- 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.
- h. If placed directly onto hard core 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.

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 450mm 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.

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

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

shall be protected against damage until final acceptance.

2.5.12 MASS CONCRETE WORKS

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

At the time of placing concrete, thickness of layer shall not be more than 450 mm for vibrated concrete per layer and limiting height of concrete shall be applicable as per IS 457, clause 4.10.7 for particular component.

2.5.13 CURING

Curing and protection shall start immediately after the compaction of the concrete. The concrete shall be protected 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.

All concrete, unless approved otherwise by the Engineer-In-Charge shall be cured by use of continuous sprays or pond water or continuously saturated coverings of sacking, canvas, hessian or other absorbent material for the period of complete hydration with a minimum of 14 days. The quality of curing water shall be the same as that used for mixing.

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

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

2.5.14 CONSTRUCTION JOINTS AND KEYS

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

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

Before resuming concreting on a surface which has hardened, all laitance and loose stone shall be thoroughly removed by wire brushing/hacking and surface washed with high pressure water

jet and treated with thin layer of cement slurry for vertical joints and horizontal layers.

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

2.5.15 FOUNDATION BEDDING

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

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

2.5.16 FINISHES

2.5.16.1 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.

2.5.16.2 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.

2.5.16.3 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.

2.5.16.4 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 discoloration, blemishes, arises, air holes 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.

2.5.16.5 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 Engineer-In-Charge shall be supplied and used as recommended by the manufacturer.

2.5.17 REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

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

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

Rejected concrete shall be removed and replaced by the contractor at his cost.

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

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Engineer-In-Charge as to the method of repairs to be adopted shall be final and binding on the Contractor. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement and sand mortar by weight. The use of epoxy for bonding fresh concrete shall be carried out as directed by the Engineer-in-charge.

2.5.18 VACUUM DEWATERING OF SLABS

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 toweling as per equipment manufacturer's recommendation.

The equipment to be used shall be subject to the Engineer-In-Charge approval.

2.5.19 HOT WEATHER REQUIREMENTS

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

Adequate provisions shall be made to lower concrete temperatures which shall not exceed 40°C at the time of placement of fresh concrete.

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

2.5.20 COLD WEATHER REQUIREMENTS

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

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

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

2.5.21 WATER RETAINING STRUCTURES

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

The minimum level of surface finish for water retaining structures shall be Type F2. All such structures shall be hydro-tested.

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

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

Any leakage that may occur during the hydro-test or subsequently during the O&M period or the period for which the structure is guaranteed shall be effectively stopped either by cement/epoxy pressure grouting, gunnitting or such other methods as may be approved by the Engineer-in-charge. All such rectification shall be done by the contractor at his cost to the entire satisfaction of the Engineer-in-charge.

2.5.22 PLACING CONCRETE UNDERWATER

- a. Under all ordinary conditions, all foundations shall be completely dewatered and concrete placed in the dry. However, when concrete placement under water is necessary, all work shall conform to IS:456 and the procedure shall be as described in the following paragraphs:
- b. Concrete shall be deposited underwater by means of tremies or drop bottom buckets of approved type.
- c. All work requiring placement of concrete underwater shall be designed, directed and inspected with due regard to local circumstances and purposes. All underwater concrete shall be placed according to the plans or specifications and as directed and approved by the

Engineer-in-charge.

2.5.23 PRECAST CONCRETE

Pre-cast concrete shall comply with IS: 456 and with the following requirements:

- a. All pre-cast units shall be cast on a suitable bed or platform with firm foundation and free from wind.
- b. Contractor shall be responsible for the accuracy of the level or shape of the bed or platform. A suitable serial number and the date of casting shall be impressed or painted on each unit.
- c. Side shutters shall not be struck in less than 24 hours after depositing concrete and no pre-cast unit shall be lifted until the concrete reaches a strength of at least twice the stress to which the concrete may be subjected to at the time of lifting.
- d. The lifting and removal of pre-cast units shall be undertaken without causing shock, vibration or undue bending. Contractor shall satisfy Engineer-In-Charge or his representative that the methods proposed to adopt for these operations will not over-stress or otherwise effect seriously the strength of the pre-cast units. The reinforced side of the units shall be distinctly marked.
- e. All pre-cast work shall be protected from the direct rays of the sun for at least 7 days after casting and during that period each unit shall be kept constantly watered or preferably be completely immersed in water if the size of the unit so permits. Otherwise, curing practice as given in Clause 2.5.13 shall be followed.

2.5.24 TESTING CONCRETE STRUCTURES FOR LEAKAGE

Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as described below or as directed Engineer-in-charge.

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.

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 water tightness of the structure. The Engineer-In-Charge 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.

Each compartment/segment of the structure shall be tested individually and then all together.

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.

2.5.25 OPTIONAL TESTS

If the Engineer-In-Charge 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, approved by the Engineer-In-Charge as per relevant IS Codes. Contractor shall have to pay for these tests.

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 Engineer-In-Charge reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing / non destructing testing / load testing of structure, etc. The Engineer- In-Charge also reserves the right to ask the Contractor to dismantle and re-construct such unacceptable work, at his risk and cost. Alternately Engineer-In-Charge also reserves the right to dismantle and re-construct such unacceptable work at the cost of contractor.

2.5.26 GROUTING

2.5.26.1 STANDARD GROUT

The proportion of Standard Grout shall be such as to produce a flow able 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 Engineer-in-charge. The grout proportions shall be limited as follows:

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

2.5.26.2 NON-SHRINK GROUT

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

General Inspection

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of Engineer-in-charge. Materials rejected by Engineer-In-Charge shall be removed from site by Contractor immediately.

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.

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;
- p. Water tightness
- q. Resistance to aggressive chemicals
- r. Resistance to freezing and thawing
- s. Very high strength
- t. Improved fire resistance

- u. Wear resistance
- v. Resistance to early thermal cracking

The Engineer-In-Charge decision as to the acceptability or otherwise of any concrete work shall be final and binding to the Contractor.

For work not accepted, the Engineer-In-Charge may review and decide whether remedial measures are feasible so as to render the work acceptable. The Engineer-In-Charge 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 be paid to the Contractor by the Employer for executing the remedial measures.

2.5.27 WATER STOPS

2.5.27.1 MATERIAL

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

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

PVC water stops shall be either of the bar type, serrated with centre bulb and end grips for use within the concrete elements or of the surface (kicker) type for external use. The width of the water stop shall be as per approved design drawing.

PVC water stops shall be of approved manufacturer. Samples and the test certificate shall be got approved from the Engineer-In-Charge before procurement for incorporation in the works.

2.5.27.2 WORKMANSHIP

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

Water stops shall be procured in long lengths as manufactured to avoid joints as far as possible. Standard L or T type of intersection pieces shall be procured for use depending on their requirement. Any non-standard junctions shall be made by cutting the pieces to profile for jointing. Lapping of water stops shall not be permitted. All jointing shall be of fusion welded type as per manufacturer's instructions.

Water stops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the water stops embedded in concrete shall be thoroughly cleaned of all mortar/concrete coating before resuming further concreting operations. The projecting water stop 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.

2.5.28 PREFORMED FILLERS AND JOINT SEALING COMPOUND

2.5.28.1 MATERIALS

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

Bitumen coat to concrete/masonry surfaces for fixing the preformed bitumen filler strip shall conform to IS: 702. Bitumen primer shall conform to IS: 3384.

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

2.5.28.2 WORKMANSHIP

The thickness of the preformed bitumen filler shall be 25 mm for expansion joints and 50 mm for isolation joints around foundation supporting rotary 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.

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.

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.

Expansion joints between beams / slabs shall be provided with 100 mm wide x 4 mm 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 6 mm 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 Zinc Chrome primer and 3 coats of synthetic enamel paint finish.

2.6 STRUCTURAL STEEL WORK

2.6.1 APPLICABLE CODES AND SPECIFICATIONS

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.

- IS: 808 Dimensions for Hot Rolled Steel sections
- IS: 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel
- IS: 800 Code of Practice for General Construction in Steel
- IS: 801 Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction
- IS: 806 Code of Practice for Use of Steel Tubes in General Building Construction
- IS: 7205 Safety Code for Erection of Structural Steel Work
- IS: 7215 Tolerances for Fabrication of Steel Structures
- IS: 4000 High Strength Bolts in Steel Structure – Code of Practice
- AISC Specifications for Design, Fabrication and Erection of Buildings
- IS: 1161 Steel Tubes for structural purposes
- IS: 102 Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming
- IS: 110 Ready Mixed paint, brushing, grey filler for enamels for use over primers
- IS: 117 Ready Mixed paint, Brushing, Finishing, Exterior Semi-gloss for general purposes, to Indian Standard colours
- IS: 158 Ready Mixed paint, Brushing, Bituminous, Black, lead free, Acid, Alkali and heat resisting
- IS: 159 Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required
- IS: 341 Black Japan, Types A, B and C
- IS: 2339 Specification for Aluminium paint for general purposes, in Dual container

- IS: 2932 Enamel, synthetic, exterior, (a) undercoating, (b) finishing -Specification
- IS: 2933 Specification for enamel, exterior, (a) undercoating, (b) finishing
- IS: 5905 Sprayed aluminium and zinc coatings on Iron and Steel
- IS: 6005 Code of practice for phosphating of Iron and Steel
- IS: 9862 Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting
- IS: 13183 Aluminium paint, Heat resistant – Specification S
- IS-05-5900 (Swedish Standard)
- IS: 1239 Mild steel tubes, tubular and other wrought steel fittings
- Part 1 – Mild steel tubes
- Part 2 – Mild steel tubular and other wrought steel pipe fittings
- IS: 1363 Hexagon Head Bolts, Screws and Nuts of product Grade C(Parts 1 to 3)(Size range M5 to M64)
- IS: 1367 (All Technical Supply Conditions for Threaded Steel Fasteners parts)
- IS: 1852 Rolling and Cutting Tolerances for Hot Rolled Steel Products
- IS: 1977 Low tensile Structural Steel - Specification
- IS: 2062-2011 Hot rolled medium and high tensile structural steel-Specification
- IS: 2074 Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming Specification
- IS: 3502 Steel Chequered Plates - Specification
- IS: 3757 Specification for High Strength Structural Bolts
- IS: 5369 General Requirements for Plain Washers and Lock Washers
- IS: 5372 Taper Washers for Channels (ISMC)
- IS: 5374 Taper Washers for I Beams (ISMB)
- IS: 6610 Specification for Heavy Washers for Steel Structures
- IS: 8500 Structural Steel-micro alloyed (medium and high strength qualities) Specification
- IS: 803 Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks
- IS: 816 Code of Practice for use of Metal Arc Welding of carbon and manganese steel
- IS: 822 Code of Procedure for Inspection of Welds
- IS: 1182 Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
- IS: 1200 Method of Measurement of Building and Civil Engineering Works
- IS: 1477 Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
- IS: 2595 Code of Practice for Radiographic Testing
- IS: 3658 Code of Practice for Liquid Penetrant Flaw Detection
- IS: 5334 Code of Practice for Magnetic Particle Flaw Detection of Welds
- IS: 9595 Metal Arc Welding of Carbon and Carbon Manganese Steel Recommendations

2.6.2 STRUCTURAL STEEL MATERIALS

All structural Steel materials shall comply with the relevant applicable code / standard as mentioned in para 2.6.1. All materials used shall be new, unused and free from defects. All the test shall be carried out as per directed by Engineer in Charge. MTC shall also have to submit before starting the work.

All steel and other materials used for steelwork and in association with steel work will conform to relevant IS (latest version with amendments if any. Only) tested materials will be used. Unless otherwise specified in the drawings,

- a. All rolled sections and plate will conform to Grade E250 "A" as per IS: 2062-2011.
- b. Plated structures subjected to dynamic loading will conform to Grade E250 "BR" as per IS: 2062-2011.

Steel sheets shall conform to IS: 1079.

Steel tubes for structural purpose shall conform to IS: 1161 (of Grade YST 240) Aluminium industrial troughed sheets conforming to IS: 1254 shall be used as follows:

- a. In roof - 0.91 mm thick
- b. Inside walls - 0.71 mm thick

Translucent sheets shall be fiber glass reinforced polyester sheets of matching profile as per appropriate standards.

Gutters shall be of copper bearing steel conforming to Grade "A" as per IS: 2062-2011. Crane rail shall conform to IS: 3443.

DRAWINGS TO BE PREPARED BY THE CONTRACTOR:

The 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. The size of steel member to be used in the work shall be available in the market.

All fabrication drawings shall be got approved from Engineer-in-charge.

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

Fabrication work shall be started by the contractor only after approval of fabrication & erection drawing by Engineer-in-charge. However, the contractor shall be fully responsible for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown on drawing and carried out. The Engineer-In-Charge 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.

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

2.6.3 FABRICATION

2.6.3.1 GENERAL

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 Engineer-in-charge, 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.

2.6.3.2 CONNECTIONS

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

In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts wherever necessary. In case of high strength friction grip bolts, hardened washers shall 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 at least 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.

Rivets shall be heated uniformly throughout their length without burning or excessive scaling, and shall be of sufficient length to provide a head of standard dimensions. They shall, when driven, completely fill the holes and, if countersunk, the countersinking shall be fully filled by the rivet. Any protrusion of the countersunk head being dressed off flush if required.

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.

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.

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. No payment shall be made for this Extra / Excess quantity.

All members likely to collect rain water shall have appropriate drain holes at proper location from design point of view.

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

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

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

- a. ER421 'C' X for mild steel of Grade 'A' and Grade 'B' as per IS: 2062
- b. EB 542 'C' H3X for Mild steel of Grade 'B' as per IS 2062 for dynamically

loaded structures (arising out of crane, vibratory screen, equipment etc.)

'C' is the value of the current as recommended by the electrode manufacturer.

Certified mill test reports of materials used in the work shall be made available for inspection to the Engineer-In-Charge upon request. All the materials will be straight and if necessary, before being worked shall be straightened and/or flattened by pressure including de-coiling of plates unless required to be of curvilinear form and shall be free from twists.

2.6.3.3 STRAIGHTENING

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 Engineer-In-Charge in writing.

2.6.3.4 ROLLING AND FORMING

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 shown on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field.

2.6.3.5 HIGH STRENGTH FRICTION GRIP BOLTING

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

2.6.3.6 WELDING

Welding procedure shall be submitted to the Engineer-In-Charge for prior 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).

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

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

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

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

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

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

All welds shall be inspected for flaws by any of the methods described under Sub-clause

2.6.6.3. The choice of the method adopted shall be agreed by the Engineer-in-charge.

The correction of defective welds shall be carried out as per relevant standards and in a manner approved by the Engineer-In-Charge 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 Engineer-In-Charge shall be used to ensure that the whole of the crack and material up to 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.

2.6.4 TOLERANCES

The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852 for indigenous steel. The tolerances for fabrication of structural steel shall be as per IS: 7215.

Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes.

2.6.5 END MILLING

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.

2.6.6 INSPECTION

2.6.6.1 GENERAL

The contractor shall have to inform the Engineer-In-Charge 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 Engineer-In-Charge inspection. The fact that certain material has been accepted at the contractor's shop shall not invalidate final rejection at site by the Engineer-In-Charge if it fails to conform to the requirements of specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Engineer-In-Charge may make because of defective or unsatisfactory materials and / or workmanship.

No materials shall be painted or dispatched to site without inspection and approval from the

Engineer-In-Charge unless such inspection is waived in writing by the Engineer-in-charge.

The contractor shall provide all the testing and inspection services and facilities for shop work except where otherwise specified.

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 Engineer-in-charge.

Inspection and tests on structural steel members shall be as set forth below.

2.6.6.2 MATERIAL TESTING

If mill test reports are not available for any steel materials the same shall be tested by the contractor to the Engineer-in-charge's satisfaction to demonstrate conformity with the relevant specification.

2.6.6.3 TESTS ON WELDS

Following test shall be done as directed by Engineer in Charge if necessary.

a. MAGNETIC PARTICLE TEST

Where fillet welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS 5334 for random 5% of the weld. Weld shall be accepted as satisfactory the defects are within limits stated in IS: 7310.

b. LIQUID PENETRATE INSPECTION

In the case fillet of welds examined by Liquid Penetrate Inspection, such tests shall be carried out in accordance with relevant IS Code 3658. All defects observed shall be repaired and re-checked.

c. RADIOGRAPHIC INSPECTION

All full-strength butt welds shall be radiography tested in accordance with the recommended practice for radiographic testing as per relevant IS: 4260 codes for random 10% of the weld length.

2.6.6.4 DIMENSIONS, WORKMANSHIP & CLEANLINESS

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 approved fabrication drawings.

2.6.6.5 TEST FAILURE

In the event of failure of any member to satisfy inspection or test requirement, the contractor shall notify the Engineer-in-charge. The Contractor must obtain permission from the Engineer-

In-Charge before any repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the Engineer-in-charge.

The Engineer-In-Charge has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the contractor.

The contractor shall maintain records of all inspection and testing which shall be made available to the Engineer-in-charge.

2.6.7 SHOP MATCHING

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 Engineer-in-charge.

2.6.8 DRILLING HOLES FOR OTHER WORKS

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 Contractor at no extra cost. The information for such extra holes will be supplied by the Engineer-in-charge.

2.6.9 MARKING OF MEMBERS

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.

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.

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.

2.6.10 ERRORS

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 Engineer-In-Charge as defective workmanship. Where the Engineer-In-Charge rejects such material or defective workmanship, the same shall be replaced by materials and workmanship conforming to the specifications by the contractor, at his cost to the satisfaction of the Engineer-in-charge.

2.6.11 PAINTING OF STEEL WORK

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

2.6.11.1 MATERIALS

Zinc chrome primer shall conform to IS: 2074.

Synthetic enamel paint shall conform to IS: 2932. Aluminium paint shall conform to IS: 2339.

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

2.6.11.2 WORKMANSHIP

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).

Minimum dry film thickness of each coat of finish paint of synthetic enamel shall be 25 microns. Surfaces inaccessible after assembly shall receive two coats of primer prior to assembly. Surfaces inaccessible after erection, including top surfaces of floor beams supporting grating or chequered plate shall receive one additional coat of finish paint over and above the number of coats specified prior to erection.

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.

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.

It is essential to ensure that immediately after preparation of the surface the first coat of 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.

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.

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.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved from the Engineer-in-charge.

2.6.12 ACCEPTANCE OF STEEL, ITS HANDLING & STORAGE

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 Engineer-in-charge.

No dragging of steel shall be permitted. All steel shall be stored 300 mm 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.

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.

2.6.13 ANCHOR BOLTS & FOUNDATIONS

The Contractor shall carefully check the location and layout of anchor bolts (GI material) embedded in foundation to ensure that the structures can be properly erected as per approved drawings.

Levelling 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.

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.

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 shall be carried out by the contractor.

2.6.14 ASSEMBLY & CONNECTIONS

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

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.

All assembling shall be carried on a level platform.

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 Engineer-in-charge.

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 Engineer-in-charge.

2.6.15 ERECTION

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 Engineer-In-Charge in writing. Care shall be taken to see that ropes in use are always in good condition.

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.

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.

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 Engineer-in-charge. 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.

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

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

Test certificates shall be furnished by the Contractor.

2.6.16 INSPECTION

The Engineer-In-Charge 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 Engineer-in-charge.

2.6.17 TOLERANCES

2.6.17.1 GENERAL

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

2.6.17.2 COLUMNS

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

- a. In longitudinal direction $\pm 5 \text{ mm}$
- b. In lateral direction $\pm 5 \text{ mm}$
- c. Deviation in the level of bearing surface of columns at Foundation top with respect to true level $\pm 5 \text{ mm}$

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

A	For columns up to and including 15 m in height or $\pm 15 \text{ mm}$ whichever is less	$\pm 1/1000$ of column height in mm
B	For columns exceeding 15 m in height or $\pm 20 \text{ mm}$ whichever is less	$\pm 1/1000$ of column height in mm
C	Deviation in straightness in longitudinal and transverse planes of column at any	$\pm 1/1000$ of column height in mm or $\pm 10 \text{ mm}$ whichever is less point along the height
D	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	$\pm 10 \text{ mm}$
E	Deviation in any bearing or seating level with respect to true level	$\pm 5 \text{ mm}$
F	Deviation in differences in bearing level of a member on adjacent pair of columns both across and along the building	$\pm 10 \text{ mm}$

2.6.17.3 TRUSSES AND BEAMS

A	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord	$\pm 1/250$ of height of truss in mm or ± 15 mm whichever is less
B	Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	$\pm 1/1500$ of span of truss in mm or ± 15 mm whichever is less
C	Lateral shift in location of truss from its true vertical	± 10 mm
D	Shift at the centre of span of top chord member with respect to the vertical plane passing through the centre of bottom chord position	$\pm 1/250$ of height of truss in mm or ± 15 mm whichever is less
E	Lateral shift in location of purlin true position	± 5 mm
F	Deviation in difference of bearing levels of trusses or beams from the true difference	± 20 mm for trusses for beams: Depth < 1800 mm: ± 6 mm Depth > 1800 mm: ± 10 mm
G	Deviation in sag in chords and diagonals truss between node points	$1/1500$ of length in mm or of 10mm whichever is smaller
H	Deviation in sweep of trusses, beams etc. in the horizontal plane	$1/1000$ of span in mm subject to a maximum of 10 mm

2.6.17.4 CRANE GIRDERS & RAILS

A	Shift in the centre line of crane rail with respect to centre line of web of crane girder	± 5 mm
B	Shift in plan of alignment of crane rail with respect to true axis of crane rail at any point	± 5 mm
C	Difference in alignment of crane rail in plan measured between any two points 2 m apart along rail	± 1 mm
D	Deviation in crane track with respect to Time gauge For track gauges up to and Including 15 m For track gauges more than 15 m	± 5 mm $\pm [5 + 0.25 (S-15)]$ where S in meters is true gauge $\pm 1/1200$ of the gauge distance or

E	Deviation in crane rail level at any Point from true level	± 10 mm whichever is less
F	Difference in the crane rail actual levels between any two points 2 m apart along the rail length	± 2 mm
G	Difference in levels between crane track Rails at Supports of crane girders Mid span of crane girders	± 15 mm ± 20 mm
H	Relative shift of crane rail surfaces at a Joint in plane and elevation	2mm subject to grinding of surfaces for smooth transition
I	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

2.6.18 PAINTING OF BARE SPOTS / RIVET HEAD

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.

2.6.19 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 in a satisfactory manner all temporary structures, waste and debris and leave the premises in a condition satisfactory to the Engineer-in-charge.

2.7 WATER SUPPLY AND SANITARY WORKS

2.7.1 APPLICABLE CODES

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

IS: 210 Grey iron castings - Specification

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 - Specification

- IS: 458 Precast 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 made on the threads
–Dimension, Tolerance and designation
- IS: 651 Specification for Salt glazed stoneware pipes and fittings.
- IS: 774 Specification for Flushing Cisterns for water closets and urinals (Other than Plastic cistern)
- IS: 775 Specification for 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 plus chromium and copper plus nickel plus chromium
- IS: 1077 Common burnt clay building bricks- Specification
- IS: 1786 Specification for high strength deformed steel bars and wires for concrete reinforcement
- IS: 1239 Mild steel tubes, Tubular and other wrought steel fittings- Specification
- IS: 1536 Centrifugally cast (spun) iron pressure pipes for water, gas and sewage - Specification
- IS: 1626 Asbestos cement building pipes, gutters and fittings (spigot and socket types).
- IS: 1703 Water fittings Copper Alloy float valves (horizontal plunger type) -Specification
- IS: 1726 Specification for Cast iron manhole covers and frames
- IS: 1729 Cast Iron/ Ductile iron drainage pipes and pipe fittings for over ground non- pressure pipeline socket and spigot series.
- 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 Specification for Automatic flushing cisterns for urinals (other than plastic cisterns)
- IS: 2470 Code of practice for installation 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 Specification for Waste plug and its accessories for sinks and washbasins
- 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
- 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 Specification for Non-ferrous alloy bottle traps for marine use

2.7.2 SANITARY INSTALLATION

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 Engineer- in-charge. 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 at his cost.

All sanitary and plumbing work shall be carried out by experienced plumbers.

All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of make and design as approved by the Engineer-in-charge.

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.

Joints between iron and earthenware pipes shall be made perfectly air and watertight by caulking with neat cement mortar.

2.7.3 INDIAN TYPE WATER CLOSET

This shall be the long pan pattern with separate foot rests 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 weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise approved by the Engineer-in-charge. 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.

2.7.4 EUROPEAN TYPE WATER CLOSET

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 weep hole at the flushing inlet. Each water closet shall have an integral trap with either "S" or "P" outlet with at least 50 mm water seal. The water closets shall have an anti-siphonage 50 mm dia. vent horn on the outlet side of the trap. The inside of water closets and traps shall be uniform and smooth in order to ensure in efficient flush. The serrated part of the outlet shall not be glazed externally. The water closet when sealed at the

bottom of the trap in line with the back plate shall be capable of holding not less than 10 litres of water between the normal water level and the highest possible water level of the water closet installed.

2.7.5 URINALS

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 fixing 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 weep hole 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.

2.7.6 WASH BASINS

Wash basins shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay as approved by the Engineer-In-Charge and conforming to IS:2556

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

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 beveled 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 non-ferrous 32mm waste fittings. Stud slots to receive the brackets on the underside 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 center 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 Engineer-In-Charge Requirements for waste plug, chain and stay shall be the same as given for sinks.

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 IS.1068.

2.7.7 SINKS

The sinks shall be of Stainless-Steel provision as approved by the Engineer-In-Charge and shall be of the following sizes: 600 x 450 x 150 mm

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 beveled 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.

2.7.8 FLUSHING CISTERNS

The flushing cisterns shall be automatic or manually operated high level or low level, as approved by the Engineer-in-charge. 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.

2.7.9 TOILET FIXTURES

2.7.9.1 MIRROR FRAMES

Mirror frame where specified will be of fibre glass of approved shape, size, colour and make. Mirror will be of superior glass with edges rounded off or levelled as specified. It will be free from flaws, specks or bubble and its thickness will not be less than 5.0 mm. The glass for the mirror will be uniformly silver plated at the back and will be free from silvering defects. Silvering will have a protective uniform covering of red lead paint.

2.7.9.2 TOILET SHELF

Glass shelf unit will consist of an assembly of glass shelf, anodized aluminium / CP brass guardrail and supporting brackets. The shelf will be of glass of best quality with edges rounded off and will be free from flaws, specks, bubbles and of thickness not less than 5.0 mm. The shelf will have guardrail, resting on rubber washers on glass plate. Ceramics shelf will be of shape, size and design as specified in the drawings/approved by Engineer- in-charge.

2.7.9.3 TOWEL RAIL

Towel rail will be of CP brass/anodized aluminium with two brackets of same material diameter and length as specified.

2.7.9.4 TOILET PAPER HOLDER

Toilet paper holder will be of CP brass, PVC with CP brass brackets or ceramic of approved make and design.

2.7.9.5 SOAP CONTAINER

Soap container will be of C.P. brass, PVC with CP brass brackets of approved make and design.

2.7.10 CAST IRON PIPES AND FITTINGS

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.

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.

The angular 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 by weight (1 cement: 2 fine sand) well pressed with caulking tool and finished smooth on top at an angle of 45°C. The joint shall be kept wet for not less than 14 days by tying a piece of gunny bag

kept moist. Joints shall be perfectly air tight as well as water tight.

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.

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.

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.

All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Engineer-In-Charge and left in working condition after completion. The smoke test shall be carried out as stated under:

Smoke shall be pumped into the pipe at the lowest and from a smoke machine which consists of a bellows 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.

Water test and air test shall be conducted as stipulated in IS: 5329.

2.7.11 GALVANISED MILD STEEL (GI) PIPES

The pipes shall be galvanized mild steel welded pipes and seamless screwed and sockets tubes conforming to the requirements of IS: 1239, for medium grade. They shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanized 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.

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.

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.

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. 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.

Any threads exposed after jointing shall be painted or in the case of underground piping thickly coated with approved anticorrosive paint to prevent corrosion.

For internal work the galvanized 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 bituminous 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 Engineer-in-charge.

GI 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.

The work of excavation and backfilling shall be done true to line and gradient in accordance with general requirements for earthworks in trenches for pipes laid underground.

The pipes shall be laid on a layer of 10.0cm sand and filled up to 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.

The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Engineer-In-Charge 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.

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.

2.7.12 STONEWARE PIPES AND FITTINGS

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.

The stoneware pipes & fittings shall be of good quality, size shall be as per requirement and as approved by Engineer-In-Charge or as shown on approved drawing.

Jointing of GSW pipes and fittings shall be done as per following method and as per the requirement of Engineer-in-charge. 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.

2.7.12.1 SPIGOT AND SOCKET JOINT (CEMENT JOINT)

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 of socket.

Cement mortar (1:1) by weight 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 off neatly outside the socket at an angle of 45°C.

The cement mortar joints shall be cured at least for 14 days before testing.

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

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

2.7.12.2 SPIGOT AND SOCKET JOINT (BITUMINOUS JOINT)

The general requirements for this type of joint shall be as specified in Clause 2.7.12.1. 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.

2.7.12.3 SPIGOT AND SOCKET JOINT (RUBBER RING JOINT)

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.

2.7.12.4 CLEANING OF PIPES

As soon as a stretch of GSW pipes has been laid complete from manhole to manhole or for a length in a proper grade as approved by the Engineer-in-charge, 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 directed by the Engineer-In- Charge to prevent entry of mud or silt etc.

If as a result of the removal of any obstruction, the Engineer-In-Charge 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 directed by the Engineer-in- charge.

It shall also be ascertained by the Contractor that each length from manhole to manhole or the length as approved by the Engineer-In-Charge 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.

After laying and jointing of GSW pipes is completed the pipe line shall be tested as per the following requirements and as directed by the Engineer-in-charge. All equipment for testing at work site shall be supplied and erected by the contractor. Damage during testing shall be the contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer-in-charge. Water used for test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Engineer-In-Charge 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.

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 Engineer-in-charge.

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

2.7.13 UN-PLASTICISED PVC PIPES FOR POTABLE WATER SUPPLIES

The plain as well as socket end pipes, made of un-plasticized Polyvinyl Chloride, are used for potable water supplies and not suitable for use in suction and delivery lines of agricultural pumps and casing pipes in tube well. These shall conform to IS: 4985 – 1988 and shall be ISI mark. The pipes other than those meant for plumbing shall be classified by pressure ratings (working pressure) at 27° 'C' as follows:

Class of Pipe	Working Pressure
Class – 1	2.5 kg/cm ² (0.25 MPa)
Class – 2	4.0 kg/cm ² (0.4 MPa)
Class – 3	6.0 kg/cm ² (0.6 MPa)
Class – 4	10.0 kg/cm ² (1.0 MPa)

The outside diameter of the pipe and wall thickness shall be as per IS: 4985. The nominal outside diameter of plain end pipes plumbing works shall be 20, 25, 32, 40 & 50 mm. Each pipe shall be clearly and indelibly marked at intervals of not more than 3 m in colour and shall also be marked with the standard mark. The marking shall show Manufacturer's name or trade mark, outside diameter, class of pipe and pressure rating, batch number word "Plumbing" in the case of plumbing pipes.

Marking in Colour except plumbing pipes which shall be marked in Pink will be as follows:

Class of Pipe	Colour
Class – 1	Red
Class – 2	Blue
Class – 3	Green
Class – 4	Yellow

2.7.14 STOP COCK AND BIB COCK

A bibcock (bib tap) 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 discolored.

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 Engineer-In-Charge and all supplies made according to the approved samples.

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.

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 Engineer-In-Charge and the defective fittings and joints shall be replaced or redone.

2.7.15 SEPTIC TANK AND SOAK PIT

Construction of septic tank shall be as per IS: 2470 for minimum of 10 users and for 5 years cleaning period.

Soak pit shall be constructed at the location specified by the Engineer-in-charge. Earthwork

excavation shall be carried out to the exact dimensions. Brick masonry lining with open joints shall be constructed in the pit up to 150 mm below the outlet pipeline. Brick masonry in cement mortar 1:6 by weight shall be constructed above this level up to 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.

2.7.16 MANHOLES / CHAMBER

2.7.16.1 LOCATION

Manholes shall be constructed at places approved by the Engineer-in-charge.

2.7.16.2 EXCAVATION

Excavation, shoring, dewatering etc. for the pits of manholes, laying of pipes and fittings / specials shall be done as per requirement & as directed by the Engineer-in-charge.

2.7.16.3 BED CONCRETE

The bed concrete for manholes shall be done in accordance with requirements described elsewhere in the document.

2.7.16.4 TOP SLAB CONCRETE

Precast reinforced concrete slab shall be casted on top of chambers in pieces or as a whole as directed.

2.7.16.5 BRICKS

Refer Clause No. 2.9.2.1 of this document.

2.7.16.6 CEMENT MORTAR

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 of good quality and as per relevant IS.

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.

The Contractor shall arrange for tests on mortar samples as per provision made in relevant IS. Retempering of mortar shall not be permitted.

2.7.16.7 BRICK MASONRY

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 of manholes shall be in the proportion specified in clause 2.7.16.5. Brick work shall be as per approved drawing. 230 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.

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°C. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS: 2212.

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.

2.7.16.8 CEMENT PLASTER

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.

The proportion of the cement mortar shall be as per approved 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 IS code provision. 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.

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 14 days.

Plastering shall be done on both faces of brick masonry in cement mortar (1:2) by volume and 20 mm thick.

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 Engineer-in-charge.

2.7.16.9 CEMENT CONCRETE CHANNEL

The channel for the manhole shall be constructed in cement concrete of M-15 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) by weight of 20 mm thickness and formed to a slope of 1 in 12 towards the channel.

2.7.16.10 PIPE ENTERING OR LEAVING MANHOLE

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) by volume, 13 mm thick between it and the bricks.

2.7.16.11 CAST IRON STEPS

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 wrappings. 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. CI 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°C and shall not be brittle as to chip off at temperature of 0°C.

Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be fixed in the wall 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.

2.7.16.12 FRAME AND COVERS

Frame and covers for manholes shall be of required type and dimensions as per approved drawing or as directed by Engineer-in-charge.

a. 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 2.7.16.11. The covers shall have a raised chequered design to provide an adequate non-slip grip. The rise of the chequered shall be not less than 4 mm. The locking device for the cover shall be provided as approved by the Engineer-in-charge. The size and slop of cover shall be as per approved drawing or as directed by Engineer-in-charge.

b. 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 approved drawing. The frame and cover shall be cast in cement concrete of M25 grade. Minimum cover to the reinforcement shall be 40 mm. The edges of frame and covers shall be provided with mild steel angles to avoid damages to the corners. These angles shall be painted with black bituminous paint. The covers should have suitable lifting arrangement.

2.7.17 DROP MANHOLE

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°C 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.

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.

2.7.18 RCC MANHOLE

M25 grade of concrete used for construction of RCC manhole shall have minimum cement content of 360 kg/cum of concrete. Minimum cover to the reinforcement shall be 50mm. Reinforcement used for construction of manhole shall be TMT (Fe500) as per relevant specification given in tender document.

2.7.19 VENT SHAFTS

a. General

Vent shafts shall be erected at such places as directed by the Engineer-in-charge

b. 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 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 Engineer-in-charge.

c. 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.

d. PVC Vent pipe

150 mm (ID) diameter with cowl. The vent shaft shall be connected to manhole as specified in (c) above through a brick masonry flue chamber.

2.7.20 MISCELLANEOUS

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

2.8 PEST CONTROL

The surfaces as below shall be treated with chemical emulsion

- a. Bottom and sides of excavation.
- b. Treating the top surface of plinth filling.
- c. Treating the junctions of walls and floor area.
- d. Treating the earth along the external perimeter of the building.

The chemicals used for the treatment shall be of the following with concentration shown against each in agencies emulsion.

Sr no	Chemicals	Concentration
1	Aldrin	0.50% (by weight)
2	Heptachlor	0.50% (by weight)
3	Chlordane	1.00% (by weight)

2.8.1 WORKMANSHIP

The chemicals barrier shall be completed and continuous under whole of the structure to be protected.

- a. The bottom and the sides of foundations up to a height of 30cm from the bottom of excavation made for masonry foundation and for basement column pits shall be treated with the chemical emulsion at the rate 5 Litres / Sq.m. of the surface area.
- b. In case of R.C.C. framed structure with columns and plinth beams, and R.C.C. basements, the treatment shall start at the depth of 50cm below ground level from this depth, back- fill around the columns, beams and R.C.C. Basement walls shall be treated at 7.5 L/Sq.m of vertical surface.
- c. The top surface of the consolidated earth within the walls shall be treated with the chemical emulsion at the rate of 5 L/Sq.m. of the surface before the sand bed or sub grade is laid. If the filled earth has been well rammed and the surface does not allow the emulsion to seep through, holes up to 50 to 75 mm deep at 150 mm centers both ways may be made with 12 mm diameter MS rod on the surface to facilitate absorption of the emulsion.
- d. The junction of wall and columns with the floor shall be treated with the chemical emulsion at the rate of 7.5 L/Sq.m. Special care shall be taken to establish continuity of the vertical chemical barrier on inner wall surfaces from the ground level up to the level of filled earth surface. To achieve this, a small channel 3 x 3 cm shall be made at the junctions of the wall and columns with floor (before laying the sub-grade) and rod holes made in the channels up to the ground level 15cm apart and the rod moved backward and forward to break-up the earth and chemical emulsion poured along the channel at the rate of 7.5 L/Sq.m. of the vertical walls or column surfaces of sub-structures so as to soak the soil right to the bottom. The soil should be tamped back into place after this operation.
- e. The external perimeter of the building shall be treated with chemical emulsions. After

building is complete, the earth along the external perimeter of the building should be rodded at intervals of 15cm and to a depth of 30cm. The rods shall be moved backward and forward parallel to the wall to break-up the earth and chemical emulsion poured along the wall at the rate of 7.5 L/Sq.m. of vertical surfaces. After the treatment, the earth shall be tamped back into place; the earth outside of the building should be graded on completion of building. This treatment shall be carried out on the completion of such grading. In event of filling being more than 30cm, the external perimeter and treatment shall be extended to the full depth of filling up to ground level so as to ensure continuity of the chemical barrier.

- f. The chemical treatment shall be carried out when the surface is quite dry. Chemical treatment shall not be carried out when it is raining or when the soil is wet with rain or sub soil water.
- g. Once formed, treated soil barriers shall be not disturbed. If by chance, treated soil barriers are disturbed, immediate steps shall be taken to restore the continuity and compactness of the barrier system.
- h. The treatment against termite infection shall remain full effective for a period not less than 10 years from date of issue of the final certificate of completion of work.

2.9 BUILDING DETAILS

2.9.1 APPLICABLE CODES AND SPECIFICATIONS

The following codes and standards are applicable. However, respective IS codes for the works not mentioned here shall also be applicable for those particular items of work.

- IS: 110 Specification for Ready mixed paint, brushing, grey filler, for enamels for use over primers
- IS: 280 Specification for mild steel wire for general engineering purposes
- IS: 287 Recommendations permissible moisture content of timber used for different purposes- Recommendations
- IS: 304 Specification for High Tensile Brass Ingots and Castings
- IS: 337 Specification for Varnish, finishing interior
- IS: 348 Specification for French polish
- IS: 383 Specification for coarse and fine aggregates from natural sources for concrete
- IS: 412 Specification for Expanded metal steel sheets for general purposes
- IS: 419 Specification for putty for use on window frames
- IS: 428 Washable Distemper-specification
- IS: 459 Indian standards unreinforced corrugated and semi-corrugated asbestos cement sheets- Specification
- 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 Specification for Wrought aluminium and aluminium alloys, bars, rods and sections (for general engineering purposes)
- IS: 15622 Specification for Pressed Ceramic Tiles
- IS: 1003 Specification for timber paneled and glazed shutters (Parts 1 & 2) IS: 1038 Specification for steel doors, windows and ventilators
- IS: 1077 Common burnt clay building bricks - Specification
- 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 Specification for 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 joints in concrete
- IS: 1838 Specification for preformed fillers for expansion joint in 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 - Specification
- IS: 2098 Specification for 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): Part 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 Specification for 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 Integral cement waterproofing compounds for cement mortar and concrete - Specification
- 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 Enamel, synthetic, exterior (a) undercoating, (b) finishing - Specification
- 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 Ready mixed paint, brushing, wood primer, pink - Specification
- IS: 3564 Hydraulically regulated Door closers specification
- IS: 3614 (Part - 1) Specification for fire checks doors: Part –I Plate metal covered and rolling type
- IS: 3614 (Part - 2) Specification for metallic and non-metallic fire check doors: Resistance test and performance criteria
- IS: 3696 Safety code of scaffolds and ladders (Parts 1 & 2)
- IS: 4020 Door shutter - Methods of test
- IS: 4021 Specification for timber door, window and ventilator frames
- IS: 4351 Steel door frames - Specification
- 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- Specification
- IS: 5411 Specification for plastic emulsion paint (Parts 1 & 2)
- IS: 5437 Figured rolled and wired glass
- IS: 5491 Code of practice for laying of in-situ granolithic concrete floor topping
- IS: 6041 Code of practice for 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 grills
- IS: 7193 Specification for glass fibre base 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 water stops at transverse contraction joints in masonry and concrete dams – code of practice
- BS: 476 Methods for determination of the fire resistance of elements of (Part – 20) construction (General Principles)
- BS: 476 Methods for determination of the fire resistance of load bearing (Part – 21) elements of construction
- BS: 476 Methods for determination of the fire resistance of Non-load (Part – 21) bearing elements of construction Part – IV Fire Protection (National Building code of India)

2.9.2 BRICKWORK

2.9.2.1 MATERIALS

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. The nominal size of the modular brick shall be 200mm x 100mm x 100mm 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 200mm and 100mm respectively. In the event of use of traditional bricks of nominal size 230mm x 115mm x 75mm with tolerance up to ± 3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115mm respectively.

Generally conventional bricks are available. So, the contractor shall have to furnish the samples of good bricks to the Engineer-In-Charge for approval of make and size. But Brick shall be used after the result of testing or as directed by Engineer in Charge.

Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified,

hand/machine molded, deep red, cherry or copper colored, 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. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 35 kg/cm² unless otherwise specified in the items of work prepared by the Contractor.

The average water absorption shall not be more than 20 percent by weight bricks. The bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not allowed to for use in the works.

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

Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:6 by volume for brickwork of thickness one brick or above and 1:4 by volume 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 Engineer-in-charge. If so, directed by the Engineer-in-charge, sand shall be screened and washed till it satisfies the limits of deleterious materials.

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 Engineer-in-charge. 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 up to 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. Dropped of mortar shall not be re-used under any circumstances. The Contractor shall arrange for test on mortar samples as directed by the Engineer-in-charge.

2.9.2.2 WORKMANSHIP

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 200 mm / 230 mm thick and over shall be laid in proper Bond as specified and directed. 100 mm / 115 mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full-size bricks shall be used for the works and cut bricks utilized only as closers to make up required wall length or for bonding. Bricks shall be laid with frogs

on top.

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 1 m. Brick work shall not be raised more than one meter per day.

Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm 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.

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.

Brickwork shall be kept constantly moist on all the faces for at least 21 days after 24 hrs. of laying. The arrangement for curing shall be got approved from the Engineer-in-charge.

Double scaffolding having two sets of vertical supports shall be provided to facilitate execution of the masonry works. The scaffolding shall be designed adequately considering all the dead, live and possible impact loads to ensure safety of the workmen, in accordance with the requirements stipulated in IS: 2750 and IS: 3696 (Part-I). Scaffolding shall be properly maintained during the entire period of construction. Single scaffolding shall not be used on important works and will be permitted only in certain cases as decided by the Engineer-in-charge. Where single scaffolding is adopted, only minimum number of holes, by omitting a header shall be left in the masonry for supporting horizontal scaffolding poles. All holes in the masonry shall be carefully made good before plastering / pointing.

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

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

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

For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3.

Proper steel wire fabric shall be provided at the junction of brick masonry and concrete element

in super structure as per the instructions of the Engineer-in-charge.

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 de-shuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

Reinforced cement concrete transoms and mullions of dimensions as indicated in the construction Drawings and as directed by Engineer-In-Charge are generally required to be provided in the half brick partition walls. Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 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.

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.

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 as directed by Engineer-in-charge. For facing brickwork, double scaffolding shall be used. Faced works shall be kept clean and free from damage, discoloration etc., at all times.

2.9.3 UN-COURSED RANDOM RUBBLE MASONRY, IN FOUNDATION, PLINTH AND SUPERSTRUCTURE

2.9.3.1 MATERIALS

Stones for the works shall be of the specified variety which is 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% as per test conducted in accordance with IS: 1124. The Contractor shall supply sample stones to the Engineer-In-Charge for approval. Stones shall be laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

Cement-sand mortar for stone masonry works shall be in the proportion of 1:4 by volume materials and preparation of mortar shall be as specified in clause 2.9.2.1.

2.9.3.2 WORKMANSHIP

For All Works below ground level the masonry shall be random rubble un-coursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.

For all works above ground level and in superstructure the masonry shall be random rubble un-

coursed, 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.

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 up to a maximum of 300 mm. Face stones or hearting stones shall not be less than 150 mm in any direction.

Chips and spaul 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 spaul in the hearting shall not exceed 20 percent of the quantity of stone masonry. Spaul and chips shall not be used on the face of the wall and below hearting stones to bring them to the level of face stones.

The maximum thickness of joints shall not exceed 20 mm. All joints shall be completely filled with mortar. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool during the progress of the work while the mortar is still green.

Through or bond stones shall be provided in walls up to 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.

All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. All connected walls in a structure shall be normally raised uniformly and regularly. However, if any part of the masonry is required to be left behind, the wall shall be raked back (and not saw toothed) at an angle not exceeding 45°C. Masonry work shall not be raised by more than 1 m per day.

Green work shall be protected from rain by suitable covering. Masonry work shall be kept constantly moist on all the faces for a minimum period of 14 days for proper curing of the joints. Type of scaffolding to be used shall be as specified in clause 2.9.2.2.

2.9.4 COURSED RUBBLE MASONRY (FIRST SORT) FOR SUPERSTRUCTURE

2.9.4.1 MATERIALS

The Material specification for the work shall be as per clause 2.9.3.1.

2.9.4.2 WORKMANSHIP

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 150mm and not more than 300mm. The width of stone shall not be less than its height.

Face stones shall tail into the work for not less than their height and at least 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 at least 75mm.

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 80mm back from the face and the side joints for at least 40mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40mm on an exposed face and 10mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6mm 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.

No spalls or pinning 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.

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.

The requirement regarding through or bond stones shall be as specified in Clause 2.9.3.2 with the further stipulation that these shall be provided at 1.5m to 1.8m apart clear in every course but staggered at alternate courses.

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 25 mm width at four edges, all the edges being in the same plane.

Type of scaffolding to be used shall be as per Clause 2.9.2.2. Requirements of execution of the work and curing shall be as stipulated in Clause 2.9.3.2.

2.9.5 CONCRETE BLOCK MASONRY

2.9.5.1 MATERIALS

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part I).

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width. The nominal dimensions of concrete block shall be as under.

Length 400, 500 or 600 mm

Height 100 or 200 mm

Width 100 to 300 mm in 50 mm increments

Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full-length blocks.

Actual dimensions shall be 10mm short of the nominal dimensions.

The maximum variation in the length of the units shall not be more than ± 5 mm and maximum variation in height or width of the units shall not be more than ± 3 mm.

Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.

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 specify. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square.

The bedding surfaces shall be at right angles to the faces of the block.

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.

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 Engineer-in-charge.

2.9.5.2 WORKMANSHIP

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 100 mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

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: 6041for autoclaved cellular concrete block masonry works.

From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.

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 by volume shall be used for the works. Preparation of mortar shall be as specified in Clause 2.9.2.1.

The thickness of both horizontal and vertical joints shall be 10 mm. 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 10 mm.

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.

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.

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.

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.

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 2.9.2 for the brick work.

Curing of the mortar joints shall be carried out for at-least 14 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

Double scaffolding as per clause 2.9.2.2 shall be adopted for execution of block masonry work.

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.

Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

2.9.6 DAMP - PROOF COURSE

2.9.6.1 MATERIALS AND WORKMANSHIP

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 100 mm thick cement concrete of M20 mix with approved water-proofing compound admixture conforming to IS:2645 in proportion as directed by the manufacturer.

Concrete shall be with 10 mm downgraded coarse aggregates.

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

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

2.9.7 MISCELLANEOUS INSERTS, BOLTS ETC.

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

2.9.8 WOOD WORK IN DOORS, WINDOWS, VENTILATORS & PARTITIONS

2.9.8.1 MATERIALS

Timber to be used shall be first class Indian Teak wood as per IS: 4021 and test shall be carried before start the work. This shall be of the best quality and well-seasoned by a suitable process before being planned 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 % 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.

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).

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

Hardware for fittings and fixtures shall be of the best quality from approved manufacturers and as approved by Engineer-in-charge.

2.9.8.2 WORKMANSHIP

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.

All works shall be executed as per the approved detailed drawings and / or as directed by the Engineer-in-charge.

All members of the door, window and ventilator shall be straight without any warp or bow and shall have smooth well-planned 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:

- For doors – 12 cm x 7 cm with paneled door shutter of 35mm thick
- For windows – 10 cm x 7 cm with paneled door shutter of 35mm thick

The workmanship shall generally conform to the requirements specified in IS: 4021.

The face of the frames abutting the masonry or concrete shall be provided with a coat of coal tar. 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.

Timber paneled 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. 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-planned faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS: 1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified.

The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidized or anodized aluminium shall be as specified. The number, size and type of the fittings and fixtures shall be as specified.

Woodwork shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the Engineer-in-charge. 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 2.9.33.

Wooden hand railing and architraves shall be of the size and shape with the fixing arrangement as indicated in the Drawings.

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 approved construction Drawings or as directed by Engineer-in-charge.

Any carpentry work which shows defects due to inadequate seasoning of the timber or bad workmanship shall be removed and replaced by Contractor with work as per Specifications.

2.9.9 GRILLS AND RAILINGS

2.9.9.1 MATERIAL:

Hot rolled steel sections for the fabrication of grills/railings shall conform to IS: 7452.

2.9.9.2 WORKMANSHIP:

All grills and railings shall be provided with necessary hold fast for fixing in the walls or other elements including welding, grouting, pinning etc.

The grills and railings shall be made from MS flats / round / square bars having consumption of 30 kg (minimum) weight per sq. meter area, including proper welding in joints, grinding, painting etc. complete as per approved drawing.

Window/door, Grill/Railing shall be fitted on suitable frame of timber.

2.9.10 STEEL DOORS, WINDOWS AND VENTILATORS

2.9.10.1 MATERIALS

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

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

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

Hardware of fittings and fixtures shall be of the best quality from the approved manufacturers.

2.9.10.2 WORKMANSHIP

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 approved Drawings. 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.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and metered. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS: 1038. Tolerance in overall dimensions shall be within ± 1.5 mm. The frames and shutters shall be free from warp or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved from the Engineer-In-Charge before further manufacture / purchase by the Contractor. 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.

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.

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 or 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.

Door shutters of flush welded construction shall be 45 mm thick, fabricated with two outer skins of 1.25 mm thick steel sheets, 1 mm 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 1.25 mm thick steel sheets, mild steel angles and stiffeners as per the Drawings prepared by the Contractor.

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.

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 or as directed by Engineer-in-charge. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

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 or as directed by Engineer-in-charge.

Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanized with thickness of the zinc coating as stipulated all as described in the respective items of works or as directed by Engineer-in-charge.

The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidized or anodized 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 or as directed by Engineer-in-charge.

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.

2.9.11 ALUMINIUM DOORS, WINDOWS, VENTILATORS & PARTITIONS

2.9.11.1 MATERIALS

Aluminium alloy used in the manufacture of extruded sections for the fabrication of doors,

windows, ventilators shall conform to designation HE9-WP of IS: 733.

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

Hardware of fittings & fixtures shall be of the best quality from approved manufacturers, as approved by the Engineer-in-charge.

2.9.11.2 WORKMANSHIP

All aluminium 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. Aluminium windows shall conform to IS: 1949, if so specified.

All aluminium units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm.

Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitered and welded at the corners to a true right angle conforming to the requirements of IS: 1948. Tolerance in overall dimensions shall be within $\pm 1.5\text{mm}$. 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.

Aluminium swing type doors, aluminium sliding windows, partitions shall be as specified.

IS: 1948 and IS: 1949 referred to incorporates the sizes, shapes, thicknesses and weight per running meter 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 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 Engineer-In-Charge and accepted only if they are equal to or marginally more than that given in the codes / as specified.

The framework of the partitions with mullions and transoms shall be with anodized aluminium box sections. Anodized 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 or as directed by Engineer-in-charge. 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.

Specific provisions as stipulated for steel doors, windows, ventilators under clause 2.9.9.2 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 Engineer- in-charge. 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.

2.9.12 STEEL ROLLING SHUTTERS

2.9.12.1 MATERIALS AND WORKMANSHIP

Rolling shutters shall be of an approved manufacturer, conforming to the requirements specified in IS: 6248.

The type of rolling shutter shall be self-coiling type (manual) for clear areas up to 12 Sq.m, gear operated type (mechanical) for clear areas up to 35 Sq.m and electrically operated type for areas up to 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.

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 approved Drawings or as directed by Engineer-in-charge.

Shutters shall be built up of interlocking laths 75 mm width between rolling centers formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters up to 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.

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.

Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.

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.

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 or as directed by Engineer-in-charge. Painting shall be carried out as per clause 2.9.34.

In case of galvanized rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanized with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating shall be at least 610 gms/sq.m.

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. The rolling shutter with handle gear operation shall be provided.

2.9.13 RUBBLE SUB-BASE

2.9.13.1 MATERIALS

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).

Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ± 10 mm. Stones shall not have a base area less than 250 sq.cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the Engineer-in-charge.

2.9.13.2 WORKMANSHIP

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 filled in with clean hard sand by booming so as to fill the joints completely.

The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

2.9.14 BASE CONCRETE

The thickness and grade of concrete and reinforcement shall be as per drawing or as specified in items of works or as directed by Engineer-in-charge.

Before placing the blinding concrete, the sub-base of rubble packing/earth filling 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.

2.9.15 TERRAZZO AND PLAIN CEMENT TILING WORK

2.9.15.1 MATERIALS

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

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

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 coloring 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. The minimum thickness of wearing layer of terrazzo tiles shall be 5mm for tiles with chips of size varying from 1mm up to 6mm or from 1mm up to 12mm. This shall be 6mm for tiles with chips varying from 1mm up to 25mm. The minimum thickness of wearing layer of cement/colored 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.

2.9.15.2 WORKMANSHIP

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

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 up to about 50mm above the level of proposed skirting/dado. 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.

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 fineness modulus between 2.1 to 3.2. 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.

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 at least 14 days after fixing of the tiles.

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.

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. 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 beveled 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.

Wall plastering of the strip left out above the level of skirting / dado shall be taken up after the tiles are fixed. Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

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.

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. Localized deviation of $\pm 3\text{mm}$ in any 3m length is acceptable in a nominally flat floor.

2.9.16 IN-SITU TERRAZZO WORK

2.9.16.1 MATERIALS

The requirements of marble aggregates for terrazzo topping shall be as per clause 2.9.14.1. 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 edge 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.

2.9.16.2 WORKMANSHIP

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

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

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

Dividing strips shall be either of aluminium, brass or other material as indicated in the items of works prepared by the Contractor. Aluminium strips should have a protective coating of bitumen. The thickness of the strips shall be not less than 1.5mm and width not less than 25mm for flooring work. Concrete base shall be finished to a reasonably plane surface to a level below the finished floor elevation equal to the specified thickness of terrazzo finish. Before spreading the under layer, the base concrete surface shall be cleaned of all loose materials, mortar droppings, dirt, laitance etc. and well wetted without allowing any water pools on the surface. Dividing strips or screed strips, if dividing strips are not provided shall be fixed on the base and levelled to the correct height to suit the thickness of the finish. Just before spreading the under layer the surface shall be smeared with cement slurry at 2.75 Kg/Sq.m. Over this slurry, the under layer shall be spread and levelled with a screening board.

The top surface shall be left rough to provide a good bond for the terrazzo topping.

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.

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.

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.

2.9.17 SHAHABAD / TANDUR/ KOTA STONE SLAB WORK

2.9.17.1 MATERIALS

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% as per test conducted in accordance with IS: 1124.

The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be ± 5 mm. This shall be ± 2 mm on dimensions less than 100 mm.

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.

2.9.17.2 WORKMANSHIP

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. Preparation of the concrete base, laying and curing shall be as per clause 2.9.14.2. Dado / skirting work shall be as per clause 2.9.14.2. 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 by weight. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

Grinding and polishing shall be as per clause 2.9.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

2.9.18 CARBORUNDUM TILE FINISH

2.9.18.1 MATERIALS

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

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.

2.9.18.2 WORKMANSHIP

Requirements as detailed for terrazzo / cement tile finish under clause 2.9.14.2 shall be applicable for carborundum tile flooring.

2.9.19 GLAZED TILE FINISH

2.9.19.1 MATERIALS

Glazed earthenware tiles shall conform to the requirements of IS:15622. 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: 15622. The size, type and shade, manufacture of tiles shall be as approved by Engineer- in-charge.

2.9.19.2 WORKMANSHIP

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.

The bedding mortar shall consist of 1 part of cement to 3 parts of sand by weight mixed with just sufficient water to obtain proper consistency for laying. Sand for the mortar shall conform to IS: 2116 and shall have fineness modulus between 2.1 to 3.2. 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. Colored 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.

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. 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.

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 14 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry. 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.

2.9.20 IN-SITU CEMENT CONCRETE FLOOR TOPPING

2.9.20.1 MATERIALS

The mix proportion for the in-situ concrete floor topping shall be M15.

The aggregates shall conform for the requirements of IS: 383. 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.

Grading of the sand shall be within the limits indicated in IS: 2571.

2.9.20.2 WORKMANSHIP

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. Preparation of base concrete/structural slab before laying the topping shall be as per clause 2.9.13. The surface shall be rough to provide adequate bond for the topping. Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer-in-charge. 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.

Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 m 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.

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.

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 troweled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after laying, the first troweling just sufficient to give a level surface shall be carried out avoiding excessive troweling at this stage. The surface shall be re-troweled after sometime to close any pores and to scrap off excess water or laitance, which shall not be troweled back into the topping. Final troweling 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.

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 14 days.

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 finishes which are difficult to repair satisfactorily.

2.9.21 IN-SITU GRANOLITHIC CONCRETE FLOOR TOPPING

2.9.21.1 MATERIALS AND WORKMANSHIP

The Requirements of materials and workmanship shall be all as per clause 2.9.19 for in- situ cement concrete floor topping except that the mix proportion of the concrete shall M 25.

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

2.9.22 FLOOR HARDENER TOPPING / IRONITE FLOORING

2.9.22.1 MATERIALS & WORKMANSHIP

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.

Floor hardener shall be metallic type iron powder for the heavy-duty function of the floor, the quantum of the ingredients and the thickness of topping shall be as specified.

The floor hardener topping shall be done in two stages:

- a. The base floor shall be 138mm thick concrete mix of grade M-15. The concrete floor shall be well compacted with the vibrator and levelled.
- b. In the second stage the topping layer of minimum thickness 12mm shall be laid.

This proportion of mixing shall be 1:4 (one portion powder and 4 parts dry cement) to give 4.4 kg / Sq.m. Weight laid in uniform thickness over a previous floor.

The topping shall be screened and thoroughly compacted to the finished level.

Troweling to a smooth finish shall be carried out as per clause 2.9.19.2. After the surface has hardened sufficiently, it shall be kept continuously moist for at least 14 days.

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

2.9.23 PVC SHEET / TILE FLOORING

2.9.23.1 PVC SHEET / TILE FLOORING

PVC floor covering shall be of either un-backed homogeneous flexible type in the form of sheets/tiles conforming to IS: 3462 or homogeneous PVC asbestos tiles conforming to IS: 3461 bearing ISI mark.

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 Engineer-in-charge.

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.

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.

The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work prepared by the Contractor.

2.9.23.2 WORKMANSHIP

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.

The surface of the under-bed shall have troweled 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.

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 underbed until the A/C units have been in operation for at least 7 days. During this period, the temperature range shall be between 20°C and 30°C and this shall be maintained during the laying operations and also for 48 hours thereafter.

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.

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.

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.

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 slide 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.

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.

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. Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

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.

2.9.23.3 CHINA MOSAIC FLOORING

Providing and laying broken chine mosaic flooring for terrace using 12 mm to 20 mm broken pieces of glazed tiles to be laid over cement mortar 1:3 to plain or slope and to be tempered to bring mortar cream out on surface.

The surface to be treated shall be first cleaned of loose mortar or dust; it should be watered and kept damp. There after a layer of plaster in C.M 1:4 admixtures with approved brand of water proofing compound over RCC slab in thickness of 20 mm in floor and depression shall be applied.

Over cement mortar layer 12 mm to 20 mm thick broken pieces of glazed tiles shall be laid in white cement and finally finishing the surfaces with trowel with neat cement slurry of white cement. On completion of the work, curing shall be done for minimum 10 days.

2.9.24 ACID RESISTING BRICK / TILING WORK

2.9.24.1 MATERIALS

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. 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.

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.

2.9.24.2 WORKMANSHIP

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.

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.

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. 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. 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 too 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.

Resin mortars are normally self-curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furan type of resin is used for the mortar. If phenolic or cashew-nut 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.

2.9.25 EPOXY LINING WORK

2.9.25.1 MATERIALS

The epoxy resin and hardener formulation for laying of joint less lining work in floor and walls of concrete tanks / trenches etc. shall be as per the requirements of IS: 9197.

The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

- a. Hydrochloric acid up to 30% concentration
- b. Sodium hydroxide up to 50% concentration
- c. Liquid temperature up to 60°C
- d. Ultraviolet radiation
- e. Alternate wetting and drying

Sand shall conform to grading zone III or IV of IS: 383.

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.

Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so, directed by the Engineer-in-charge.

2.9.25.2 WORKMANSHIP

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.

The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

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.

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.

Rigid PVC/stainless steel / chromium plated tools shall be used for laying. Troweling shall be carried out to obtain uniformly the specified thickness of lining.

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.

2.9.26 FIVE COURSE WATER PROOFING TREATMENT

2.9.26.1 GENERAL

The work shall include waterproofing for the building roofs, terraces, walls, plasters, Chhajjas, sills and another area and at any other locations and situations as directed by the Engineer-in-charge.

Providing and fixing five course water proofing treatment felt consisting of second and fourth course of blown bitumen or / and residual bitumen applied hot 1.20 kg. / sq. mt. of area for each course and third course with fibre base self-finished felt type 2 Grade-I, fifth and final course of stone grit 6 mm and down size or pea sized gravel spread at 0.008 cum / sq. mt. including preparation of surface, excluding grading complete.

2.9.26.2 MATERIALS

The tar felt shall conform to clause 2.1.26. The bitumen primer shall conform to relevant I.S. The bitumen shall conform to I.S. 702-1961. The grit or gravel shall conform to clause 2.1.5.

2.9.26.3 WORKMANSHIP

- Preparation of Surface

1. Well-defined cracks other than hair cracks in the roof structure shall be cut to 'V' section cleaned and filled up flush with cement and sand slurry or with bitumen confirming to I.S. 702-1961. The surface to be treated shall have a minimum slope of 1 in 120. The grading shall be carried out prior to the application of water proofing treatment by cement mortar or line surkhi mortar or as specified in description of item.
2. The surface of room, part of parapet and gutters, drain mouths etc. over which the water proofing treatment is to be applied, shall be cleaned of all foreign matter such as fungus, moss and dust by wire brushing and dusting.
3. Drain outlet shall be suitably placed with respect to the roof gradient to ensure rapid drainage and prevent local accumulation of water on the roof, surface, masonry drain mouth, shall be widen sufficiently and rounded with cement mortar.
4. Form cast iron drain outlets; a groove shall be cut all round to touch the treatment.
5. When a pipe passes through a roof on which water proofing treatment is to be laid, a cement, concrete angle fillet shall be built round it and the water proofing treatment taken over the fillet.
6. In case of parapet wall over 450 mm. in height for tucking in the water proofing treatment, a horizontal groove 75 mm wide and 65 mm. deep at minimum height of 150 mm above roof level shall be left in the vertical face at the time of construction, the horizontal face of the groove shall be shaped with cement mortar 1:4 by volume.
7. In case of low parapet where the height does not exceed 450 mm no groove shall be provided and the water proofing treatment shall be carried right over the top.
8. In case of existing R.C.C. and stone walls cutting the chase for tacking in the water proofing treatment is not recommended.
9. At the junction between the roof and vertical face of the parapet wall, a fillet 75 mm in radius shall be constructed.
10. At the drain mouths the fillet shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water.
11. Outlet at every low dividing wall about less than 300 mm in height shall be rounded smooth and corners rounded off for easy application of water proofing treatment.

- Priming Coat

1. Bitumen primer shall conform to IS: 3385-1965. A priming coat consisting of bituminous solution of low viscosity shall be applied with brush on the roof and wall surface at specified per unit area to assist adhesion of bonding materials as specified in the description of the item.
2. Where a floating treatment of water proofing with self-finished bitumen felt is required i.e., where water proofing treatment is required to be isolated from the roof structure, layer of bitumen saturated felt (underlay) shall be spread over the roof surface and tucked into the flashing grooves. To keep the underlay free from the structure no bonding materials shall be used below underlay. Overlapping to the adjoining strip of underlay shall be minimum of 75

mm at sides and 10 mm at ends and shall be sealed with the same bonding materials, as used for the self-finished felt treatment. The underlay shall be of type-1 saturated felt conforming to I.S. 1322 – 1970.

- Laying of Felt

1. The self-finished tar felt shall be cut to the required lengths, brushed clean of dusting materials, laid out flat on the roof to eliminate curls and subsequent stretching. The felt shall be laid in length running at right angles to the direction of runoff gradient commencing at the lowest level and working up to crest, so that the lower laps of the adjacent felt layer offer minimum obstruction to the flow of water. The felt shall not be laid in a single piece of very long lengths as it is likely to shrink 6 to 8 m are suitable length. The roof shall be cleaned and dried before the felt treatment is begun.
2. Each length shall be laid in position and rolled up for a distance of half its lengths. The hot bonding materials heated to correct working temperature as specified by manufacture shall be poured on to the roof across the full width of the felt as the latter is steadily unrolled and pressed down. The excess of bonding materials, which squeezes out at the ends shall be removed as the laying proceeds. The pouring shall be so regulated that correct weight of the bonding materials as per unit area is spread uniformly over the surface. When the first half of the tar felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding materials in the same way. Subsequent strips shall also be laid in the same manner. Each strip shall overlap the preceding one by at least 75 mm at the longitudinal edges and 100 mm at the end. All overlaps shall be firmly bonded with hot bitumen. Streaks and tailings of bitumen near edges of laps shall be levelled by heating the overlaps with blowlamp and levelling down unevenness.
3. Third layer of bonding materials in four course treatments shall be carried out in similar manner after the flashing has been complete.
4. Water proofing treatment shall be carried out in the drain pipe or outlets by at least 100 mm. The water proofing treatment laid on the surface shall overlap the upper edge of water proofing treatment in the drain outlets by at least 100 mm. Flashing felts shall be laid as flashing. Wherever junction of vertical horizontal surfaces occurs longitudinal laps shall be 100 mm. The lower layer of flashing felt shall overlap the roofing felt by 100 mm. On vertical and sloping faces. Last course of flashing should not be stone, grit or pea sized gravel but it shall be replaced by providing two coats of bitumen solution of approved quality.
5. The lower edge of flashing shall overlap the flat portion of the roof and the upper edge of the flashing shall be tucked in the horizontal groove 75 mm thick wide, 65 mm deep provided at minimum height of 150 mm from top of the roof surface. The flashing treatment shall be firmly held in place in the grooves with wooden wedges at intervals and the grooves shall be followed with cement mortar 1:4 by volume (1 cement: 4 coarse sand) or cement concrete M15 grade and surface finished smooth with the rest of wall. The cement work shall be cured for 14 days. When dry, the exposed plaster joints of grooves shall be pointed with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing.

6. After the top flashing felt layer has been laid, the penultimate layer of bonding materials shall be applied over the roofing felt and horizontal overlap, and vertical and sloping surface of flashing shall be spread uniformly over the hot bonding materials on the horizontal roof surface and pressed into it with wooden roller.
7. The material for surface finish shall be spread as described in the item top layer.
8. If ballooning occurs the defects may be rectified as under.
9. Remove the gravel on the ballooned surface. Then cut open and squeeze out the trapped vapour by firm pressure applied by hand, seal the bitumen felt so lifted back on the surface by applying additional bitumen, finally seal the cut with piece of bitumen felt with bitumen application.

2.9.27 WATERPROOFING OF ROOFS / TERRACES, ETC.

2.9.27.1 WATER PROOFING OF HORIZONTAL SURFACES

The waterproofing shall be applied as follows:

A coat of Blown Bitumen 85 / 25 shall be applied at the rate of 1.45 kg/Sq.m.

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 were directed by the Engineer-in-charge, as the unrolling progresses.

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

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.

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.

Top of membrane finally shall be painted with anti-glouse reflective paint.

2.9.27.2 WATERPROOFING OF VERTICAL SURFACES AT ROOF LEVEL AND GUTTERS

The Water proofing shall be applied as described above.

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.

The membrane shall be overlapped with treatment for the horizontal surface by at least 500 mm. The membrane shall be taken up to a pre-cut chase anchored and sealed.

2.9.28 KHURRAS AND RAINWATER DOWN PIPES

Down pipes shall be isolated from RCC work with 6mm 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 0.075mm 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.

2.9.29 TESTING OF WATERPROOFING

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.

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

2.9.30 CEMENT PLASTERING WORK

2.9.30.1 MATERIALS

The proportions of the cement mortar for plastering shall be 1:3 by volume. Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per relevant IS standards. The quality and grading of sand for plastering shall conform to IS: 1542. The mixing shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the Engineer-in-charge. If so desired by the Engineer-In-Charge sand shall be screened and washed to meet the Specifications. The mortar thus mixed shall be used as soon as possible preferably within 30 minutes from the time water is added to cement. In case the mortar has stiffened due to evaporation of water this may be re-tempered by adding water as required to restore consistency but this will be permitted only up to 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. Dropped mortar of plaster shall not be re-used under any circumstances.

2.9.30.2 WORKMANSHIP

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

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

All joints in masonry shall be raked as the work proceeds to a depth of 10 mm / 20 mm 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. Interior plain faced plaster - This plaster shall be laid in a single coat of 15mm

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 troweled 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 still faces, etc. as directed by the Engineer- in-charge. 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. Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 12 mm thick in CM 1:3 by volume. 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 8 mm thick in CM 1:1 by volume.

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 14 days.

Interior plain faced plaster 15mm thick if specified for uneven faces of brick walls or for random/coursed rubble masonry walls shall be executed in 1 coat similar to the procedure stipulated in above paragraph.

Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats. The first coat shall be approximately 12mm thick in C: M 1:3 by volume and the second coat shall be 8 mm thick in C:M 1:1 by volume. These coats shall be applied as stipulated above.

However, only approved quality sand shall be used for the first and 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.

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 Engineer-In-Charge 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 14 days.

In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the Engineer-in-charge.

Where specified in the drawings or as directed by Engineer-in-charge, 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 or as directed Engineer-in-charge.

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 14 days.

For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified

in manufacturer's instruction while preparing the cement mortar.

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.

Double scaffolding to be used shall be as specified in clause 2.9.2.2.

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.

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

1. Plastering work shall be deferred as much as possible so that fairly complete drying shrinkage in concrete and masonry works takes place.
2. Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement – applicable for interior plastering.
3. Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

2.9.30.3 WATER PROOF CEMENT PLASTER

20 mm thick cement plaster in C. M. 1:3 by volume is to be applied on inside face & bottom of water retaining structure. The detail specification of cement plaster as shall be followed and in addition water proofing admixture is to be added. Water proofing admixture shall conform to the requirements of IS: 2645 & shall be of approved manufacture. The admixture shall not contain calcium chloride. The quality of admixture to be used for the work and method of mixing etc. shall be as per manufacturer's instructions & as directed by the Engineer-in-charge.

2.9.31 CEMENT POINTING

2.9.31.1 MATERIALS

The cement mortar for pointing shall be in the proportion of 1:3 by weight. 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 as per IS and as approved by Engineer-In-Charge and if directed by the Engineer-In-Charge it shall be washed / screened to meet specification requirements.

2.9.31.2 WORKMANSHIP

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

green.

Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The 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.

The work shall be kept moist for at-least 14 days after the pointing is completed. Whenever colored pointing has to be done, the coloring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the Engineer-in-charge.

2.9.32 WATER-PROOFING ADMIXTURES

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

2.9.33 PAINTING OF CONCRETE, MASONRY & PLASTERED SURFACES

2.9.33.1 MATERIALS

Oil bound distemper shall conform to IS: 428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

Cement paint shall conform to IS: 5410. The primer shall be a thinned coat of cement paint.

Lead free acid, alkali and chlorine resisting paint shall conform to IS: 9862.

Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the Engineer-in-charge.

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

2.9.33.2 WORKMANSHIP

Contractor shall obtain the approval of the Engineer-In-Charge regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting. Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub- strata. 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.

Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

2.9.33.3 WHITE WASH

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 3 coats shall be applied unless otherwise specified. The dry surface shall present a uniform finish without any brush marks.

2.9.33.4 COLOUR WASH

Colour wash shall be applied in the same way as for white wash. A minimum of 3 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.

2.9.33.5 CEMENT PAINT

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.

2.9.33.6 OIL BOUND DISTEMPER

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.

2.9.33.7 ACID, ALKALI RESISTING PAINT

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.

2.9.33.8 PLASTIC EMULSION PAINT

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.

2.9.33.9 ACRYLIC EMULSION PAINT

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.

2.9.34 PAINTING & POLISHING OF WOOD WORK

2.9.34.1 MATERIALS

Wood primer shall conform to IS: 3536. Filler shall conform to IS: 110.

Varnish shall conform to IS: 337. French polish shall conform to IS: 348.

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 Engineer-In-Charge for the brand of manufacture and the colour / shade. All materials shall be brought to the site of works in sealed containers.

2.9.34.2 WORKMANSHIP

The type of finish to be provided for woodwork of painting or polishing, the number of coats, etc. shall be as specified in the respective items of work and as directed by Engineer-in-charge.

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.

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).

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/ spray. The number of primer coats shall be as specified in the item of work and as directed by Engineer-in-charge. 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 under coat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing/ spray 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 applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Engineer-in-charge. The number of coats of paint to be applied shall be as specified in the item of work and as directed by Engineer-in-charge.

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/ spray. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the Engineer-in-charge. 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.

2.9.35 PAINTING OF STEEL WORK

2.9.35.1 MATERIALS

Zinc chrome primer shall conform to IS: 2074. Synthetic enamel paint shall conform to IS: 2932. 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 Engineer-In-Charge for the brand of manufacture and the

colour/shade. All the materials shall be brought to the site in sealed containers.

2.9.35.2 WORKMANSHIP

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).

The type of paint, number of coats etc. shall be as specified in the respective items of work and as directed by Engineer-in-charge.

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.

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. It is essential to ensure that immediately after preparation of the surfaces; the first coat of zinc chrome primer shall be applied by brushing / spray 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/ spray to obtain a film free from 'holidays'.

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 under coat of synthetic enamel paint of optimum thickness shall be applied by brushing/ spray 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 under coat is completely removed. The surface shall then be allowed to dry.

The first finishing coat of paint shall be applied by brushing/ spray 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/ spray.

At least 24 hours shall elapse between the applications of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the Engineer-in-charge.

2.9.36 FLASHING

2.9.36.1 MATERIALS

Anodized Aluminium sheets shall be 1.00 mm thick with anodic film thickness of 0.025 mm. Galvanized mild steel sheets shall be 1.00 mm thick with zinc coating of 800gms/sq.m.

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.

2.9.36.2 WORKMANSHIP

The type of the flashing and method of fixing shall be as specified.

Flashing shall be of the correct shape and size as indicated in the construction Drawings and as directed by Engineer-In-Charge and they shall be properly fixed to ensure their effectiveness.

Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.

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 and as directed by Engineer-in-charge. Curing of the mortar shall be carried out for a minimum period of 4 days.

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.

2.9.37 THERMAL INSULATION FOR CEILING

Thermal insulation shall be “Thermocole” TF type or similar approved or Resin bonded fibre glass boards.

2.9.37.1 “THERMOCOLE” BOARDS

Soffit of R.C.C Slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS: 702 shall be applied uniformly over the surface at the rate of 1.5 Kg/m².

Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen.

The boards shall be further secured with screws, washers and plugs. The joints of the boards shall be sealed with bitumen.

2.9.37.2 FIBRE GLASS BOARDS

Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centers with 6mm x 65mm long wood screws. 20 gauges G.I. lacing wire shall be tied to the pegs.

‘Crown’ 200 fiberglass 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.

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. 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.

2.9.37.3 CEILING WITH FIBER INSULATING BUILDING BOARDS INSULATING BUILDING BOARDS

The insulating building boards shall be of approved quality as per IS code 3348 and, unless otherwise specified, shall have square edges. The dimension shall be subjected to the tolerances given in the Table

Sr. No	Type of Board	Nominal Thickness mm	Tolerance on Thickness mm	Length cm	Width cm	Tolerance on length and width
(i)	Fiber insulation board, ordinary or flame retardant type	09	± 0.75	365, 300	180,150	120 cm and below $\pm 3\text{mm}$ Above 120 cm $\pm 6\text{ mm}$
		12	± 0.75	270, 240	120,100	
		18	± 1.00	210,180	90, 60	
		25	± 1.25	150,120	45 and 30	
				100, 90		
				60, 45 and 30		

2.9.38 ANTI-TERMITE TREATMENT

Anti-termite treatment shall be done in the foundations, trenches, plinth filling areas, to prevent the termite in the building. Treatment shall be done below concrete or masonry layers. Material used shall be of approved quality and mixed in water to required proportion so as to give minimum 10 years guarantee.

The measurement will be given equivalent to the plinth area of the building. The certificate and pour-card shall be prepared to keep up to date record.

2.9.39 BRICK PAVING

Conventional size burnt clay bricks having compressive strength 35 kg/cm² shall be used for the brick paving work. Before laying bricks, the material shall be wetted fully for the prevention of the further moisture content. The base shall be prepared by using the 4T/m² mechanical compactor, fully compacted. The bricks shall be then laid in 100 mm thick (Vertical) dimensioning with joint sizes not exceeding 8 to 10mm apart.

The joints shall be filled in C:M (1:6) by weight and cured for 14 days.

2.9.40 G.I. PIPE RAILING

2.9.40.1 GENERAL

The specification lays down the requirement of material, labour for fixing G.I pipe railing.

2.9.40.2 MATERIALS

a. Posts

The post shall be MS angle of 65mm x 65mm x 8mm of 1.15m height. The same shall be fixed to the bottom slab firmly at 1.85m distance.

b. Railing

For railing the G.I pipes of medium duty of 25mm nominal dia. and 3 numbers of rows are to be provided. The G.I pipe shall pass through the vertical post. For circular railing the pipes shall be carefully bent along the curvature and the same shall have no kinks.

c. Painting

The railing shall be painted by means of appropriate type of paints such as synthetic enamel paint three coats for M.S and G.I materials.

2.9.40.3 FIXING

All the materials fabricated as per specified sizes etc. shall be transported to site of work by the contractor at his own risk and cost. The vertical posts shall be fixed to the bottom slab etc. firmly by means of hold fasts of adequate size or as directed by the Engineer-in-charge. The horizontal pipes shall be in parallel rows at specified distance. Painting shall be carried out after final erection is completed. The work shall be carried out to the entire satisfaction of the Engineer-in-charge.

2.9.41 WATER LEVEL INDICATOR**2.9.41.1 GENERAL**

The specification lays down the requirement of materials and labour required for water level indicator.

2.9.41.2 MATERIALS

The contractor shall provide at his own cost all the parts of the water level indicator which shall be got approved from the Engineer-in-charge.

Unless otherwise specified in the item, the water level indicator shall consist of:

150 mm wide enameled gauge plate wooden plate with Formica top to read accurately up to 0.1 M alternative division being printed in different colours. The height shall be equal to full depth of water in structure up to 3 M brass pulleys and copper wire 3 mm dia / nylon string of equate strength if permitted by Engineering- in-charge.

Indicator arrow painted in shining colour with guide.

Copper / GI float of 0.4 m dia.

Counter weight for smooth moving of the indicator arrow.

2.9.41.3 ERECTION & TESTING

The above equipment shall be erected and fixed as per standard practice or as directed by the Engineer-in-charge. The gauge plate shall be of full scale type up to 3 M water depth and fixed so that the man of normal vision can read the same from G.L. The height of gauge plate may be reduced proportionately if the height of water depth is more than 3 M with the permission of the Engineer-in-charge, in which case the water level indicator would be of ratio type instead of full-

scale type.

After the erection is completed, the same should be tested for accuracy and trouble-free working in the presence of the Engineer-in-charge.

2.9.42 PROVIDING AND FIXING M.S. LADDER

Sturdy MS ladders, 450 mm wide, using angle iron 65mm x 65mm x 8mm size and 20 mm MS bars at 25 cm c/c with necessary supports of same angle iron as directed including hand railing on both sides with 25mm dia GI pipes with angle iron props at 2 m intervals and 0.50 m height with two coats of non-poisonous anticorrosive bituminous paint. It shall include the cost of all material, skilled and unskilled labour, fabrication, transportation, painting etc.

2.9.43 EXHAUST FAN

Adequate numbers of exhaust fan of max 450mm sweep with louvers in the pump house, toilets as approved by the Engineer shall be provided.

- a. Impeller shall be with blades of an aero foil design. Blades shall be mounted on stream lined hub. Impeller shall be mounted directly on the motor shaft.
- b. Casing shall be of heavy gauge construction properly reinforced for rigidity. It shall be provided with suitable supports.
- c. In case of cane axial fans, guide vanes shall be provided on the discharge side.
- d. Materials of construction
 - (a) Casing: Mild Steel
 - (b) Impeller: Mild Steel / Cast Aluminium
 - (c) Inlet / Outlet: Mild Steel
- e. Exhaust fan shall be provided with louver shutter made of MS sheet / Aluminium, which opens, by fan draft and close by gravity when the fan is switched off. The make of exhaust fan shall be of good quality and as approved by the Engineer-in- in charge.

2.9.44 MS CHEQUERED PLATE

M.S. Chequered Plate shall confirm to IS: 3502:1994

2.9.44.1 MATERIAL

General requirements relating to the supply of chequered plates shall conform to IS 8910:1978. Steel for the chequered plates shall conform to the requirements of Grade A of IS 2062:1992 or 1977:1975.

2.9.44.2 WORKMANSHIP

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 consultant / owner. 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 and as directed by Engineer-in-charge
- d. Smoothing of edges
- e. Fixing of chequered plates by tack welding or by countersunk bolts
- f. Providing lifting hooks for ease of lifting.

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

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

Test certificates shall be furnished by the Contractor.

2.9.45 PVC RAIN WATER PIPE

The item of PVC rain water pipe (min. 6 kg/cm²) includes providing and fixing of standard-length marked rigid un-plasticized PVC pipes with require Specials & approved quality solvent cement, couplers confirming to IS 4985, including freight loading unloading etc. complete. The PVC pipes shall be fixed as directed.

PVC pipes shall be fixed on wall with wooden plugs and suitable clamps. The PVC pipe of 110 mm diameter shall be used.

2.10 VALVE CHAMBERS

The contractor has to construct Valve Chambers for all types of Valves of minimum dimensions as per drawings. However, 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 from reinforced concrete grade as shown in the drawing. Chambers shall have opening & locking arrangements. The bidder has to provide C.I. steps for access to the chambers. In addition to valve chamber, contractor has to construct flow meter and overflow chamber of suitable size. The top slab of valve chamber shall be minimum 30 cm above nearby G.L. or 30 cm above nearby pond/ drain F.R.L.

2.11 CUTTING OF ASPHALT ROAD

Cutting of asphalt surface of any thickness including demolishing carpet, soling, metaling etc. complete including carting away the debris from site. Before starting the work, the contractor

shall provide proper traffic diversion arrangement and place the board “Diversion”, “Road Closed”, “Work in Progress”, also provide red lighting arrangement during night time. The place shall be cordon by rope & vertical post. The road shall be cut to required width and depth through asphalt, metal, rubble and earthen embankment to form a trench for the crossing of the road by main pipeline as directed by Engineer-In-Charge.

The item includes following:

- a. Cutting the road for forming a trench as mentioned above.
- b. Storing excavated material properly so as not to disturb the passing traffic.
- c. Refilling of trench and consolidation of refilled material.

2.12 DISMANTLING APPROACHES AND OTHER STRUCTURES

The structures shall be dismantled carefully and the resulting materials so removed as not to cause any damage to the serviceable materials to be salvaged, the part of the structure to be retained and any other properties or structures nearby. In removing pavements, kerbs, gutters and other structures like guard-rails, fences, manholes, catch-basins, inlets, etc. where portions of the existing construction are to be left in the finished work, the same shall be removed to an existing joint or cut and chipped to a true line with a face perpendicular to the surface of the existing structure. Sufficient removal shall be made to provide for proper grades and connections with the new work as directed by the Engineer-in-charge.

All materials obtained by dismantling shall be the property of Employer. Unless otherwise specified, materials having any salvage value shall be placed in neat stacks of like materials within the right-of-way, as directed by the Engineer-In-Charge with all lifts and up to a lead of 1000 m.

2.13 REINSTATEMENT OF ASPHALT ROAD / PAVEMENT

Reinstatement of asphalt road/ pavement shall be done in three layers, 300 mm thick Granular sub- base, 230mm WBM and 150mm thick cement concrete at top in M-30 grade as described in clause 2.3.6 of this document including all labour and material.

Whenever necessary at crossing of main road and approach, reinstatement of road shall be done immediately after laying the pipe.

All material, labour, machinery and equipment shall be brought by contractor at his own cost.

2.14 BARBED WIRE FENCING

Providing and fixing 0.60 m. high fencing with 1.00m. long MS angle post of Y shape of 50 mm x 50 mm x 6 mm and oil painting three coats fixed at 2.5 m. c/c with three horizontal rows of galvanized steel round barbed wire weighing 9.38 kg. / 100 Rmt. Stretched and fixed to posts with GI staples including fixing the posts in concrete.

2.14.1 MATERIAL

Seven strands twisted galvanized iron fencing wire no. 4 shall be used. It shall be of usual commercial type barbed wire shall conform to IS 278 – 1951 or its latest revision.

Mild steel angle iron of 50mm x 50mm x 6mm shall conform to relevant IS. The length shall be as specified in the item. Galvanized iron straining bolts 30 cm long & 16mm dia shall be of the standard commercial type.

2.14.2 ERECTING

The posts shall be of size mentioned in the item & shall be fixed to 2.5m c/c. The posts shall be embedded in the RCC columns & shall be held in correct position. The flange of the tee or one side of the angle shall face outside. Holes shall be drilled into the web of the tee or in the leg of the angle at right angles to the outside leg for passing the wire through or tying wire with staples of U shape or closed staples. The posts at every 30m & at corner or at angles shall suitably be strutted on either side of the posts. These struts shall be of angle iron & shall have foundation of 1:2:4 cement concrete like vertical post.

This strut shall be fixed at 45° & be fixed at the top most wire.

After the posts have set, the fencing wire shall be fixed through holes made in the post & strained with straining bolts. Alternatively, a galvanized iron staples shall be used for fixing barbed wire. The no. of rows shall be as specified in the item. The steel posts shall be painted with a priming coat of red lead & two coats of good oil paint of approved shade. Red lead paint primer shall conform to IS-102-1962.

2.15 RCC PIPES

2.15.1 SCOPE

This specification covers the requirements for manufacturing, testing, supplying, jointing and testing at work sites of Reinforced Cement Concrete RCC NP-2, NP-3, NP-4 pipes, of both pressure and non-pressure varieties used for casing pipes.

2.15.2 APPLICABLE CODES

The manufacturing, testing, supplying, jointing and testing at work sites of RCC pipes shall comply with all currently applicable standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

2.15.2.1 MATERIALS

CODE DESCRIPTION

IS: 458-1988	Specification for pre-cast concrete pipes (with and without reinforcement)
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IS: 3597 – 1966	Methods of test for concrete pipes.
IS: 5382	Specification for rubber sealing rings for gas mains, water mains and sewers
IS: 516	Method of test for strength of concrete

2.15.2.2 CODE OF PRACTICE

Code Description

IS: 456	Code of practice for plain and reinforced concrete.
IS: 783	Code of practice for laying of concrete pipes

2.15.3 DESIGN

Design of RCC pipes including reinforcement details and the ends of pipes shall be in accordance with the relevant clauses of IS: 458.

2.15.4 MANUFACTURING

2.15.4.1 GENERAL

- a. The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant clause of IS: 458. The surface and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.
- b. The RCC pipes and collars shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality.
- c. The Engineer-In-Charge shall at all reasonable times have free access to the place where the pipes and collars are manufactured for the purpose of examining and testing the pipes and collars and of witnessing the test and manufacturing.
- d. All tests specified either in this specification or in the relevant Indian Standards shall be performed by the supplier / contractor at his own cost and in presence of the Engineer- In-Charge if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer-in-charge.
- e. If the test is found unsatisfactory, the Engineer-In-Charge may reject any or all pipes of that lot. The decision of the Engineer-In-Charge in this matter shall be final and binding on contractor and not subject to any arbitration or appeal.

2.15.4.2 MATERIALS

- a. Cement

Cement used for the manufacture of RCC pipes and collars shall be ordinary Portland cement 53 grades conform to relevant IS: 12269.

b. Aggregates

Aggregates used for the manufacture of RCC pipes and collars shall conform to IS: 383. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20 mm, whichever is smaller.

c. Mixing and curing water

Water shall be clean, colorless and free from objectionable quantities of organic matter, alkali, acid, salts or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar.

d. Reinforcement

Reinforcement used for the manufacture of the RCC pipes and collars shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part-1) or hard drawn steel wire conforming to IS: 432 (Part-2). A reinforcement cage for pipes and collars shall be as per relevant requirements of IS: 458.

e. Concrete

Concrete used for the manufacture of RCC pipes and collars shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS: 458. Compressive strength tests shall be conducted on 15cm X 15cm X 15cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

2.15.4.3 CURING

Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured for the minimum stipulated curing period in accordance with the relevant requirements of the latest revised IS: 458 for different classes of pipes.

2.15.4.4 DIMENSIONS

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement and strength test requirements shall be as per the relevant clauses / tables of IS:458 for different classes of pipes. The tolerances regarding overall length, internal diameter of pipes of sockets and barrel wall thickness shall be as per relevant clause of IS: 458.

2.15.4.5 WORKMANSHIP AND FINISH

- a. Pipes shall be straight and free from cracks except that craze cracks may be permitted. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.
- b. The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between The Engineer-In-Charge and the manufacturer or supplier.

- c. The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or molding.
- d. The pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.
- e. The deviation from straight in any pipe throughout its effective length, tested by means of a rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters 3 mm for every meter run.

2.15.4.6 TESTING

- a. All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.
- b. During manufacture, tests on concrete shall be carried out as per IS: 456-1988. The manufacture shall supply, when required to do so by The Engineer-In-Charge the results of compressive tests of concrete cubes. The manufacture shall supply cubes for test purposes required by the Engineer-In-Charge and such cubes shall withstand the test prescribed as per IS: 458-1988. Every pressure pipe shall be tested by the manufacture for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.
- c. The specimen of pipes for the following tests shall be selected in accordance with relevant Clause of IS: 458 and tests in accordance with the methods described in IS: 3597.

Hydrostatic test

Three edge bearing test

Absorption test

Note: Three edge bearing strength to produce 0.25 mm crack and ultimate load in case of special design of pipes shall be as per IS:3597 — 1966.

2.15.4.7 SAMPLING AND INSPECTION

- a. In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of these specifications shall be ascertained on the basis of tests on pipes selected from it.
- b. The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 of IS: 458.
- c. Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every pipe be selected till the requisite number is obtained, being the integral part of N/n where N is the lot size and n is the sample size.
- d. All pipes selected shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

- e. The number of pipes to be tested for tests shall be in accordance with column 4 of Table 15 of IS: 458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.
- f. A lot shall be considered as conforming to the requirements of IS: 458 if the following conditions are satisfied. The number of defective pipes shall not be more than the permissible number gives in column 3 of Table 15 of IS: 458.

All the pipes tested for various tests shall satisfy corresponding requirements of the tests.

In case the number of pipes not satisfaction requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

2.15.5 MARKING

The following information shall be clearly marked on each pipe;

- a. Internal diameter of pipe
- b. Class of pipe.
- c. Date of manufacture, and
- d. Name of manufacturer or his registered trade-mark or both.

2.15.6 LAYING OF PIPES

The laying of RCC pipes shall be carried out in accordance with provision of IS: 783 with necessary bedding.

2.15.7 JOINTING

2.15.7.1 GENERAL

Jointing of RCC pipes new & old shall be done as per the requirements of following specifications and as per the relevant IS. The type of joints shall be collar joint (Rigid). After jointing, extraneous material, if any, shall be removed from the inside of the pipe and the newly made joints shall be thoroughly cured.

2.15.7.2 COLLAR JOINT (RIGID) FOR LAYING OF RCC PIPE IN OPEN EXCAVATION

After laying the RCC pipes at proper alignment and gradient their abutting faces shall be coated with hot bitumen in liquid condition by means of a brush. The wedge-shaped groove in the end of the pipe shall then be filled with a tarred gasket in one length for each joint. The collar shall then be slipped over the end of the pipe and the next pipe butted well against the tarred gasket by suitable appliances approved by the Engineer- In-charge so as to thoroughly compress the tarred gasket into the grooves, care being taken that the concentricity of the pipes and levels are not disturbed during this operation. The collar shall then be placed symmetrically over the end of the two pipes and the space between the inside of the collar and the outside of the pipe filled with a mixture of cement and sand in the proportion 1:1, tempered with just sufficient water to

have a consistency of the semi-thy conditions, well packed and thoroughly rammed with caulking tools. The joints shall be finished off with a fillet sloping at 45°C to the side of the pipe. The finished joints shall be protected and cured thoroughly as directed by The Engineer-in-charge. Any plastic solution or cement mortar that may have been squeezed into the inside of the pipe shall be removed so as to leave the inside of the pipe perfectly clean.

During pushing of RCC pipes shall be jointed with MS collar 300mm wide and 8mm thick with connection arrangement by bolting with concrete pipes.

RCC pipes which are to be pushed shall be coated with two coats of epoxy material on all outsides of pipe and intermediate shields.

2.15.7.3 COLLAR JOINT (SEMI-FLEXIBLE)

This joint is made up of a loose collar which covers two specially shaped pipe ends. Each end shall be fitted with steel plate collar with connection arrangement by bolting with concrete pipes during pushing of pipe. Stiff mixture of cement mortar shall then be filled into the remaining annular space and rammed with a caulking tool.

2.15.7.4 CLEANING OF PIPES

- a. As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by the Engineer-in-charge, contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer-In-Charge to prevent entry of mud or silt etc.
- b. If as a result of the removal of any obstructions the Engineer-In-Charge considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer-in-charge.
- c. It shall also be ascertained by contractor that each stretch from manhole to manhole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

2.15.8 TESTING AT WORK SITE

- a. After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per the following specifications and as directed by the Engineer-in charge. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to the still satisfaction of the Engineer-in- charge. Water used for test shall be removed from pipes and not released to the excavated trenches.

- b. After the joints have thoroughly set and have been checked by the Engineer-in- Charge and before backfilling the trenches, the entire section of the sewer or storm water drain shall be proved by contractor to be water tight by filling in pipes with water to the level of 7.0 m (as per IS 458 1988 Cl. No. 10.3.2) & above the top of the highest pipe in the stretch and heading the water up for the period of one hour. The apparatus used for the purpose of testing shall be approved by the Engineer-in charge. Contractor if required by the Engineer-In-Charge shall dewater the excavated pit and keep it during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity added should not exceed 1 litre / hour / 100 linear m / 10 mm of nominal internal diameter. 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.
- c. In case of pressure pipeline the completed stretch of pipeline shall be tested for site test pressure. The site test pressure should not be less than the maximum operating pressure, plus the calculated surge pressure, but in no case should it exceed the hydro static test pressure as specified in IS: 458.

2.16 DRY RUBBLE STONE PUCCA PITCHING

This specification shall cover the requirement for providing and laying dry rubble stone pucca pitching including hand packing and trimming & dressing slopes etc. complete. The area shall be prepared by shaping and trimming to accommodate the stone work and shall be thoroughly compacted by hand-ramming to minimize subsequent settlement. Rubble shall be of selected quality and shall be got approved by the Engineer-In-Charge before use. The stone used shall be perfectly sound and regular in shape as possible and with lengths equal to the thickness of the required pitching. The stone shall be as far as practicable, selected as to the size and shape to secure fairly large flat surface stones, which will lay with an even surface and minimum of voids. The stone shall be placed on edges with broadest base down and face normal to the slope and in the same manner on the horizontal surface. Beginning at the bottom of the slope's stones shall be laid compactly with broken joints and so matched and interlocked that they shall be keyed together with minimum of joint space. Rock fragments and spalls shall be lightly driven into the interstices to wedge the pitching in place and close direct openings to underlying slope. The thickness of pitching shall be minimum 300mm. The finished surface of the pitching shall present an even, tight and neat appearance with no stones varying by more than 25 mm from specified surface grades or lines.

The joints of the pitching thus laid shall be flush pointed with CM 1:2 by volume and keep constantly wet for 14 days. Before the mortar is applied, the surfaces of the stones shall be thoroughly cleaned of adhering dirt and clay then moistened. The mortar shall be placed in a continuous operation for any day's run at any one location. The mortar shall be worked into the pitching so as to ensure that all spaces or voids between the stones are completely filled with mortar, and to the depth of stone pitching. Testing shall be done as directed by Engineer In charge.

2.17 VITRIFIED TILE FLOORING, DADO/ SKIRTING / FACIA

2.17.1 MATERIALS

The tiles shall be of approved make like Marbonite / Granamite or equivalent and shall generally conform to the approved standards. They shall be flat and true to shape, free from cracks, crazing spots, chipped edges and corners. Unless otherwise specified, the nominal sizes of tiles shall be as under:

The tiles shall be square or rectangular of nominal sizes such as: 600 x 600 mm; 900 x 900 mm or as directed by the Engineer-in-Charge. Thickness shall be as per recommendations of the approved manufacturers.

Technical specifications of the tiles shall be generally conforming to the following standards:

Table - Technical Specification for Vitrified Tiles		
Sr. No.	Property	Expected Standards
1	Deviations in length	(+/-) 0.6%
2	Straightness of sides	(+/-) 0.5%
3	Rectangularity	(+/-) 0.6%
4	Surface flatness	(+/-) 0.5%
5	Water absorption	<0.50%
6	Mohs. Hardness	> 6
7	Flexural strength	> 27N / mm ²
8	Abrasion resistance	< 204 mm ²
9	Skid resistance (friction coefficient)	> 0.4
10	Glossiness	Min 85% reflection

The tiles shall conform to the relevant standards in all respects. Samples of tiles shall be got approved from the Engineer-In-Charge before bulk procurement for incorporation in the work.

2.17.2 PREPARATION OF SURFACE FOR FLOORING

Sub grade concrete or RCC slab or side brick wall / or plastered surfaces on which tiles are to be laid shall be cleaned, wetted and mopped.

Cement mortar for bedding shall be prepared of mix 1:4 by volume. The amount of water added while preparing mortar shall be the minimum necessary to give sufficient plasticity for laying. Care shall be taken in preparation of the mortar to ensure that there are no hard lumps that would

interfere with even bedding of the tiles. Before spreading the mortar bed, the base shall be cleaned off all dirt, scum or laitance and loose materials and well wetted without forming any pools of water on the surface. The mortar of specified proportion and thickness shall then be evenly and smoothly spread over the base by use of screed battens to proper level or slope.

Once the mix is prepared, no further water be added and the same shall be used within one hour of adding water. Apply on an average 20 mm thick bedding of mortar over an area of 1 Sq.m at a time over surface of the area for laying tiles, in proper level and allowed to harden sufficiently to offer a fairly good cushion for the tiles to set.

2.17.3 LAYING OF TILES FOR FLOORING

The tiling work shall be done as per the pattern as directed by the Engineer-in-Charge.

As a general practice laying of tiles shall be commenced from the centre of the area and advanced towards the walls. Cut tiles, if any, shall be laid along wall with necessary border pattern as directed by the Engineer-in-Charge. Tiling work shall be completed by pressing tiles firmly into place along the wall / floor. White cement slurry to the back of the tile to be applied to ensure proper and full bedding. The tiles shall be laid on the bedding mortar when it is still plastic but has become sufficiently stiff to offer a fairly firm cushion for the tiles. Tiles, which are fixed on the flooring adjoining the wall, shall be so arranged that the surface on the ground edge tiles shall correspond to the skirting or dado. Press gently the tile with wooden mallet for even adherence at the back of the tile.

Do not use an iron hammer or some heavy material to press the tile.

The edges of the tiles shall be smeared with neat white cement slurry and fixed in this ground one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. There shall be no hollows in bed or joints. The joints shall be kept as close as possible and in straight line. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with white / matching colour cement slurry. After fixing the tiles, finally in an even plane or slope, the flooring shall be covered with wet sand and allowed undisturbed for 14 days.

2.17.4 FIXING TILES FOR DADO & SKIRTING / FACIA

The fixing of tiles on wall surfaces shall be done only after completing fixing of the tiles on the floor. Following procedure shall be followed:

The back of tiles shall be cleaned off and covered with layer of approved adhesive with proper toweling as per manufacturer's recommendations.

The edge of the tiles shall be smeared with the adhesive and fixed on the wall one after the other, each tile being well pressed and gently tapped with a wooden mallet till it is properly fixed in level with the adjoining tiles. There shall be no hollows on the back or in joints. Unless otherwise specified, joint-less tiling shall be done butting the tiles with each other. If joint is specified, the same shall not exceed 1.00 mm. in width. The joint shall be grouted with approved adhesive.

The joints shall be kept in straight line or as per the approved pattern.

While fixing tiles in dado / skirting work, care shall be taken to break the joints vertically. The top line shall be touched up neatly with the rest of the plaster above. If doors, windows or other openings are located within the dado area, the corners, sills, jambs etc. shall be provided with true right angles without any specials. The contractor will not be entitled to any extra claims on this account for cutting of tiles if required.

The fixing shall be done from bottom of wall to upward without any hollows in the bed of joints. Each tile shall be as close as possible to one adjoining. All tiles' faces shall be in one vertical plane.

2.17.5 GROUTING OF JOINTS IN FLOOR / SKIRTING / DADO

The joints, if specified, shall be cleaned of and all dust and loose particles removed.

Joints shall then be filled with approved adhesive. After finishing the grouting process, after 15 minutes, wipe off excess grout with a damp sponge and polish the tiles with a soft & dry cloth for a clean surface. The Finished work shall not sound hollow when tapped with a wooden mallet.

2.17.6 CLEANING

As directed by the Engineer-in-Charge, the tiles shall be cleaned by mild acid (However, Hydrofluoric acid and its derivatives should not be used). After the tiles have been laid in a room or the days fixing work is completed, the surplus cement grout / adhesive that may have come out of the joints shall be cleaned off before it sets. The dado / skirting shall be thoroughly cleaned. In the case of flooring, once the floor has set, the floor shall be carefully washed clean and dried. When drying, the floor shall be covered with oil free dry sawdust. It shall be removed only after completion of the construction work and just before the floor is used.

This specification covers the general requirements for Design, 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.

2.17.7 TRASH RACK

Trash rack shall be provided in sump / reservoir to prevent entry of debris / floating particles.

For trash rack, vertical channels of ISMC 100 x 50 x 6 mm shall be erected in groove provided in RCC columns, which shall be fixed with MS embedded plates fixed in RCC columns at suitable distance. Trash rack of suitable height maximum 2 m. height shall be prepared and installed in pieces. The frame of trash track shall be prepared from ISMC 75 x 40 x 6 mm in which crimp wire jali of size 75 x 25 x 5 mm. weighing minimum 7.75 Kg. /M2 shall be fixed. The additional support of MS flat 25 x 6 mm. shall be provided and fixed as directed. The required MS lugs shall be provided on trash rack pieces for handling.

The required I section of ISMB 300 x 125 mm shall be fixed at appropriate height for installing / removing trash rack from its position for maintenance. The E.O.T. hoist of 2 MT shall also be

provided for the trash rack maintenance.

All MS sections and wire mesh Jali shall be epoxy painted in two coats to prevent corrosion.

The trash rack arrangement is to be provided to suit site requirement as per the drawing and as directed by E.I.C.

2.18 CERAMIC TILE FLOORING, DADO/ SKIRTING / FACIA

2.18.1 PRESSED CERAMIC TILE FLOORING

The tiles shall be of approved make and shall generally conform to IS 15622. They shall be flat, and true to shape and free from blisters crazing, chips, welts, crawling or other imperfections detracting from their appearance. The tiles shall be tested as per IS 13630.

Classification and Characteristics of pressed ceramic tiles shall be as per IS 13712.

The tiles shall be square or rectangular of nominal size. Table 1,3,5, and 7 of IS 15622 give the modular preferred sizes and table 2,4,6 and 8 give the most common nonmodular sizes. Thickness shall be specified by the manufacturer. It includes the profiles on the visible face and on the rear side. Manufacturer/supplier and party shall choose the work size of tiles in order to allow a nominal joint width up to 2mm for unrectified floor tiles and up to 1mm for rectified floor tiles. The joint in case of spacer lug tile shall be as per spacer. The tiles shall conform to table 10 of IS 15622 with water absorption 3 to 6% (Group BII).

The top surface of the tiles shall be glazed. Glaze shall be either glossy or matt as specified. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be preferably free from glaze. However, any glaze if unavoidable, shall be permissible on only up to 50 per cent of the surface area of the edges.

2.18.2 PRESSED CERAMIC TILES IN SKIRTING AND DADO (FULL HEIGHT)

The tiles shall be of approved make and shall generally conform to IS 15622. The tiles shall be pressed ceramic covered by a glaze thoroughly matured and fitted to the body. The tiles shall be sound, true to shape, flat and free from flaws and other manufacturing defects affecting their utility.

The top surface of the tiles shall be glazed. The underside of the tiles shall not have glaze on more than 5% of the area in order that the tile may adhere properly to the base. The edges of the tiles shall be free from glaze, however, any glaze if unavoidable shall be permissible on only up to 50 per cent of the surface area of edges.

The glaze shall be free from welts, chips, craze, specks, crawling or other imperfections detracting from the appearance when viewed from a distance of 1m. The glaze shall be either glossy or matt as specified. The glaze shall be white in colour except in the case of colored tiles when colours shall be specified by the Engineer-in-Charge. There may be more than one colour on a tile.

3. TECHNICAL SPECIFICATION FOR M.S. PIPES

MS PIPE: Manufacture, supply & delivery of submerged arc spiral welded MS Pipe with inside lining food grade solvent free epoxy of 406 micron thickness & outside 3 LPE Coating having beveled ends plate or coil confirming to IS-3589- 2001 or its latest revision/ amendment for following thickness & outside diameter at Departmental store/ site including Providing and Laying/ Fixing the specials anywhere in the Project area including all taxes, insurance, transportation, freight charges, Octroi, inspection charges, loading, unloading, conveyance to Department store/ sites, stacking etc. complete as instructed by EIC, including Excavation for pipe trench incl. all safety provisions using site rails and stacking excavated stuff up to a lead directed by EIC, Cleaning the site etc. complete for all lifts and all strata, Lowering & laying in position to correct line & level M.S. Pipe as above on pedestal or chairs upon prepared formation or completely dry or completely saturated sand bedding of 100 mm thickness in trenches, the rates include conveyance from store to site of work loading, unloading, jointing, hydrotesting etc. complete & Refilling the Pipeline trenches incl. ramming, watering, consolidating disposal of surplus stuff as directed within Project area as per approved design and drawing by EIC or his Authorized Representative. (Rate for MS Pipe based on the ex. works price of HR Coil as Rs.58500 per MT - without GST (Above 3.15 mm to 10 mm) & Rs. 59000.00 per MT without GST (Above 10 mm) as on Jan-23. (WPI Index of H. R Coil of Dec-22 is 144)).

Note: - The required size and quantity of above item is as per price bid.

- This item includes;
- 1. Excavation & refilling the pipe line trenches incl. disposal of surplus stuff as directed within a radius of 3.0 km.
- 2. Procurement, Supply, Transportation, Lowering, Laying & Jointing MS pipes of confirming to IS-3589-2001 or its latest revision/ amendment including hydraulic testing, trial run etc. complete.
- 3. Procurement & Installation of Specials suitable to MS pipes such as Bend, Tee, Reducer, Flange Tail Piece, Saddle Piece etc. as per requirement.
- 4. ROU / ROW to lay pipe line and constructing chamber in width of 30.0 m along alignment including payment of standing crop compensation.

This specification covers the general requirements for Design, 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. For MS pipe where the pipe to be supply is less than 150 m then the Material Test Certificate shall be sufficient and the pipe shall be brought from the approved vendor but if the Engineer-in-charge wishes to inspect the testing as narrated below shall be allowed at cost to the Agency. Further the hydro Test shall be performed for all pipes to be utilized.

3.1 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.

Sr. No.	Code	Description
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 Pipes.

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

3.2 MANUFACTURING, SUPPLYING, DELIVERY, LOWERING, LAYING, JOINTING OF MS PIPELINE

3.2.1 Scope of Work

Design, Manufacture, supply and delivery of submerged Arc welded M.S Pipe having beveled 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, 300 mm thick sand bedding, refilling around the MS pipeline shall be done as stated in clause no. 3.16 which do not damage the external 3LPE coating 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, inspection charges, transportation, etc. complete including all labour, materials and ROU/ROW as per specification and to the satisfaction of Engineer-in-charge.

ROU/ROW: The bidder/ Contractor shall refer the Contract Conditions-Vol II, Clause No. 2.15 The contractor shall be responsible for the hydraulic and structural design of pipe for the required flow and head (including surge). However minimum pipe diameter and thickness shall be as specified in tender document.

Detail survey, long section of pipe line, Hydraulic & structural design of pipe line shall get approved from Engineer In-charge by the contractor before commencing of the work.

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.

3.2.2 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.

3.2.3 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.

Name of project- Dobhada LI Project

1. Manufacturer's brand name and / or trade mark.
2. Purchaser's mark as "NWRWS & K" be stenciled
3. Diameter, Length and wall thickness.
4. Heat No., 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 2540mm shall be provided with ISI certification mark on each pipe.

3.2.4 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 / equipment 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.

3.2.5 Workmanship

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

3.2.6 Test Certificate

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

3.3 MATERIALS

3.3.1 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.

3.3.2 Welding Consumable

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

3.4 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 and coils 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
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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 low 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 manufacturing 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.

3.4.1 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.

3.4.2 Acceptance of pipes & 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 its transportation or any other cost.

3.4.3 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.

3.4.4 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)/GIRDA
2. State/ Central Govt. laboratory/ Government Engineering College.
3. State/Central Government/ BIS approved laboratory.

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.

3.4.5 Wall Thickness

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

3.4.6 Pipe Ends

The pipe shall have beveled 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 ± 0.8 mm. The root face of the bevel may be prepared by hand finishing if required.

3.4.7 Length of Pipes

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

3.4.8 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.

3.4.9 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.

3.4.10 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.

3.4.11 Condition of Supply

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

3.4.12 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.

3.4.13 Inspection

All materials will be subjected to inspection by the Engineer In-charge, his authorized representative. The inspection charges shall be borne by the Government / Department. 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.

3.5 FABRICATION OF MS PIPE

3.5.1 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.

3.5.2 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. The agency will furnish following details with respect to the pipe manufacturing vendor.

1. List of orders successfully executed for similar size of MS pipe lines as per tender size.
2. Destructive and non-destructive testing facility at their works and availability of testing facilities.
3. Approvals of testing laboratory by competent authorities including governments.
4. Daily and yearly production capacity of similar sizes of pipelines.
5. Capacity for the production of the stock in hand within given time frame of the project quantity.
6. List of testing to be done outside of factory laboratory.
7. Pipe coating and Lining facilities available at factory as per tender specifications.
8. Quality assurance and control arrangements set-up at factory.
9. Technical details, year of installation and make of the pipe mills and coating plant

After the proposal by the agency for selecting a particular pipe manufacturer to the client, the client may select a pipe vendor for manufacturing of pipes. 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 flange's 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/ radiography/ 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.

3.5.3 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.

3.5.4 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.

3.5.5 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.

3.5.6 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.

3.5.7 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 equipment, 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 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.

3.5.8 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. If any defect is found in 15% of UT weld length, then 45% of weld length shall be checked with UT. If any defect found in 45% of UT, then UT will be carried out 100%. The same shall be repaired by welding / grinding after repair. Re-UT will be carried out confirm the removal of defect. 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). The field joint visual inspection will be carried out in presence of TPIA and as per instruction of Engineer In-Charge.

The Manual ultrasonic testing (MUT) of the weld joint shall be carried out by latest method which will include following type of inspection.

Phased Array Ultrasonic testing (PAUT) inspection: -

All Welded Joints are to be Examined in accordance with

1. ASTM E-2700-09: Standard Practice for Contact Ultrasonic Testing of Weld Using Phased arrays
2. ASME SEC V- Article -4: Ultrasonic Examination Methods for Welds.

A complete Set of PAUT Records shall be retained by the contractor and keep of file for a period of five years. PAUT operator/Technician shall be qualified in accordance with PCN Level-II/SNT-TC- 1A with Prior Demonstration of PAUT testing.

PAUT equipment shall be as per ASTM - E 2700-09.

Acceptance of Weld sections are as per API 1104 - latest Addition Cl. No 9.

In case of field joints minimum 10% of weld length of each joint at random shall be subjected to Phased Array Ultrasonic testing (PAUT). In case of failure of Joints, the contractor shall be required to carry out PAUT of additional 45%. Even after such Testing if any failure found the contractor shall be required to carry out PAUT of full Joint.

Also, MUT will be carried out on fittings and specials at 10% of the total weld length. The Recordable UT equipment used to perform the examination must be capable of recording the UT data to facilitate the analysis by a third party and for the repeatability of subsequent examinations. All records must be submitted in digital and printed format for permanent record for witness by the client/TPI.)

3.5.9 Radiographic test of welded Joints

In case of field joints, minimum 10 % of weld length of each joint at random shall be subjected to radiography test.

In case of failure of joints, the contractor shall be required to carry out radiography of thrice the number of segments failing during the radiography test. Even after such radiography testing, if any one of the segments fails, the contractor shall be required to carry out radiography of full joint.

The weld ripples or weld surface irregularities, on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or Gamma ray equipment.

The photographs are to be marked in such a way that the corresponding portion of the welded seam can be readily identified. All radiographs will be reviewed by the Engineer to identify the defect and determine those which must be removed. Defects that are not acceptable shall be removed by chipping, machining or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Engineer In-charge based on the latest standards prescribed by Indian Standard specification.

All X-ray shall be made with equipment and by personnel furnished by the Contractor. Films shall be developed within 24 hours of exposure and be readily accessible at all times for inspection by the Engineer In-charge. The Contractor shall provide for the use of the Engineer In-charge suitable X-ray viewing equipment. X-ray films shall be properly maintained by the Contractor and shall be handed over to the department on completion of the Contract. All films shall be identified by the no. and chart prepared indicating location of the joint each X-ray photo represents. In the event of additional radiographic inspections required of any work associated with the pipe erection, such inspection shall be performed by the Radiographer at the discretion of the Engineer In-charge.

3.5.9.1 Radiographic Inspection

1. General

The Engineer shall assure himself that the welding procedure employed in the construction of pipes has been qualified. The Contractor shall submit evidence to the Engineer In-charge that the requirements have been met. The Contractor shall certify that the welding of pipes has been done only by qualified welders and welding operators and the Engineer In-charge shall ensure himself that only qualified welders and welding operators have been used.

The Contractor shall make available to the Engineer In-charge a certified copy of the records of the qualification tests of each welder and welding operator. The Engineer In-charge shall have the right at any time to call for and witness tests of welding procedure or of the ability of any welder and welding operator.

2. Radiographic Inspection of Welded Joints

All welded joints are to be radio graphed and shall be examined in accordance with:

Code	Description
IS: 2595-1978	Code of Practice for Radiographic Testing
IS: 4853-1982	Recommended Practice for Radiographic Inspection of Fusion Welded Butt joints in Steel Pipes.
IS: 1182-1983	Recommended Practice for Radiographic Examination of Fusion Welded Butt-Joints in steel plates. (Second revision)
IS: 2598-1966	Safety Code for Industrial Radiographic Practice.

The reinforcement on each side of all butt-welded joints shall not exceed 1.5 mm.

A complete set of radiographs and records as described in IS:2595 Clause 14, for each job shall be retained by the Contractor and kept on file for a period of at least five years.

Radiographers performing radiograph shall be qualified in accordance with SNT-TC-1A. Supplements and Appendices "Recommended Practice for Non-destructive Testing Personnel Qualification and Certification" published by the American Society for Non-destructive testing as applicable for the technique and methods used.

Final acceptance of radiographs shall be based on the ability to see the prescribed penetrometer image and the specified hole.

Sections of welds that are shown by radiography to have any of the following types of imperfections shall be judged unacceptable and shall be repaired.

- any type of crack, or zone of incomplete fusion or penetration,
- any elongated slag inclusion which has length greater than 6 mm,
- any group of slag inclusion in line that have an aggregate length greater than thickness in a length of 12 times thickness, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group
- Rounded indications in excess of that specified by the acceptance standards given earlier

3.5.10 Destructive Test

The destructive test of pipe joints on the field shall be carried out as per IS 3600. For every 2 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.

3.5.11 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 beveled as per IS-3589 and/or IS-5504.

For the shell thickness, no negative tolerances are acceptable.

3.5.12 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.

3.5.13 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.

3.6 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.

3.7 PROCEDURE FOR RECEIVING STEEL PIPES

3.7.1 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.

3.7.2 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.

3.7.3 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.

3.7.4 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.

3.7.5 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.

3.8 SPECIFICATION FOR LIQUID EPOXY COATING SYSTEMS FOR INTERIOR LINING OF STEEL WATER PIPELINES

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.

3.8.1 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.

3.8.2 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 Abrader
- 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

3.8.3 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.

3.8.4 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

3.8.5 Coating Application

3.8.5.1 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.

3.8.5.2 Pipe preparation

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 μm to 75 μm) 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.

3.8.5.3 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.

3.8.6 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.

3.8.7 Material acceptance, inspection and testing

3.8.7.1 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.

3.8.7.2 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.

3.8.7.3 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 3.1 (Clause no 3.8.4). Out of 25 Nos. of pipes, one pipe shall be tested for the thickness at two selected places.

3.8.7.4 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.

3.8.7.5 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 3.1 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.

3.8.7.6 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.

3.8.7.7 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 406μ.

3.8.8 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.

3.8.8.1 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.

3.8.8.2 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 joined 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.

3.8.9 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.
- i. 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.

3.8.10 Preservation, Marking and Shipping Preservation

3.8.10.1 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.

3.8.10.2 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.

3.8.10.3 Shipping

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

3.8.11 Documentation

3.8.11.1 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.

3.8.12 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

3.8.13 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.

The finished epoxy coating surface shall be able to deliver a guaranteed 'C' value of 145 for pipes. The arrangement for 'C' value testing is to be arranged by the contractor. On satisfactory completions of 'C' value testing, the amount retained for 'C' value testing will be released.

3.9 OUTSIDE 3LPE COATING

3.9.1 Scope

This Specification defines the minimum requirements for the application of three- layer polyethylene coating to the external surface of steel pipes.

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).

3.9.2 Codes and Standards

This latest edition of the following codes and standards shall establish the minimum standards for the work

Codes	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	Standard 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 content in olefin in define plastics
ASTM D1928	Standard practice for preparation of compression- moulded 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 Moulding Thermoplastic Materials into Test Specimen, Plaques or Sheets.
ASTM F372	Standard test method for water vapour 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 Cathodic Disbonding 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.

3.9.3 General

3 LPE coating shall have minimum coating thickness of minimum 3.7 mm on body and 3.3 mm on weld.

3.9.3.1 Environmental Conditions

The environmental conditions operating conditions, product data, etc. under which the pipes shall operate and defined in Documents. Scope of Work, Project Design Data and Site Conditions and Specification for Pipeline construction.

3.9.3.2 Abbreviations

ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
DIN	German Standards Institute
ISO	International Organization for Standardization
NACE	National Association of Corrosion Engineers

NPS	Nominal Pipe Size
MPI	Magnetic Particle Inspection
UT	Ultrasonic Testing
SIS	Swiss standard
AWWA	American Water Works Association

3.9.4 Handling of Coating Materials

3.9.4.1 General

Materials shall be handled and stored in accordance with the material manufacturer's recommendations, which shall be available for review by the Engineer In-charge at the 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 In-charge.

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

- a. Name of manufacturer
- b. Complete material identification – trade name, chemical name and
- c. type of product details
- d. Batch number
- e. Date of manufacture
- f. Place of manufacture
- g. Shelf life/expiry date (if appropriate)
- h. Health and safety, and environmental instructions
- i. Hazard Warnings
- j. Storage instructions
- k. Quantity
- l. Manufacturing Standard

Any material not labelled with the above information shall not be used.

3.9.4.2 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 2.5 & ISO 8502-3.

3.9.4.3 Fusion Bonded Epoxy (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 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;

- a. Gel Time
- b. Moisture content
- c. Particle size distribution
- d. Density
- e. Infrared Scan
- f. Thermal analysis

3.9.4.4 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:

- a. Adhesion
- b. Density
- c. Melt flow index

3.9.4.5 Polyethylene

The polyethylene selected shall be 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 by incorporation of minimum 2% well dispersed Carbon black of particle size 10-25 nm.

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

3.9.4.6 Properties of Epoxy Powder and Adhesive

- i. The Contractor shall choose such a brand of epoxy powder and adhesive that will achieve the functional requirement and properties of coating system as specified in this specification. In

addition, the coating material manufacturer shall also furnish Infra-red Scan for each batch of epoxy powder. The coating materials manufacturer shall issue test certificates as per EN 10204, 3.1 for each batch of materials supplied to the contractor and the same shall be submitted to the department for approval prior to their use. Epoxy powder properties shall be as per CSA Z245.20.98 (latest version). The colour of epoxy powder shall be either green or dark red or any other colour approved by the department except grey colour. Copolymer grafted adhesive shall have the following properties.

Sr. No.	Properties	Unit	Requirement	Test Method
A	Melt Flow Rate (190°C/2.16 kg)	g/10 minutes	1.0 min	ASTM D 1238
B	Vicat Softening Point	°C	100 min	ASTM D 1525
C	Specific Gravity	-	0.926 min	ASTM D 792

ii. Properties of Polyethylene Compound

Sr. No.	Properties	Unit	Requirement	Test Method
a	Tensile Strength @ + 25 °C	N/mm ²	17 min	ASTM D638
b	Melt Flow Rate (190°C / 2.16 kg)	g/10 minutes	0.25	ASTM D 1238 or DIN 53735
c	Specific Gravity + 25°C	-	0.926 min. (MDPE) 0.941 min. (HDPE)	ASTM D 792
d	Hardness @ + 25°C	Shore D	50 min.	ASTM D 2240
e	Water Absorptions, 24 hours @ + 25°C	%	0.05 max.	ASTM D 570
f	Volume Resistivity @ + 25 °C	Ohm-cm	10 ¹⁵ min.	ASTM D 257
g	Dielectric withstand, 1000 Volt/sec rise @ + 25°C	Volts/mm	30,000 min.	ASTM D 149
h	Vicat Softening Point	°C	110 min.	ASTM D 1525
i	Elongation	%	600 min.	ASTM D 638
j	Oxidative Induction Time in Oxygen at 220°C, Aluminium 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	300 300	ASTM D 1693
l	Carbon Black Content	%	2 min.	ASTM D 1603

- iii. In addition to vendor's certificate, the contractor shall draw samples from each batch of epoxy, adhesive and polyethylene in the presence of department's representative 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.
- Epoxy Powder: Gel Time, Cure Time, Moisture content, Thermal Characteristics (Tg1, Tg2, ΔH).
 - Adhesive: Specific gravity, Melt Flow Rate, Vicat Softening Point.
 - 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 as per this specification 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.

- iv. The Contractor 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.

v. Properties of coating System

Sr. No.	Properties	Unit	Requirement	Test Method
a	Bond Strength (using Type 2 test assembly i.e., Dynamometer) - @ 20+ /- 5°C - @ 65 +/- 5°C	Kg/cm	15.0 min 5.0 min	DIN 30670
b	Impact Strength (Mon. of 30 impacts on body along the length. No breakdown allowed when tested at 25 Kv)	Joules per mm of coating thickness	7 min	DIN 30670
c	Indentation Hardness - @ 23 +/- 2°C - @ 70 +/- 2°C	mm	0.2 max 0.3 max	DIN 30670
d	Elongation at Failure	%	400 min	DIN 30670
e	Coating Resistivity (*)	Ohm-m ²	10 ⁸ min.	DIN 30670
f	Heat Ageing (*)	-	Melt Flow rate shall not deviate by more than 35% of original value	DIN 30670
g	Light Ageing (*)	-		DIN 30670
h	Cathodic Dis-boudment	Min. radius of		ASTM G42

	<ul style="list-style-type: none"> - @ + 65°C after 30 days - @ + 65°C after 48 hrs 	Disbondment in mm (**)	15 max 7 max	
i	Degree of Cure of Epoxy <ul style="list-style-type: none"> - Percentage Cure, ΔH - ΔT_g 	%°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.

(**) Disbandment 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.

3.9.5 Acceptance of Pipe Materials

3.9.5.1 Identification and Tracking

Upon receipt at the coating factory, the 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 or 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 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 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.

3.9.5.2 Preliminary Inspection

The Contractor shall carry out visual inspection of all pipes.

The 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 In-charge and the Pipe shall not be coated without prior release by Engineer In-charge.

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 In-charge.

3.9.5.3 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 In-charge.

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 In-charge 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.

3.9.6 Prior to Coating Application

3.9.6.1 Stages

The principal stages of pipe coating shall be as follows:

- a. Solvent cleaning followed by steam or hot bath cleaning (if required)
- b. Abrasive blasting
- c. Application of fusion bond epoxy (FBE) layer
- d. Application of adhesive layer
- e. Application of polyethylene layer

3.9.6.2 Cleaning Prior to Abrasive Blasting

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 In-charge.

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, DIN EN ISO: 8502-5, 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.

3.9.6.3 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 abrasive's mixture shall be removed from the hopper and checked for hydrocarbon contamination. The sample shall be placed in a beaker to which de-ionised 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.

- a. Correct abrasive size distribution shall be carried out by sieve analysis.
- b. 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 In-charge 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 of the clauses above. 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 In-charge.

The elapsed time between the start of blasting and the heating of pipe shall be indicated in the application procedure submitted by the 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:

PERCENT RELATIVE HUMIDITY	ELAPSED TIME (HOURS)
85	0.5
80	1.0
70	2.0
60	2.0

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.

3.9.7 Coating Application

3.9.7.1 General

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

The 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.

3.9.7.2 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°C in accordance with AWWA C213, section 4.4.3.1 Preheating".

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.

3.9.7.3 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 Contractor shall establish to the satisfaction of the Engineer In-charge that the adhesive is applied within gel time window of the FBE and at the temperature recommended by the adhesive manufacturer. The Contractor shall state the proposed minimum and maximum time interval between FBE and adhesive applications at the proposed pre-heat temperature.

3.9.7.4 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.

PIPE DN	TOTAL THICKNESS OF POLYETHYLENE COATING
> DN 100 ≤ DN 250	2.7 mm
> DN 250 < DN 500	2.9 mm
≥ DN 500 < DN 800	3.2 mm
≥ DN 800	3.7 mm

The thickness may be less than the minimum thickness locally as long as these local areas do not exceed 5cm² per 1m length of pipe and the difference between the actual thickness and the minimum thickness is not greater than 10%.

Inspection of Thickness: Inspection of thickness shall be as per Annexure A (normative) of DIN 30670.

A polyethylene layer cutback of 150 mm (±20mm) shall be provided at pipe ends.

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°C before handling.

The ends of the coating shall be chamfered and beveled to less than 30°.

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

3.9.8 Inspection, Testing and Certification

3.9.8.1 General

In order to demonstrate that the manufacturer's proposed coating procedure is capable of meeting the specification, the Contractor shall undertake coating procedure qualification testing (PQT) prior to commencing production, or at his own risk at the start of production. The 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 Contractor. The Engineer In-charge shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection supervision work

3.9.8.2 Coating Procedure Qualification Testing (PQT)

Prior to commencing or at the start of full production five pipe of each diameter coated with FBE only and five pipe 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 In-charge 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 In-charge 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 in 3.9.8.3 before production commences.

Any change in the coating material or coating procedure shall require approval from Engineer In-charge.

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 In-charge, the Contractor's quality plan and procedures shall be revised, and submitted to the Engineer In-charge for approval. All items coated using the rejected procedures shall be striped and recoated to the revised procedures.

3.9.8.3 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 Pipe	Each Pipe
<u>After Cleaning</u>		
• Chloride	2 mg/cm ²	Each Pipe
• Oil	No contamination	
• Salt	3 mg/cm ²	
<u>After Abrasive Blasting</u>		
• Cleanliness	SA 2.5 acc to ISO 8501	Each Pipe
• Profile	50 – 100 um	Each Pipe
• Contamination	No contamination	Each Pipe
• Visual Inspection	No surface defects	Each Pipe
• Holidays	No holidays	Each Pipe
• Thickness	Min/Max see clause 3.9.7.2	10 per pipe
• Adhesion	See clause 3.9.7.3	2 per pipe
<u>Holidays Visual Inspection</u>	No surface defects	Each Pipe
Coating	120+10/-0 mm width	Each Pipe
Bare steel at pipe ends	10 to 40 mm width, Chamfered	Each Pipe
Production FBE PE cut backs	150 ±20 mm bevel <30°	Each Pipe
<u>Adhesion</u>		
• Peel Test	> 100 N/cm at 20 °C +5° > 50 N/cm at 50 °C +5°	2 per Pipe 2 per Pipe
<u>Impact Resistance</u>	See Clause 3.9.8.4d	1 per pipe
<u>% Elongation at Failure</u>	See Clause 3.9.8.4f	2 per pipe
<u>Cathodic Disbondment</u>	See Clause 3.9.8.4h	2 per pipe
<u>DIN 30670</u>	See Clause 3.9.8.4g	1 per pipe

3.9.8.4 Production Testing

A. Production testing shall be performed at the frequency shown below:

Property	Acceptable Values	Frequency of Tests
<u>On Arrival</u>		
• Pipe Damage	Minor damage/grinding <3 Per Pipe	Each Pipe
<u>After Cleaning</u>		
Chloride	2 mg/cm ²	Each Pipe

Oil Salt	No contamination 3 mg/cm ²	
After Abrasive Blasting • Cleanliness • Profile • Contamination • Pipe Damage	ISO-SA 50 – 100 um No contamination See clause 3.9.5	Each Pipe 20 Each Pipe 20
<u>FBE Layer</u> • Visual Inspection • Holidays • Thickness • Adhesion	No surface defects No holidays Min/Max see clause 3.9.7.2 See clause 3.9.7.3	Each Pipe Each Pipe 10 per pipe 2 per pipe
<u>Holidays 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 ±20 mm bevel <30°	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 Temperature</u>	See Clause 3.9.8.4h	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 In-charge as a result of change of materials or consistent poor production performance.

B. Holiday Detection

i. 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.

ii. 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 Contractor shall demonstrate to the Engineer In-charge 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 Contractor shall immediately stop the coating operation to determine the cause and remedy it.

C. 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. Disbandment 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 detailed in procedure qualification and production testing of this specification. 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.

D. Impact Test

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

E. 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 $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

F. 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 400% on each of the full system pre-qualification pipes, 2 samples per pipe to the requirements of DIN 30670.

G. Other DIN 30670 Tests

The 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.

H. 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 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 In-charge 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.

I. 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 in accordance with this specification shall be rejected. Subject to the approval of Engineer In-charge, 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 In-charge. The cause of failure shall be established and reported to the Engineer In-charge and if deemed necessary by the Engineer the coating procedure shall be amended and re-qualified. The Engineer In-charge 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.

J. Coating Repairs

The Contractor shall submit detailed coating repair procedures for approval by Engineer in-charge. 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).

i. Repair areas of sizes $< 5 \text{ mm}^2$

Pinhole damage shall be repaired by cleaning with an emery cloth followed by application of a two (2) pack epoxy 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.

ii. Repair areas of sizes $< 5 \text{ mm}^2$ up to $< 250 \text{ mm}^2$

The area shall be swabbed with solvent and a braided with an emery cloth to ensure that the surrounding polyethylene is well bonded, the surface shall be roughened for a distance of at least 25mm beyond the damage area. An 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-a braided area. Torch heat and smoothing pressure shall be applied to fuse the patch and ensure that no blisters are formed.

iii. Repair areas of sizes 250 mm^2 up to 625 mm^2

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 70°C.

Install the sleeve over the area to be coated.

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

iv. Repair areas of sizes exceeding 625 mm²

No single defect shall exceed an area of 625 mm². Pipes with a coating defect exceeding 625 mm² shall be cause for rejection and shall be subsequently rejections 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 as described in this specification.

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°C.

K. Handling, Transport and Storage Rules

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

The contractor 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 carried-out at the contractor's expense.

L. Handling

The pipes shall be handled without causing damage to the pipe bevels and coating. Direct contact steel or hump 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.

M. Transfer to storage yard

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

N. Storage yard of the contractor

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.

O. Pipe loading for shipment

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

P. Repair of Coating

The contractor shall submit to Department, its methods and materials proposed to be used for executing a coating repair and shall receive approval from the department prior to use. In open storage the repair materials must be able to withstand a temperature of at least (+) 80°C without impairing its serviceability and properties. The contractor 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 cm² 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 20cm² shall be rebuild 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 300mm 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, the contractor 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 repairs of coating shall be as follows:

- Holiday repair of size $\leq 100\text{cm}^2$ 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 the contractor.

Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the department. In any case the contractor shall establish his material, methods and procedure of repair that result in an acceptable quality of product by testing and shall receive approval from department 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. the contractor shall test repairs to coating as and when required as and when required by department.

Repair Material:

Heat Shrink Sleeves - HTPL-80, PERP 80 PERP FILLER, S 1239 Epoxy or Canusa GTS-80, CRP 80 Mastic Filler, S/E/liquid epoxy and then should be followed by or equivalent material to be qualified by the material manufacturer and approved by department.

- Any combination of epoxy, adhesive and polyethylene shall be tested and certified by an internationally recognized agency.
- In case the contractor proposed coating material other than above mentioned combination of epoxy, adhesive and polyethylene, coating procedure and qualification need to be carried out by an internationally recognized agency by the coating material Manufacturer.
- All materials to be used shall be supplied in sealed, damage free containers and shall be suitable marked with the following minimum information:
 - a. Name of the Manufacturer
 - b. Type of Materials
 - c. Batch Number
 - d. Place and Date of Manufacture
 - e. Shelf Life/Expiry Date (if Applicable)
 - f. Quantity

All materials noted to be without above identification shall be deemed suspect and shall be rejected by the department. Such materials shall not be used for coating and shall be removed from site and replaced by the contractor at his expense.

LOFC: List of Operation of Fabrication and Control

Each LOFC must contain the following information as a minimum (all clearly marked and separated):

- a. Company name and references relating to the order;
- b. All technical and other information required in order to define the items covered.
The area of application will be limited to that item or those items considered in fabrication and control as a natural unity.
Details of plants, layout, capacity, production rate, testing equipment, yard facility.
- c. A numerical sequence of operations with description will be built-up in a logical way of work progress.
The first operation will be the control over the incoming material(s) and documents.
The last operation will be the control over the final documentation.
The following operations have to be included (not limited to):
 - Procedure prior to the commencement of production shall be approved by the department
 - Each step which calls for own quality control (eventually QA);
 - Each applicable examination as part of this specification;
 - Document control-stamping and final documentation.
- d. Each operation will be followed by the applicable specification or procedure number (with the latest revision).
- e. Columns to be provided for possible interventions of:
 - the manufacture's fabrication control;
 - the manufacturer's quality control (eventually QA);
 - inspection Agency;
 - and place of intervention if not by the manufacturer.

The interventions will be indicated per operations with H or w and/or R.

H = hold point - no further steps may be undertaken before the intervention of the designated responsible takes place.

W = witness point - the designated responsible has to be notified of the operation in advance, but production will continue whether the intervention took place or not.

R = point for which a control report or a recording has to be made.

The manufacturer will fill in his own H, W and R points. The inspection Agency will do the same in its designated column, but this will not implicate a relaxation or waiving of the requirements of the manufacturer's controls.

Each intervention has to be signed and dated by person acting as controller. Only the original

documents will be presented for this purpose.

- a. One column to be provided for report or record number (point marked R) and one for the review or these documents by the Inspection Agency.
- b. Two extra columns may give reference to non-conformity report if any and to the resolution give to it.

Completion of the LOFC does not automatically rise to a release of the material or it must be stipulated otherwise in the contract.

The steps indicated in the LOFC must be executed following the sequence as stipulated in LOFC.

3.10 COATING OF FIELD JOINT, SPECIAL SECTIONS & CONNECTIONS FITTINGS OF STEEL PIPELINES FOR WATER

3.10.1 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 either EN 12068- “Cathodic Protection – External Organic Coatings for the Corrosion Protection of Buried or Immersed Steel Pipelines used in Conjunction with Cathodic Protection – Tapes and Shrinkable Materials” Or AWWA C216 and the requirements of this specification. Unless modified/replaced by this specification, all the requirements of EN 12068 or AWWA C216 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.

3.10.2 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:

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)
ISO 8503-1	:	Part 1: Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces.
ISO 8503-4	:	Part 4: Methods for calibration of ISO surface profile comparator and for the determination of surface profile - Stylus instrument procedure.
SIS 055900	:	Pictorial Surface Preparation Standard for Painting Steel Surfaces.
SSPC-SP1	:	Steel Structure Painting Council.
EN12068	:	Cathodic Protection - External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection. Tapes and shrinkable materials
SSPC-SP 3	:	Power Tool Cleaning

ISO 8501-1	:	Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness
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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.

3.10.3 Materials and Equipment

3.10.3.1 Field Joint coating Material:

Field joint anti-corrosion coating material shall be heat shrinkable wraparound sleeve suitable for a maximum operating temperature of (+) 60°C (max. T).

In addition, the field joint anti-corrosion coating shall comply the requirements specified in this specification.

a. 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 as per EN12068 Or Butyl Rubber based adhesive as per AWWA C216. The coating sleeves shall be type II laminated material consisting of a cross linked polyolefin backing & a homogeneous adhesive layer consisting of Butyl or Hydrocarbon based polymer. The backing layer shall be provided with suitable means P C I (thermo-chrome paint, dimple, or other means) to indicate the desired heat during shrinking in field is attained. The sleeve shall be supplied either as per Type-II (as per AWWA C216) Or Class-C, Class HT, Class UV (As per EN 12068) pre-cut sizes to suit the pipe diameter and the requirements of overlap.

The total thickness of heat shrinkable wraparound sleeve in the “As Applied” condition shall be as follows:

i. Sleeve confirming to EN 12068 on SA 2½ surface.

Pipe Size (Specified Outside Diameter)	Thickness (mm)		
	On Pipe Body		On Weld Bead
	Average	Min.	(Min.)
<30” (762.0mm)	2.0	1.8	1.6
>32” (813.0mm)	3.0	2.7	2.5

ii. Sleeve confirming to AWWA C 216 on ST-3 surface.

Property	Requirements (Min) (for type - II)	Requirements (Max) (for type - III)	Test Method
Thickness (Applied)	2.0 mm	2.8 mm	Sec 5.5.2

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.

The Contractor shall propose the manufacturer's details, heat shrinkable sleeve details/ properties and the specific grade of field joint coating system meeting the requirements of this specification.

3.10.3.2 Functional Requirements of Field Joint Coating

Properties of the PE backing shall be as follows:

Sr. No.	Properties	Unit	Requirement
a	Tensile Strength @ +25 °C	N/mm ²	>12
b	Ultimate Elongation @ +25 °C	%	>250
c	Dielectric withstand with 1000 Volts/sec	KV	>30
d	Water absorption @ +25 °C For 24 hours	%	<0.05
e	Volume Resistivity @ +25 °C	Ohm-cm	>10 ¹⁵

3.10.3.3 Functional Properties of Joint Coating System (As supplied)

As applied field joint coating system shall comply the requirements of DIN EN 12068 Table 1 & 2 / AWWA C 216 Table 1 & 2, except as modified below:

- i. Cathodic Disbondment Resistance at Tmax i.e. 60°C shall be 20mm when tested as per Annexure K of EN 12068 / Sec 5.2.8 of AWWA C 216 Test shall be carried out at (+) 60°C
- ii. Peel /Adhesion strength as per AWWA-C216 Sec 5.5.4 shall be as follows:

Peel Strength	Temperature	Unit	Requirement for Mech. Resistance Class-C (minimum)
To Pipe Surface	18°C-29°C	lb-inch (N/mm)	15 pli (2.6 N/mm)
	60°C	lb-inch (N/mm)	1.5 pli (0.26 N/mm)
To Factory Coating	18°C-29°C	lb-inch (N/mm)	15 pli (2.6 N/mm)
	60°C	lb-inch (N/mm)	1.5 pli (0.26 N/mm)

- iii. Peel /Adhesion strength as per EN12068 shall be as follows:

Peel Strength	Temperature	Unit	Requirement for Mech. Resistance Class-C (minimum) as per EN 12068 Table 1
To Pipe Surface	23°C	N/mm	1 N/mm
	60°C	N/mm	0.1 N/mm
To Factory Coating	23°C	N/mm	1 N/mm
	60°C	N/mm	0.1 N/mm

Contractor shall obtain prior approval from the department 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 of clause 3.10.3.1 and 3.10.3.2 shall be submitted to Employer for this purpose. The Contractor shall furnish test certificates from manufacturer test /an independent T.P.I lab/ DIN / AWWA recognized/approved laboratory for all the properties required for the specified EN / AWWA designation of joint coating and the requirements of this specification.

The material shall be tested at the manufacturers works before dispatch to the site in the presence of departmental representative.

3.10.3.4 Cut back

Cut back length of the pre-coated pipes shall be 150 mm +10, -0.0 mm (No -ve) protected by butyl primer and compatible UV stabilized PVC/PE end seal tape of minimum thickness 0.3 mm after surface preparation from factory to preserve. (Note: Same shall be amended in the specification of 3 LPE coating.)

3.10.3.5 Field joint coating system

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 3 LPE coated pipes which shall be duly abraded including the bevel edges.

3.10.4 Application Procedure

3.10.4.1 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 demonstrated to and approved by the department. The contractor's 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 trained by manufacturer's representative and certified with 1 year validity 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.

- c. The PVC/PE end seal tape applied at factory to preserve the surface preparation shall be removed only before welding on field joint.
- d. Any 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.
- e. During cleaning the pipe surface temperature shall be simultaneously more than 5°C and more than 3°C 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 / St-3 in accordance with Swedish Standard SIS-055900. 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 cleanliness shall be checked on every joint and the surface property / roughness profile shall be checked 1 every 5 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 5 joints.

Prepared & 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 cleaned again.

- f. 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-blast cleaned if the defective area is larger than 50mm in diameter.
- g. 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.
- h. 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.
- i. Protection coating shall be applied on the joints immediately after the completion of cleaning

operation.

3.10.4.2 Application Procedure for Heat Shrink Wraparound/Sleeves

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

- a. 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 duly abraded.
- b. 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.
- c. 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.
- d. For heat shrinkable sleeves as per EN12068 if recommended by manufacturer, the exposed bare metal of the welded field joint including 10 mm on the adjacent pipeline coating after abrasive blasting to Sa-2 (1/2) and pre-heating shall be applied with two pack epoxy primer to a thickness as per manufacturer's recommendation or 200 micron wet film thickness whichever is higher including 10 mm on the adjacent pipeline coating. For heat shrinkable sleeve as per AWWA 216 If recommended by manufacturer, the exposed bare metal of the welded field joint including 100 mm on the adjacent pipeline coating after wire brushing to ST-3 surface shall be applied with butyl primer as per manufacturer's recommendation or 75 micron thickness whichever is higher. 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.
- e. Immediately after, the wraparound sleeve shall be entirely wrapped around the pipe in case of the epoxy primer when it is still wet or butyl rubber primer when it is still touch dry. Sleeve shall be positioned such that the closure patch is located to one side of the pipe in 10 or 2 O'clock position, with the edge of the undergoing layer facing upward and an overlap of min. 50 mm. Gently heat by appropriate torch the backing and the adhesive of the closure and press it firmly into place.
- f. 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.

- g. 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.

3.10.4.3 Joint Coating Application

Joint Coating Application shall be done under supervision of the contractor's personnel during the field trial demonstration and testing work. Presence of manufacturer's representative is a mandatory requirement and contractor shall be required to furnish specific commitment to this. Minimum 50 (fifty) field joint coating to be carried out under supervision of the joint coating supplier's representative. Application procedure and environment protection methodology demonstrated at the time of field trial shall be strictly followed during the entire work.

Repairs

- a. 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:
 - 1) Determine the cause of the faulty results of the field coating.
 - 2) Mobilize the expert of manufacturer, if required.
 - 3) Test to the complete satisfaction of Company, already completed field coatings.
 - 4) Stop the field coating works until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Company.
- b. Contractor shall replace all joint coating found or expected to be unacceptable as per relevant section of this specification.
- c. Contractor shall, at his own cost, repair all areas where the coating has been removed for testing by the Company.
- d. 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 with equipment such as the "Pearson Meter" and the resistance meter. If coating defects 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

- a. Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material.
 - i. Complete information as per clause no. 3.10 and DIN EN 12068/AWWA C216 along with descriptive technical catalogues.
 - ii. Test certificates and results of previously conducted tests, for all properties listed in as

per clause no. 3.10.3.2 of this specification

- iii. 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, any 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.

- b. Prior to shipment of materials from the Manufacturer's Works, Contractor shall furnish the following documents:
 - i. Test certificates/results as per Manufacturer's Quality Control Procedure for each batch of material.
 - ii. Specific application instructions with pictorial illustrations.
 - iii. Specific storage and handling instructions.
- c. All documents shall be in English language only.

3.11 LOWERING, LAYING & JOINTING OF PIPE

3.11.1 General

The pipeline shall be buried with minimum cover of 1.2 m at top; however, pipeline shall be laid as per detailed Engineering approved by Engineer In-charge. 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.

3.11.2 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.

3.11.3 Temperature

The components of the pipeline such as base plates, top plates and pedestals have been so designed that the centers 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.

3.11.4 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.

3.11.5 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:

Thickness 't' (mm)	Offset in Longitudinal joints (mm)	Offset in Girth joints (mm)
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.

3.11.6 General Sequence of Operations

Before commencing the work of pipe laying, the Contractor shall study the L-section of the

pipeline for the section concerned. He shall also study the details of laying i.e. underground or aboveground. The underground pipeline shall be laid on sand cushioning/ bedding as shown on the drawing. The difference in depth due to uneven excavations shall be made up by sand cushioning.

Pipe laying shall generally start from the fixity points on either side, the expansion joints if required for pipeline aboveground being provided last. Fixing points are at all anchor blocks. Where such blocks are not required for long lengths, fixity shall be achieved by fixing the pipeline to the special type of R.C.C. or steel saddles as directed. The distance between successive fixity points shall not exceed 300 m.

Anchor blocks shall be constructed before commencing the pipe laying work in any section. The construction of the blocks shall be carried out in 3 stages: in the first stage the lower part up to 150 mm below the invert of the pipeline including concrete chairs to support it shall be constructed; in the second stage the pipeline on this part of the block shall be laid; and lastly, the remaining block around and over the pipeline shall be constructed. Necessary curing to concrete shall be carried out for 14 days or as instructed Engineer in charge.

The fixity saddles and ordinary saddles if the pipeline is aboveground shall be cast-at least 3 weeks before the pipeline is laid on them. After all saddles between successive fixity points have been cast, a line plan showing the actual position thereof shall be prepared, after taking levels and measuring distances. In case of any errors in casting the pedestals, corrections shall be applied. The pipe laying work shall then start from the fixity points and shall proceed towards the expansion joints. The method of jointing the pipes and erecting them on previously cast R.C.C. saddles shall be determined by the Contractor depending upon the type of plant equipment and personnel available with them.

The pipe stacking shall be assembled in position on the saddles either by the cranes, portable gantries, shear legs or any other equipment approved by the Engineer In-charge. Normally, not more than two pipes shall be aligned, tacked and kept in position on temporary supports. The Contractor shall not proceed with further work, until the circumferential joints of these pipes are fully welded. During assembly, the pipeline shall be supported on wooden sleepers and wedges, with the free end of the pipeline held in position by slings to avoid deflection due to temperature variations during the day. In general, the assembly of pipe stacking and one run of welding shall be done during the day time while full welding including the external gouging and sealing runs shall be done after 5 p.m. or so. The Contractor shall maintain the continuity of the work by adding two more pipes on the second day in a similar manner, after full welding of the previous joints is completed during the night. While this new work is being done, the Contractor shall proceed with the work of providing permanent supports for the pipeline assembled and welded previously.

3.11.7 Fixing Expansion Joint

The work of laying pipeline in aboveground, laying starts from the fixity points and proceeds towards the expansion joints. It shall be continued until the gap between the pipe ends is less than the lengths of the expansion joint plus pipe stake length. At this stage, the exact gap between the pipe ends shall be measured at mean temperature of that locality. Let it be 'X'. Similarly, the exact length of the pipe stake and the expansion joint bought at site shall be

measured at the same temperature let these be 'Y' and 'Z' respectively. Normally, the length of the expansion joint ('Z') is standard.

- a. Case when 'Y' plus 'Z' is more than 'X' or equal to 'X' (i.e., fixing of expansion joint without strip)

At mean temperature the exact gap between pipes shall be measured. Free ends of pipes shall be brought in a correct line and level; lateral movement, if any, shall be corrected. Then the gap between the free ends shall be made equal to the exact length of the expansion joint by cutting one of the pipe ends. Choice of the end to be cut must be made from the point of view of bringing the expansion joint to a central position.

The expansion joints are normally supplied without packing. The normal length of the expansion joint shall be reduced by about 100 mm by cutting the inside locks and inserting the inner strake by means of turnbuckles. At mean temperature this expansion joint shall be inserted inside the gap (care being taken to keep the tapered portion on the down-stream side), and both ends shall be tack welded to the pipe ends, after pulling the expansion joint. (Tacks of these two joints shall be of longer length, approximately 100 mm long).

Welding of these two joints of the expansion joints shall be started only after it is ascertained by taking observations that the expansion joint is functioning properly. The procedure to be followed for taking observations is given in Clause c.

- b. Case when 'Y' plus 'Z' is less than 'X' (i.e., fixing of expansion joints with strap)

The expansion joint shall be laid in locked position. Before laying the pipes adjacent to the expansion joint, the exact gap between the pipes shall be calculated by taking measurements of the first pipe (upstream of the expansion joint), and the second pipe (downstream of the expansion joint) at Mean Temperature.

If the gap is less than 100 mm, the second pipe shall be cut to make the desired gap of at least 100 mm. If the gap is more than 200 mm, suitable distance piece of not less than 700 mm shall be inserted after cutting necessary length of the first pipe.

The second pipe shall then be laid in position. Then a strap of length equal to three times the gap length shall be welded to the pipe, overlapping the second pipe by the gap length. The other end of the strip shall be kept free.

At mean temperature the other end of the strap shall be tacked to the first pipe, after checking of the line and level. Simultaneously, all the locks of the expansion joint shall be removed and chipped off properly.

Welding of the joints between the strap and the first pipe shall be started only after observations are over and it is ascertained that the expansion joint is functioning properly.

- c. Observations

Before fixing the expansion joint, two mercury cups - one on the left and the other on the right side - shall be fixed on the pipe near the upstream side of the expansion joint.

Immediately after the expansion joint in case (a) above or the strap in case (b) above is tack

welded, observations for total expansion or contraction shall be started and continued for 48 hours round the clock. Similarly, the central and end fixity pedestals shall be kept constantly under observation.

The expansion and contraction shall be measured by making a temporary marking on the inner strake (on the upstream side) and measuring the distance between this mark and the edge of the gland of the expansion joint.

The observations shall be recorded in the following proforma;

Reading No.	Time	Pipe temp on upstream side	Pipe temp on downstream side	Atmospheric temperature	Dist. between edge of gland and marking
1	2	3	4	5	6

3.12 SPECIALS

3.12.1 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.

3.12.2 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.

3.12.3 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.

3.12.4 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.

3.12.5 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.

3.12.6 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.

3.12.7 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 bolt holes 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.

3.12.8 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.

3.12.9 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.

3.13 FIELD HYDRAULIC TEST

The pressure test shall be conducted in dry weather to observe whether any leakage takes place or not. For field hydraulic test water will pass through entire pipe line with a working pressure of all working pumps (Six nos) for a period of seven days continuously after attaining the required pressure and water reaches at the outlet of transmission main. A leakage equivalent to 0.267 litre per mm of pipe dia. per Kilometer 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 defect 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.

3.14 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.

3.14.1 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 joint 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. 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 fills 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 meters 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.

3.14.1.1 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.

L - section of route is tentative. Contractor has to prepare a fresh Longitudinal Section before starting the work, showing all service lines coming across or parallel.

Alignment of pipeline may require to be changed on same route due to any obstructs or service lines. No extra payment made to contractor.

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.

3.15 ADDITIONAL REQUIREMENT FOR PIPE TO BE LAID BY PUSHING METHOD

For insertion of casing pipe boring shall be carried out by auger type boring device with cutting head to drill a horizontal bore. The hole drilled shall be of suitable size to accommodate casing pipe. The casing pipe shall be inserted along with boring to keep the formation supported to prevent any settlement. The casing pipe shall be installed with even bearing throughout its length. The work will be done under the supervision of Engineer In-charge as per restrictions & precautions as may be stipulated by the Engineer In-charge.

The casing pipe will be minimum 1.2 m below the level & 0.9 m below the natural G.L. The length of casing pipe shall be up to the boundary of Road or as directed by Engineer-in-charge. Casing pipe shall be provided with minimum 50 mm dia GI pipe of 2 m height above G.L. with screen at top. Rates are inclusive of bottom & side rollers of suitable size to be provided inside casing pipe at 4 m interval to facilitate insertion of carrier pipe of required dia. The ends of casing pipe shall be suitable sealed.

The casing pipe is to be provided with epoxy treatment as below on outer face of the pipe before lowering.

Zinc rich Epoxy Primer	
Description	Two pack zinc rich consisting of –
Base	Fine Zinc Dust Ground in Epoxy Resin Solution, supplied in paste form
Catalyst	Abduct type- the non-volatile portion of the material (mixed) should consist of 92 % Zinc Dust & 8-10% Epoxy Resin & curing agent
Shade	Grey
Characteristics	The paint shall provide a complete rust inhibitive barrier coating of high mechanical & abrasion resistance. The film shall be compatible for fusion & spot weld.
Pot-life	4-6 hours
Mixing Ratio	The proportion of mixing of base & hardener should be as specified by the Manufacturer by weight & volume. The mixed primer shall conform to the specifications detailed.
Viscosity of ready mixed paint	15-22 in Fort Cup No. 4 at 30°C
Drying time	i. Dust free – 10-15 minutes ii. Chamber curing – 24-28 hours
Thickness	4 mils

3.16 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 up to centerline shall be done in layers not exceeding 225mm and compacted to 85 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 SO₃ %, sulphate as SO₃ 2:1 water soil extract as per I.S. 456:2000.

No swelling soils shall be used for backfilling work. For the purpose of back filling requirements of I.S. 3114:1994 shall be satisfied.

As per approval by EIC suitable material in backfilling may be use in lieu of earth, sand, or rounded river-run gravel / crushed sand.

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 sand 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 / Sand for refilling is not available from excavation the Contractor shall bring selected material 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.

3.17 SAND BEDDING

The sand bedding of minimum 300 mm thickness & level shall be provided below pipe, prior to laying the pipe in trenches. It shall be compacted with a light hand rammer. Any reduction in thickness due to compaction shall be made up by adding sand during ramming.

Sand used for bedding below pipes shall be confirming to requirements of IS 383-1970 of grading zone – I & II combined. Gradation of sand used for pipeline bedding should be as below.

IS Designation	Percentage passing
10 mm	100 %
4.75 mm	90 – 100 %
2.36 mm	60 – 100 %
1.18 mm	30 – 90 %
600 Micron	15 – 59%
300 Micron	5 – 30 %
150 Micron	0 – 10 %

Limit Range for F.M. of Sand: 2.11 to 4

Sand shall not contain any harmful material such as pyrites, coal, lignite, mica, shale, or similar laminated material, clay, alkali, soft fragments sea shells and organic impurities. Deleterious material in sand shall satisfy requirements of I.S. 383-1970. Silt content shall not be more than 3%. Total deleterious finer than 75 microns shall not be more than 5 % (including silt content) for uncrushed natural sand.

If, sand is not available within 50 km lead, the contractor may use cone crusher at site to make sand from excavated rock. Sand grading for crushed sand shall confirm to relevant IS specification for sand.

Tests specified for determining silt in sand & organic impurities as described in IS: 383 shall apply. Sieved sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particles of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the contractor.

During the work of providing sand bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures.

3.18 BEDDING

If rocky strata are meeting with at bottom during excavating, the trench shall be excavated for additional depth & suitable sand bedding shall be provided as directed. Trench bottom and bedding shall be well compacted & rammed. Before laying the pipeline in trench, the loose material from the sides of edges of the trench shall be prevented from falling inside the trench by providing and taking suitable measures.

3.19 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 Kilometer intervals along the buried pipe line. Indicators shall consist of 10 cm x 10 cm pre-cast concrete posts 1.25 m long, set 0.75 m 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.

3.20 TEMPER PROOF AIR VALVE WITH ISOLATION SLUICE VALVE WITH M.S. SHAFT MINIMUM 5.0 M LONG

The C.I. temper proof valve shall be proposed at a distance not more than 200 to 250 m and / or near each peak point as per requirement and good engineer practice so as to allow easy escape and inlet of during filling and emptying of pipeline. Detail specifications for material of this item are furnished in Mechanical specification. The item also includes the cost of MS pipe as a shaft for minimum 5 m. long. Steel pad of 750 mm x 750 mm x 12 mm thick, stiffener RCC encasing around MS pipe in M-20, including painting the MS pipe, pad, stiffener with 3 LPE coating or 1000-micron thick epoxy paint.

The CI temper air proof are to be erected as per drawing.

3.21 C-VALUE OF THE PIPELINE

The pipeline's co-efficient of roughness or in other words, the "C"-Value of the entire pipeline shall be determined by conducting an actual performance testing of the pipeline at site at constant flow condition in presence of Client / TPIA. The "C" value factor, thus determined by conducting an actual performance testing shall be higher than the "C" value, as referred to in the Hazen William's formula, considered for the hydraulic design of the pipe line. The report for the actual testing of the "C" value of the pipeline shall be submitted by the contractor for review and approval by Client / TPIA.

Following points shall be considered for this activity

- a. The "C" value factor shall be applicable to the entire pipe length. In view of it, the contractor has to carry out experimental determination of "C" value with respect to the entire pipe length.

- b. Readings of the line pressures at "Start" point, "End" point & "Intermediate" points are required to be noted while carrying out the testing and pressure drop to be measured accordingly. Pressure gauges shall be provided at every five kilometers on the pipe lines for measurement of line pressures and determination of "C" value. Also, pressure gauges with required accuracy shall be provided at the inlet and outlets of all the fittings, butterfly valves and zero velocity valves and actual pressure drop shall be measured
- c. The documents for supporting the value of Chain-ages & RLs considered at various measuring locations shall be submitted along with the report.
- d. The accuracy class and calibration certificates of all the measuring instruments valid till the date of measurement should be submitted along with the report.
- e. The minor losses across the bends and fittings shall be measured to cross-check with the minor losses considered for the hydraulic design. The actual pressure drop across the fittings shall be measured by fitting pressure gauges at inlet and outlet of the fittings and co-related with design consideration.
- f. This minor loss exercise shall be carried out for pipeline Butterfly Valves (BFVS) and Zero Velocity Valves (ZVV) also.
- g. The conceptual design report (CDR) for hydraulic design shall be considered as valid only after confirmation of the actual losses as referred above.
- h. The contractor shall submit a procedure for onsite experimental determination of the "C" value for review and approval by the Client / TPIA prior to conducting the experimental determination of the 'C' factor according to and in compliance with the above.

"C" value in pipe line shall be as under	
Pipe material	"C" value
M.S. Pipe with inside epoxy lining up to 1200 mm dia	140
-DO- Above 1200 mm dia	145

3.22 MODE OF MEASUREMENT AND PAYMENT

- a. Unit of Measurement: Per Running Meter (rmt) of laid, jointed, tested pipe including fittings.
- b. Payment should on per running meter basis.
- c. Payment Includes manufacturing, internal/external coating, delivery to site, excavation, bedding, laying, jointing, testing, and backfilling, field joint coating, weld testing, and special fittings.
- d. No extra payment shall be made for site handling, shifting from store to laying site, damaged pipes due to mishandling, minor bends, elbows, or anchors unless specified separately.

4. TECHNICAL SPECIFICATION OF H.D.P.E. PIPES

Providing & supplying in standard length ISI mark high density Polyethylene H.D.P.E suitable for potable water as per IS 4984/2016 including all local and central taxes, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, etc. complete. including Excavation for pipe trench incl. all safety provisions using site rails and stacking excavated stuff up to a lead directed by EIC, Cleaning the site etc. complete for lifts and strata as specified Lowering & laying in position to correct line & level and on pedestal or chairs upon prepared formation or prepared bedding in trenches the rates include conveyance from store to site of work loading, unloading, joint plastering, hydro testing etc. complete & Refilling the Pipeline trenches incl. ramming, watering, consolidating disposal of surplus stuff as directed within Project Area and as per approved design & drawing by EIC or his Authorized Representative. Note: - Rate for HDPE (PE-100) Pipe based on the rate of HDPE Resin as Rs. 121185/MT (Price Without GST).

Note: - The required size and quantity of above item is as per price bid.

- This item includes;
 1. Excavation & refilling the pipe line trenches incl. disposal of surplus stuff as directed within a radius of 3.0 km.
 2. Procurement, Supply, Transportation, Lowering, Laying & Jointing HDPE pipes as per IS 4984/2016 and its latest version or amendments including hydraulic testing, trial run etc. complete.
 3. Procurement & Installation of Specials suitable to HDPE pipes such as Bend, Tee, Reducer, Flange Tail Piece, Saddle Piece etc. as per requirement.
 4. ROU / ROW to lay pipe line and constructing chamber in width of 15.0 m along alignment including payment of standing crop compensation.

4.1 GENERAL TECHNICAL SPECIFICATIONS:

4.1.1 SCOPE OF WORK

The scope of work includes manufacturing, supplying and laying of HDPE pipes having pressure rating PN-6 & material grade PE-100 bearing IS 4984/2016 and its latest version or amendments. The HDPE pipes shall be supply in standard length.

4.1.2 STANDARD

The HDPE pipes is to be procured, supplied under the scope of this item and which shall be meet the requirement of pressure rating of PN 6 and material grade PE-100 in accordance and confirming to IS:4984/2016 or its latest version or amendments with IS certification mark.

4.1.3 TEMPERATURE VARIATION

All the pipes to be supplied and delivered shall be subject to weather condition like sun, dust, rain, wind as prevailing in state of Gujarat. They shall also be subject to carry and convey drinking water under temperature condition of Gujarat state.

4.1.4 TECHNICAL SPECIFICATION

a) Manufacture of pipes.

The General requirement relating to the manufacture of HDPE pipes shall be confirming to IS 4984 - 2016 and its latest revision /amendments.

- a. The dimension, material composition, tests etc. shall be as per IS 4984 – 2016 and its latest revision/ amendments.
- b. HDPE pipes shall be marked with ISI certification mark.
- c. The pipe dimensions and tolerances shall be as per latest revisions and amendments of IS 4984 -2016.
- d. The colour of pipes shall be black as per IS 4984 -2016 and its latest revision/amendments.

b) Test

The following tests as per IS 4984-2016 and its latest revision/amendments will be carried out by the agency in the presence of representative of Engineer-In-Charge / Third party Inspection (T.P.I). (Laboratory tests as well as field tests). The testing charges shall be borne by the contractor.

- a. Dimensions (Inside and outside diameter, Wall thickness and Length of pipe)
- b. Visual appearance
- c. Hydraulic Characteristics
- d. Reversion test
- e. Over all migration test
- f. Density
- g. Melt flow rate (MFR)
- h. Carbon Black content and dispersion test.
- i. Acceptance test.
- j. Internal Creep Rupture Test

c) Sampling.

The scale of sampling for tests for Hydraulic characteristics, Reversion, Overall Migration, Density, MFR and Carbon Black Content, Dispersion shall be as per IS 4984 – 2016, as mentioned below:

Sr No	Nos of Pipes	Sample Size
1	Up to 150	3
2	151 to 1200	5
3	1201 to 35000	8

The scale of sampling for visual and dimensional requirement shall be as per Table No: of IS

4984 – 2016 or as directed by Engineer-In-Charge.

The sampling shall be made on random basis, from a lot manufactured. The samples required for testing shall be taken as directed by Engineer-In-Charge or his representative.

The Agency should provide the test certificates from the manufacturer for the internal creep rupture tests conducted, as given here under along with the supply of pipes. These tests are to be performed in the presence of Engineer-In-Charge or his representative in the in-house laboratory of the pipe manufacturer. At the discretion of NWRWS&K, if required the representative will be deputed for checking raw material and production process. Internal creep rupture test shall be in accordance with procedure given in Annex - B of IS 4984-2016 or latest revision/ amendments. The pipes under test shall show no signs of localized swelling, leakage or weeping and shall not burst during the prescribed test period. The temperature for Duration of test and induced stress for the test shall confirm to IS 4984.

During execution if required the sampling of pipes shall be made from the procured, tested and delivered lot of pipes at site randomly. The same shall be tested for the tests mentioned in para as above. The contractor shall have to borne all the cost of testing in such a case over and above the cost of regular testing.

d) Type Test

The type test shall be carried out as per IS 4984 - 2016 and its latest revision/ amendments. The type tests are intended to prove the suitability and performance of anew composition, a new technique or a new size of a pipe. Such tests, therefore, need be applied only when a change is made in Polymer composition or method of manufacture, or when a new size of pipe is to be introduced. Engineer-In-Charge or his representative may call for the fresh samples for the type tests if required.

4.1.5 MARKING

The method of marking to all the pipes to be used under the scope of contract shall ensure that all the information as mentioned in clause 10 of IS: 4984and/or its latest amendments. The marking will remain legible even after transportation, storage in open space etc. In general, the legible and indelible marking upon the pipes shall indicate the following:

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- a. Manufacturer's name or trade mark.
- b. Grade of material.
- c. Class of pipes and pressure rating.
- d. Nominal diameter.
- e. Lot number / Batch number of manufacturers.
- f. ISI certification Mark.
- g. Purchaser's mark of NWRWS&K Department.
- h. Any other important detail.

4.1.6 PACKING AND HANDLING

When the pipes are transported at railway risk, special packing as per IRCA rules are absolutely necessary for which the extra cost if any shall be borne by the contractor.

The contractor shall have proper handling instrument / equipment and shall follow suitable method of handling of pipes while unloading, and stacking material.

4.1.7 MATERIAL AND WORKMANSHIP:

1. General requirement of material and workmanship shall mean any material or articles either raw material or additives or finished are required to be used in the manufacturing process of pipes.
2. The material used for manufacturing of pipes should not constitute any toxic hazards should not support microbiological growth and should not give rise to unpleasant test or odor, cloudiness or discoloration of water. The contractor shall have to produce Pipe manufacturer's certificate, that the material meets the PE 100 requirements as per IS 4984/2016 and its latest revision / amendments.

All other quality parameters like density, MFR, carbon black content, antioxidant and reworked material of raw material use for manufacturing of pipes shall be strictly as per IS:4984/2016 or its latest revision or amendment.

The original invoice of raw material requires to manufacture ordered length of HDPE pipes and batch wise test certificate of raw material will be verified by Engineer-In-Charge or his representative.

The carbon black master batch if used shall be certified by the master batch seller as fit for the purpose of standard for which the HDPE pipe are under order.

3. The HDPE pipe shall be manufactured from the certified raw material of PE-100 grade and suppliers have to submit the certificate from raw material manufacturer.

4.2 SPECIFICATION FOR LAYING AND JOINTING OF H.D.P.E PIPELINE

4.2.1 FOR LAYING AND JOINTING

The contractor shall have to arrange demonstration of the installation and testing of pipe by manufacturer including fixing all specials and valves properly at least up to 10 % of total quantity to be supplied by them at any place of the site of work under the bid.

In addition to the in-house testing of HDPE pipe in manufacturer laboratory, the Contractor shall have to arrange for random testing of pipes brought on site, in CIPET as decided and directed by the Engineer-in-charge.

4.2.2 WELDING

HDPE pipes are joined by BUTT Fusion welding method with the help of electric heat (Mirror) and hydraulically operated welding jack.

4.2.2.1 PRECAUTIONS

Since critical parameters for sound welding joint are temperature and pressure, welding methods should ensure proper temperature and pressure by using proper equipment. The welding area has to be protected from adverse weather condition like rain water, moisture, rough wind, dust and low ambient temperature (less than 5° C). Primary inspection of pipes should be done for ensuring defect free pipe before starting welding.

4.2.2.2 WELDING PROCEDURE

Two ends of pipes to be welded are to be cut perpendicular to the pipe axis and then cleaned and planed by using proper planning tool. The pipes are fixed in welding jack and aligned properly in axial direction. The pipes then are pressed against a hot plate (called heating mirror or simply mirror) till a bead of molten material is formed. The mirror is electrically heated by in- built electric resistance heating coil. The heating should be uniform all-around mirror plate on both sides. The mirror should be provided with a temperature control device so that during welding the surface temperature is automatically maintained within the required limit i.e., $200 \pm 10^\circ \text{C}$. Proper Teflon cloth covering should be provided on mirror surface to avoid sticking of melted HDPE material on plate surface.

After attaining the welding temperature of 200°C on mirror surface the pipe ends are simultaneously brought in contact with the heating surfaces of mirror. This is done by using hydraulically operated welding jack. Initial contact pressure is applied which is maintained till the uniform ring of molten bead is achieved. Then the contact pressure is reduced until proper fusion takes place.

After proper fusion, the welding mirror is removed carefully without damaging the head. The time of removal of the mirror should be as short as possible. After removal of mirror, pipe ends are brought immediately to contact with each other under initial welding pressure which is gradually increased to final welding pressure. This pressure depends on the total welding surface of pipe.

The final welding pressure is maintained to be applied till the joint is cooled down to ambient temperature naturally. Artificial cooling such as wrapping with wet cloth, spraying of water etc. are not allowed.

4.2.3 INSPECTION OF JOINTS

The visual inspection of each joint should be done to ensure correct bead formation. Weld joint should be checked for axial alignment of welded pipes.

4.2.4 LAYING OF PIPES

The required length of HDPE pipes is made alongside the trench. The pipe is lowered in to the trench carefully avoiding damage to pipe and joints. Laying should be carried out as per relevant IS.

4.2.4.1 TRENCH

Since the welding of pipe is done outside of trench, the width of trench should be kept as minimum as possible, normally pipe O.D. plus 300 mm width should be sufficient for laying.

The depth of trench will be as per the requirement of client depending on level survey (L.S) Here in our case the earth cover of minimum 1.5 m. on top of pipe is to be provided. Hence the depth of trench will be pipe O.D. plus 1.5 m.

The trench should be made as straight as possible. Wherever necessary, trench can be made with smooth curve but not below allowed bending radius of HDPE pipe, which is 25 times of O.D.

The bottom of trench should be properly dressed and made free from any sharp objects.

4.2.4.2 LAYING & BACK FILLING

Laying of pipe lengths to be done carefully from one end without giving any impact on pipe and as per IS. Provision. After laying of pipe, trench should be backfilled with the layers of good earth of dug soil as available. Extra soil will be embedded on trench which will be compacted with water.

4.2.4.3 TESTING OF FEEDER PIPELINE: (HDPE)

a. Inspection and test after erection

In addition to the progressive supervision and inspection by the Engineer-In-Charge or his representative, the contractor shall offer for inspection to Engineer-In-Charge or his representative, the complete, erected or its parts on which tests are to be carried out. After such inspection by Engineer-in-charge, the contractor shall have to carry out the testing for leakage / seepage from pipe line in the presence of Engineer-In-Charge or his representative.

b. Testing

1. The contractor shall have to make all the arrangement of water for testing, labours, supervisory staff etc. for the period of testing. The necessary arrangement for plugging of opening shall be made by the contractor at his cost. After testing contractor shall have to remove the plugging at his cost, but care should be taken that no damage will occur to the work executed. If any damage will occur to any parts of work executed the same shall be required to be repaired by the contractor at his cost to the satisfaction of Engineer-in-charge.
2. The testing of pipe line shall be carried out before backfilling of trenches and the space around the structures.

The water shall be filled in the pipeline and thereafter the suitable pressure shall be created by using suitable equipment in order to found any leakage in pipe.

During the testing the joints of pipe line shall be observed for the entire length of pipeline including joints and structures for checking for leakage and if any leakage is found the same shall be rectified by the contractor at his own cost. The test is repeated again till there is no any leakage observed in entire length and joint of pipe line.

4.2.5 AIR VALVE FIXING

Suitable size of air valve will be installed on HDPE pipe with the help of metallic saddle. Metallic flange for air valve will be provided on upper part of saddle for fixing air valve. Valve chamber of suitable size with top cover will be made for each air valve. HDPE fitting shall confirm IS 8360 and/ or 8008.

4.2.6 METHOD OF MEASUREMENT AND PAYMENT

The measurement shall be recorded in running meter of pipe length laid along the centerline of axis of pipeline including tees, enlarges, reducers and bends, correct up to 0.01 m length. No payment shall be made for overlaps etc.

The payment shall be made as mentioned in price bid.

The payment shall be made on running meter base. Item includes all taxes, octroi, insurance, transportation, freight charges, loading, unloading, conveyance to site, staking etc. including excavation for trenches, Bedding, refilling of pipeline trenches after laying, charges for statutory permission for pipeline crossings and necessary testing charges.

Compensation for standing crops along the pipeline alignment, charges for statutory permissions for pipeline crossings and other miscellaneous charges shall have to be borne by the contractor.

4.3 H.D.P.E. SPECIALS

4.3.1 SCOPE

The Scope of work covers general requirements for material, sizes, performance requirements, sampling and marking of all types of fabricated HDPE fittings intended for connection to HDPE pipes covered by IS: 4984-2016 for potable water supplies.

4.3.2 MATERIAL

The pipes used for the fabrication of HDPE fittings for potable water supplies shall conform to IS: 4984-2016.

4.3.3 SIZES OF FITTINGS

The sizes of the fittings shall be designated by their outside diameters at the free end. The outside diameters at the free end of the fittings shall correspond to the outside diameters of the pipes as given in IS: 4984 2016.

4.3.4 DIMENSIONS OF FITTINGS

- a. The outside diameters and corresponding wall thicknesses of fittings at the free ends for weld shall comply with those given in Table 1 of IS: 4984-1972
- b. The outside diameters shall be the average of two measurements taken at right angles. The wall thickness shall be measured with a ball ended micrometer. Resulting dimension shall be expressed to 0.1 mm.

4.3.5 PERFORMANCE REQUIREMENTS

Hydraulic Proof Test - A fitting duly plugged, when subjected to a hydraulic proof test of twice the recommended working pressure at ambient temperature and for a period of one hour shall not show any sign of localized swelling, leakage or weeping and shall not burst during the prescribed test duration.

4.3.6 SAMPLING

- a. Lot - All fittings of the same size, same thickness, same length and fabricated in a single consignment, shall be grouped together to constitute a lot.

- b. The conformity of the lot to the requirements of this specification shall be ascertained for each lot separately. The number of fittings to be sampled from each lot shall depend on the size of the lot and shall be in accordance with column 1 and 2 of Table 4.1 of IS 4984-1972.
- c. For testing the sample of fittings shall be selected from the lot at random. In order to ensure the randomness of selection, procedures given in IS: 4905 - 1968 shall be followed.
- d. Number of Tests and Criteria for Conformity
- e. Each fitting so selected shall be examined for requirements given in 4 and 5. Any fitting failing in one or more of these requirements shall be considered as defective. The lot shall be considered as conforming to the requirements of this specification if the number of defective fittings found in the sample does not exceed the corresponding acceptance number as given in column 3 of Table 1
- f. The lot rejected according to Ref IS / table 6.3.1 may be retested for characteristics for which it has failed. For this purpose, the number of fittings to be selected at random from the lot shall be according to column 1 and 2 of Table 1 of IS. A fitting failing to satisfy the requirements of any of these characteristics shall be considered as defective. The lot shall be deemed to satisfy the requirements of the specification if the number of defective fittings found in the sample does not exceed the corresponding acceptance number as per relevant IS, otherwise the lot shall be rejected.

4.3.7 MARKING

All fittings shall be clearly and indelibly marked at a prominent place visible even after the installation of the fittings with the following information:

- a. The manufacturer's name or identification mark, and
- b. The size of the fitting and the appropriate class (working pressure) of IS: 4984-1972* to which the pressure rating of the fitting corresponds.

HDPE fittings conforming to specific requirements as prescribed in the relevant parts of the standard may also be marked with the ISI Certification Mark.

The rate Includes supply of H.D.P.E pipe, specials, necessary excavation, refilling, lowering, laying, jointing, testing, etc. complete. The rate also includes the cost of ROU / ROW permission for laying pipeline.

4.4 MODE OF MEASUREMENT AND PAYMENT

Unit of Measurement: Running Meter (RM) of laid and tested pipe (including fittings).

Rate Includes supply and delivery of HDPE pipe (PE-100 grade), transportation, inspection, loading/unloading, excavation, bedding, laying, jointing, and hydrotesting, backfilling and disposal of excess soil.

5. TECHNICAL SPECIFICATION FOR PIPELINE CROSSING & SURGE CONTROL SYSTEM

5.1 PIPE PUSHING METHOD FOR ROAD

5.1.1 SCOPE OF WORK

The scope of work includes following:

1. Preparing the required drawings & to get the permission / approval for lowering, pushing, laying & jointing pipeline below State Highway / National Highway / Major District Road under the supervision of the concerned authority & also obtaining completion certificate from the authority after completion of work. Engineer-In-Charge will sign the necessary papers / proposed related to the work as per requirement. All the statutory and other charges, expenditure, etc. for crossing shall be paid by the contractor. However, if the concerned department / authority insists to pay such statutory and other charges through Engineer-in-charge, such charges will be paid by the Engineer-In-Charge & the such amount paid to concerned authority shall be adjusted / recovered from the contractor.
2. Drilling horizontal bore & providing, fixing MS casing pipe with welding, etc. complete.
3. Constructing temporary R.C.C. thrust block & base concrete as per requirement for facility of pushing the pipe and dismantling the same on completion of work.
4. Fixing of MS water main pipe. (Water carrier pipe)
5. Sealing the both ends with construction of brick work including C.C 1:3:6. The contractor shall also refer the Clause no. 22 (Point no. 6) and Clause no. 80 of Volume-II in regards to the works of crossings (pipe pushing) and its structures.

- Clause no. 22 (Point no. 6)

The contractor shall note that the works of crossings (pipe / box pushing) and its structures such as Railway, State Highway, National Highway and other crossings should be completed within six months (Excluding monsoon period) after obtaining approval from the department. If the contractor fails to execute the above referred works within stipulated time limit as mentioned, he shall attract compensation at 0.1% per day of cost of respective work, calculated on the basis of BOQ, and it will have cumulative effect till the actual date of completion of the delayed work. The compensation recovered under this clause will of permanent nature and will remain non-refundable under any circumstances. For carrying out these works, he may be allowed for sub-letting these works only after getting prior approval/ clearance from the department and with tri-party agreement (i.e., between contractor + sub-letting agency + department).

- Clause no. 80- Work not to be sublet

“Contractor may be rescinded and security deposit forfeited for subletting it without approval or for bribing a public officer or if contractor becomes insolvent”

The contractor shall not be assigned or sublet without the written approval of the Engineer-in-charge. And if the contractor shall assign or sublet his contract or attempt to do so or become insolvent or commence any proceeding to get himself be adjudicated an insolvent or

make any compromise with his creditors, or attempt to do so, the Engineer-in-charge may, by notice in writing rescind the contract. Also, if any bribe, gratuity, gift, loan, perquisite, reward or advantage pecuniary or otherwise, shall either directly or indirectly be given promised or offered by the contractor for any of his servants or agents to any public officer or person in the employ of government in any way relating to his office or employment or if any such officer or persons shall become in any way directly or indirectly interested in contract, the Engineer-in-charge may thereupon by notice in writing rescind the contract in the event of contract being rescinded, the security deposit of the contractor shall thereupon stand forfeited and be absolutely at the disposal of the government and the same consequences shall ensure as if the contract had been rescinded under Clause-79 whereof and in addition the contractor shall not be entitled to recover or be paid for any work therefore actually performed under the contract.

5.1.2 GENERAL TECHNICAL REQUIREMENTS

1. Casing pipe shall be of mild steel. These pipes shall be fabricated as per IS: 3589 and/or IS: 5504 from steel plates/HR coil conforming to IS: 2062. The casing pipe shall be designed for MBG loading standard or any other current loading standard as defined in IRS Bridge Rules
2. The field welds (of casing pipe) shall be tested cent percent radio-graphically as per IS: 1182
3. The diameter of casing pipe & minimum thickness of the casing pipe to be provided shall be as per the approval from the concerned authority.
4. For insertion of a casing pipe, boring shall be carried out with cutting edge to drill a horizontal bore. The hole drilled shall be of suitable size to accommodate casing pipe. The casing pipe shall be inserted along with boring to keep the formation supported to prevent any settlement of the existing structure. The casing pipe shall be installed with even bearing throughout its length. The work shall be done under the supervision of the concerned authority under suitable speed restrictions & precautions as may be stipulated by the authority.
5. The casing pipe will be minimum 1.5 m below the formation level and 0.9 m below the natural ground level. The length of casing pipe shall be up to the end of SH / NH land boundary to accommodate future requirements. Casing pipe shall be provided with minimum 50 mm dia vent pipe MS or CI. Bottom and side rollers of suitable size are to be provided inside casing pipe at 4-meter interval to facilitate insertion of water carrier pipe of required diameter. The ends of casing pipe shall be suitably sealed.
6. Care shall be taken to isolate the pipeline crossing installation from aerial electrical wires & shall be suitably insulated from underground conduits carrying electrical wires.
7. The pipeline shall be tested for specified test pressure to check for leakage.
8. To protect casing pipes as well as carrier pipe against corrosion, following action will be taken:
 - a. Outer surface of casing pipe will be painted with a coat of zinc rich epoxy primer of thickness 4 mils.

- b. Inside surface of casing pipe shall be painted with high build epoxy to RDSO specification No. M&C C/PCN/111/88 to a dry film thickness of 415 micron.
 - c. Suitably 3 roller supports at 4 m interval of steel pipe shall be welded spacers of high-density polyethylene or either similar material shall be installed in between the carrier & casing pipe to prevent carrier pipe forming metallic contact with casing pipe.
9. The alignment of the pipeline shall be so decided that it crosses the highway nearest to right angle.
 10. These special conditions and the schedule of work shall govern the work to be executed under this contract in addition to and / or in part super session of the General Conditions of Contract & Standard Specifications.

In order to avoid interference to road traffic excavation on existing road intercepted on pipeline alignment, PIPE PUSHING technique is envisaged in preference to any other conventional methods for the laying of pipeline through such road particularly for State Highway / National Highway / Major District Road crossing intercepted.

The MS pipe shall be as per detailed specifications given in this volume.

5.1.3 SCOPE ALSO COVERS

1. Shifting of service lines and reinstating the same
2. Demolishing all types of R. C. C., masonry work
3. Pumping / Bailing out water etc. if required.

No extra payment shall be made for dewatering when any work is done below water level.

The rate quoted by the Contractor shall be deemed to include diversions, bunds, approach road to the site of work etc. and such other works, necessary for setting out and execution of works in different phases as directed by the Engineer-In-Charge and / or his representative. No extra payment shall be made for such works or any other phase works carried out which are necessary for satisfactory execution of work.

Any timbering work required to be done for retaining earth during excavation of foundations shall have to be arranged by the contractor which shall conform to the provision laid down in the relevant IS codes.

The working area may be water logged during monsoon or any untimely rains. Contractor should take the special note while preparing the program schedule for this work. Contractor should also specify the method which they propose to avoid water logging in the working area. However, it may be clearly noted that bailing out / pumping out of water shall not be paid separately.

The rate is basis for specified length as per detail description in the item. However, during execution as per site condition, if the length of pushing is increased / decreased the excess or reduce payment will be adjusted according.

5.2 PIPELINE MARKERS

5.2.1 INTENT

The scope of work includes the minimum requirements for supply, fabrication and erection of

pipeline markers to be installed at various locations along the pipe route.

Following two (2) types of pipeline markers are proposed for the transmission mains.

- a. Pipeline Warning Signs
- b. Kilometer Markers

The pipeline markers shall be installed, as far as possible, at locations where no hindrance to the regular use of the land or to the traffic is caused.

5.2.2 PIPELINE WARNING SIGN

Pipeline warning signs shall be generally installed at the following crossings:

- a. Roads (excepting cart roads & kuchha roads)
- b. Rivers
- c. Nallahs
- d. Railways, Oil / Gas Pipeline, Other Utility Service Lines

Pipeline warning sign will indicate existence of the buried pipeline at the crossing and display the name address of the client, name of the project and telephone number (for contact in case of emergency).

For the rest of the crossings as mentioned above, the warning signs shall be generally installed at a distance of 50 m on the upstream side only.

The warning sign shall be located 500 mm to the left of the pipe outside diameter, viewing in the direction of flow and shall face the item being crossed (i.e., road, river, rail track etc.).

5.2.3 KILOMETRE MARKERS

Kilometer markers shall be installed along the pipe route at every one Kilometer interval. Markers will display the distance (in full kilometer) from the upstream pumping station (in case of rising mains) or upstream reservoir (in case of gravity mains) and name of the client. Kilometer markers shall be located 500 mm to the left of the pipe centerline viewing in the direction of flow.

5.2.4 SCHEME OF PAINTING

The underground steel structure except that embedded in concrete shall be painted with coal tar epoxy of minimum 300-micron DFT. For over ground steel structure, one coat of primer & two coats of colour paint shall be applied.

Colour scheme to be adopted for the markers shall be subject to Employer's approval. Following colour scheme is proposed for reference:

- WARNING SIGN
 - a. All letters shall be painted black except for the word "Warning" which shall be painted red. Background colour shall be yellow.

- b. Post shall be painted with 250 mm wide alternate bands of black & white paint.
- c. All above ground steel structure shall be painted yellow.

- **KILOMETRE MARKERS**

- a. All above points for warning sign shall be equally applicable for Kilometer markers also.
- b. Figures shall be stenciled on both sides of the post.

5.2.5 LANGUAGE

Pipeline warning sign plates & kilometer markers shall be prepared in regional language in line with guideline for providing information as above & shall be got approved from the Engineer-in-charge.

5.3 THRUST BLOCK AND ANCHOR BLOCK

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

5.4 ENCASING PIPELINE

Encasing of pipeline with the reinforced concrete of desired grade as shown in the approved 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.

5.5 ARRANGEMENT FOR TRAFFIC DURING CONSTRUCTION

5.5.1 GENERAL

The Contractor shall at all times carry out work on the roads in a manner creating least interference to the flow of traffic while consistent with the satisfactory execution of the same. For all works involving improvements to the existing roads, the Contractor shall, in accordance with the directives of the Engineer-in-charge, provide and maintain, during execution of the work, a passage for traffic either along a part of the existing carriageway under improvement, or along a temporary diversion constructed close to the road. The Contractor shall take prior approval of the Engineer-In-Charge regarding traffic arrangements during construction.

5.5.1.1 PASSAGE OF TRAFFIC ALONG A PART OF THE EXISTING CARRIAGEWAY UNDER IMPROVEMENT

For widening/strengthening existing carriageway where part width of the existing carriageway is proposed to be used for passage of traffic, treated shoulders shall be provided on the side on which work is not in progress. The treatment to the shoulder shall consist of providing at least 150 mm thick granular base course covered with bituminous surface dressing in a width of at least 1.5 m and the surface shall be maintained throughout the period during which traffic uses the same to the satisfaction of the Engineer-in-charge. The continuous length in which such a work shall be carried out, would be limited normally to 500m at a place. However, where work is allowed by the Engineer-In-Charge in longer stretches passing places at least 20 m long with additional paved width of 2.5 m shall be provided at every 0.5 km interval.

After obtaining, permission of the Engineer-in-charge, the treated shoulder shall be dismantled, the debris disposed of and the area cleared as per the direction of the Engineer-in-charge.

5.5.1.2 PASSAGE OF TRAFFIC ALONG A TEMPORARY DIVERSION

In stretches where it is not possible to pass the traffic on part width of the carriageway, a temporary diversion shall be constructed with 7 m carriageway and 2.5 m earthen shoulders on each side (total width of roadway 12 m) with the following provision for road crust in the 7 m width:

- a. 200 mm (compacted) granular sub base;
- b. 225 mm (compacted) granular base course; and
- c. Premix carpet with Seal Coat/Mix Seal Surfacing.

The alignment and longitudinal section of diversion including junctions and temporary cross drainage provision shall be as approved by the Engineer-in-charge.

5.5.1.3 TRAFFIC SAFETY AND CONTROL

The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Engineer-In-Charge for the information and protection of traffic approaching or passing through the section of the highway under improvement. Before taking up any construction, an agreed phased program for the diversion of traffic on the highway shall be drawn up in consultation with the Engineer-in-charge.

The barricades erected on either side of the carriageway/portion of the carriageway closed to traffic, shall be of strong design to resist violation, and painted with alternate black and white stripes. Red lanterns or warning lights of similar type shall be mounted on the barricades at night and kept lit throughout from sunset to sunrise.

At the points where traffic is to deviate from its normal path (whether on temporary diversion or part width of the carriage way) the channel for traffic shall be clearly marked with the aid of pavement markings, painted drums or a similar device as per the directions of the Engineer-in-charge. At night, the passage shall be delineated with lanterns or other suitable light source.

One-way traffic operation shall be established whenever the traffic is to be passed over part of the carriageway inadequate for two-lane traffic. This shall be done with the help of temporary traffic signals or flagmen kept positioned on opposite sides during all hours. For regulation of traffic, the flagmen shall be equipped with red and green flags and lanterns/lights.

On both sides, suitable regulatory/warning signs as approved by the Engineer-In-Charge shall be installed for the guidance of road users. On each approach, at least two signs shall be put up, one close to the point where transition of carriageway begins and the other 120 m away. The signs shall be of approved design and of refractory type, if so directed by the Engineer-in-charge.

5.5.1.4 MAINTENANCE OF DIVERSIONS AND TRAFFIC CONTROL DEVICES

Signs, lights, barriers and other traffic control devices, as well as the riding surface of diversions shall be maintained in a satisfactory condition till such time they are required as directed by Engineer-in-charge. The temporary travelled way shall be kept free of dust by frequent applications of water, as directed by the Engineer-in-charge.

5.6 SURGE CONTROL SYSTEM FOR PUMPING MAIN

5.6.1 ACCEPTED CONTROL SYSTEM

1. EPC contractor has to design and analysis of surge system in pipe network of this package for surge pressure (i.e., Positive and negative) of various working scenarios within permissible condition as per specifications and standards including vetting by IISC / IIT. Supply and installation along with all accessories / equipment including all allied civil work / enclosures etc. complete. EPC contractor has to suggest suitable equipment for the surge control.
2. EPC contractor shall have to indicate the equipment of electric power with location to run the proposed system. The above factor is required for tender evaluation.
3. Following types of control systems are only accepted for control of water hammer pressures in the pumping mains.
 - a) Zero Velocity Valves and
 - b) Air Cushion Valves
4. The contractor has to submit the design of surge protection device and get approved by Engineer In-charge. Water hammer control devices shall be procured only after approval of the design as per design requirement.
5. The specification of water hammer control devices is furnished below. However, EPC contractor can propose alternative suitable system along with tender document for consideration.

5.6.2 WATER HAMMER CONTROL DEVICES

5.6.2.1 SPECIFICATION FOR ZERO VELOCITY VALVE

BODY:

The Spring-Loaded self-actuating Zero Velocity valve has an outer fabricated casing ('Main Body') in which a 'Central Rod' is held by struts. In order to create an annular flow, the included angle of the cone at upstream of the disc should be 75 - 100°C and the cone at downstream of the cone should be 20 - 35°C. The barrel at inlet and outlet of the valve should suit the pipe diameter. The entry barrels should have minimum length of 900-1000 mm, while the exit barrel should be minimum 500-650 mm long for the ease of installation. The total length of the valve should not be less than 3800 mm.

The valve should be provided with 1 (One) no. of manhole of internal dia 450 mm (minimum) on exit cone to facilitate attending the valve. A suitable cover shall be provided on manhole.

Two Bypass pipe with a Valve of 300 NB connecting upstream and downstream sides of valve should be provided. Minimum two plugs should be provided to mount Pressure gauges at the upstream and downstream of the valve.

Adequate transportation saddle should be provided on the valve as an integral part of the valve.

INTERNAL:

Closing Disc is mounted on 'Central Rod' clad with Stainless Steel (SS as per AISI304) for the adequate length so that the disc moves on the clad portion. Bush of the disc should be lined securely with Brass sleeve (minimum 3 mm thick) for smooth sliding of the disc.

Disc is held in closed position by a adequate number of 'Stainless Steel Springs' (SS as per AISI304). The anti-rotation guides should be provided on the edge of 'Central Disc' with minimum resistance to flow and minimum possibility to lock during sliding of the disc. The 'Anti Rotation Guide' should be clad with Stainless Steel Strip (SS as per AISI304) and 'Guide Fork' lined with brass liners. The valve should be provided with a 'Stationary Central Dome' to create an annular streamlined passage for smooth flow of water.

Painting: The Valve will be painted in Zinc Rich Epoxy Paint from outside and food grade epoxy from inside both in min two layers with total thickness of 406 microns.

Material of construction of principal parts:

Sr No	ITEM	MATERIAL
A	Entry Barrel Shell and Cone	MS IS: 2062 – 250 BR FE. 410W A
B	Exit barrel Shell and Cone	
C	Lap Ring	
D	Guide Dome	
E	Central Shaft (S.S. 304 Lined)	
F	Spring	SS 304

G	Bypass Pipe	Carbon Steel IS 1239 (part – I) / ASTM 106 B
H	Bush for Disc (with Brass inner Bush)	MS IS: 2062 – 250 BR Fe. 410 W A
I	Bush for Supporting ribs	
J	Hand Hole	

INSPECTION AND TESTING:

The Zero Velocity Valves shall be subjected to Hydrostatic body test by applying the rated pressure for the hydrostatic test. Both the ends (upstream and downstream) of the valve shall be closed using the dish/dummy ends. In case of more than one valves of same size and pressure rating, the valves can be joined together from barrel (or bolted in case of flange ended valves). The Bypass pipe along with valve will be mounted the zero-velocity valve. The bypass valve shall be kept in open condition during the testing. A pressure gauge shall be mounted on the Zero Velocity Valve to check the applied hydrostatic test pressure.

The 'Test pressure' specified shall be applied using the hand pump or motor pump for a duration of 15 (fifteen) Minutes. No water leakage is permissible through the main body of the zero velocity and bypass valve during the above period.

5.6.2.2 SPECIFICATION FOR AIR CUSHION VALVE

The valve consists of a 'Main Body' and 'Top Housing'. On the side of main body, two 'Air Inlet Valves' loaded with a light spring are fitted. The 'Inlet' is protected by a cover.

The 'Top Housing' has an opening for air escape. A spring loaded 'Poppet' with a brass seat and Neoprene 'Sealing Ring' covers the top of the opening. The spring pressure on the valve is adjustable by a screw (S.S. as per AISI-304).

The 'Housing' has a tapered outlet, the opening of which is adjustable by a tapered plug and Screw (S.S. as per AISI- 304). The outlet is protected by a cover. On its lower side a cage holding a ball float is fitted. 'Main Body', 'Top Flange', are fabricated from M.S. (as per I.S.2062/I.S.1239 Part I & II). The 'Top Housing' is made from high grade cast iron.

Main body, float ball and air inlet flange are hydraulically pressure tested. Stems of valves are in stainless steel (as per AISI-304), and work in 'Brass Bushes'. Sealing rings are of good quality rubber and seats are of brass. The Valve will be painted in Zinc Rich Epoxy Paint from outside and food grade epoxy from inside both in min two layers with total thickness of 500 microns.

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.D. 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, tees 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.

All flanges will be drilled as per I.S. 1538. Thickness of all flanges will be as per I.S. Thickness

of pipes Strength of steel pipes is verified to check effect of positive and negative pressures during transients due to power failure and surge protection devices shall be provided to avoid any damage to the pipeline integrity, shape and structure.

5.6.3 SURGE CONTROL SYSTEM - REQUIREMENTS

1. The requirements given in the tender documents are tentative. The contractor must carry out the surge analysis based on the longitudinal section, Pump and Motor characteristics of the selected pumps by the contractor.
2. During detailed engineering following information must be submitted based on the Surge Control System' selected by the contractor.

For design of surge control system following limits will be adhered to (The surge pressures will be estimated after all working pumps at designed discharge, trip simultaneously)

- a. Maximum upsurge anywhere in the system will not exceed 10.0 Kgf/cm² or 1.2 times the Normal Working Pressure at manifold whichever is lower.
- b. The lowest pressure (Minimum Down surge) anywhere in the system will not be lower than (-) 0.33 Kgf/cm² (i.e., @ 0.50 Kgf/cm² above absolute zero) (Only 50% of the installed air valves can be assumed as operative for this condition.).
- c. The contractor will submit Surge analysis without any control system to ascertain the requirement of surge control system and the results along with details will be submitted during detailed engineering in case of award of contract.

5.7 MODE OF MEASUREMENT AND PAYMENT

Measurement Unit: Number of Water Hammer Control Devices supplied, installed, and commissioned.

Measurement for road crossing of pipeline alignment is on running meter basis.

Payment Includes Supply of zero velocity valves and air cushion valves with all accessories, all jointing materials, hardware, transportation, loading/unloading, and site installation, testing, commissioning, and submission of certificates, rate excludes actuator.

6. MANUALLY OPERATED BUTTERFLY VALVE

Providing & erecting Ductile Iron D/F Butterfly valves IS 13095 with ISI Mark (PN-1.6) as Isolation Valves with jointing to pipe work (including all hardware and packing) water quality, having non-rising spindle with hand wheel and without bypass arrangement, spindle, etc. as per requirement, including providing and fixing expansion Bellow. Hydraulic tests certificate & certificate of material of construction of parts shall be submitted before dispatch of valve of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to site, stacking etc. complete rate for Butterfly valve including followings but Without Actuator. Also, including SITC of flange ends Expansion Bellow as per EJMA standards of overall length of minimum 300 mm, designed for 15 mm axial compression and 5 mm axial extension with tie rods etc. of following MOC & pressure ratings. MOC: Bellows: SA 240 Gr. 304; Internal Sleeve: SA 240 Gr. 304; Weld ends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B (Drilling as per IS 1538 / IS 6392) & Limit Rods & Nuts: CS - IS 1367. complete of same dia including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to site, stacking etc. complete rate for Butterfly valve including fixing in position.

Note: - The required size and quantity of above item is as per price bid.

6.1 GENERAL

- a. This specification covers the design, engineering, manufacturer, transportation to site, installing, testing double flanged and wafer type of metal seated, dual eccentricity ductile iron electrically/manually operated butterfly valves.
- b. Valves covered under this specification are electrically and manually operated. Fabricated valve will not be considered.

6.2 DESIGN CRITERIA

- a. Butterfly valve shall be as per IS 13095 (ISI Marked (up to 2000 mm dia.)) /BS 5155. Valve shall be suitable for mounting in any position.
- b. Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centerline.
- c. The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel and free from sharp projections.
- d. The valve seat shall be of integrally cast or renewable design. When the valve is fully closed, the seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.
- e. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.
- f. Valve shall be suitable for throttling purpose.
- g. All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.
- h. All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the

direction of rotation for opening and closing being indicated on the hand wheels.

6.3 SERVICE APPLICATIONS

- a. Valves shall be suitable for one or more of the following applications
- b. Tight Shut off- A valve having no visible leakage on the disc in closed position under test conditions
- c. Regulating - A valve intended for regulating purpose and which may have a Clearance between the disc and the body in close position.
- d. Low leakage - A valve which has specified maximum leakage rate on the disc in the closed position.
- e. Vacuum Condition - Where valves are to be used under vacuum conditions, the detailed design provision shall be mutually agreed between the purchaser and the manufacturer

6.4 NOMINAL PRESSURES

Valve shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (MPa) at 20° C temperatures as follows:

PN 0.25, PN0.6, PN1.0, PN 1.6, PN 2.0 & PN 2.5

6.5 PRESSURE/TEMPERATURE RATINGS

Maximum permissible gauge working pressure and operating temperatures shall be in accordance with IS 6418: 1971 and IS 13159 (Part-1):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 0°C.to 65 0°C.

6.6 BODY ENDS

6.6.1 Double Flanged Body Ends

- a. The dimensions of flanged body ends and drillings shall be in accordance with the IS 9523 (latest). Flanges as per any other specific requirements of the Owner may also be given “As Agreed” between the manufacturer and the Owner.
- b. 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.

6.6.2 Water Body Ends (Where ever applicable)

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

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

6.6.3 Face to Face Dimension

Face to face dimensions of double flanged and wafer types of valves shall be as per standard. Face to face dimensions is 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 or wafer type face to face are manufactured. Tolerance on face-to-face dimension shall be as follow.

Face to face Dimension of the Valve (mm)		Tolerance (mm)
Over	Up to and including	
0	250	± 2
250	500	± 3
500	800	± 4
800	1,000	± 5
1,000	2,400	± 6

6.6.4 Bodies

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

6.6.5 Disc and shafts

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 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.

6.6.6 Seating and linings

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

6.6.7 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.

6.7 OPERATION

6.7.1 Electrically and Manually Operated

All valves shall be electrically (pump house valve) and manually operated (rising main valves) and capable of operate at a differential pressure across the disc as marked on the valve.

6.7.2 Direction of Operation

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 traveling 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 traveling nut operators shall be packed with grease for life time operation. Gear / traveling 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 enclosure.

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

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.

6.8 TESTING

All valves shall hydrostatically test by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. There shall be no air entrapped within the part of the valves subjected to test pressure.

6.8.1 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.

6.8.2 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 water. Valves may be tested in any suitable manner as directed by Engineer-In-Charge. 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 per standard.

6.8.3 Seat Test

- a. 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 manufacture and the owner to avoid the possibility of damage under the condition of the test.

Nominal diameter (mm)	Minimum test duration(minutes)	
	Body Test	Seat Test
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 2.000	5.00	3.00

- b. 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 the valve disc during test and valves shall be drop tight. Seat test shall be carried out in both the direction of valve.
- c. The seat pressure applied on upstream side shall be equivalent to 1.6 (16 Kg/Cm²) times the maximum permissible working pressure at 20°C and shall be applied with water.

6.8.4 Disc Strength Test

- a. 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°C With disc in closed position, hydro test pressure shall be applied to the lower face of the disc for duration as per above table.
- b. 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 (Sampling test sample as per IS 2500).
- c. Pouring witness and sampling of the integral test bar shall be carried out at the foundry by TPI for the valves above 500 mm diameter. Necessary provision shall be made in the quality assurance plan (QAP) submitted by the agency for review and approval.

6.8.5 Positive material Identification (PMI Test)

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

6.8.6 Painting

Each valve shall be drained, cleaned, prepared & shot blast cleaning of valve should be done before application of paint. Cast Steel parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin-based coating with at least 75 microns dry film thickness is to be provided. In addition, the parts are to be provided with adequate number of coats of RAL 5005 Grade epoxy coating to a dry film thickness of 175 microns including primer coating.

6.9 TEST CERTIFICATES

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

VALVE TEST	LEAKAGE RATE
Tight shut of	No Visible leakage for duration of test
Low leakage	$0.1 \text{ mm}^2 / \text{s} \times \text{DN (sec 5)}$
Regulating	Not specified (outside the scope of this standard)

6.10 INSPECTION

- The Owner & TPI representative shall have access to the manufacturer's works at all reasonable times to inspect assembled valve at factory. The Contractor has to make necessary arrangements for testing facilities of the valves as per the relevant Standard at factory.
- Pouring witness and sampling of the integral test bar shall be carried out at the foundry by TPI for the valves above 500 mm diameter. Necessary provision shall be made in the quality assurance plan (QAP) submitted by the agency for review and approval

6.11 WITNESSING OF TESTS

When the Owner desires to witness the tests, this shall be specifically agreed in advance by Owner representative.

6.12 MARKING

Marking shall be cast integral on the body or on a plate securely attached to the body for 'DN' size and 'PN' rating. The markings shall be in accordance with I.S. 9866:1981 or Latest Edition.

6.13 PREPARATION FOR DISPATCH

- a. Valve shall be complete in all respect when dispatched. Each valve shall be drained, cleaned, prepared and suitable protected with 2 coats of red oxide on machined surfaces and rust preventive coats on machined and flanged surfaces for 'seaworthy dispatch' in such a way as to minimize the possibility of damage and deterioration during transit and storage.
- 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.

6.14 FIXING OF VALVES

- a. Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. Valves used in pipeline shall be straight through type. 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.
- b. The Contractor has to provide dismantling joint in rising main for easy assembly /disassembly and maintenance or replacement of the manually operated butterfly valve.

6.15 TECHNICAL PARTICULARS OF MANUALLY OPERATED BF VALVE(PN – 1.6)

Sr No	Description	Requirements
1	General	
1.1	Type	Both end flanged hand wheel / Gear operated / Actuator Operated as mentioned in BOQ
1.2	Rating of valves	PN 1.6
1.3	Manufacturing Standard	IS 13095 / BS 5155
1.4	Sizes and quantity	As per price bid
2	Materials of construction	
2.1	Internal Hardware	Stainless Steel AISI - 304
2.2	Body/ Disc	DI IS1865 Gr500/7

2.3	Body ring (Retainer/seat)	Stainless steel AISI -304
2.4	Shaft	Stainless steel AISI-410
2.5	Disc Seat	EPDM rubber
2.6	Disc Pin	SS 304
2.7	Bush	Stainless steel Backed PTFE
2.8	Nut Bolts	Stainless steel AISI -304
2.9	Flange End	IS 9523

6.16 MODE OF MEASUREMENT AND PAYMENT

Measurement: Per number of Butterfly Valve with expansion bellows, installed and commissioned.

Payment Includes supply and delivery of valve and bellows assembly, Loading/ unloading, transportation, insurance, installation and jointing including all hardware, Hydrotesting and certification, Documentation and submission of test certificates.

7. REFLUX VALVE (DPCV)

SITC of Providing and supplying ISI mark CI D/F Reflux Valves as per IS:5312 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. Also, including SITC of flange ends Expansion Bellow as per EJMA standards of overall length of minimum 300 mm, designed for 15 mm axial compression and 5 mm axial extension with tie rods etc. of following MOC & pressure ratings. MOC: Bellows: SA 240 Gr. 304; Internal Sleeve: SA 240 Gr. 304; Weld ends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B (Drilling as per IS 1538 / IS 6392) & Limit Rods & Nuts: CS - IS 1367. complete of same dia including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to site, stacking etc. complete.

Note: - The required size and quantity of above item is as per price bid.

7.1 DESIGN REQUIREMENTS

- a. The design and manufacture of the valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall relieve the Contractor of his responsibility.
- b. The non-return valves shall be of dual plate check valve type design. It shall be free from sharp projections.
- c. The valves shall be designed for minimum head loss. The valves shall have flanged ends.
- d. The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.
- e. Valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.
- f. Dual plate check valves shall conform to API 594. They shall have metal to metal sealing. The spring action shall optimize the equal closing rates of each plate especially when the friction coefficients are uneven due to one plate resting upon one another. The plates shall not drag on the seat while opening. The plates shall not vibrate under full or partial flow condition.
- g. In case of the nozzle check valve, the disc shall be correctly positioned at all times to achieve fully non-slam closure. The spring shall be fully shielded from the flow stream by the central flow diffuser.
- h. Sealing shall be metal to metal. The disc shall be stable and shall not vibrate under full or partial load conditions. The pressure designation of the valve shall be as per the Data Sheet.

7.2 CLEANING

Prior to factory inspection, all manufacturing waste such as metal chips debris and all other foreign matter shall be removed from interior of valve. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

7.3 PAINTING

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of coal tar epoxy paint. The resulting coating shall be uniform and smooth and shall adhere perfectly to the surface.

7.4 TESTING AND INSPECTION

- a. Valves shall be tested as per the relevant Indian standards. Specification IS 5312, Part – II, with latest revisions.
- b. Valves shall be offered for visual inspection and dimensional checks.
- c. The hydrostatic and water tightness testing shall be witnessed by the Owner.

7.5 FIXING OF VALVES

- a. Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. Valves used in pipeline shall be straight through type. 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.
- b. The Contractor has to provide dismantling joint in rising main for easy assembly /disassembly and maintenance or replacement of the manually operated butterfly valve.

7.6 TECHNICAL PARTICULARS OF DUAL PLATE CHECK VALVE (PN 1.6)

Sr. No.	Description	Requirement
1	General	
1.1	Type	Both ends flanged
1.2	Rating of Valves	PN 1.6
1.3	Manufacturing Standard	API 594 / 598
1.4	Sizes and quantity	As per price bid
1.5	Maximum pressure drops at design flow rate (mwc)	0.5
1.6	Maximum permissible leakage rate (cc/hr./mm diameter)	7.0
2	Materials of construction	
2.1	Body	DI IS1865 Gr500/7
2.2	Door & Door Face	DI IS1865 Gr500/7
2.3	Stop, hinge pin & washer	Stainless Steel – SS 304
2.4	Seat ring (Body)	Stainless Steel – SS 316

2.5	Bearings (Body & Plate lug)	PTFE
2.6	Seat ring (Plate)	Cast steel ASTM A216 Grade WCB With 13% Cr. Steel overlay
2.7	Spring	Stainless Steel – SS 410
2.8	Hardware	Carbon Steel IS 1367 CL 4.6/4.0
2.9	End Cover	Mild Steel
2.10	Flange End	IS 9523

7.7 MODE OF MEASUREMENT AND PAYMENT

Measurement Unit: Per number of reflux valve including expansion bellows, installed and commissioned.

Payment includes supply and delivery of reflux valve and expansion bellows, transportation, insurance, loading/unloading, and stacking, installation, jointing, and testing, submission of certificates and documentation.

8. MANUALLY OPERATED SLUICE VALVE

SITC of double flanged Gear Operated Sluice Valve generally conforming to IS:780 / IS: 2906, having body, door, cover in graded cast iron to IS:210, FG: 200, inside screw non-rising spindle of stainless steel - AISI 410, Body and door seat (four) ring of stainless-steel CF-8. Spindle nut of leaded TIN bronze grade LTB: 2 to IS:318. Valve seat tested to 10 kg/cm² and body to 15 kg/cm² flanges machined faced and drilled to IS: 1538 / 1976 Part-IV/VI. Hydraulic tests certificate & certificate of material of construction of parts shall be submitted before dispatch of valve of following class and diameter including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to site, stacking etc. Also, including SITC of flange ends Expansion Bellow as per EJMA standards of overall length of minimum 300 mm, designed for 15 mm axial compression and 5 mm axial extension with tie rods etc. of following MOC & pressure ratings. MOC: Bellows: SA 240 Gr. 304; Internal Sleeve: SA 240 Gr. 304; Weld ends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B (Drilling as per IS 1538 / IS 6392) & Limit Rods & Nuts: CS - IS 1367. complete of same dia including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to site, stacking etc. complete rate for sluice valve including Expansion Bellow but Without Actuator including fixing in position.

Note: - The required size and quantity of above item is as per price bid.

8.1 GENERAL

- a. This specification covers the design, engineering, manufacturer, transportation to site, installing, testing double flanged manually operated Sluice valves.
- b. Valves covered under this specification are manually operated. Fabricated valve will not be considered.

8.2 DESIGN FEATURES

- a. Sluice valve shall conform to IS 14846. Except pump house, these valves are to be installed in valve chamber.
- b. All valves of pump house and rising mains shall be non-rising stem type. However, for rising main, it shall be complete with its “as required length” “valve key” for valve operation from outside of chamber.
- c. The valves shall be free from sharp projections, which are likely to catch and hold stringy materials.
- d. Valves shall close with clockwise rotation of the handwheel. The direction of closing and opening shall be marked on the hand wheel.
- e. The stuffing box gland shall be of one-piece design.
- f. other technical data required please refer technical datasheet of volume –III (E)

8.3 FEATURES OF CONSTRUCTION

- a. The valves shall have non-rising spindle. The valves shall be provided with a valve position locking arrangement (Mechanical).
- b. Valves shall be provided with back seating arrangement. Renewable body and wedge ring

shall be provided. Valve shall be double flanged and holes drilling on flange shall conform to the standard IS 9523.

- c. The valves shall be completely overhauled before placing in position.
- d. Necessary joining materials viz. bolts, nuts, washers, packing etc. shall be provided by the contractor at his cost. The valves shall be fixed so as to have axis perfectly horizontal.
- e. If required the contractor shall also carry out drilling of holes of appropriate diameter in flanges in required numbers.
- f. A handwheel shall be provided for emergency operation. The handwheel drive shall be mechanically independent.
- g. The valve design shall take care of the pressure drop across the valve disc in case of partial opening of the valve and shall take care of the erosion and cavitation effect on the body and disc during such operation.
- h. Valve(s) subjected to backpressure shall have the valves eat, disc and the operator suitably designed to ensure trouble-free operation.
- i. Valve body shall be of Ductile iron with flanged ends.
- j. The shaft diameter shall take into consideration, the maximum to require for the valve operation, the maximum differential pressure across the valve disc when the valve is closed and the shock load due to accidental closure of the valve disc.
- k. The disc shall be designed for maximum differential pressure across the valve as well as the shock load due to accidental closure of the valve. Disc design shall offer minimum head loss. Disc shall also offer minimum resistance to flow Disc shape shall be contoured.
- l. Valve seats shall be of a design that permits removal and replacement at site and shall be securely clamped on the body or disc of the valve.
- m. Seat material shall be suitable for the operating conditions and handling fluid and may be suitably reinforced, if required.
- n. The seat design shall permit easy removal for replacement purposes without the need for removing the valve from the line. No deposited or welded seat rings permitted.
- o. The valve bearings shall be of self-lubricated type and shall not have any harmful effect due to handling fluid.
- p. Adjustable thrust bearing(s) shall be provided to hold the valve disc securely in the center of the valve seat.
- q. Each Sluice Valve shall be provided with a handwheel form annual operation. The handwheel and associated gearing arrangement shall be designed to limit the maximum manual effort to around twenty (20) kg for valve operation. For the Valves located at in accessible position, it shall be provided with extension spindle and floor stand or hand lever/round chain to facilitate manual operation.

8.4 OPERATION

All valves shall be electrically (pump house valve) and manually operated (rising main valves) and capable of operate at a differential pressure across the disc as marked on the valve.

8.5 INSPECTION AND PERFORMANCE TESTS

- a. Manufacturer shall conduct all tests and stage inspections required to ensure that the equipment offered by him conform to the specification requirement.
- b. Test certificates for all shop tests shall be furnished to Consultant / Owner for approval. The Client may witness the tests, if he so desires.
- c. The Contractor shall arrange for inspection of valves at manufacturer's premises and shall arrange for testing of valves for body test pressure and seat test pressure of all the valves to be supplied in presence of Consultant / Owner in line with the approved Quality Assurance Plan.
- d. Defects noted during inspection, test and operation of valves shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Consultant / Owner.

8.6 VARIOUS TESTS

8.6.1 Material Test

Material to be used for the valve components shall be of tested quality. Chemical analysis and mechanical test on materials to be used shall be done as per relevant standard.

8.6.2 Non-destructive Test

Valve body and disc shall be subjected to Non – Destructive Testing (NDT). Components subjected to NDT and shall be stamped for identification.

8.6.3 Hydrostatic Test

Each valve body shall be subjected to hydro static test as specified. For valves to back subjected pressure condition, leakage test shall be carried out on both sides of the disc.

8.6.4 Performance Test

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

8.6.5 TESTS AT SITE

Performance of the valves shall be tested at site at actual working condition.

8.7 CLEANING

Prior to factory inspection, all manufacturing waste such as metal chips debris and all other foreign matter shall be removed from interior of valve. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

8.8 PAINTING

Valves shall first give two coats of zinc base primer after completely cleaning the surface and the nit shall be coated with three coats of epoxy paint. The resulting coating shall be uniformed smooth and shall adhere perfectly to the surface.

8.9 HANDWHEEL

A hand wheel shall be provided for emergency operation. The hand wheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency manual operation in a reasonable time.

8.10 TESTS AND INSPECTION

Valve shall be offered by vendor for visual inspection before shipment. Valves shall be tested as per the relevant standards. The hydro static testing shall be witnessed by the purchaser.

8.11 MATERIAL OF CONSTRUCTION

All sluice valves shall be of body Ductile Iron, Spindle SS. All valves shall be supplied with matching companion flanges with necessary bolts, nuts and gaskets.

8.12 DUCTILE IRON SLUICE VALVES

End flanges shall be Ductile iron with the body.

The body to bonnet joint shall be flanged, male & female, tongue & groove or ring joint type. The bonnet joint shall have at least four through bolts.

8.13 FIXING OF VALVES

- a. Loading at store and unloading at site of works shall be done carefully using suitable mechanical handling devices such as crane, chain pulley etc. Valves used in pipeline shall be straight through type. 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.
- b. The Contractor has to provide dismantling joint in rising main for easy assembly /disassembly and maintenance or replacement of the manually operated Sluice valve.

8.14 ELECTRIC ACTUATOR

- a. Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and head stocks shall be provided with adequate points for lubrication.
- b. The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.
- c. The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.
- d. The starter housing shall be fitted with contacts and terminals for power supply, remote

control and remote positional indication, and shall also be fitted with internal heaters so as to provide protection against damage due to condensation. Heaters shall be suitable for single phase operation. The heaters shall be switched “ON” when the starters are “OFF” and shall be switched “OFF” when the starters are “ON”.

- e. Only for pump house Sluice Valve shall be attached with electric actuator.
- f. However, for rising main “CI SV” (Refer Technical Particulars 7.16 3b & 3c) shall be with suitable size manually gear attachment because of its isolated cross-country different locations.
- g. Electric actuator for “DI SV” (Refer technical Particulars 7.16 3a) of pump house shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position. If required in future, these positions (open or closed position) shall be computable for extending its signals with RS 485 Ethernet port to central control room through PCB-SCADA system.
- h. Each starter shall be equipped as follows:
 - i. A.C. electric motor.
 - ii. Reduction gear unit.
 - iii. Torque switch mechanism complete with set of torque switches.
 - iv. Limit switch mechanism complete with set of limit switches.
 - v. Hand wheel for manual operation.
 - vi. Hand-auto changeover lever with suitable locking arrangement.
 - vii. Local control switch / push buttons
 - viii. 415 V / 240 V AC control transformer
- i. The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ time the maximum required torque and shall be suitable for at least 15 minutes continuous operation.
- j. All local controls shall be protected by a lockable cover.

8.15 TECHNICAL PARTICULARS OF SLUICE VALVE (PN – 1.6)

Sr. No.	Description	Requirement
1	General	
1.1	Type	Both end flanged hand wheel / Gear operated / Actuator Operated as mentioned in BOQ
1.2	Rating of Valves	PN 1.6
1.3	Manufacturing Standard	IS 14846
1.4	Sizes and quantity	As per price bid

2	Materials of construction	
2.1	Body	DI IS1865 Gr500/7
2.2	Bonnet	DI IS1865 Gr500/7
2.3	Wedge	DI IS1865 Gr500/7
2.4	Gland	DI IS1865 Gr500/7
2.5	Stem	SS 410
2.6	Body Ring/Wedge Ring	IS 318 Gr LTB-2
2.7	Gland Packing	EPDM
2.8	Nut Bolts	SS 304
2.9	Wedge Nut and Stem Nut	IS 318 Gr LTB-2
2.10	Hand Wheel	Ductile Iron
2.11	Flange End	IS 9523

8.16 MODE OF MEASUREMENT AND PAYMENT

Measurement Unit: Per number of sluice valve including expansion bellows installed and commissioned.

Payment includes supply and delivery of sluice valve and expansion bellows, all taxes, transportation, insurance, octroi, loading/unloading, stacking, installation, jointing, and hydrostatic testing, documentation and submission of test certificates.

9. TAMPER PROOF AIR VALVE

9.1 GENERAL

kinetic Air valve with isolation valve confirming to IS 14845 (latest), AWWA C 512, having one outlet of large capacity for admission and release of bulk volume of air during emptying and filling of the pipeline and another having small outlet for escape of smaller quantities of trapped air.

The ball sealed orifice shall always remain open while air is exhausting and is immediately closed when Water rises in the chamber, lifts 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) ball to drop into when the valve 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 to 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 all air escape at 300 m/sec. The total impact force on the 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 low-pressure cover shall be massive and designed to withstand full operating thrust in working Conditions.

The 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 as per IS: 210 grade FG 260.

9.2 JOINTING MATERIAL

Each valve shall be supplied with all necessary joints on all the flanges of valve supplied under this Contract including those flanges which will be jointed to pipe system. The lengths of bolts shall be assumed to be suitable for jointing MS pipes.

The cost of all jointing material supplied under the contract shall be inclusive of rates. Joint ring shall be of flat section at least 3 mm thick. It shall be of rubber in accordance with IS: 638 Or its latest edition (specification for rubber and insertion jointing) of hardness proven in practice so as to form a water tight joint and use of jointing paste shall not be allowed. Bolt holes shall be drilled according to centre lines. Bolt heads and nuts shall be hexagonal and shall confirm to IS: 1363 (Specification for black hexagonal bolts, nuts and black hexagonal Screws).

9.3 BALL

The ball of large orifice shall bear a calculated mathematical relation with inlet diameter of the valve (i.e., the average cross section area of escaping air stream) so that it will result in the ball being blow shut by a stream of water but held down by a stream of air.

The buoyancy of the floats shall be such that it will ensure effective sealing of large orifice even at low pressures.

The weight of floats of the same size and type shall not differ by more than 2%. The SS material

used in the manufacture of floats shall be suitable for perfectly sitting on the large orifice. The float provided in high pressure chamber, manufactured from SS, shall be also being suitable for seating on the small orifice.

9.4 HIGH PRESSURE ORIFICE

The high-pressure orifice and the high-pressure chamber shall be so designed that the orifice is effectively sealed in working condition by float.

The material of the orifice shall be SS. 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.

9.5 VALVE FLANGE

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 (Specification of CI fittings for pressure pipes for water etc.). All flanges shall be supplied with matching companion flanges, nuts, bolts and gaskets.

9.6 CLEANING

Prior to the factory inspection, all manufacturing waste such as metal chips, debris and all other foreign material shall be removed from interior of valve. All mill scale, rust, oil, grease, chalk and all other deleterious material shall be removed from the interior and exterior surfaces.

Valves shall first be given two coats of zinc base primer after completely cleaning the surface and then it shall be coated with three coats of epoxy paint. The resulting coating shall be Uniform and smooth and shall adhere perfectly to the surface.

Valves used in pipes carrying water, the inside coating shall not contain any constituent soluble in water or any ingredient which could impart any taste to the water.

9.7 TESTING

All valves shall hydrostatically test by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. There shall be no air entrapped within the part of the valves subjected to test pressure. Test pressure as per AWWA C512 or API 598.

9.8 POSITIVE MATERIAL IDENTIFICATION (PMI TEST)

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

9.9 TEST CERTIFICATES

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

9.10 MARKING

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

9.11 PAINTING

Each valve shall be drained, cleaned, prepared & shot blast cleaning of valve should be done before application of paint. Cast Steel parts shall be sand blasted to near white cleaning before painting. Edges, sharp covers etc. shall be ground to a curve before sand blasting. A primer coat of a zinc rich epoxy resin-based coating with at least 75 microns dry film thickness is to be provided. In addition, the parts are to be provided with adequate number of coats of RAL 5005 Grade epoxy coating to a dry film thickness of 175 microns including primer coating.

Note: 50% Quantity shall be witnessed at Factory site at the time of final inspection.

9.12 DOCUMENTS / DRAWINGS TO BE SUBMITTED ALONGWITH TENDER

- a. Preliminary outline dimensional drawings.
- b. Typical cross section drawings with bill of material and material of construction and necessary Supports for mountings.
- c. Flow v/s head loss curve for valves.
- d. List of spare

9.13 TECHNICAL PARTICULARS OF AIR VALVE

Sr. No.	Component	PN- 1.0/ 1.6/ 2.0
1	Body	ASTM A216 Gr. WCB
2	Cover	ASTM A216 Gr. WCB
3	Float	SS 304
4	Seat	EPDM
5	Float Guide	SS 304
6	Orifice	SS 304
7	Gasket	EPDM
8	Nut Bolt	Stainless Steel
9	Flange End	ISO-7005-1

9.14 MODE OF MEASUREMENT AND PAYMENT

Measurement Unit: Number of air valve assemblies supplied, installed, and commissioned.

Payment includes Supply of air valves, sluice valves, raising pipes with epoxy coating, Jointing materials, concrete encasement, painting, hardware, and mounting supports, transportation, insurance, loading/unloading, installation, and testing, submission of test certificates.

10. COFFER DAM

10.1 General

This item involves the design, construction, and maintenance of a coffer dam to facilitate the safe execution of works related to a submerged well and pump house in the site area as per the specifications provided in the tender documents. The coffer dam shall be designed to withstand the hydrostatic and hydrodynamic pressures expected during the work period and must ensure a dry and safe working area.

10.2 Scope of Work

The scope includes, but is not limited to:

1. Site Investigation and Design:

- Conduct a detailed site survey, geotechnical analysis, and hydrological assessment.
- Prepare structural and hydraulic designs of the coffer dam, including dimensions, materials, and anchoring systems.
- Submit design drawings and calculations for approval by the Engineer-in-Charge.

2. Construction Activities:

- Mobilize necessary machinery, materials, and manpower.
- Construct the coffer dam using suitable materials (earthen, RCC, sandbags, steel sheet piles, or combination as approved).
- Provide dewatering arrangements, sealing, and reinforcement as required.
- Ensure stability against seepage, sliding, and overturning.

3. Safety and Protection Measures:

- Install safety signage and barriers.
- Ensure all work adheres to environmental, health, and safety regulations.
- Provide continuous monitoring during the active phase of construction.

4. Maintenance and Removal:

- Maintain the coffer dam during the entire working period.
- Dismantle and dispose of the structure responsibly after completion of the well and pump house works, restoring the site to its original condition or as directed.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled ‘Design Criteria for Structural Design’ and ‘Technical Specification of Civil Works’. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

10.3 Workmanship

1. Materials:

- All materials must comply with IS standards and be approved prior to use.

- Materials typically used may include earth fill, boulders, sandbags, steel sheet piles, geotextiles, and concrete, depending on site conditions.

2. Execution:

- The dam should be built to precise levels and dimensions indicated in the approved design.
- Water-tightness is essential; adequate sealing must be ensured.
- Regular inspection and repairs must be carried out during the active phase.

3. Environmental Considerations:

- Minimize disturbance to water flow and aquatic life.
- Ensure silt control and waste management.

10.4 Mode of Measurement and Payment

- Unit of Measurement is on running meter (Rmt) basis or as per tender provision.
- Payment:
- Will be made based on the completed and approved work and on running meter (Rmt) basis.
- Includes all costs for design, labor, materials, machinery, dewatering, safety, and dismantling.
- No extra payment will be made for maintenance or delays due to water level changes unless specified.

10.5 Approvals and Documentation

- Submit design and construction methodology to the Engineer-in-Charge for approval before execution.
- Provide Design reports, As-built drawings, Maintenance logs, Completion and dismantling certificates etc. to the department.

11. INTAKE WELL

11.1 General

This item covers the designing and construction of a Reinforced Cement Concrete (RCC) Intake Well at site location, in accordance with the relevant technical specifications, standards, and the approved tender documents. The work shall be executed using RCC of grade M20 and reinforcement steel of Fe-500 grade. The structure must be designed to withstand hydrostatic pressure, uplift, seismic forces, and operational loads.

11.2 Scope of Work

The scope includes:

1. Design Phase:

- Site visit and data collection.
- Preparation of detailed structural and hydraulic design.
- Submission of detailed drawings, bar bending schedules, and design calculations for approval.
- Design must conform to IS 3370 (for water-retaining structures), IS 456, and relevant codes.

2. Construction Phase:

- Excavation and dewatering, if necessary.
- Construction of intake well foundation and substructure.
- RCC works using M20 grade concrete with Fe-500 TMT reinforcement.
- Installation of intake screens, bell mouth entry, and other hydraulic features as per design.
- Backfilling and site restoration post-completion.

3. Quality Control:

- Concrete mix design approval before work.
- Cube testing, slump testing, and steel testing as per standard norms.
- Supervision by qualified civil engineers.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

11.3 Workmanship

1. Materials:

- Cement: OPC 43/53 grade.
- Aggregates: Clean, crushed angular aggregates confirming to IS 383.
- Reinforcement: Fe-500 TMT bars conforming to IS 1786.

- Water: Potable quality as per IS 456.

2. Construction Methodology:

- RCC work shall be executed using shuttering, centering, and vibration to avoid honeycombing.
- Proper curing (minimum 14 days) is mandatory for all concrete components.
- Reinforcement must be placed as per structural drawings and tied securely.

3. Safety and Environmental Compliance:

- Adequate safety measures (scaffolding, PPE, signage) to be followed.
- Site to be kept clean, with proper disposal of debris and waste.

11.4 Mode of Measurement and Payment

- Unit of Measurement: per number basis or as per tender.
- Payment Basis:

Based on actual quantity or as per itemized schedule.

Includes cost of design, labor, materials, machinery, scaffolding, dewatering, and curing.

No separate payment for design unless specified.

11.5 Submission & Documentation

- Contractor must submit - Design calculations and drawings, Reinforcement records (bar bending schedule, site inventory), As-built drawings after completion.

12. RCC PIPE

12.1 General

This item includes the supply, transportation, and laying of ISI-marked R.C.C. pressure pipes, made with Sulphate Resisting Cement (SRC), from the intake well to the sump of the pump house. The scope includes delivery at site, proper laying, jointing (collar or rubber ring), bedding, and trench works, as well as ancillary structures like air vents and joint encasement in RCC.

All works shall comply with ISI standards (IS 458:2003 or latest) and must be suitable for water conveyance in submerged and aggressive soil conditions.

12.2 Scope of Work

The work includes:

1. Manufacturing & Supply:

- Supply of ISI-certified R.C.C. pipes of specified class (NP2/NP3/NP4) and diameter.
- Pipes must be manufactured using Sulphate Resisting Cement and reinforced as per IS norms.
- Pipes shall be of standard length and suitable for collar joints or rubber ring joints.

2. Transportation and Handling:

- Delivery of pipes to site including loading, unloading, stacking, and insurance.
- Includes freight, octroi, transit insurance, and third-party inspection charges.

3. Installation:

- Excavation of trench in all types of soil strata.
- Preparation of pipe bedding using sand or lean concrete.
- Laying and alignment of pipes, including required slopes and curves.
- Jointing using either collars with cement mortar or rubber gaskets, ensuring watertight sealing.
- Air vent pipes shall be installed at high points.
- Cradle concrete of M20 and encasement of joints with RCC as per design.
- Backfilling with suitable material after joint testing.

4. Ancillary Works:

- Construction of air vents, thrust blocks, anchor blocks if required.
- Testing of pipeline for leakage before commissioning.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

12.3 Workmanship

1. Pipe Quality:

- All R.C.C. pipes must conform to IS 458 and be inspected before dispatch.
- Pipes must be free from cracks, surface defects, or honeycombing.

2. Jointing:

- Collar joints shall be properly aligned and sealed with 1:1 cement mortar or approved gasket rings.
- All joints to be tested for leakage by hydrostatic pressure test.

3. Bedding and Encasement:

- Minimum 100 mm sand bedding below pipe or as per drawing.
- RCC cradle around joints (M20 grade) reinforced with Fe-500 TMT steel bars.

4. Safety:

- Proper shoring and barricading of trenches must be ensured.
- Workers must use PPE and trenches shall be inspected daily for stability.

12.4 Mode of Measurement and Payment

- Unit of Measurement: Running Meter (RM) of laid and tested pipe (including all components).
- Payment Includes:
 - a. Cost of R.C.C. pipe with SRC and reinforcement
 - b. Transportation, handling, and insurance
 - c. Excavation, bedding, laying, jointing, testing
 - d. RCC cradle, joint encasement, TMT steel, and air vents
 - e. Backfilling and site cleanup
- No separate payment shall be made for minor fittings, bends, or tools required.

12.5 Documentation and Approvals

- Contractor must submit ISI certificates for pipes, Test results (crushing strength, permeability, pressure test), Site layout plan and pipe-laying logbook, As-built drawings upon completion.

13. HR GATE

13.1 General

This item includes the providing, fabrication, painting, transportation, and erection of Hydraulic Regulation (HR) gates, comprising both service gates and emergency gates, along with all necessary embedded parts and hoisting arrangements. All work shall be completed as per approved design and drawings, including surface finishing and protective painting, and shall comply with standard specifications.

13.2 Scope of Work

The complete scope includes:

1. Design Confirmation:

- Fabrication and erection to be done as per approved G.A. (General Arrangement) drawings and detailed fabrication drawings issued by the Engineer-in-Charge.
- Gate components must comply with IS 4622, IS 3043, IS 2062, or other relevant standards.

2. Material Supply and Fabrication:

- Mild Steel (MS) or structural steel to be used (IS 2062 grade).
- Fabrication of gate leaf, stiffeners, skin plate, seals, and frame.
- Fabrication of embedded parts (anchor frames, guide channels, sill beams, etc.).
- Machining of contact surfaces and alignment for smooth operation.

3. Painting and Finishing:

- Surface preparation by sand blasting or wire brushing.
- One coat of epoxy zinc primer and two coats of epoxy paint (as per IS 2932 or approved specification).
- Finish color and coating system to be approved by the department.

4. Transportation and Handling:

- Transport fabricated gates and parts to site including loading, unloading, and insurance.
- Safe storage and handling at site without distortion or damage.

5. Erection and Installation:

- Installation of embedded parts into RCC structure with proper alignment.
- Erection of gate leaf and frame, ensuring water-tightness and ease of movement.
- Installation of sealing arrangements (rubber seals, bronze contact strips, etc.).
- Installation of hoisting mechanism (manual or mechanical, as per design).

6. Testing and Commissioning:

- Dry run testing of gate movement.
- Water-tightness check and final adjustments.
- Submission of test reports and O&M instructions.

Note: - All design and construction parameters not explicitly stated herein shall comply with

the applicable provisions outlined in the chapters titled ‘Design Criteria for Structural Design’ and ‘Technical Specification of Civil Works’. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

13.3 Workmanship

1. Welding and Fabrication:

- All welding shall be done by certified welders, and tested by dye-penetrant or ultrasonic methods.
- Components must be dimensionally accurate and free from warping or distortion.

2. Tolerances:

- As per IS code tolerances and engineering standards to ensure proper sealing and movement.

3. Safety and Standards:

- Work must adhere to all applicable safety standards (scaffolding, PPE, rigging).
- Electrical or mechanical hoisting system must comply with IS standards and include locking mechanism, limit switches, and hand operation provision.

13.4 Mode of Measurement and Payment

- Unit of Measurement: Per Square Meter (Sqm) of gate surface area or as per tender provision.
- Rate Includes:
 - a. All materials (steel, seals, bolts, hoisting gear)
 - b. Fabrication, painting, transportation
 - c. Erection, embedded parts, hoisting system
 - d. Testing, commissioning, and documentation
- No extra payment shall be made for minor accessories, bolts, nuts, or fitting unless specified.

13.5 Documentation and Submission

- Contractor must submit the Fabrication and erection drawings, Welding and paint test reports, Material test certificates (steel, paint, seals), Operation and Maintenance (O&M) manual, As-built drawings and commissioning report.

14. PUMP HOUSE

14.1 General

This item refers to the designing and construction of a Pump House with an underground sump, panel/control room, loading/unloading bay, retaining wall, and associated civil, electrical, and MEP works. The structure shall be a Reinforced Cement Concrete (RCC) frame structure with M20 grade concrete and Fe-500 grade reinforcement steel. All works shall be completed as per detailed drawings, specifications, and instructions of the Engineer-in-Charge (EIC).

14.2 Scope of Work

1. Design & Engineering

- Preparation of detailed architectural and structural drawings.
- Structural analysis and design conforming to IS codes (IS 456, IS 3370, IS 875, etc.).
- Approval of all designs and drawings from Engineer-in-Charge.

2. Civil Construction

- Excavation for foundation, sump, and pipeline manifold area.
- Construction of:
 - Underground RCC sump with inlet and outlet arrangement.
 - Pump room and panel/control room with RCC columns, beams, slab, and brick masonry walls.
 - Loading/unloading bay with adequate height and ramp if needed.
 - Flooring with tiles or IPS as specified.
 - Retaining walls and accessibility embankments around the pump house.
 - RCC manifold and thrust blocks for pipeline/header connections.
 - RCC slab over sump with openings for pump installation.
 - Backfilling with selected soil from outside, ramming, watering, and compaction in layers.

3. Finishing Work

- Brickwork, internal and external plastering.
- Painting (interior and exterior) with weatherproof acrylic or approved brand.
- Doors, windows, and ventilators as per drawing.
- Furniture installation for control room (table, chair, rack, etc.).
- Tiling, dado work, and false ceiling (if specified).

4. Mechanical & Electrical Works

- Air conditioning system for the control/panel room.
- Electrical wiring, lighting, switches, DBs, and conduit layout.
- Provision for cable trays, pump control panels, and earthing pits.
- Cable trench with cover for cable routing.

5. Site Development & Miscellaneous

- Site grading, leveling, and compaction.
- Walkways, access roads (if required), and drainage around pump house.
- Manifold and header pipe connections with proper RCC support.
- Safety signage, railing, and lighting for operation during night.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

14.3 Workmanship

1. Concrete & Reinforcement:

- Use M20 grade concrete with controlled batching.
- Use Fe-500 grade TMT bars with proper lapping, anchoring, and cover.
- Curing for at least 14 days and cube testing at regular intervals.

2. Brickwork & Plastering:

- Brickwork using approved class bricks in 1:6 cement mortar.
- Plastering in 1:4/1:6 cement mortar, smooth finish, and curing.

3. Flooring & Finishing:

- Floor should be slip-resistant and durable, using tiles/IPS/polished concrete as directed.
- High-quality paint with primer and putty base application.

4. Soil Backfill & Compaction:

- Selected soil to be approved by EIC.
- Compacted in layers of 150 mm with watering and mechanical rammers.

14.4 Mode of Measurement and Payment

- Unit of Measurement: per number basis or as per tender BOQ.
- Rate Includes:
 - a. All civil, structural, electrical, and finishing works.
 - b. RCC and reinforcement for sump, columns, slabs.
 - c. Brick masonry, plastering, and painting.
 - d. Soil backfills, ramming, and consolidation with external soil.
 - e. Furniture, air conditioning, electrical and mechanical arrangements.
- No separate payment shall be made for Temporary works, scaffolding, curing water, etc., Mobilization/demobilization, Safety equipment or routine testing.

14.5 Documentation and Approvals

Contractor shall submit the Structural and architectural drawings (pre and post construction),

Concrete cube test results, Steel test certificates, O&M Manual for air conditioning and electrical system, As-built drawings for all services and structural elements.

15. RCC CHAMBER

15.1 General

This item covers the construction of cast-in-situ M20 grade RCC chambers designed to house Flowmeter, Butterfly Valve (BFV), Sluice Valve (SV), Reflux Valve (RV), and Air Valve at various locations. Chambers shall be constructed as per detailed drawings, specifications, and instructions of the Engineer-in-Charge (EIC).

15.2 Scope of Work

- Construction of RCC chambers of required size with wall thickness, bottom slab thickness, and top slab thickness as per drawings.
- Use of M20 concrete for RCC with minimum reinforcement using Fe415 TMT bars as specified.
- Provision of Plain Cement Concrete (PCC) 1:3:6 at the bottom base for proper bedding.
- Excavation and refilling of earth for chamber foundation and surroundings, including compaction.
- Proper curing of RCC for minimum required period as per standards.
- Providing and fixing precast concrete M20 top manhole cover with frame.
- Providing and fixing Heavy Duty PVC Steps embedded in chamber wall concrete for easy access.
- All work to comply with the detailed drawings, project specifications, and EIC instructions.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

15.3 Materials

Material	Specification
Concrete (RCC)	M20 Grade
Reinforcement	Fe415 TMT Bars
PCC	1:3:6 Cement Concrete
Manhole Cover	Precast Concrete M20 Grade
PVC Steps	Heavy Duty PVC, corrosion resistant

15.4 Workmanship

- All RCC work to be carried out with proper shuttering, mixing, placing, compacting, and curing.
- Reinforcement placement shall be as per structural drawings ensuring correct cover.

- PCC base to be compacted and leveled before RCC placement.
- Excavation shall be done to required dimensions and refilled with suitable material, compacted in layers.
- Manhole cover and PVC steps to be fixed securely and aligned properly.
- Curing shall be done for minimum 7 days or as directed by EIC for ensuring strength.

15.5 Mode of Measurement and Payment

- Measurement Unit: Number of RCC chambers constructed as per approved size and drawings.
- Payment Includes:
 - Excavation, PCC, RCC casting, reinforcement.
 - Curing, finishing works including manhole cover and PVC steps.
 - Refilling, compaction, and site cleanup.
 - All labor, materials, tools, equipment, and supervision.

15.6 Documentation

- Submit inspection and test reports for concrete strength.
- Reinforcement bar test certificates.
- As-built drawings indicating chamber locations and dimensions.
- Completion report certified by Engineer-in-Charge.

16. THRUST BLOCK

16.1 General

This item covers the providing, casting, and curing of in-situ thrust blocks in concrete grade M-20 as per the project specifications and applicable IS codes. Thrust blocks are to be constructed to safely transfer pipeline thrust loads to the surrounding soil and prevent pipeline movement.

16.2 Scope of Work

- Supply and use of Concrete Grade M-20, with proportions based on approved mix design or as per Table 9 of IS 456 by mass using weigh batching.
- Use of granite, quartzite, or trap metal aggregates of size 6 mm to 20 mm for RCC concrete.
- Complete casting of thrust block including:
- Excavation and preparation of foundation.
- Providing and placing Plain Cement Concrete (PCC) below the thrust block projecting minimum 15 cm on both sides.
- Providing and placing reinforcement bars — minimum 10 mm diameter @ 250 mm center to center on each concrete surface and around the pipe as per typical drawings.
- Formwork, centering, and scaffolding as required.
- Needle vibration for concrete consolidation.
- Curing of concrete for specified period.
- Application of waterproofing compound as per project requirement.
- Execution inclusive of all lead, lift, transportation, and material handling.
- Work shall be done in accordance with typical thrust block drawings and instructions of Engineer-in-Charge (EIC).

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled ‘Design Criteria for Structural Design’ and ‘Technical Specification of Civil Works’. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

16.3 Materials

Material	Specification
Concrete	M-20 Grade (as per IS 456, Table 9 or approved mix)
Aggregates	Granite, Quartzite, Trap metal (6 mm to 20 mm)
Reinforcement Steel	TMT bars, minimum 10 mm diameter @ 250 mm c/c
Waterproofing Compound	As specified by project requirements
PCC	1:3:6 mix for base below thrust block

16.4 Workmanship

- All work to be executed with skilled labor under supervision.
- Ensure proper excavation and compacted bedding for thrust block placement.
- Reinforcement to be tied and placed accurately as per drawing.
- Concrete mixing to be done with weigh batching and to achieve specified strength.
- Use needle vibrators for proper compaction of concrete.
- Maintain curing for minimum 7 days or as directed.
- Waterproofing compound to be applied uniformly to prevent water ingress.
- Ensure cleanliness and smooth finish of exposed surfaces.

16.5 Mode of Measurement and Payment

- Measurement Unit: Volume of RCC thrust block cast in cubic meters (m³).
- Payment Includes:
 - All materials including cement, aggregates, reinforcement, waterproofing compound.
 - Excavation, PCC base, formwork, scaffolding, compaction, curing, finishing.
 - All labor, machinery, transport, lead and lift.

16.6 Documentation

- Reinforcement cutting and bending schedules.
- Inspection and curing records.
- Inspection reports and as-built drawings.

17. ENCASING

17.1 General

This item covers the providing and casting of encasement for pipes using Cement Concrete (CC) Grade M-10 with specified trap metal aggregate, reinforcement, and proper workmanship as per project drawings and specifications.

17.2 Scope of Work

- Supply and cast Cement Concrete Grade M-10 for pipe encasing.
- Use trap metal aggregate of nominal size 12 mm to 50 mm, specifically 20 mm nominal size for this item.
- Provide and fix minimum temperature reinforcement of Fe 415 TMT bars at approximately 5 kg/m².
- Work includes:
 - Necessary formwork and shuttering.
 - Proper compaction and consolidation of concrete.
 - Adequate curing to achieve required strength.
 - Shaping encasement as per approved drawings.
 - Complete execution for various pipeline locations as directed by Engineer-in-Charge.
 - All lead, lift, transportation, and materials handling included.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

17.3 Materials

Material	Specification
Concrete	CC M-10 Grade
Aggregate	Trap metal 12 mm to 50 mm size, nominal 20 mm
Reinforcement	Fe 415 TMT Bars, minimum 5 kg/m ² for temperature reinforcement
Formwork	Suitable for concrete shaping and curing

17.4 Workmanship

- Reinforcement to be placed accurately and securely as per specifications.
- Formwork to be strong and leak-proof to hold concrete in shape.
- Concrete to be mixed uniformly, placed carefully around pipes, and consolidated using suitable methods.
- Proper curing for at least 7 days or as per project requirements.

- Ensure no damage or displacement of pipes during encasement.
- Finished encasement to be smooth and consistent with drawings.

17.5 Mode of Measurement and Payment

- Measurement Unit: Volume of concrete encasement in cubic meters (m³).
- Payment Includes:
 - Supply of concrete, reinforcement, formwork, and curing.
 - Labor, transport, handling, and execution.
 - Complete encasement works as per drawings and instructions.

17.6 Documentation

- Reinforcement placement records.
- Curing records.
- Inspection reports and as-built drawings.

18. ROU/ROW

18.1 General

This item includes all activities related to land acquisition for laying the water pipeline from the Intake Pump House to village tanks, covering both private and government lands along the pipeline route. The contractor shall be responsible for all surveys, statutory procedures, legal payments, and coordination with authorities.

18.2 Scope of Work

- Conduct detailed field survey to determine the extent and details of land (private and government) along the pipeline alignment.
- Mark the pipeline route and width on village maps clearly showing the Right of Use (ROU) or Right of Way (ROW).
- Prepare and submit detailed land acquisition proposals with justifications for approval by competent authority.
- Complete all statutory formalities required for land acquisition, including agreements with landowners or government entities as directed by Engineer-in-Charge (EIC).
- Lay pipeline within the acquired ROU/ROW as per the approved alignment and width.
- The contractor shall initially make all legal payments including- Rent for ROU/ROW, standing crop compensation, other compensations or fees related to land acquisition.
- The Department will reimburse these payments upon submission of valid receipts.
- The Department will assist by signing necessary documents for permissions and clearances.
- The contractor shall ensure coordination and obtain sanctions and NOCs from concerned authorities and landowners to facilitate smooth acquisition and pipeline laying.
- Payment to the contractor shall be made pro rata based on the actual length of pipeline laid within the acquired ROU/ROW.

18.3 Workmanship & Responsibilities

- All surveys and proposals must be accurate and detailed.
- Ensure legal compliance with all government regulations and local laws.
- Maintain transparent documentation for all payments and agreements.
- Provide timely coordination with authorities for approvals.
- Keep Engineer-in-Charge informed on progress and issues related to land acquisition.
- Manage any disputes or claims arising during acquisition and pipeline laying.

18.4 Mode of Measurement and Payment

- Payment will be made pro rata on the length of pipeline laid within the approved ROU/ROW.

- Payment includes all land acquisition activities, survey, statutory compliance, coordination, and legal payments reimbursed by the Department.
- Contractor to submit valid receipts for reimbursement claims.

18.5 Documentation

- Field survey reports and marked village maps.
- Land acquisition proposals with justifications.
- Agreements and legal documents with landowners and authorities.
- Receipts of payments made for rent, compensation, and other legal fees.
- NOCs and sanction letters.
- Progress reports to Engineer-in-Charge.

19. STAFF QUARTER/ PANAL ROOM/ STORE ROOM

19.1 General

This item covers the design, supply, and construction of Staff Quarters/ Panal room/ store room using Reinforced Cement Concrete (RCC) M-30 including all associated works such as steel reinforcement, plastering, electrical fittings, doors, windows, and water supply facilities as per detailed drawings and project specifications.

19.2 Scope of Work

- Construction of Staff Quarters structure with RCC Grade M-30.
- Provide and fix required steel reinforcement (Fe 500 or as specified).
- Complete plastering works on internal and external walls as per specification.
- Supply and installation of doors and windows with necessary hardware.
- Complete electrical works including lighting fittings and wiring.
- Provision of water supply facility within the quarters including plumbing.
- All works to be executed as per detailed drawings, specifications, and instructions of Engineer-in-Charge (EIC).
- Includes all materials, labor, scaffolding, curing, finishing, and site cleanup.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

19.3 Workmanship

- Use high-quality materials conforming to relevant IS standards.
- RCC to be properly mixed, placed, compacted, and cured for durability.
- Steel reinforcement to be accurately placed and securely tied.
- Plastering to be smooth and free from cracks.
- Electrical fittings to be installed safely and tested.
- Water supply system to be leak-proof and functional.
- Maintain safety and cleanliness at all times on site.

19.4 Mode of Measurement and Payment

- Measurement based on completed structure area (sq.m.) or as per contract unit.
- Payment covers all materials, labor, scaffolding, fixtures, and finishing works.

19.5 Documentation

- Structural design and reinforcement details.
- Material test certificates.
- Progress and quality inspection reports.
- Electrical and plumbing test certificates.
- As-built drawings on completion.

20. COMPOUND WALL & FANCING

20.1 General

This item covers the construction of a compound wall along with wire fencing as per the detailed drawings, specifications, and instructions of the Engineer-in-Charge (EIC) during the execution period.

20.2 Scope of Work

- Construction of compound wall with specified height, thickness, and length using concrete blocks, bricks, or RCC as per detailed drawings.
- Provision of foundation and footing for the compound wall including excavation, PCC, and reinforcement if required.
- Construction of the wall with plastering, finishing, and painting as specified.
- Supply and erection of wire fencing over the compound wall or on standalone posts as per drawing.
- Provide supporting posts, stays, and necessary fittings for the wire fencing.
- All works shall conform to the detailed specifications and comply with safety and quality standards.
- Site clearance, curing, and maintenance during the execution phase.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

20.3 Workmanship

- Use good quality materials as per IS standards and approved samples.
- Proper curing and finishing of plastered surfaces.
- Wire fencing should be taut, securely fixed, and rust-protected (galvanized or PVC coated).
- Maintain clean and safe site throughout the work.
- Follow all safety regulations during excavation and erection.

20.4 Mode of Measurement and Payment

- Measurement based on length and height of compound wall constructed and fencing erected.
- Payment includes all materials, labor, scaffolding, plastering, painting, and fencing works.
- Work to be certified complete by Engineer-in-Charge before payment.

20.5 Documentation

- Detailed drawings showing alignment and specifications.
- Material test certificates.
- Inspection reports during and after construction.
- Completion certificate from Engineer-in-Charge.

21. MS GATE

21.1 General

This item covers the fabrication, supply, and fixing of a Main Gate measuring 5.0 m (width) x 2.0 m (height) to be installed in the compound wall. The gate shall be fabricated from Mild Steel (MS) sections including boxes, channels, flats, rods, etc., as per approved design and drawings, including all necessary welding, fixtures, and fastening.

21.2 Scope of Work

- Fabricate the gate structure from MS sections (boxes, channels, flats, rods) as per approved drawings.
- Carry out welding, cutting, and joining operations as per structural and design requirements.
- Supply and fix all necessary hardware like hinges, bolts, locks, and fastening accessories.
- Apply one coat of red oxide primer and two coats of enamel paint of approved quality after fabrication.
- Install the gate in the compound wall opening as per the specified dimensions.
- Ensure proper alignment, smooth operation, and secure fixing.
- All works shall comply with instructions and directions of the Engineer-In-Charge (EIC).

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

21.3 Workmanship

- Use high-quality MS materials conforming to relevant IS standards.
- Welding should be continuous, neat, and free from defects.
- Surfaces must be cleaned, free of rust and oil before painting.
- Painting should be uniform, smooth, and durable.
- Installation must ensure gate operates without hindrance and is firmly fixed.

21.4 Mode of Measurement and Payment

- Measurement based on one complete gate fabricated and fixed as per specification.
- Payment includes all materials, labor, welding, painting, hardware, and installation.
- Payment to be released after successful installation and approval by EIC.

21.5 Documentation

- Approved design and fabrication drawings.
- Completion and handover certificate by Engineer-in-Charge.

22. SITE GRADING

22.1 General

This item covers all work related to site grading, including levelling of ground, scrubbing/removal of trees and plants, clearing and carting away debris, and preparing the site for further construction activities. All work shall be carried out as per the instructions and direction of the Engineer-in-Charge (EIC).

22.2 Scope of Work

- Removal of vegetation, including trees, shrubs, plants, roots, and other organic matter from the designated site area.
- Scrubbing and clearing all bushes, plants, and unwanted growth.
- Levelling and grading the ground to achieve the required level and slope as per approved drawings and instructions.
- Carting away all debris (trees, plants, roots, stones, and other materials) from the site to a designated disposal area approved by EIC.
- Disposal of debris shall comply with environmental and local regulations.
- The site shall be cleaned thoroughly and left ready for subsequent construction work.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

22.3 Workmanship

- Use appropriate mechanical equipment and manual labor for removal and grading.
- Trees and plants removal should avoid damage to nearby structures or utilities.
- Level the surface uniformly to avoid water pooling or unevenness.
- Ensure safe handling and transport of debris.
- Maintain proper safety and environmental protection measures during execution.

22.4 Mode of Measurement and Payment

- Measurement will be done on area basis (per square meter) of site cleared and graded.
- Payment includes all costs related to removal, carting, grading, equipment, labor, and disposal.
- Work certified complete by Engineer-in-Charge will be payable.

22.5 Documentation

- Site clearance reports.
- Site leveling and grading approval from Engineer-in-Charge.

23. INTERNAL RCC ROAD

23.1 General

This item covers the construction of internal roads with RCC M-20 grade concrete including all preparatory works such as box cutting, sub-base preparation, cement concrete base, reinforcement, compacting, vibrating, and curbing as per approved drawings and specifications.

23.2 Scope of Work

- Box cutting: Excavation to required levels and dimensions to prepare road base.
- Preparation of sub-base: Compacting and leveling the subgrade to support the pavement structure.
- Providing and laying PCC (Plain Cement Concrete) 1:3:6 (cement: sand: coarse aggregate) of 15 cm thickness as a base layer.
- Reinforced Cement Concrete (RCC) M-20 of 15 cm thickness: Using 10 mm diameter reinforcement bars placed at 300 mm center-to-center spacing.
- Vibrating and compacting: Ensure concrete is properly vibrated for compaction and elimination of voids.
- Providing and fixing curbs: As per design, for road edges.
- Finishing and curing of RCC road surface.
- All work completed as per detailed drawings and instructions of Engineer-in-Charge.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

23.3 Workmanship

- Excavation and box cutting should be accurate to required levels and slopes.
- Sub-base material must be compacted to the specified density.
- Reinforcement must be placed as per drawing ensuring correct spacing and cover.
- Concrete mixing, placing, and curing to conform to IS codes and good engineering practice.
- Vibrating concrete properly to ensure compaction without segregation.
- Curing must be done for minimum 7 days to ensure strength gain.

23.4 Mode of Measurement and Payment

- Measurement based on area of RCC road constructed in square meters.
- Payment includes all excavation, sub-base prep, PCC, RCC, reinforcement, curing, curbing, and finishing.

23.5 Documentation

- Drawings showing road alignment, levels, and reinforcement details.
- Material test certificates for concrete and steel.
- Inspection and quality control reports.
- Curing and finishing reports.
- Work completion certificate by Engineer-in-Charge.

24. APPROACH ROAD

24.1 General

This item covers the construction of Approach Road including box cutting, preparation of sub-base, compaction, and curbing, all carried out as per the approved drawings, specifications, and instructions of the Engineer-in-Charge (EIC).

24.2 Scope of Work

- Box Cutting: Excavation to the required depth and profile for road formation.
- Sub-base Preparation: Supplying, spreading, leveling, and compacting sub-base material to provide a stable foundation for the road.
- Compaction: Ensuring sub-base is compacted to specified density to avoid settlement.
- Curbing: Providing and installing curbs along the edges of the road as per design and drawings.
- Site Cleanup: Removal of all debris and surplus material after construction.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

24.3 Workmanship

- Excavation shall be carried out to the specified dimensions and levels.
- Sub-base material shall be free from organic matter and debris.
- Compaction to be done with mechanical rollers to achieve required compaction.
- Curbs to be aligned and fixed properly with neat finishing.
- The site must be left clean and suitable for further construction or use.

24.4 Mode of Measurement and Payment

- Measurement based on area (square meters) of approach road constructed.
- Payment shall be inclusive of excavation, sub-base material, compaction, curbing, and site cleanup.

24.5 Documentation

- Site preparation and excavation reports.
- Compaction test reports.
- Inspection reports for curbing.
- Completion certificate from Engineer-in-Charge.

25. DIVERSION

25.1 General

This item includes the diversion of an existing bituminous (bitumen) road to facilitate construction activities (e.g., pipeline laying, structure building, etc.), and restoration/resurfacing of the diverted route to match the standard of the existing road. The work shall be carried out in accordance with the directions of the Engineer-in-Charge (EIC) and must ensure minimum disruption to existing traffic and public utilities.

25.2 Scope of Work

- Identification and marking of proposed diversion route in consultation with EIC.
- Clearing, excavation, and grading of the proposed diversion alignment.
- Construction of sub-base and base courses similar to existing road cross-section.
- Laying of bituminous surfacing to match the quality and thickness of the existing road.
- Side drains provision, road signage, and safety measures as required for public use.
- Maintenance of the diverted road during the construction period.
- Final dismantling of temporary diversion (if required) and restoration of original route as per instructions.

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled ‘Design Criteria for Structural Design’ and ‘Technical Specification of Civil Works’. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

25.3 Workmanship

- Ensure diversion is trafficable, safe, and well compacted with adequate camber and drainage.
- Bituminous surfacing should use hot mix technology and match the grade, thickness, and quality of the existing road.
- Use traffic signage and barricading to maintain public safety and awareness.
- Surfacing should be smooth, even, and durable for temporary or semi-permanent use.
- Road to be maintained free of potholes and water logging during the use period.

25.4 Mode of Measurement and Payment

- Measurement based on number of diversions of road diverted and resurfaced.
- Rate includes all preliminary work (survey, site clearance), sub-base and base preparation, bitumen surfacing, road furniture and safety signage, maintenance during use period.

25.5 Documentation

- Approved alignment and design drawings of diversion route.

- Test reports for road layers and bituminous materials.
- Traffic management and safety compliance reports.
- Work completion certificate from EIC.

26. DISSIPATION STRUCTURE

26.1 General

This item pertains to the construction of a Dissipation Structure (also known as an Energy Dissipator) used to reduce the velocity and energy of flowing water (e.g., at outfalls, canals, or pipelines). The structure shall be built using Reinforced Cement Concrete (RCC) with proper foundation, reinforcement, formwork, and finishing, strictly following the approved structural design and drawings provided by the department.

26.2 Scope of Work

- Site preparation including clearing, excavation, and leveling.
- Foundation construction based on soil condition, including PCC if required.
- Formwork, reinforcement, and RCC works for energy dissipation blocks, stilling basin, baffle blocks, wing walls, apron, etc. as per drawing.
- Use of M-20 or higher grade RCC and Fe-500/Fe-415 TMT reinforcement steel as specified.
- Curing, shutter removal, and finishing of exposed RCC surfaces.
- Ensuring hydraulic alignment and integrity to effectively reduce flow velocity.
- All works to be carried out under supervision of Engineer-in-Charge (EIC).

Note: - All design and construction parameters not explicitly stated herein shall comply with the applicable provisions outlined in the chapters titled 'Design Criteria for Structural Design' and 'Technical Specification of Civil Works'. The Engineer-in-Charge is required to consult these chapters for comprehensive guidance and detailed requirements.

26.3 Workmanship

- Ensure proper excavation and foundation leveling.
- Reinforcement must be tied securely and placed as per bar bending schedule.
- Concrete must be mixed, placed, vibrated, and cured as per IS:456.
- Use of needle vibrators to ensure proper compaction without honeycombing.
- All components (floor, baffles, side walls, wing walls, apron, etc.) must be constructed as per the hydraulic and structural design.

26.4 Mode of Measurement and Payment

- Measurement shall be based on number basis or specified in BOQ.
- Rate to include excavation and foundation work, shuttering, reinforcement, concrete, curing, surface finishing, all labor, tools, and materials.
- Payment certified by EIC upon satisfactory completion.

26.5 Documentation

- Approved construction drawings
- Bar bending schedule
- Concrete mix design and cube test results
- Steel test certificates
- Site inspection records and completion report