

GANDHIDHAM MUNICIPAL CORPORATION



Bid Documents For

Design, Engineering, Supply, Construction, Installation, Testing and Commissioning of Integrated Water Supply Infrastructure including Water Distribution Systems for Meghpar Kumbhardi and Meghpar Borichi Areas; Construction of 56 MLD Capacity Water Treatment Plant at Rambaugh; Construction of Ground Service Reservoirs (GSRs), Pumping Stations and Miscellaneous Water Supply Works within GDMC Area; Providing and Installation of Grid-Connected Solar Rooftop Systems at Various Locations; and Providing, Supplying, Lowering, Laying, Jointing, Testing and Commissioning of MS Bulk Water Pipeline from Varsamedi to Rambaugh including all Civil, Mechanical, Electrical, Instrumentation Works and Allied Appurtenances under Gandhidham Municipal Corporation.

Volume-II Technical Specifications & Drawings

Milestone Dates for e-tendering is as under

1. Downloading of e-Tender documents	As per NIT.
2. Pre Bid Meeting	As per NIT.
3. Online submission of e - Tender	As per NIT.
4. Physical submission of EMD, Tender fee as below mentioned address.	As per NIT.
5. Opening of online tender	As per NIT.
6. Opening of Price Bid (If possible)	As per NIT.
7. Bid Validity	120 Days

For further details, pre-qualification criteria etc. visit www.GDMC.nprocure.com

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:: TECHNICAL SPECIFICATIONS ::

A. GENERAL

1. SCOPE OF CONTRACT :

The work entitled comprise of excavation of trenches with shoring and strutting wherever required bailing out water wherever necessary, laying of pipes, jointing including supply of material and material required for jointing, testing as per specifications, Construction of appurtenances such as brick Masonry / RCC chambers etc. as per the type design specified entirely of the specification of various works stipulated in the e- Tender. The work includes supply of DI K-7 pipes ISI Marked and which shall have to be supplied at site or Municipal store by the contractor at specified and shown in schedule "B". Other material like cement etc. shall have to supplied by the contractor from open market.

The scope of works comprises the following:

- Carrying out necessary topographical survey and geotechnical investigations
- Excavation of pipe trenches in soil, soft rock, hard rock, WBM and concrete roads, dismantling of paver block including dewatering etc. complete.
- Supplying and Laying of DI pipes with all specials along the route as per the network map
- Jointing of pipes with existing pipes (wherever required) with all required accessories and specials
- Obtaining statutory approval from government bodies.
- Contractor shall plan and accordingly phase the supply of items according to his requirement to best utilize the available storage space at site.
- Providing and fixing sluice valves, Scour valves and Air Valves on the existing as well as new pipeline, as specified in relevant datasheets, detailed technical specifications, particular technical specifications and BOQ.
- Providing pipe bedding as per the requirements.
Backfilling of pipe trench with selected soil immediately after erection of pipe excluding pipe joints.
- Encasing of underground pipelines as per specifications.
Hydro testing of pipeline in segments.
Backfilling of pipe trench at pipe joints.
- Construction of RCC Sluice/ Butterfly Valve Chambers/RCC Thrust blocks/ Saddles/ Anchor blocks. The typical drawings for various structures are enclosed in Bid drawings for reference.
- Reinstatement of WBM, Tar and Concrete Roads after laying and testing of pipeline.

- Demolishing old structures in the route of pipeline, if require Flushing of entire pipeline with clean water at least for 24 Demolishing old structures in the route of pipeline, if require Flushing of entire pipeline with clean water at least for 24 hours.
- By demolition of existing 40 MLD Water Treatment plant located at Rambaug we are proposing the upgraded 56 MLD Water Treatment Plant.
- For the Transmission of 12 MLD Raw Water from Varsamedi headworks to Rambaug headworks via MS pipe line along with the Pump House at varsamedi Headworks.
- Construction of 30 Lakh liter Elevated Service Reservoir at the suggested location at Meghpar Borichi by engineer in charge with the staggering height and technical specification as per Volume 2 to be done.
- Also Construction of 16 Lakh liter Elevated Service Reservoir at the suggested location at Meghpar Kumbhardi by engineer in charge with the staggering height and technical specification as per Volume 2 to be done.
- Pump House construction with aesthetically looking good with all technical specification to be done properly as per the volume 2.

Testing and commissioning. Preparation of as-built drawings.

2. e-TENDER PRICE:

The rates quoted in the bill of quantities shall cover everything necessary for the due and complete execution of the work according to the drawings and other condition and stipulations of the contract including specifications of the evident, intend and meaning of all or either of them or according to customary usage and for periodical and final inspection and test and proof of the work in every respect and for measuring, numbering or weighing the same, including setting out and laying or fixing in position and the provision of all materials, power, tools, rammers, labour, tackle, platforms with impervious lapped joints for scaffolding, ranging roads, straight edged, cantering and boxing, wedges, moulds, templates, posts, straight rods, straight edged, cantering and boxing, wedges, molds, templates, posts, straight rails, boning staves strutting, barriers, fencing lighting pumping apparatus, temporary arrangement for passage of traffic access to premises and continuance to drainage water supply and lighting (if interrupted by contractor's work) temporary sheds, painting, varnishing, polishing establishment for efficient supervision and stating arrangements for the efficient protective of life and property and all requisite plant and machinery of every kin

The contractor shall keep every portion of the work clear of accumulation from time to time and shall leave every portion of the work clean, clear, perfect and at the conclusion of whole, providing at their own cost all

such material implement, appliances and labour as the Engineer in charge may require to prove if it to be so.

3. COMPLETION SCHEDULE:

The contract period shall be as prescribed in tender document, from the date of notice to proceed i.e. Work Order. The Contractor shall submit his completion schedule and the program of works together with this e-Tender in conformity with completion schedule given in the documents.

4. Packing and Handling:

- 4.1. Necessary care shall be taken and required packing shall be provided to avoid damage to pipe barrels and the edges of the pipe ends in transit.
- 4.2. Where the goods are required to be dispatched at Railway risk, special packing as per IRCA rules are absolutely necessary, which would be payable by the contractor himself.
- 4.3. The contractor shall use proper handling equipment or follow suitable standard handling method for **DI pipes & DI Specials** as approved by the Engineer-in-charge to unload the materials at the delivery site to prevent damage to the goods.
- 4.4. The contractor shall take all care for Transportation & supply of HC connections items to be supplied with its standard handling process, stored at site under his store / the delivery site to prevent damage to the goods.

5. GENERAL TECHNICAL GUIDELINE:

- 5.1. All the items occurring in the work and as found necessary during actual execution shall be carried out in the best workman like manner as per specifications and the written order of the Engineer in charge
- 5.2. Extra Claim in respect of extra work shall be allowed only if such work is ordered to be carried out in writing by the Engineer in charge
- 5.3. The contractor shall engage a qualified Engineer for the Execution of work who will remain present for all the time on site and will receive instructions and orders from the Engineer in charge or his authorized representative. The instruction and orders given to the contractor representative on site shall be considered as it given to the contractor himself.
- 5.4. The work order book as prescribed shall be maintained on the site of the work by the contractor and the contractor shall sign the orders given by the inspecting officers and shall carry out them properly.

- 5.5. Quantities specified in the e-Tender may vary at the time of actual execution and the contractor shall have no claim for compensation on account of such variation
- 5.6. Unexcavated lengths shall be left wherever required and so directed by the Engineer in charge during the currency of the contract and shall be tackled if required, before completion of work.
- 5.7. Diversion of road, if necessary, shall be provided and maintained during the currency of the contract by the contractor at his cost.
- 5.8. Figured Dimensions of drawing shall supersede measurements by scale, special dimensions or directions in the specifications shall supersede all other dimensions.
- 5.9. All levels are given on drawings and the contractor shall be responsible to take regular level on the approved alignment before actually starting the work. The levels shall commence to the G.T.S. levels and shall be got approved from the Engineer in charge
- 5.10. If the arrangement of temporary drainage is required to be made during any work of this Contract, this shall be made by the Contractor without claiming any extra cost.

6. CLASSIFICATION OF STRATA:

- 6.1. All materials encountered in excavation will be classified in the following groups irrespective of mode of excavating the materials and the decision of the Engineer in charge in this regard shall be final and binding to the contractor.
- 6.2. Soils :
Soils of all sorts, silt, sand, gravel, soft murrum, stiff clay, kankar and other soft excavation not covered in the items mentioned hereunder.
- 6.3. Hard Murrum :
Hard Materials comprising of all kinds of disintegrated rock or shale or indurate conglomerate interspersed with boulders, weathered and decomposed rock which could be removed with pick, bar, shove, wedges and hammers, though not without some difficulties.
- 6.4. Soft – Rock:
This shall include all materials which is rock but which does not need blasting and can be removed with a pick bar, wedges, pavement breakers, pneumatic tools etc.
- 6.5. Hard Rock:
This shall include rock occurring in mass or boulders which need blasting, this will also include rock to be removed by chiseling or any other method where blasting is not permissible.

7. The rates are inclusive of dewatering, if require
8. Regarding water supply for hydro testing, necessary water, power, labour, etc. required for necessary test shall be arranged by the contractor at his own cost.
9. During construction activity, proper care must be taken for labour safety and must follow the provisions of the Labour laws.
10. TMT bars of Fe-500 should be confirming to IS:1786. The approved makes shall be TATA, SAIL, Vizag, Gallent, Electrotherm or other equivalent make as approved by engineer-in-charge.
11. Cement shall be ordinary Portland cement conforming to IS:269, IS:8112 or IS:12269 for all the works as per the instructions of engineer-in-charge. The approved makes shall be Ambuja, Ultratech, LOTUS, Siddhi, Sanghi, Hathi or as per IS confirming.
12. Minimum Cement content for the work should be as per attached circular No.RMC/C/Vigi.(Tech)/231 dt. 11/03/2022.
13. Testing of the materials like Brick, Sand, Aggregate, Reinforcement steel, etc. should have to be tested periodically as suggested by the Engineer-in-charge at Government approved material testing Laboratory and testing charges for the same has to be borne by the contractor.
14. In case of any ambiguity found in inspections / drawings etc., the decision of engineer-in-charge shall be final and binding to the contractor.

DETAILED SPECIFICATIONS OF MATERIALS

M-1 WATER :

1.1 Water shall not be salty or brackish and shall be clean reasonably clear and free from objectionable quantities of silt and tract of oil and injurious alkalis, salts, organic mater and other deleterious materials which will either weaken the mortar or concrete or cause efflorescence in R.C.C.. The container for transport, storage and handling of water shall be clean. Water shall conform to the standards specified in I.S. 456-2000 (latest revision).

1.2 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 of 30 minutes either 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.

1.3 Water for curing mortar, concrete or masonry should not be too acidic and also not 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.

1.4 Hard and bitter water shall not be used for curing.

1.5 Potable water will be generally found suitable for curing mortar for preparing or concrete.

M-2 CEMENT :

2.1 Cement shall be Sulphate Resistant Cement conforming to IS : 12330, Ordinary portland cement as per I.S. 269-1976 or Portland slag cement as per I.S. 455-1976.

2.2 Testing of Cement : It should be specifically noted that the cement brought by the contractor at site of work shall be used after the same is tested at the approved laboratory as per the direction of the Engineer-in-charge. Such approved laboratory may be located at Ahmedabad. All the charges for transport and testing of the samples shall have to be borne by the contractor. The frequency of testing of such materials shall be in accordance to the relevant Indian standard as directed by the Engineer-in-charge.

M-3 SAND :

3.1 Sand shall be natural sand, clean, well graded, hard strong, durable and gritty particles free from injurious 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 8 percent of silt as determined by field test. If necessary the sand shall be washed to make it clean.

3.2 COARSE SAND :

The fineness modulus of coarse sand shall not be less than 2.5 and shall not exceed 3.0. The sieve analysis of coarse shall be as under:

I.S. Sieve Designation	Percentage by Weight Passing sieve	I.S. Sieve Designation	Percentage by Weight Passing through sieve
4.75 mm.	100	600 Micron	30-100
2.36 mm.	90 to 100	300 Micron	5-70
1.18 mm.	70-100	150 Micron	0-50

3.3 FINE SAND :

The fineness modulus shall not exceed 1.0. The sieve analysis of fine sand shall be as under :

I.S. Sieve Designation	Percentage by Weight Passing sieve	I.S. Sieve Designation	Percentage by Weight Passing through sieve
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4.75 mm.	100	600 Micron	40-85
2.36 mm.	100	300 Micron	5-50
1.18 mm.	70-100	150 Micron	0-10

M-4 STONE GRIT :

4.1 Grit shall consist of crushed or broken stone and be hard, strong dense, durable, clean, of proper gradation and free from skin or coating likely to prevent proper adhesion of mortar. Grit shall for as possible flaky elongated pieces shall be avoided.

It shall generally comply with the provisions of I. S. 383-1970. Unless special stone of particular quarried is mentioned. Grit special stone of particular quarries is mentioned. Grit shall be obtained from the best black trap or equivalent hard stone as approved by the Engineer - in -charge. The grit shall have no deleterious reaction with cement.

4.2 The grit shall conform to the following gradation as per sieve analysis:

I. S. Sieve Designation	Percentage by Weight Passing sieve	I S. Sieve Designation	Percentage by Weight Passing through sieve
12.50 mm	100 %	4.75 mm	0.20 %
10.00 mm	85-100 %	2.36 mm	0.25 %

4.3 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.

4.4 The necessary tests for grit shall be carried out as per the requirements of I.S. 2386 (Parts I to VIII) 1963, as per instruction of the Engineer-in-charge. The necessity of test will be decided by the Engineer-in-charge.

M-5A STONE COARSE AGGREGATE FOR NOMINAL MIX CONCRETE :

5A.1 Coarse aggregate shall be of machine crushed stone of black trap or equivalent and be hard, strong, dense, durable, clean and free from skin and coating likely to prevent proper adhesion of mortar.

5A.2 The aggregate shall generally be cubical in shape. Unless special stones of particular quarries are mentioned, Aggregates shall be machine crushed from the best black trap or equivalent hard stone as approve 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 6 mm less than the minimum lateral clear distance between bars or 6 mm. less than the cover whichever is smaller.

TABLE

I.S. Sieve Designation	Percentage passing for single sized aggregates of Nominal size			I.S. Sieve Designation	Percentage passing for single sized aggregates of Nominal size		
	40 mm	20 mm	16 mm		40 mm	20 mm	16 mm
80 mm	-	-	-	12.5 mm	-	-	-
63 mm	100	-	-	10 mm	0.5	0.20	0.30
40 mm	85-100	100	-	4.75 mm	-	0.50	0.50
20 mm	0-20	85-100	100	2.35 mm	-	-	-
16 mm		-	85-100				

NOTE :- The percentage may be varied by the Engineer-in-charge when considered necessary for obtaining better density and strength of concrete.

5A.3 The grading test shall be taken in the beginning and at the change of source of materials. The necessary tests indicated in I.S. 383-1970 I. S. 456-1978

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 inter mixed on different aggregates. If the aggregates are covered with dust, they shall be washed with water to make them clean.

M-5B BLACK TRAP OR EQUIVALENT HARD STONE COARSE :

5B.1 Aggregate for Design Mix concrete : Coarse aggregate shall be of machine crushed stone of black trap or equivalent hard stone and be hard, strong, dense, durable clean and free from skin and coating likely to prevent proper adhesion of mortar.

5B.2 The aggregates shall generally be cubical in shape. Unless special stones of particular quarries are mentioned, aggregates shall be machine crushed from the best, black trap or equivalent hard stones as approve Aggregate shall have no deleterious reaction with cement.

5B.3 The necessary tests indicated in I. S. 383-1970 and I.S.456-1978 shall have to be carried out to ensure the acceptability of the material.

5B.4 If aggregate is covered with dust it shall be washed with water to make it clean.

M-6 CEMENT MORTAR:

6.1 Water shall conform to specification M-1. Cement shall confirm to specification M-2, sand shall confirm to M-3.

6.2 Proportion of Mix :

6.2.1 cement and sand shall be mixed to specified proportion, sand being measured by measuring boxes. The proportion of cement will be by volume

on the basis of 50 Kg/bag of cement being equal to 0.0342 cum. The mortar may be hand mixed or machine mixed as directed.

6.3 Preparation of Mortar:

6.3.1 In hand 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 homogenous 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.

6.3.2 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.

M-7 BRICK BATS AGGREGATE :

7.1 Brick bat aggregate shall be broken from well burnt or slightly over burnt and dense brick. It shall be homogeneous in texture roughly cubical in shape, clean and free from dirt of any other foreign material. The brick bats shall be of 40 mm to 50 mm size unless otherwise specified in the item. The underburnt or overburnt brick bats shall not be allowed.

7.2 The brick bats shall be measured by volume by suitable boxes or as directed.

M-8 BRICKS :

8.1 The bricks shall be hard or machine moulded and made from suitable soils and kiln burnt. They shall be free from cracks and flaws and nodules of free lime. They shall have smooth rectangular faces with sharp corners and shall be of uniform colour.

The bricks shall be moulded 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 thrown on the ground from a height of 600 mm.

8.2 The size of modular bricks shall be 190 mm x 90 mm.

8.3 The size of the conventional bricks shall be as under :

$$\left(9'' \times \frac{4\frac{3}{4}}{4} \times \frac{2\frac{3}{4}}{4} \right) 225 \times 110 \times 75 \text{ mm.}$$

8.4 Only bricks of one standard size shall be used on one work. The following tolerance shall be permitted in the conventional size adopted in a particular work.

Length : = 1/8" (3.0 mm) Width : = 1/16" (1.50 mm)
Height : = 1/16" (1.50 mm)

8.5 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 percent by weight. Necessary tests for crushing strength and water absorption etc. shall be carried out as per I.S. 3495 (Part-I to IV) - 1976.

M-8A FLY-ASH LIME BRICKS :

The fly ash lime bricks shall conform to Grade-1 or Grade-2 of IS-3812-1981. The frog of the 80 to 100 mm x 40 mm x 10 to 20 mm size.

The size of modular bricks shall be 190 mm x 90 mm x 90 mm.

The size of conventional brick shall be 225 mm x 110 mm x 75 mm.

Only bricks of one standard size shall used on one work. The following tolerances shall permitted in the conventional size adopted in a particular work:

Length : + 3 mm
Width : + 3 mm
Height : + 2 mm

The physical characteristic of bricks shall be as follows.

The minimum compressive strength of fly ash lime bricks shall not be less than 75 Kg/Sq.Cm. and the test shall be conform to IS-3495 (Part-I):1992.

The average drying shrinkage of the brick when tested by the method described in IS 4139-1989 being shall not exceed 0.15 percent.

The averages water absorption not more than 20 percentage by mass and the test shall conform to IS-3495 (Part-3):1992.

M-9 MILD STEEL BARS :

9.1 Mild steel bars reinforcement for R.C.C. work shall conform to I.S. 432 (Part-II) 1966 and shall be tested quality. It shall comply with relevant part of I.S.456-1978.

9.2 All the reinforcement shall be clean and free from dirt, paint, grease, mill scale or loose of thick rust at the time of placing.

9.3 For the purpose of payment the bar shall be measured correct upto 10 mm length and weight payable worked out the rate specified below :

1. 6 mm	0.22 Kg./Rmt.	8. 20 mm	2.47 Kg./Rmt.
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2. 8 mm	0.39 Kg./Rmt.	9. 22 mm	2.98 Kg./Rmt.
3. 10 mm	0.62 Kg./Rmt.	10.25 mm	3.35 Kg./Rmt.
4. 12 mm	0.89 Kg./Rmt.	11.28 mm	4.83 Kg./Rmt.
5. 14 mm	1.21 Kg./Rmt.	12.32 mm	6.31 Kg./Rmt.
6. 16 mm	1.58 Kg./Rmt.	13.36 mm	7.31 Kg./Rmt.
7. 18 mm	2.00 Kg./Rmt.	14.40 mm	9.86 Kg./Rmt.

M-10 TMT FE-500 STEEL BARS FOR REINFORCEMENT :

10.1 Reinforcement bars shall conform to IS-432, IS-226 or IS-1786 and welded wire fabrics to IS : 1566. Only TMT bars for reinforcement in RCC duct shall be used which shall be clean, free from pitting, oil, grease, paint, loose mill scale, rust, dirty dust or any other such substance that will destroy or reduce bond. It is permitted by the Engineer-in-charge reinforcement shall be done in accordance with IS-2751 or IS-9147 as applicable.

10.2 Other provision and requirements shall conform to specification No. M-7 for mild steel bars.

M-11 MILD STEEL BINDING WIRE :

11.1 The mild steel wire size and quality shall conform to I.S. 280-1972.

11.2 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.

M-12 STRUCTURAL STEEL :

12.1 All structural steel conform to I.S.226 - 1975. The steel shall be free from the defects mentioned in I.S. 226-1975 and shall have 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 I.S. 1148-1973.

12.2 When the steel is supplied by the contractor test certificate of the manufacturers shall be obtained according to I.S. 226-1975 and other relevant Indian Standards.

M-13 SHUTTERING :

13.1 The shuttering shall be either of wooden planking of 30 mm. minimum thickness with or without steel lining or of steel plates stiffened by steel angles. The shuttering shall be supported on battens and beams and props of vertical ballies properly cross braced together so as to make the centering rigid. In places of bulged props, brick pillar of adequate section built in mud mortar may be used.

13.2 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 live load of men working over 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.

13.3 If at any stage of work during or after placing concrete in the structure, the form sags or bulges out beyond the required shape of the structure, the concrete shall be removed and work redone with fresh concrete and adequately rigid form work. The complete form work shall be got inspected by and got approved from the Engineer-in-charge, before the reinforcement bars are placed in position.

13.4 The props shall consist of bullies having 100 mm minimum diameter measured at mid length and 80 mm 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 Sq.m. laid on sufficiently hard base.

13.5 Double wedges shall further be provided between the sole plate and the wooden props so as to facilitate tightening and easing of shuttering without jerking the concrete.

13.6 The timber used in shuttering shall not be so dry as to absorb water from concrete and swell or bulge nor so wet to shrink after erection. The timber shall be properly sawn and planned on the sides and the surface coming in contact with concrete. Wooden form work with metal sheet lining or steel plates stiffened by steel angles shall be permitted

13.7 As far as practicable, clamps shall be used to hold the forms together and use of nails and spikes avoided

13.8 The surface of timber shuttering that would come in contact with concrete shall be well wetted and coated with soap solution before the concreting is done. Alternatively coat of raw linseed oil or oil of approved manufacture may be applied in place of soap solution. 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

13.9 The shuttering for beams and slabs shall have camber of 4 mm per meter (1 in 250) or as directed by the Engineer-in-charge so as to offset of subsequent deflection for cantilevers the camber at free end shall be 1/50 of the projected length or as directed by the Engineer-in-charge.

M-14 HARD DRAWN WIRE :

The Hard drawn steel wire should conforming to IS-432 (Part 2), Hard drawn steel wire shall be manufacture and its chemical composition should be as per para 3.0. The finished wire should be free from defects and finished in a workman like manner. Nominal sizes, Tolerances, Physical requirements are as per IS : 432 (Part-II) latest edition. Hard drawn steel wire should be tested as specified in IS : 432 (Part-II) latest edition.

DETAIL TECHNICAL SPECIFICATIONS

Item No.1, 28, 45, 77, 96:

Excavation for pipe line trenches for water supply, sewerage line, manhole etc. all with shoring and strutting if required as per required gradient and line including safety provisions using site rails and stacking excavated stuff including up to all required lead cleaning the site etc. complete for all lifts and strata as specified

In all sorts of soil & soft murrum Upto 1.50 mt depth

In hard murrum, boulders incl. macadam road Upto 1.50 mt depth

In hard murrum, boulders incl. macadam road Upto 1.50 mt depth

Excavation for pipe line trenches with shoring, strutting, bailing or pumping out watered from trenches whenever necessary of required length, width and depth including extra excavations for sockets and all safety measures and provisions such as site rails fencing, lighting, watching including refilling the trenches in layers including ramming and removing the excavated staff with 90m lead and clearing the site etc. as stipulated in the tender specification complete before starting work and after completion of work for all lifts and soil strata as specified.

- a) In all sorts of soil soft murmur, hard murrum, boulders, macadam and asphalt roads including breaking of lime and cement masonry and lime concrete.
- b) In soft rock, cement concrete, hard rock and cutting of cement concrete and R.C.C. of any proportion, etc. with controlled blasting and or chiseling whichever is necessary and feasible as required by site conditions.
- c) In hard rock

1.1 Clearing of sites :

- 1.1.1 The site at which the pipe line is to laid and the area required for setting out and other operations shall be cleared of all obstructions , loose stones, and rubbish of all kinds ; stumps of trees, brushwood as well as all trees shall be removed as directed. The roots shall be entirely grubbed up.
- 1.1.2 The products of the clearings to be stacked in such a place and in such a manner. As directed by the Engineer-in-charge.
- 1.1.3 In site clearing, all trees not specially marked for preservation, bamboos jungle wood and brush wood shall be cut down and their roots grubbed up. All wood and materials from the clearing s hall be the property of corporation and shall be arranged as directed by the Engineer-in-charge or his authorized agent. The materials found to be useful by the Engineer-in-charge s hall be conveyed and properly stacked as directed within the specified limit. Unless materials will be burnt or otherwise disposed off as directed.

1.1.4 All holes or hollows, whether originally existing or produced by digging up roots, shall be carefully filled up with earth, well rammed and leveled off, as may be directed shall not be paid for. The contractor shall get approval of design of shoring. The shoring shall be of sufficient strength to resist side pressure and ensure safety from slips and blows and to prevent damaged to work and property and injury to persons. It shall be removed as directed after all the items of work for which it is required are completed.

1.1.5 Protection:

1.1.5.1 The foundation pits and trenches, etc. shall be strongly fenced and red light Signals shall be kept at night in charge of watch-man to prevent accidents. Sufficient care and protective measure shall be taken to see that the excavation shall not affect or damaged the adjoining structures. The contractor shall be entirely responsible for any injury to life and damage to the properties etc. Necessary protection work such as guide ropes, crossing places, barricades, the contractor at his own cost shall provide caution boards etc.

1.6 Classification of Strata :

1.6.1 The decision regarding classification of strata shall rest with the Engineer- in- Charge and his decision shall be final and binding to the contractor.

1.6.2 All the materials encountered in the excavation shall be classified as described in 2.0 of general specifications.

1.7 Dewatering :

1.7.1 Unless specially provided for as a separate item in the contract, the rate of excavation would include bailing or pumping out all water met with in excavation or which may accumulate in the excavation during the progress of the work either, by percolation, seepage, springs , rain or any other cause and diverting surface flow if any, by earthen bunds or by other means. The bunds shall be removed as soon as the work is complete

1.7.2 Unless specially provided as a separate item of contract, pumping of water from foundation pit, trenches etc shall be carried out by the contractor at his won cost and he shall arrange for required numbers of dewatering pumping sets for the above work. He shall take precaution to prevent any damage to the foundation trenches, concrete or masonry or any adjacent structure. The excavation shall be kept free from water by the contractor (1) during inspection and measurement (2) When concrete and/or masonry work are in progress and till the construction work reaches above the natural water level and (3) till the Engineer – in – charge considers that the mortar is sufficiently set. The rate shall be paid for cum. of excavation.

1.8 Excavation in Rock :

1.8.1 Blasting with Gun Power:

Blasting operations shall be carried out with the prior permission and in the presence of the Engineer – in – charge or his authorized representative and during fixed time hours of the day. All

safety precautions such as providing safety nylon netting etc. shall be carried out as per instructions of the Engineer – in – charge.

Red danger flags shall be prominently displayed and all the people, except those who have actually to light the fuse must be away to a safe distance, not less than 200 meters.

All fuses shall be cut to the length required before being inserted into the holes.

The number of charges to be fired and the actual number of shots heard shall be compared and the person responsible must satisfy himself by examination that all the charges have exploded before work people are permitted to approach the scene. The withdrawal of a charge which has not exploded shall under no circumstances be permitted, but the tamping and charge shall be flooded with water and the hole marked in a distinguishing manner. The next hole to be fired shall be at a distance of about 500mm from the old hole and fired in the usual way.

The contractor or any of his competent authorized person shall be in charge of the blasting operations and shall be held responsible for strictly observing the safety rules, particularly applicable to blasting operations, in addition to other safety rules.

In blasting rocks with dynamite, the following general principles shall be observe In general, the following diameter of drills shall be used for different depth of boreholes:

From 1 – 2 metres	25 mm diameter
From 2 – 3 metres	37 – 50 mm diameter
From 3 – 4.75 metres	50 – 60 mm diameter

The borehole should generally be not more than 1.3m deep and the distance apart should be from one and half to twice the depth.

Cracks and fissures in the rock to be blasted shall be carefully studied to ascertain the best portion forth the boreholes. Charge s hall always be placed in a round piece of rock, if possible not nearer than 30mm from the crack.

Rules for blasting with dynamite and other high explosives

The person - in- charge must s how that he is thoroughly acquainted with all blasting operations and that he understands the rules herewith laid down. He will be held responsible for any accident that may occur.

Boreholes must be of such sizes that the cartridge can easily pass down them. The position of all holes to be drilled must be marked out with white paint and the person – in – charge must take particular note of these positions.

The drilling operation being finished, the person – in – charge must make a second inspection and satisfy himself that the boreholes marked out by him have been drilled. The person – in – charge must prepare all charges necessary for boreholes.

Only ten holes may be loaded and fixed at one time and the charges should be fixed simultaneously as far as practicable. Boreholes must be thoroughly cleared before a cartridge is inserted.

The loading is to be done by the person – in – charge himself and the position of the charge holes carefully noted by him. Wooden tamping rods only to be used in charging holes (not pointed but cylindrical throughout, one cartridge at a time must be inserted and gently pressed with the tamping rod.

Immediately before firing blast, due warning must be given and the person – in – charge must see that all the labourers have retired to safety.

The safety fuse of the charged holes are to be lighted in the presence of the person – in – charge, who must see that the fuses of the holes charged have properly ignite After the blast, the person – in – charge must carefully inspect the work and satisfy himself that all the charges have explode.

1.8.2 Misfires:

Misfires are a source of great danger, if it is suspected that part of the blast failed to fire or is delayed, allow sufficient time to elapse before entering the danger zone. When fuse and blasting caps are used, a safe time, at least of an hour should be allowed.

None of the drillers are to work near this hole until the two following separations have been done by the person – in – charge.

(a) The person – in – charge should very carefully extract the tamping with a wooden scrapper and withdraw the fuse with the primer and detonator attached, after which a fresh primer and detonator with fuse should be placed in this hole and fired or.

The hole may be cleared of 300mm of tamping and the direction then ascertained by placing a stick in the hole. Another hole may then be drilled

150mm away and parallel to it, the hole to be then charged and fire T he person – in – charge shall also at once report to the Engineer – in charge all cases of misfire, that cause of the same and what steps have been taken in connection herewith.

Precautions against misfire:

The safety fuse should be cut in an oblique direction with a knife.

All saw dust must be cleared from the inside of the detonator this can be done by blowing down the detonator and tapping the open end. No instrument shall be inserted into the detonator for this purpose.

After inserting the fuse in the detonator, it shall be fixed by means of nippers.

If there is water present, or if the boreholes be damp, the junction of the fuse and detonator must be made water tight by means of grease, white or lead

The detonator should be inserted into the cartridge, so that about one third of the copper tube is left exposed outside the explosives. The safety fuse outside the detonator, should be necessarily tied in position in the cartridge. Water proof fuse only to be used in the damp boreholes, or when water is present in the bore-holes.

If a misfire has been found to be due to defective fuse detonator or dynamite, the whole quantity or box from which the defective article was used shall be rejected.

Storage of materials for blasting shall be as per regulations/stipulations of the concerned authorities.

It shall be the contractor's responsibilities to arrange proper storage of explosives and obtain required permission from concerned authorities. No separate payment will be made for the above.

The refilling will generally refer to refilling of trenches up to ground level with excavated stuff. Filling materials shall be from excavated stuff.

Excavated stuff to be used shall be cleared of all rubbish, large size stones, brick bats etc. Big clods shall be broken down to a size of 50 mm or less.

Refilling :

After the pipes have been laid and jointed and the chambers are constructed and as soon as the joints have been inspected and passed by the Engineer-in-charge, the pipe line has been tested for water tightness, and after all concrete work thoroughly set the trenches shall be fulfilled with the materials taken there from. In refilling the trenches, the utmost care shall be exercised so as not to disturb, break or damage the jointed pipes. Over and around every pipe, the finest selected material shall be put. No lumps of rock earth or other material around the pipe or be thrown into the trenches until the same has been broken to specified size and pipes covered by the fine material above referred to. The selected fine material shall be carefully placed next to the permanent work and well packed and well rammed in layers of 150mm for a depth of at least 300mm over the top of the pipe. The remaining of the excavation shall be filled in with the best and most suitable portions of the excavated material in layers of not more than 600 mm deep, each layer shall be thoroughly rammed before the next layer is placed. One man shall be employed for hand ramming for every 30m of refilling up to the level of 300mm over the top of the pipe. Surplus soil shall be piled on top of

the filling to the extent possible for expected subsidence. All road materials to from a compact neat surface. The surface of the filled in trench shall be hand rolled by a hand roller weighing not less the ½ tones as directed by the Engineer- in-charge.

The contractor shall maintain all refilling and surfaces until reinstate
The contractor shall responsible for claims arising from accidents due to subsidence or inadequate maintenance or improperly refilling work.

The contractor s hall be responsible for any settlement during the defects liability period including monsoon and the same shall be refilled with stuff brought from outside, if necessary.

Where excavated material is not considered suitable for refilling by the Engineer-in-charge, the Contractor will be required to cart selected surplus excavated materials in place of unsuitable materials. The contractor may also be instructed to supply suitable granular or other hard filling material for use in refilling. Such imported filling material s hall be paid for at the rates given in the Bill of quantities.

No payment shall be made for carting away surplus material arising either because of rejection of excavated material for refilling or because of surplus material.

Measurement:

The contractor's shall be for the **unit of one cubic meter** of the quantity excavated limited to the dimensions and provisions specified in the specifications or as directed by the Engineer-in- charge. The extra excavation to provide for jointing pipes, shoring etc. will not be paid for. The rates shall include cleaning and clearing the trench site by cutting grass, shrubs and trees of girth (circumference) not exceeding 10 feet and removing their obstructing roots in the trench cleaning the site, setting out works as per sanctioned plans, provide shoring, excavation and removal of all material from trenches.

(a) Excavations up to depth of 1.5M

The trench section is to be provided with Max. width OD of pipe + 250 mm to 300mm either sides. Depth of trench shall be minimum Bedding + OD of pipe + 0.60mt. cover above the top of pipe.(For 100mm dia. pipe).Depth of trench shall be minimum Bedding + OD of pipe + 1.0mt. cover above the top of pipe. (For Other dia. pipe).

The payment of excavation will be given considering bottom width of the pipe trench & as per actual.

Item No.2, 29, 46, 78, 97:

Refilling the pipeline trenches including ramming, watering, consolidating disposal of surplus stuff as directed within a radius of 3km.

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. The excavated material nearest to the trench shall be used filling. 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 30cm over the top of the pipe except as may be necessary for tamping etc., during backfilling work.

The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150mm in size if sufficient quantity of good earth and murrum are not available. 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. The top 300mm layer or fertile agricultural soil shall be kept aside during excavation and shall be laid in layers near ground level during refilling.

To prevent buckling of pipe shell of diameters 1200mm 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 2m & shall be welded in such a way that internal coating does not get burnt.

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 use

If any material remains as surplus it shall be disposed of as directed by the Engineer, which includes loading, unloading, transporting and spreading as directed within all lea If the Contractor fails to remove the earth from site within 7 days after the period specified in a written notice, the Engineer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as

he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refilling is not available for excavation the Contractor shall bring earth, murrum of approved quality as directed by the Engineer.

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 has been obtained. Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 24 months from the completion of the Contract Works, the Contractor shall make good the same at his own cost or the Engineer may without notice to the Contractor, make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer 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.

Measurement and Payment

Payment of refilling shall be made on Cubic meter basis.

After Refilling the pipe / chamber trenches by the excavated stuff is 15 cm thick layer, including After Refilling the pipe / chamber trenches by the excavated stuff is 15 cm thick layer, including ramming, watering and consolidating up to possible extent as specified in excavation & refilling item, the surplus stuff shall be disposed off at the following sites as directed within the prescribed limits of Notification as directed by the engineering in charge.

The excavated material of black cotton soil and other useful materials should be stacked at the location specified by the engineer in charge.

If the contractor fails to dispose the excavated stuff as specified, penalty will be imposed by Gandhidham Municipal Corporation as per the Notification for C&D waste.

After refilling surplus earth shall have to carted by the contractor within specified limit including loading transporting unloading spreading.

Item No.3, 30, 47, 98:

Providing and supplying D.I. K-7 pipes for following nominal bore diameter with internal cement mortar lining including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stocking etc. complete. (IS 8329-2000)

&

Providing and supplying D. I. K-9 grade pipes for following nominal bore diameter with internal cement mortar lining including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete. (IS 8329-2000). Rate for DI pipe based on wholesale Price Index of Pig Iron as 149.2 for the month of Jan-22. For Sewerage project cement mortar lining shall be with sulphate resistance cement

This item includes:

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

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

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

- ✓ AWWA C600 Installation of ductile iron water mains and their appurtenances.

1.0 Internal Diameter:

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

2.0 Length:

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

3.0 Thickness:

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

$$e = K(0.5 + 0.001 \text{ DN})$$

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

4.0 EPDM Rubber Gasket:

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

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

5.0 Sampling Criteria:

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

6.0 Tolerances on External Diameter:

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

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

7.0 Tolerance on Ovality:

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

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

8.0 Tolerance in thickness

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

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

9.0 Coating

Pipe shall be delivered internally and externally coated.

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

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

Internal lining: Internally pipe shall be Portland Cement mortar lined (as per IS - 8329-2000). The mortar shall contain by mass at least one part of cement to 3.5 part of sand. All pipes and fittings shall be internally lined with cement mortar using high speed centrifugal process in accordance with IWO 4179/IS 8329.

Cement mortar lining shall be applied at the pipe manufacturing shop in conformity with the aforesaid standards. No admixtures in the mortar shall be used without the approval of the Engineer.

The sand to cement proportion of sand if justified by the sieve analysis.

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

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

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

10.0 Joint

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

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

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

1. Hardness
2. Tensile strength
3. Compression set
4. Accelerated aging test
5. Water absorption test
6. Stress relaxation test

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the type of joint, the size of the pipe with which they are to be used, the manufacturer's name and trade mark, the month and year of manufacture and the shelf life.

11.0 Testing of Pipe:

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

[a] Mechanical Tests

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

[b] Brinell Hardness Test

For checking the Brinell hardness the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and

tensile test in accordance with IS:1500. The test shall comply with the requirements specified in IS:1500/ISO 6506.

[c] Re-tests

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

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

Stage 1

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

Stage 2

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

12.0 Quality Assurance

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

MARKING :

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

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

INSPECTION

Inspection of pipes and specials will be carried out by Executive engineer or his representative agency appointed by MMC. All the expenditure for inspection shall be borne by the contractor except

inspection charges if any in case of inspection agency appointed by MMC shall be paid by MMC.

PAYMENT

The payment shall be on RMT basis.

Mode of Payment : Payment restricted to 70% on receipt of material at project site, 20% payment on lowering, laying, jointing, refilling and disposal of surplus stuff, 10% payment on hydraulic testing and commissioning of project. Payment for 2 Km. of unlaidd pipes of each diameter except 100 mm dia. will be paid on receipt at site. Payment for 100 mm dia. Pipe upto 5 Km. will be paid on receipt at site.

Item No.4, 31, 48, 99:

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

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

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

The contractor shall make his own arrangement for obtaining permission for storing & stacking of pipes etc. from land boards whether they are Government, Municipal Local Bodies or Private land owner.

Every pipes before lowering into the trenches shall be got checked and thoroughly cleaned and the beds of the trenches shall be properly graded and leveled as required on the line, without any claim for extra cost whether it is require The pipe shall be carefully lowered into the trenches with the help of a suitable type of chain pulley blocks, which shall first be approved by the Engineer-in-Charge. Each pipe shall be properly jacked and the spigot perfectly fixed into the socket. No jointing operation shall be started unless the gradients levels are approved by the Engineer-in-Charge or his representatives.

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

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

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

TESTING OF WATER PIPES:

After each section of the pipeline has been completed it shall be tested for water tightness before being covered. The contractor shall at his own

cost fill up water in pipe line and given necessary hydraulic test section by section and the pipe line shall stand the pressure which shall stand the pressure which shall exceed the working pressure by

- (a) 50% of the highest pressure in the section.
- (b) 30m whichever is less without showing any leakage or sweating anywhere in the pipes joints specials valves etc. if any defect are found the contractor shall be made good the same at his own cost.

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

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

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

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

Method Of Measurement Of Pipes:

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

No payment shall be made for overlaps etc.

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

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

Item No.5, 32, 100:

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

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

PAYMENT

The payment shall be made on kg. basis.

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

Item No.6, 33, 101:

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

Design Features

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

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

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

Hydrostatic Test

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

Performance Test

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

Positive material Identification (PMI Test)

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

Test Certificates

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

Marking

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

Painting

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

Electric Actuator

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

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

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

The actuator shall be suitable for operation in the climate conditions and power supply conditions given in the specification. The actuator shall be capable of producing not less than 1½ time the maximum required torque and shall be suitable for at least 15 minutes continuous operation. All local controls shall be protected by a lockable cover.

Datasheet:

SLUICE VALVE/GATE VALVE					
Sr. No.	Component	PN-1.0/1.6	PN-2.0	PN-2.5	PN-4.0
1	Body	CI IS 210 Gr. FG260	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB/ ASTM A351 Gr. CF8
2	Bonnet	CI IS 210 Gr. FG260	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB/ ASTM A351 Gr. CF8
3	Wedge	CI IS 210 Gr. FG260	ASTM A217 Gr. CA15	ASTM A217 Gr. CA15	ASTM A217 Gr. CA15
4	Gland	CI IS 210 Gr. FG260	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB	ASTM A216 Gr. WCB/ ASTM A351 Gr. CF8
5	Stem	SS 410	SS 410	SS304	SS 316
6	Body Ring/Wedge Ring	IS 318 Gr LTB-2	ASTM A217 Gr. CA15	ASTM A217 Gr. CA15	ASTM A217 Gr. CA15
7	Gland Packing	Jute and Hemp	Graphoil Filler	Graphoil Filler with SS 304 wire winding	Graphoil Filler with SS 304 wire winding
8	Nut Bolts	Carbon steel	ASTM A320 Gr L7 and ASTM A194 Gr 4	ASTM A320 Gr L7 and ASTM A194 Gr 4	ASTM A320 Gr L7 and ASTM A194 Gr 4
9	Wedge Nut and Stem Nut	IS 318 Gr LTB-2	SS 304	SS 304	SS 304
10	Hand Wheel	Cast Iron	Cast Steel	Cast Steel	Cast Steel/SS
11	Flange End	IS 1538	ASME/ANSI B16.5 Class 150	ASME/ANSI B16.5 Class 300	ASME/ANSI B16.5 Class 400

Mode of measurement and payment:

The measurement shall be taken **per number of sluice valve** of specified size. The rate will be **per number** fitted in a pipe line. 5% amount shall be withheld for hydraulic test and same shall be released after satisfactory hydraulic test.

Item No. 92

REFLUX VALVE / DUAL PLATE CHECK VALVE:

Providing and supplying of ISI mark C.I D/F Refluxr valves as per IS:5312 (Latest Edition) of following class and diameter including all taxes, insurance, transportation, freight charges, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.

1. Scope of Work

The scope of work shall include the complete design, engineering, manufacture, inspection, testing at works, supply, transportation, delivery, unloading, storage, installation, testing, and commissioning (DSITC) of Dual Plate Check Valves (Wafer Type / Lug Type Non-Return Valves) along with all necessary accessories, fasteners, gaskets, supports, and associated fittings required for satisfactory installation and operation in the pipeline system. The valve shall be designed to operate automatically without any external actuation and shall effectively prevent reverse flow in the pipeline under all operating conditions including normal flow, shutdown, and surge conditions. The contractor shall ensure compatibility of the valve with the pipeline material, pressure rating, and fluid characteristics, and shall be responsible for providing a complete and functional system meeting all specified performance requirements.

2. Applicable Codes and Standards

The Dual Plate Check Valve shall be designed, manufactured, and tested in accordance with internationally recognized standards such as API 594 for dual plate check valves, API 598 / ISO 5208 for inspection and testing, and ASME B16.5 / B16.47 for flange compatibility, unless otherwise specified. The face-to-face dimensions shall conform to EN 558 standards, ensuring interchangeability with standard pipeline components. Where applicable, Indian standards such as IS 5312 and IS 13095 shall also be complied with. The valve shall be suitable for use in water supply, raw water transmission, or sewage applications as per guidelines of the CPHEEO Manual, and all materials used shall be suitable for potable water where required.

3. General Design and Functional Requirements

The Dual Plate Check Valve shall be of compact wafer or lug type construction, consisting of two semi-circular plates hinged at the center and operated by a torsion spring mechanism. The valve shall be designed to allow flow in one direction and automatically prevent reverse flow by closing rapidly upon flow reversal. The design shall ensure minimum pressure drop, low inertia of moving parts, and quick response time, thereby reducing the risk of water hammer and pressure surges in the system. The valve shall operate silently without vibration, chatter, or slamming under varying flow conditions.

The internal geometry of the valve shall be streamlined to ensure smooth flow passage with minimal turbulence. The plates shall open fully under normal flow conditions and shall return to the closed position immediately when the flow ceases or reverses. The design shall also consider the effects of partial opening, ensuring that the valve components are protected against erosion, cavitation, and excessive wear.

4. Materials of Construction

The materials used in the construction of the valve shall be selected based on operating pressure, fluid characteristics, and environmental conditions. The valve body shall typically be manufactured from Cast Iron (IS 210 FG260), Ductile Iron, or Cast Steel (ASTM A216 WCB) depending on pressure class and application. The dual plates (discs) shall be made of Ductile Iron or Stainless Steel (SS 304 / SS 316) with appropriate surface finishing to ensure durability and corrosion resistance.

The hinge pin or shaft shall be manufactured from high-strength stainless steel (SS 410 / SS 304 / SS 316) to withstand repeated cyclic loading. The spring mechanism shall be of stainless steel (preferably SS 316) to ensure long life and resistance to corrosion. The seat shall be either elastomeric (EPDM / NBR) for bubble-tight sealing or metallic depending on application requirements. All fasteners shall be of high tensile carbon steel or stainless steel with suitable anti-corrosion protection.

5. Pressure Rating and Design Criteria

The valve shall be designed for pressure ratings such as PN 1.0, PN 1.6, PN 2.5, PN 4.0 or higher, as specified in the BOQ or design documents. The valve shall be capable of withstanding not only the working pressure but also surge pressures and transient conditions that may occur during operation. The design shall incorporate adequate safety factors to ensure reliable performance under maximum differential pressure across the valve. The structural components, including body, plates, and hinge assembly, shall be designed to resist shock loads resulting from sudden closure of the valve.

6. Seating and Sealing Arrangement

The valve shall be provided with a precision-engineered seating arrangement to ensure effective sealing under reverse flow conditions. For water supply applications, an elastomeric seat such as EPDM or NBR shall be preferred to achieve zero leakage performance. The seat shall be securely mounted within the valve body and shall be resistant to wear, deformation, and chemical attack. In the case of metal-seated valves, the sealing surfaces shall be machined and finished to ensure compliance with allowable leakage limits as per applicable standards.

The sealing mechanism shall ensure tight shut-off even under low-pressure conditions and shall maintain integrity over repeated operating cycles. The seat design shall allow for easy maintenance and replacement, if required, without necessitating complete removal of the valve from the pipeline.

7. Installation Requirements

The valve shall be suitable for installation in both horizontal pipelines and vertical pipelines with upward flow direction. Proper alignment between pipeline flanges shall be ensured during installation to avoid undue stresses on the valve body. The valve shall be installed using appropriate gaskets, bolts, nuts, and washers, and all jointing materials shall be provided by the contractor.

Care shall be taken to ensure that the valve is installed in the correct orientation as indicated by the flow direction arrow marked on the body. The installation shall be carried out in accordance with manufacturer's recommendations and standard engineering practices to ensure optimal performance and longevity of the valve.

8. Hydraulic and Operational Performance

The valve shall be designed to provide minimum head loss during forward flow and rapid closure during reverse flow conditions. The dual plate configuration shall ensure that the valve responds quickly to changes in flow velocity, thereby minimizing the occurrence of water hammer. The spring-assisted closing mechanism shall ensure that the plates return to the closed position smoothly and without impact.

The valve shall operate efficiently over a wide range of flow conditions and shall not exhibit any undesirable characteristics such as fluttering, vibration, or noise. The design shall ensure that the plates do not obstruct the flow path when fully open, thereby maintaining hydraulic efficiency of the system.

9. Testing and Inspection

Each valve shall undergo rigorous testing at the manufacturer's works in accordance with API 598 or ISO 5208 standards. The testing shall include hydrostatic body test to verify structural integrity and seat leakage test to ensure proper sealing performance. For soft-seated valves, zero leakage shall be ensured, while for metal-seated valves, leakage shall be within permissible limits.

The valve shall also be subjected to functional testing to verify smooth operation of the plates and spring mechanism. The manufacturer shall provide all relevant test certificates, including hydrostatic test reports, material test certificates, and inspection reports. Where specified, Third Party Inspection (TPI) shall be carried out prior to dispatch.

10. Surface Preparation and Coating

All internal and external surfaces of the valve shall be thoroughly cleaned and prepared prior to coating. The valve shall be provided with fusion bonded epoxy (FBE) coating or equivalent epoxy coating of minimum thickness 150–250 microns DFT. The coating shall be suitable for potable water applications and shall comply with WRAS / NSF approval where required.

The coating shall be uniform, free from defects, and capable of providing long-term protection against corrosion in buried or exposed conditions.

11. Marking and Identification

Each valve shall be permanently marked with essential identification details including manufacturer's name, nominal diameter (DN), pressure rating (PN/Class), flow direction arrow, serial number, and heat number. The markings shall be either cast integral with the body or provided on a securely attached metal plate.

12. Handling, Transportation, and Storage

The valves shall be handled with care during transportation and installation to prevent damage to the body, coating, and internal components. Proper lifting equipment such as slings and cranes shall be used, and direct dropping or dragging of valves shall be strictly prohibited. The valves shall be stored in a dry and protected environment to prevent deterioration prior to installation.

13. Measurement and Payment

The measurement for payment shall be made on a per number basis, considering each valve supplied, installed, tested, and commissioned as a complete unit. The rate shall include all costs associated with supply, installation, testing, accessories, and incidental works required for proper functioning of the valve.

A retention amount (typically 5%) may be withheld and released only after satisfactory completion of hydraulic testing and commissioning, in line with standard tender practices.

14. Special Tender Requirements

The contractor shall submit a detailed Quality Assurance Plan (QAP) for approval prior to commencement of manufacturing. Only approved makes shall be used, and all materials shall comply with specified standards. Any deviation from the specification shall require prior written approval from the Engineer-in-Charge.

The valve shall be designed and supplied considering actual site conditions, including pressure variations, environmental factors, and operational requirements, ensuring long-term reliability and maintenance-free operation.

Item No.7, 34, 51, 53, 83, 85, 93, 95, 102:

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

Lowering, Laying and Jointing of Sluice valve

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

2.0 JOINTING MATERIAL

- 2.1 The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool etc.
- 2.2 All tools and plant required for installation of sluice valve shall be provided by the contractor.
- 2.3 All jointing materials shall be not approved from the engineer-in- charge before us
- 2.4 The nut and bolts shall conform to Item No MSP-19 of specification of materials.
- 2.5 The rubber packing shall confirm all specifications as narrated in Item No MSP-20 of specifications of materials.

3.0 INSTALLATION

- 3.1 The sluice valve/butterfly valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.
- 3.2 If necessary tail pieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.
- 3.3 The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice/butterfly valve bore. It shall be even at both the inner and outer edges.
- 3.4 The flange faces thoroughly grease

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

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

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

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

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

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

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

4.0 TESTING

4.1 After installation of sluice valve/butterfly valve the same is tested to 1 1/2 times of its test pressure.

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

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

5.0 MODE OF MEASUREMENT AND PAYMENT

5.1 The measurement shall be taken per number of sluice valve/butterfly valve of specified size.

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

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

Item No.8, 35, 103:

Construction of valves Chambers in brick masonry using common burnt clay building brick, locally available in C.M 1:6 foundation concrete 150 mm thick, CC coping in M-15, cement Plaster 12 mm thick using cement : mortar in Proportion 1:3 with Niru finishing curing and 16 mm thick MS frame & cover with material. (With 16 mm thick M.S cover Plate) complete.

Materials such as Cement, sand, coarse aggregate, bricks, reinforcement, water etc. to be used for this work shall be confirming to specification laid down in material section.

Location

Chamber shall be constructed at places approved by the Employer's Representative. Where valves are provided for maintenance of the pipeline.

Excavation / P.C.C.

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

Bed Concrete

The bed concrete 150 mm thick for chamber shall be done in C.C. 1:4:8 as directed by the Engineer-in-charge using trap metal of 25 mm to 40 mm.

Bricks

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

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

Cement Mortar

Mortar for masonry shall be as per IS: 2250. Chambers shall be constructed in brick masonry with cement mortar (1:6) unless otherwise specified. Gauge boxes for sand shall be of such dimensions that one bag containing 50 kg. of cement forms one unit. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be as approved by the Employer's Representative. If required by the Employer's Representative sand shall be thoroughly washed till it is free of any contamination.

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 if so required by Employer's Representative. Re-tempering of mortar shall not be permitted.

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 Chambers shall be in the proportion specified in drawing. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

All brickwork shall be in plumb and square/ circular unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS: 2212.

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.

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 commence 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 approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

Curing of plaster shall be started as soon as the applied plaster has hardened enough so as not to be damage Curing shall be done by continuously applying water in a fine spray and shall be carried out for at least 7 days.

Plastering shall be done on inner face of brick masonry in cement mortar (1:3) and 15 mm thick unless otherwise specified.

Cement pointing in C: M (1:3) shall be done on outside the chamber including racking out joints, curing etc. complete as directed by the engineer-in-charge.

Cement Concrete Block

The C.C. blocks for the chamber shall be constructed in cement concrete of M15 grade to take care of weight of valves.

Pipe Entering or Leaving Chamber

Whenever a pipe enters or leaves a chamber, bricks on edge must be cut to a proper form and laid around the upper end of the pipe so as to form an arch. All around the pipes, there shall be a joint of cement mortar (1:2) 13 mm thick between it and the bricks. 16 mm thick MS cover plate should be provided with 16 mm thick. Frame and cover with all fixing, material to cover the valve chamber.

Measurement and Payment

- The payment for valve chamber shall be on number basis of completed item as per working drawing issued during execution and as directed by Engineer in charge

Item No.9, 37:

Providing, Supplying, Lowering, Laying, Jointing and Fixing House Service Connection from D.I. Water Distribution Main up to Property Line using U.P.V.C. Pipe (SCH-40) including all necessary fittings and accessories such as U.P.V.C. couplings, elbows, brass female elbows, bib tap, clamps, and fixing arrangement; providing and fixing of suitable size D.I. Service Saddle, making hole in existing D.I. pipeline, ferrule connection, and ensuring watertight joint.

The work shall include excavation of trench in all types of strata, lowering, laying and jointing of pipe, hydraulic testing, refilling of trenches with proper compaction, disposal of surplus material within specified lead, cutting of road surface (WBM/BT/CC/RCC) wherever required and restoration of the same to original condition including providing and laying PCC (1:4:8) where necessary.

The item also includes all labour, materials, tools & plants, conveyance, lead & lift, taxes, duties, and all incidental charges complete as per relevant IS codes, GWSSB/R&B specifications and as directed by the Engineer-in-Charge.

TECHNICAL SPECIFICATIONS FOR COMPRESSION FITTINGS 90 DEG COMPRESSION ELBOW WITH METAL INSERT

One end of the Metal threaded compression Elbow will be with Taper male threads & other end will have compression fitting suitable to connect to PE pipe. The Taper male threads will be pressure tight. Pressure rating will be PN16.

Body, Nut and Thrust Ring will be injection molded from Polypropylene and UV stabilized body & thrust ring black in colour, Nut blue in colour. Lip gaskets in Food safe Rubber (NBR) black colour must have a conical shape on inside of gasket for easy insertion of pipe & with two lips on bottom to guarantee good sealing. Use of O ring not permitted Clamp ring material will be Polyacetal (POM) white colored and shall not be connected to thrust ring. Male threaded part will be made of SS 304.

The product will be tested as per below

Type test	Standard
Dimensions of the threads	ISO 7/1
Tightness of the joints	ISO 3458
Tightness of the joints when subjected to bending	ISO 3503
Resistance to pull-out	ISO 3501
Internal under-pressure test	ISO 3459
Long term pressure test	ISO/DIS 14236

90 DEG COMP ELBOW with COMPRESSION JOINT BOTH ENDS

The Compression Elbows will have compression ends in both sides, so that PE pipes can be connected at both ends. Pressure rating will be PN 16.

Body, Nut and Thrust Ring will be injection molded from Polypropylene and UV stabilized body & thrust ring black in colour, Nut blue in colored. Lip gaskets in Food safe Rubber (NBR) black colour must have a conical shape on inside of gasket for easy insertion of pipe & with two lips on bottom to guarantee good sealing. Use of O ring not permitted Clamp ring material will be Polyacetal (POM) white colored and shall not be connected to thrust ring.

The product will be tested as per below

Type test	Standard
Dimensions of the threads	ISO 7/1
Tightness of the joints	ISO 3458
Tightness of the joints when subjected to bending	ISO 3503
Resistance to pull-out	ISO 3501
Internal under-pressure test	ISO 3459
Long term pressure test	ISO/DIS 14236

FEMALE THREADED ADAPTER with METAL OFFTAKE

One end of the Female adaptor with metal off take will be with female threads & other end will have compression fitting suitable to connect to PE pipe. The Taper male threads will be pressure tight. Pressure rating will be PN16.

Body, Nut and Thrust Ring will be injection molded from Polypropylene and UV stabilized body & thrust ring black in color, Nut blue in color. Lip gaskets in

Food safe Rubber (NBR) black color must have a conical shape on inside of gasket for easy insertion of pipe & with two lips on bottom to guarantee good sealing. Use of O ring not permitted Clamp ring material will be Polyacetal (POM) white coloured and shall not be connected to thrust ring. Female threaded part will be made of SS 304.

The product will be tested as per below

Type test	Standard
Dimensions of the threads	ISO 7/1
Tightness of the joints	ISO 3458
Tightness of the joints when subjected to bending	ISO 3503
Resistance to pull-out	ISO 3501
Internal under-pressure test	ISO 3459
Long term pressure test	ISO/DIS 14236

The pipe and fitting shall be lowered, laid and joint using electro-fusion process and hydraulic testing shall be done as specified above in electro-fusion fitting.

Or

Compression fittings used for House service connection comply as per ISO 14236

Material of Construction

Compression fittings material shall confirm to ISO14236.Clause -5.

A .Body-Polypropylene

b. Nut / Cap –Polypropylene.

c. Clip Ring-POM (Acetylic resin)

Packing bush- Polypropylene

e. "O" ring – NBR

f. Threaded metal inserts –SS 304 with BSP Threads

Pressure testing

The pressure rating of compression fittings as per clause 8 of ISO 14236 which shall be PN16

Dimensions:

The Dimension of compression fittings shall be as per clause 7.1 of ISO 14236

Performance requirements

The compression fittings shall be tested as per ISO 14236. Following Test methods shall be performed

Clause 8.2.1 -Leak tightness under internal pressure.

Clause 8.2.2 -Resistance to Pull out.

Clause 8.2.3 -Leak tightness under Internal Vacuum.

Clause 8.2.4 -Long term Pressure Test for Leak tightness for assembled joint

Clause 8.3.2.1

Clause 8.3.3.1

Effects on Quality of Water

The Compression fittings for intended for conveyance of Potable water for Human consumption to be tested to comply with BS 6920 specifications in any of the laboratories like DVGW / KIWA / SPGN / WRc –NSF and certificate of compliance to be produced for the following parameters :

a. Odour & Flavour
of Water. b.

Appearance of
Water.

c. Growth of Micro Organism

Extraction of substances that may be of concern to Public
Health (Cyto Toxicity)

e. Extraction of Metals.

For clear identification of the water services, the nuts of the fittings should be coloured blue while the body to be black. All fittings with threaded ends should be with BSP threads.

Excavation

General

Any soil which generally yields to the application of pickaxes and shovels, phawaras rakes or any such ordinary excavating implement or organic soil, gravel, silt and turf loam, clay, peat etc. fall under this category.

Clearing the site

The site on which the structure is to be built shall be cleared, and all obstructions, loose stone, materials and rubbish of all kind, bush, wood and trees shall be removed as directed. The materials so obtained shall be property of the Government and shall be conveyed and stacked as directed within 50 m. lea The roots of the trees coming in the sides shall be cut and coated with a hot asphalt.

The rate of side clearance is deemed to be included in the rate of earthwork for which no extra will be paid.

Setting out

After clearing the site, the centre lines will be given by the Engineer in charge. The contractor shall assume full responsibility for alignment, elevation and dimension of each and all parts for the work. Contractor shall supply labours, materials, etc. required for setting out the reference marks and bench marks and shall maintain them as long as required and directed

Excavation

The excavation in foundation shall be carried out in true line and level and shall have the width and depth as shown in the drawings or as directed. The contractor shall do the necessary showing and shutting or providing necessary slopes to a safe angle, at his own cost. The payment for such precautionary measures shall be paid separately if not specified. The bottom of the excavated area shall be leveled both longitudinally and transferely as directed by removing and watering as require No earth filling will be allowed for bringing it to level, if by mistake or any other reason excavations is made deeper or wider than that shown on the plan or directed. The extra depth or width shall be made up with concrete of same proportion as specified for the foundation concrete at the cost of the contractor. The excavation upto 1.5 m. depth shall be measured under this item.

Disposal of the excavated stuff

The excavated stuff of the selected type shall be used in filling the trenches and plinth or levelling the ground in layers including ramming and watering etc. The balance of the excavated quantity shall be removed by the contractor from the site of work to a place as directed with lead upto 50 m. and all lift.

Dismalting of asphalt / metal road

Under this item contractor shall demolish existing asphalt or WBM / CC pavement met with during laying pipe.

Only area of pavement intercepted in pipe laying shall be demolished. If excess area is demolished same shall be reinstated by the contractor.

Demolished material like asphalt pavement lump and metal shall be stacked separately as directed by the Engineer in charge.

Work done to the extent of requirement for laying of drain and as per specifications shall be measured in sq.m. and paid at the tender rate.

Mode of measurements and payment

The description of each item shall, unless otherwise stated, be held to include where necessary, conveyance, and delivery, handling, unloading, storing, fabrication, hoisting, all labour for finishing to required shape and size, setting, fitting in position, straight, cutting and waste, return of packings etc.

The length shall be measured on running metre basis of finished work. The length shall be taken along the centre line of the pipe and fittings. The pipes fixed to walls, ceiling, floors etc. shall be measured and paid under this item.

All the work shall be measured in decimal system as fixed in its place, subject to tolerance given below unless otherwise state

(i) Dimensions shall be measured to the nearest 0.01 metre.

(ii) Area shall be worked out to the nearest 0.01 sq.metre.

All measurements of cutting shall unless otherwise stated be held to include the consequent waste.

In case of fitting of unequal bore, the largest bore shall be measured for the test.

Testing of pipe lines, fittings and joints include for providing all plant and appliances necessary for obtaining access to the work to be tested and carrying out the tests.

The rate includes all the electro-fusion fittings such as female adopter, elbow, bend, reducer, coupling etc. required for the water meter connection.

The rate shall be for a unit of one running metre.

Providing, supplying and fixing Ductile Iron strap saddle inclusive of of all taxes, insurance, transportation, freight charge, inspection charges etc. complete as per the detailed specification.

DI Strap Saddle required for providing house service connections on DI/CI mains.

General specification:

Strap saddles shall be suitable for CI/DI pipes of nominal size 60 mm to 300 mm with nominal outlet connection size from 1/2", 3/4" & 1" BSP female thread

The body shall be **Resicoat® epoxy** coated with thickness >250 micron as per GSK standard & EN14901. The saddles shall be single type upto pipe sizes of NB 300 and service outlet of 1/2", 3/4" and 1" BSP female thread

Fasteners shall be of threaded nut-bolt-washer type. Nut-bolts of size 1/2" (M12) shall be use

Saddle strap shall be with NBR protection rubber.

The sealing between the saddle and mains shall be obtained by using a profiled elastomeric seal matching to the curvature of the pipe. The seal shall be of NBR elastomeric type, suitable for all potable water applications.

The clamp saddles shall be suitable for online tapping with spatula & drilling tool, maximum working pressures upto **16** bars.

Material and Design Specifications

Saddle body: DI GGG40 with **Resicoat® epoxy** (for corrosion protection of fittings) coating with length 172 mm, width 75 mm, height 67 mm & thread depth 24.5mm. The body shall have retaining cavity housing for internal and external retention of the elastomeric seal. Sealing shall be achieved by pressure exerted by the body while fastening the saddle straps & body on the pipe.

Saddle strap: Saddle straps shall be made of stainless **steel 304 grade, gauge 16 & width 40mm** to prevent corrosion over the long service life & should be with no weld joint to avoid inconsistency of strength.

Strap Protection Rubber: NBR UV protected Elastomeric (rubber) shall be such that none of the Stainless Steel Strap is in direct contact with the pipe. It shall ensure a firm non slip grip mounting on the pipe due to external loading.

Saddle seal: It shall be virgin rubber NBR Class 70 complying with EN 682-2002. It shall be of type pressure activated hydro-mechanical design. It shall be contoured gasket to provide a positive initial seal which increases with increase in the line pressure. Gasket shall be, with the outlet section having o-ring contacting the saddle body.

Nuts – Bolts- Washer: Stainless Steel Type 304, NC rolled thread, Tightening torque for ½" (M12) nut-bolt: 14-15 kg m.

OR

Specifications for Clamp Saddle for Service Connections

General Specifications :

Clamp saddles for service connection from water distribution mains shall be of wrap around design, wide skirt and wide straps support, which shall reinforce the pipe while providing excellent stability to the saddle.

Clamp Saddles for service connections shall be of fastened strap type with threaded outlet for service connection.

The service connection threading sizes shall be conforming to IS: 554

Clamp saddles shall be suitable for DI pipes of nominal size 3" (NB 80) to 12" (NB 300) with nominal service connection size from ½" (NB 15), ¾" (NB 20), 1" (NB 25), 1 ¼" (NB 32), 1 ½" (NB 40) and 2" (NB 50).

The straps shall be elastomer coated (insulated) type for firm grip on pipe as well as to protect the coating on the pipe and to insulate the un-identical metals. The saddles shall be single strap type upto pipe sizes of NB 600 and service outlet of ½", ¾" and 1".

The saddles shall be double strap type for pipe sizes above NB 600 or when the service outlet is 1 ¼", 1 ½" or 2".

Fasteners shall be of threaded nut-bolt-washer type. Nut-bolts of size ½" (M12) shall be used for saddles of size up to 4" (NB 100) and Nut-bolts of size 5/8" (M16) shall be used for saddles of size 6" (NB 150) and above.

The sealing between the saddle and mains shall be obtained by using a profiled elastomer seal matching to the curvature of the pipe.

The seal shall be of elastomer type, suitable for all potable water applications.

The Material of construction of the body, straps, fasteners etc. shall be of a non corrosive material such as engineering plastic (PE/PP) or stainless steel or a combination of both.

The design of the saddle body should be such that, the service connection outlet metal insert shall project out towards pipe side and align with the hole drilled on the pipe to ensure positive locking against rocking or creeping on the pipe, as might be caused by vibration, pressure or excessive external loading.

The clamp saddles shall be suitable for maximum working pressures upto 10 bars.

Material and Design Specifications:

Saddle Body: Non corrosive Engineering Plastic body moulded with Stainless steel threaded metal insert for tapping outlet. Also, the stirrup metal plate shall be duly embedded in the plastic body, except at the place of nut-bolt lugs. Threading size and dimensions shall conform to IS: 554. The body shall have retaining cavity housing for internal and external retention of the elastomeric seal. Sealing shall be achieved by pressure exerted by the body while fastening the saddle straps & body on the pipe.

Saddle Strap: Saddle straps shall be made of stainless steel 304 grade to prevent corrosion over the long service life.

Strap Insulation: Elastomeric (rubber) insulation / lining shall be such that none of the Stainless Steel Strap is in direct contact with the pipe. It shall ensure a firm non slip grip mounting on the pipe to prevent the saddle from rocking or creeping on the pipe, as might be caused by vibration, pressure or excessive external loading.

Saddle Seal: It shall be virgin rubber SBR Grade 30 / NBR (NSF 61 approved). It shall be of type pressure activated hydro-mechanical design. It shall be contoured gasket to provide a positive initial seal which increases with increase in the line pressure. Gasket shall be gridded mat, with tapered ends, with the outlet section having o-ring contacting the saddle body multiple o-rings contacting the pipe, preferably with a Stainless steel reinforcing ring insert moulded to prevent expansion under pressure.

Nuts-Bolts- washer: Stainless Steel Type 304, NC rolled thread, Tightening torque for ½" (M12) nut-bolt: 14-15 kg.m and for 5/8" (M 16) nut-bolt: 21-23 kg.m

Providing and fixing brass ferrule of approved make of following sizes inclusive of all taxes, insurance, transportation etc. complete.

(i) 15 mm dia. (ii) 25 mm dia. (iii) 40 mm dia. (iv) 50 mm dia.

The brass ferrule shall be best quality and make as approved by Engineer-in-charge.

The work shall be carried out in good workmanship manner as directed by the Engineer-in-charge with proper fixing of ferrule as require

Providing, supplying and fixing U PVC ball Valves with compression end on one side to connect PE Pipes and female threading on the other side for connecting BSP threaded fittings or pipes. The product shall confirm to ISO 4422-4 Standards. The rate shall be inclusive of all taxes, insurance, transportation etc. complete.

(i) 20 mm dia. (ii) 32 mm dia. (iii) 50 mm dia. (iv) 63 mm dia.

The U PVC ball Valves will have Compression end on one side to connect PE Pipes and female threading on the other side for connecting BSP threaded fittings or pipes. The product shall confirm to ISO 4422-4 Standards and pressure rating will be PN 16. The product should be suitable for use in drinking water for human consumption.

Body, Nut and Thrust Ring will be injection molded from Polypropylene and UV stabilized body & thrust ring black in color, Nut blue in color Lip gaskets / O Ring in Food safe Rubber (NBR) black color must have a conical shape on inside of gasket for easy insertion of pipe & with two lips on bottom to guarantee good sealing. Use of O ring not permitted Clamp ring material will be Poly acetal (POM) white clouored and shall not be connected to thrust ring. The Compression Fittings & U PVC Ball Valves for drinking water applications should have undergone type test by WRc-NSF, U.K. according to BS 6920 and a certificate from either WRc-NSF or WRAS (Water Regulations Advisory Scheme) should be available evidencing this fact.

The payment shall be made as per number basis.

Excavation in bituminous road as per required gradient and line including safety provisions using site rails and stacking excavated stuff including up to all required lead cleaning the site etc. complete for all lifts as specified.

a) Excavation in bituminous road

Item shall be executed as per MoRTH Specification Section 202. Item shall be measured and paid on Cu.m. basis.

Labour charges for repairing of leakage in AC pipeline of 150 mm / 200 mm / 250 mm / 300 mm / 350 mm diameter at different places including necessary excavation manually or by mechanized

excavation. removing of mud. cleaning of pipe and leakage portion, cutting the pipeline & removing piece of pipe from trench with inclusive of mechanical deviced JCB, Hydra/Crain if necessary & labours required with providing material such Trueend C.I.D. joints with nut bolt, rubber rings etc. comp. {incl. all material but Exclu. cost of pipe) (A.C.PL)

- 1) The excavation for trenches shall be done before laying of the pipes as per required depth and width so that adequate space can be made available for joint.
- 2) The pipes & joints shall be procured, supplied by the Contractor at work site at his own cost. Every care shall be taken in carting them to site. During transportation any damage shall be occurring to pipes for fittings the replacement of pipes given by the contractor at his own cost.
- 3) Before laying the pipes it shall be brushed throughout length so that the dust and soil can be removed.
- 4) Reducer bends tees, and adopter etc. to be supplied by the contractor as per requirement.
- 5) All the specials such as bends, tees, reducer, etc. shall be fixed as per instruction of engineer-in-charge in the pipeline.
- 6) The pipe shall be hydraulically tested during the testing no leakage shall be observed. If, leakage observed, it shall be set rightly by the contractor at his own cost as per the instruction of engineer-in-charge. The payment shall be as per payment schedule.

b) CID Specials

1. Specials as per site requirement shall be supplied by the contractor. The specials should be as per standard and shall be got approved by the Engineer in charge before being used. The specials should be perfectly in working condition and having necessary threads holes etc. as per standard.
2. CID specials should be as per IS standard specification and should be price make. All the specials should be suitable for CID pipes for which it is being used.

The Scope For The Item Cover

Cost of additional excavation required for jointing clearing the site of all scrubs, bushes, and trees and dewatering where necessary.

Labour for laying pipes in trenches to correct alignment at required depth with tools, including cutting of pipes and specials if required for laying of pipes including connecting pipes to specials and appurtenances. Cost of the scaffolding, tools and plants, ropes etc.

Protection of existing works from damage and cost of repair to the damages carried out to the existing structure, sewer line telephone/electricity cables, electric cables, electric lines, gas pipe line, irrigation pipe line etc Providing, supplying and fixing all CID specials required for laying.

The pipe laying across the state highways, national highways etc. will have to be done either through open cut method or through push through

method depending upon the requirement to be prescribed by the sanctioning authority. However, mostly it would be push through method. MMC will not be able to provide water for testing of the pipelines & water containers of the project. This shall have to be managed by the contractor at his cost and risk.

Labour for making joints including jointing material for joints, tools as well as tests. Testing of pipes for leakage under water pressure and flushing the pipes after testing and construction work shall have to be arranged by the contractor at his own cost.

After each section of the pipeline has been completed it shall be tested for water tightness before being covered. The contractor shall at his own cost fill up water in pipe line and given necessary hydraulic test section by section and the pipe line shall stand the pressure which shall stand the pressure which shall exceed the working pressure by (a) 50% of the highest pressure in the section. (b) 30m whichever is less without showing any leakage or sweating anywhere in the pipes joints specials valves etc. if any defect are found the contractor shall be made good the same at his own cost.

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

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

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

If the pipe lines are laid in detached sanctioned & not in continuous length due to any reasons such as non-availability of specials or due to obstacle etc. The contractor shall see that no end of pipes length is kept open-ends

are immediately covered up either by suitable blank flange or cap slug or by means of double layer gunny bags clothes tied properly by mild steel wire without any claim for extra-cost.

Method Of Measurement Of Pipes:

The measurement shall be recorded in running meter of pipe length laid along center line or axis of pipe line including tees, enlarges, reducers and bends correct up to 0.01M. length.

No payment shall be made for overlaps etc.

The payment shall be paid after completion of whole item as mentioned in Schedule-B.

Labour charges for repairing of leakage in MS pipeline 508.00 mm diameter at different places including necessary excavation manually or by machinery, dewatering, removing or mud, cleaning of pipe and leakage portion. grinding. cutting the pipeline or joint if necessary incl. welding the joint by using ISI marked welding rods duly approved by EIC of appropriate number and size inclusive of excavator, Hydra / Crane. D.G. set, welding machine, Gas cutter with LPG Cylinder. Oxygen cylinder. Grinding machine etc. with fuel, operator & labour as required. (incl. all material but excluding cost of pipe)

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 outside coating of pipe is not damaged in anyway during the lowering and assembling.

After the pipe is lowered into the trench, it shall be laid in correct line and level by using the leveling instruments, sight rails, theodolite, etc. Care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends in perfect contact and alignment. It may also be necessary to use jacks for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work.

On completion of the pipe jointing and external protection, the trench shall be cleaned of outside coating rebound. The welding shall be filled and compacted in 150mm layers with the bedding material. Backfilling shall be carried out as detailed here under.

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.

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.

TESTING OF WATER PIPES:

After each section of the pipeline has been completed it shall be tested for water tightness before being covered. The contractor shall at his own cost fill up water in pipe line and given necessary hydraulic test section by section and the pipe line shall stand the pressure which shall stand the pressure which shall exceed the working pressure by (a) 50% of the highest pressure in the section.

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

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

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

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

If the pipe lines are laid in detached sanctioned & not in continuous length due to any reasons such as non-availability of specials or due to obstacle etc. The contractor shall see that no end of pipes length is kept open-ends are immediately covered up either by suitable blank flange or cap slug or by means of double layer gunny bags clothes tied properly by mild steel wire without any claim for extra-cost.

The rate shall be per meter of pipe line laid including all specials and fitting jointly etc. Cutting and waste shall not be paid separately. The length shall be measured not on the straight line and curves along the center line over the pipe and specials correct up to 1 cm.

Item no 10, 11, 38, 39, 87: Drilling Horizontal bore

Drilling of 500 mm dia Horizontal borehole for watermain pipeline under the railway/national highway tracks incl all starta with required length including fixing of 400 mm dia MS casing pipe of minimum 6 mm thick Or IRS Casing Pipe with welding pushing etc. complete. Providing & fixing various size of pipe for 193.7 mm/219.1 mm/ 244.5 mm dia watermain of GI/ MS pipe of minimum 6.3 mm thick for railway/National Highway premises as per instructions & regulations of Railway Authority/NHAI & under supervision of Railway authority incl providing supplying & fixing of space at specified interval if required in between casing pipe and water main ISI make sluice valve of required size at both side at railway boundary with construction of brickege pavement incl CC encasing 1:3:6 in 10 mtr length of pipe at both side incl providing & fixing of MS/Iron manhole frame with cover for valve chamber with locking arrangement etc complete with all material labour fabrication, hydraulic testing, of pipe and valve etc complete for 45 m lenthg which includes horizontal pushing and with all open excavation.

MS casing pipe + water Main size 193.7 mm
MS casing pipe + water Main size 219.1 mm

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Drilling of 600 mm dia Horizontal borehole for watermain pipeline under the railway/national highway tracks incl all starta with required length including fixing of 500 mm dia MS casing pipe of minimum 8 mm thick Or IRS Casing Pipe with welding pushing etc. complete. Providing & fixing various size of pipe for 273.1 mm/ 323.9 mm/ 355.6 mm dia watermain of GI/ MS pipe of minimum 6.3 mm thick for railway/National Highway premises as per instructions & regulations of Railway Authority/NHAI & under supervision of Railway authority incl providing supplying & fixing of space at specified interval if required in between casing pipe and water main ISI make sluice valve of required size at both side at railway boundary with construction of brickege pavement incl CC encasing 1:3:6 in 10 mtr length of pipe at both side incl providing & fixing of MS/Iron manhole frame with cover for valve chamber with locking arrangement etc complete with all material labour fabrication, hydraulic testing, of pipe and valve etc complete for 45 m lenthg which includes horizontal pushing and with all open excavation.

MS casing pipe + water Main size 323.9 mm

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Drilling of 900 mm dia Horizontol borehole for watermain pipeline under the railway/national highway tracks incl all starta with required length including fixing of 800 mm dia MS casing pipe of minimum 12 mm thick Or IRS Casing Pipe with welding pushing etc. complete. Provding & fixing various size of pipe for 406.4 mm/457 mm/ 508 mm dia watermain of GI/ MS pipe of minimum 6.3 mm thick for railway/National Highway premises as per instructuions & regulations of Railway Authority/NHAI & under supervision of

Railway authority incl providing supplying & fixing of space at specified interval if required in between casing pipe and water main ISI make sluice valve of required size at both side at railway boundary with construction of brickwork pavement incl CC encasing 1:3:6 in 10 mtr length of pipe at both side incl providing & fixing of MS/Iron manhole frame with cover for valve chamber with locking arrangement etc complete with all material labour fabrication, hydraulic testing, of pipe and valve etc complete for 45 m length which includes horizontal pushing and with all open excavation.

MS casing pipe + water Main size 508 mm

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Drilling of 1300 mm dia Horizontal borehole for watermain pipeline under the railway/national highway tracks incl all starta with required length including fixing of 1200 mm dia MS casing pipe of minimum 16 mm thick Or IRS Casing Pipe with welding pushing etc. complete. Providing & fixing various size of pipe for 559 mm/ 610 mm/ 660 mm dia watermain of GI/ MS pipe of minimum 6.3 mm thick for railway/National Highway premises as per instructions & regulations of Railway Authority/NHAI & under supervision of Railway authority incl providing supplying & fixing of space at specified interval if required in between casing pipe and water main ISI make sluice valve of required size at both side at railway boundary with construction of brickwork pavement incl CC encasing 1:3:6 in 10 mtr length of pipe at both side incl providing & fixing of MS/Iron manhole frame with cover for valve chamber with locking arrangement etc complete with all material labour fabrication, hydraulic testing, of pipe and valve etc complete for 45 m length which includes horizontal pushing and with all open excavation.

MS casing pipe + water Main size 711 mm

Pushing of the completed segments of the pipe shall be commenced as per the procedure described in above paras till the entire length of the pipe in the embankment is built up.

- Permission for Highway & Canal crossing shall be procured by agency/department from competent authority of the concerned department. Necessary letter of recommendation shall be given by department.
- At canal, public state highways, at such other crossings as are shown in the construction drawings issued by the company the pipeline shall be installed in MS casing of as recommended by canal / state highway authority casing pipes conforming to the specifications given herein.
- The casing pipes / box shall be installed in accordance with the details given in drawing and the casing, bushing and insulators, etc., shall be installed on the carrier pipe as detailed in drawings. Casing pipe size shall be as per Engineer in charge instruction to facilitate the insertion of the later without disturbing the casing pipe and to provide adequate drainage, Casing shall be installed with even bearing throughout its length and shall slope towards one end, as specified or desired by the

engineer-in-charge. The ends of the casing shall be sealed to outside of carrier pipe in accordance with the details given in drawing.

- Before installation, holes for installing vent pipes shall be cut and burrs if any shall be removed. The welding of both carrier pipe and casing pipe shall be done in accordance with the welding specifications, given herein. Before installing the casing pipe, it should be cleaned of all internal obstructions and during installation care should be taken to keep the inside clean
- The section of carrier pipe to be placed in any casing shall be closed at each end, hydrostatically tested preferably with dead weight tester for at least two hours. Only on successful completion of this test, the carrier pipe shall be inserted in the casing pipe. The installation of casing may open cut as circumstances may permit or require as directed by the engineer-in-charge.
- The installation of casing in bended section of the carrier pipe shall be performed by meter bends of the casing pipe provided that the length of each meter cut out of casing pipe shall be such as to provide a clearance of at least 1-1/2" between the inside of the casing pipe and the outside of the coated carrier pipe.
- Excavation for casing installation shall be immediately backfilled at the completion of the work with suitable solid matter and packed thoroughly to prevent seepage of water into the excavation.
- ROAD, RAILWAY AND IRRIGATION CANAL CROSSINGS:
 - At road, canal and railway crossings the work shall be performed to the specifications of local authorities or such public bodies as may be in charge
 - (S) of roads, railways and canals to be crossed.
 - In case, however the minimum requirements of the governing agencies are less than those set out in the drawing or the specifications given herein, then the requirements given in the drawings and the specifications given for encased line shall be followed.
 - Whereas the casing pipe in the case of encased line to be laid normal by boring, tunneling, engineer-in-charge may at his discretion permit open-cuts to be made for the installation of casing provided, however, that the TENDERER shall procure the necessary permit / license for the same from competent authority. At locations wherein the open cut methods are permitted, the TENDERER shall pass the carrier pipe through the casing located in the trench after the approval of the engineer-in-charge in writing and care shall be exercised to avoid damage to pipe coating and wrapping during this operation. The TENDERER shall produce a certificate in writing from concerned authorities for its satisfactory restoration and payment therefore.
 - At all crossings the carrier pipe shall be laid straight without bends so that if necessary the pipe at a later date may be replaced without cutting the casing. The carrier pipe shall extend at least 2 meters beyond the end of casing pipe at either end.

- At railway crossings the TENDERER shall eliminate unnecessary bending of pipe to conform to the contour of ground by gradually deepening the ditch at such approaches as directed by the engineer- in-charge. Where the installation of the casing has been made by open cut TENDERER shall install suitable temporary bridge work ensuring the safety of the traffic aids and safeguards for protection of the public safety, or he shall provide suitable diversions as desired by the engineer-in-charge.
- At all railways pipeline crossings shall be bored with horizontal boring machine. The method of carrying out a cased crossing by boring for various crossings on this pipeline route shall be jointly inspected by the representative of the COMPANY and TENDERER for each category of work prior to commencement of actual work.
- Pipeline under railway track and irrigation canal an applicable portion of the right-of-way shall be encased in accordance with the specification. This item of work shall include, necessary clearing and grading required therefore, trenching to the depths and widths required, welding of casing and carrier pipes, testing, lowering in, installation of vent assemblies, end seals, insulator and all other fittings that may be required, backfilling, clean up, complete restoration to the original condition and further strengthening and protective works as may be required. The work shall be carried out in accordance with the drawings and as directed by the engineer-in-charge. For various operations mentioned above, the specifications pertaining to these operations shall apply in Addition to the specifications given herein.
- The TENDERER shall be permitted to use William Sons type Neoprene seals in place of concrete end seals for the crossings. The item shall be procured by the TENDERER himself as per the provisions under the appropriate head of work in case TENDERER so desires. The representative of the COMPANY may also be associated to determine the quality of the material and its delivery schedule from the open market. However, the particular work defined under the proper head shall not be delayed on account of non- availability of Neoprene end seals. In such case, concrete seals may be provided.
- On both ends of pushing concrete supports are to be provided as per direction of engineer in- charge.

MODE OF PAYMENT:

The payment shall be made on actual running meter basis as shown in relevant schedule.

Item No.

16,17,18,19,20,21,22,23,24,25,26,27,61,62,63,64,65,66,67,68,69,70:

For All Electrical Items Refer Electrical Specification attached separately.

Item No. 71,72,73,74,75:

Refer Civil Specification attached separately.

Item No. 90 & 91 :

Refer instrumentation Specification attached Separately.

Item 12, 40:

Designing structurally and aesthetically complying provisions of relevant Indian standards and constructing RCC elevated service reservoir ESR of the following capacity and height using latest soil investigation report of proposed site seismic zone wind speed zone including

- (1) Container shape any suitable type (or as specified)
- (2) Staging consisting of column brace / shaft / combination column-brace and shaft as appropriate (or as specified) and
- (3) Appropriate foundation system. This includes excavation in all types of soil strata including Hard Rock, casting 100 mm thick PCC leveling course in M10. Refilling the beat with proper soil and disposing of the surplus stock at all required lead.
- (4) This will also include cement plaster in CM 1:2 which approved waterproofing compound all over inside container (i.e. Walls, base, top slab/dome bottom etc. all)
- (5) All types of labour and material charges of lowering, laying, erecting / hoisting and joining of pipe assembly of inlet, outlet, overflow, washout and bypass arrangement as per hydraulic design are including.
- (6) Providing and fixing of any accessories specified, CI manhole frame, and covers, water level indicator, lightning conductor, GI pipe railing around walkway of roof level, at gallery and around landing of inside shaft adequate cowl type ventilators or Lantern type ventilators with stainless steel jail.
- (7) Scope of work includes constructing RCC spiral staircase with adequate tie beams, staircase footing, RCC chambers for valves, ventilating shaft and ventilators as well as door in shaft. SS grating to be provided to outlet pipe (inside container) for safety
- (8) Including providing and applying three coats of cement paint (as specified) to the whole structure

(9) it also includes satisfactory water tightness test as per relevant IS code and painting name of scheme and capacity of the tank as per direction of engineer in charge.

List of Indian standards for designing of ESR

Note: the structural design of ESR shall be in accordance with provisions of relevant Indian standards

(1) IS 3370 Part I and II 2009 or latest revision

(1.1) IS 3370 part III and IV 1965 or latest revision

(2) IS 458-2000 all latest revision

(3) IS 11682-1985 for latest revision

(4) IS 1893-2002 part I to V or latest revision

(5) IS 13920-1993 or latest revision

(6) IS 875 part I to III 1987 or latest revision

(7) IS 11089-1987 all latest revision

General Specifications:

(1) The minimum concrete grade for RCC shall be M30. Proportion of concrete ingredients shall be as per mix design using weigh batching.

(2) HYSD (Fe 415) or higher grade reinforcing bars conforming to IS1786 /1138 or CRS/TMT bars Shelby use as per detailed specification

(3) In case of Columbus dressed I type staging having more than 8 columns internal horizontal bracing is obligatory one bracing Shelby at foundation level in case of individual footings

(4) Minimum size / thickness of various components shall be provided as per design criteria /specifications /IS code (or as per practice). Capacity of the ESR shall be considered excluding free board.

(5) Minimum dimensions specified for various components in tender data/specifications should be provided.

(6) The safe bearing capacity (SBC) / allowable pressure on soil shall be referred from latest SBC test report or tender data sheet. During execution, if poor soil strata or groundwater table is encountered, the SBC shall have to be re ascertained and the design should be revised accordingly.

(7) Maximum spacing between horizontal bracings shall be 5 m (story height).

(8) The BB machinery cabin with MS Door shall be constructed when spiral staircase is outside the staging.

(9) RCC staircase/ MS Staircase shall be provided and fixed for access to roof when height of roof from GL is up to 10m. For ESR having more than 10 m height proper RCC staircase or suitable RCC spiral staircase shall be constructed. Railing should be provided throughout the staircase and around the toe ring beam.

(10) For ESR having height more than 15 m the spiral staircase shall be provided inside the staging with effective tie beams in more than One Direction.

(11) Water level indicator shall be provided and fixed float type electronic (as specified)

(12) The rate shall include providing and fixing pipes, specials and valves required for inlet, outlet, washout, overflow and bypass arrangement. The scope of work includes constructing supporting RC pillars, erecting, laying, fixing and joining pipes and specials up to five m length from face of staging (outermost column)

(13) DI pipes and specials shall only be used

(14) The rate shall include cost of dewatering during execution making all arrangements with any dewatering techniques

(15) The structure shall be designed properly for uplift due to ground water table specified in data or GWT encountered during execution. No extra payment shall be paid for the same

(16) Effective curing shall be carried out up to require period as per specifications

(17) Contractor shall engage qualified consulting engineer for designing the structure and shall visit the site for guidance of work at all levels i.e. Below foundation up to GL, above GL (or all lifts up to container)

Staging Height of 16 m and Seismic Zone V - 16,00,000 Lit. Cap. ESR

&

Staging Height of 20 m and Seismic Zone V- 30,00,000 LIT. CAP. ESR

1.1 Design Submissions

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

1.1.2 The design considerations described hereunder establish the minimum basic requirements of plain and reinforced concrete structures, masonry structures and structural steel works. However, any particular structure shall be designed for the satisfactory performance of the functions for which the same is being constructed. The Contractor shall also take care to check the stability of partly completed structures.

1.2 Design Standards

1.2.1 All designs shall be based on the latest Indian Standard (I.S.) Specifications or Codes of Practice. The design standards adopted shall follow

the best modern engineering practice in the field based on any other international standard or specialist literature subject to such standard reference or extract of such literature in the English language being supplied to and approved by EMPLOYER. In case of any variation or contradiction between the provisions of the I.S. Standards or Codes and the specifications given along with the submitted tender document, the provision given in this Specification shall be followed.

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

I.S. 456 Code of Practice for plain and reinforced concrete

I.S. 875 Code of Practice for design loads for buildings and structures (Part 1 to 5)

I.S. 3370 Code of Practice for concrete structures for the storage of liquids (Part I to IV)

I.S. 1893 Criteria for earthquake resistant design of structures

I.S. 2974 Code of Practice for design and construction of machine foundations (Part 1 to 4)

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

I.S. 800: Code of Practice for general construction in steel

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

1.3 Design Life

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

1.4 Design Loading

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

1.4.1 Dead Load

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

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

- (i) Weight of water : 9.81 kN/m³
- (ii) Weight of soil (irrespective of strata available at site and type of soil used for filling etc). However, for checking stability against uplift, actual weight of soil as determined by field test shall be considered. : 20.00 kN/m³
- (iii) Weight of plain concrete : 24.00 kN/m³
- (iv) Weight of reinforced concrete : 25.00 kN/m³
- (v) Weight of brickwork (exclusive of plaster) : 22.00 N/m² per mm thickness of brickwork
- (vi) Weight of plaster to masonry surface : 18.00 N/m² per mm thickness
- (vii) Weight of granolithic terrazzo finish or rendering screed, etc. : 24.00 N/m² per mm thickness

1.4.2 Live Load

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

- (i) Live load on roofs (accessible) : 1.50 kN/m²
(Non-accessible) : 0.75 kN/m²
- (ii) Live load on floors supporting equipment such as pumps, blowers, compressors, valves, etc.: 10.00 kN/m²
- (iii) Live load on all other floors
walkways, stairways and platforms. : 5.00 kN/m²

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

1.4.3 Wind Load

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

1.4.4 Earthquake Load

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

1.4.5 Dynamic Load

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

1.5 Joints

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

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

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

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

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

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

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

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

1.6.2 Design Conditions for Elevated Service Reservoir.

- (i) The foundation depth shall be minimum 3 mt or up to hard rock strata whichever is more.
- (ii) In case of supporting structure as a shaft, the minimum diameter of the shaft shall be 12 mt. and tolerance limit in the diameter will be $\pm 0.5\%$. The thickness of the shaft shall not be less than 250 mm and grade of concrete for shaft and foundation shall be M-30.
- (iii) The minimum thickness of components of container will be as under:
 - a) Bottom dome 250 mm
 - b) Conical dome 600 mm
 - c) Cylindrical wall 250 mm
 - d) Top dome 200 mm
- (iv) Depth of water in container maximum 7.6 mt.

1.7 Foundations

- (i) The minimum depth of foundations for all structures, equipment, buildings and frame foundations and load bearing walls shall be as per IS 1904.

(ii) Maximum safe bearing capacity of soil strata shall be taken as indicated in geotechnical reports.

(iii) Care shall be taken to avoid the foundations of adjacent buildings or structure foundations, either existing or not within the scope of this Contract. Suitable adjustments in depth, location and sizes may have to be made depending on site conditions. No extra claims for such adjustments shall be accepted by EMPLOYER.

(iv) Where there is level difference between the natural ground level & the foundations of structure or floor slabs, this difference shall be filled up in the following ways:

- In case of non-liquid retaining structures the natural top soil shall be removed till a firm strata is reached (minimum depth of soil removed shall be 500 mm.) and the level difference shall be made up by compacted backfill as per specifications. However the thickness of each layer shall not exceed 150 mm. The area of backfilling for floor slabs shall be confined to prevent soil from slipping out during compaction. The safe bearing capacity of this well compacted backfilled soil shall not exceed 100 kN/sq.m.
- In case of liquid retaining structures, the natural top soil shall be removed as described above and the level difference shall be made up with Plain Cement Concrete (1:5:10)

1.8 Design Requirements

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

- a) All blinding and leveling concrete shall be a minimum 100 mm thick in concrete grade CC 1:2:4 for all structures.
- b) All structural reinforced concrete for water retaining structures shall be of a minimum M30 grade with a maximum 20 mm aggregate size for footings and base slabs and with a maximum 20 mm aggregate size for all other structural members. For non water retaining structures the concrete shall be of M25 grade. The structures shall have to be designed as per IS : 3370 (Part I-IV).
- c) The reinforced concrete for water retaining structures shall have a minimum cement content of 400 kg/m³ with a maximum 20 mm size aggregate.
- d) If limit state design method is adopted, as per IS 3370 – 2009, at serviceability load, maximum stress in reinforcement shall not exceed 0.5 f_y (Where f_y is characteristic strength of reinforcement)
- e) The minimum reinforcement for water retaining structures in each direction should be 0.35% of cross section. The minimum clear cover to all reinforcement including stirrups and links shall be 50 mm for all water retaining structures.

- f) All buildings shall have a minimum 1 metre wide, 100 mm thick plinth protection paving in CC 1:2:4 grade concrete or stone slabs/tiles. All plinth protection shall be supported on well compacted strata.
- g) Any structure or pipeline crossing below roads shall be designed for Class A of IRC loading.
- h) The bridges & bridge supporting structures shall be designed to safely withstand the loading.
- i) All pipes & conduits laid below the structural plinth & road works shall be embedded in reinforced concrete of grade CC 1:2:4 of minimum thickness 150 mm.
- j) Approved quality water proofing compound (chloride free) shall be added during concreting of all liquid containing structure in the proportions specified by manufacturer or 2 % by weight of cement whichever is higher.
- k) The wall and floor panels shall be poured in sequential order with a minimum time gap of 4 days.

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

- (i) Walls for liquid retaining structures : 250 mm
- (ii) Channel / Launder : 150mm
- (iii) Roof slabs for liquid retaining structures : 150 mm
(other than flat slabs)
- (iii) Bottom slabs for liquid retaining structures : 200 mm
- (iv) Floor slabs including roof slabs, walkways,
canopy slabs : 125 mm
- (v) Walls of cables / pipe trenches,
underground pits etc. : 125 mm
- (vi) Column footings : 300 mm
- (vii) Parapets, chajja : 100 mm
- (viii) Precast trench cover : 100 mm

☐ In Mix design, the water cement ratio should not exceed 0.45. The exposure condition to be considered as severe.

1.9 Materials in General

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

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

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

1.9.4 As soon as practicable after receiving the order to commence the Works, the Contractor shall inform EMPLOYER of the names of the suppliers from whom he proposes to obtain any materials but he shall not place any order without the approval of EMPLOYER which may be withheld until samples have been submitted and satisfactorily tested. The Contractor shall thereafter keep EMPLOYER informed of orders for and delivery dates of all materials.

1.9.5 Materials shall be transported, handled and stored in such a manner as to prevent deterioration, damage or contamination failing which such damaged materials will be rejected and shall not be used on any part of the Works under this contract.

1.10 Samples and Tests of Materials

The Contractor shall submit samples of such materials as may be required by EMPLOYER and shall carry out the specified tests directed by EMPLOYER at the Site, at the supplier's

premises or at a laboratory approved by EMPLOYER. EMPLOYER may appoint separate third party inspection for the material testing to ensure the quality of the work. The Contractor shall replace the defective material as an outcome of these tests.

1.10.1 Samples shall be submitted and tests carried out sufficiently early to enable further samples to be submitted and tested if required by EMPLOYER.

1.10.2 The Contractor shall give EMPLOYER seven days' notice in writing of the date on which any of the materials will be ready for testing or inspection at the supplier's premises or at a laboratory approved by EMPLOYER. Representative of EMPLOYER shall attend the test at the appointed place within seven days of the said date on which the materials are expected to be ready for testing or inspection according to the Contractor, failing which the test may proceed in his absence unless instructed by EMPLOYER to carry out such a test on a mutually agreed date in his presence. The Contractor shall in any case submit to EMPLOYER's Representative within seven days of every test such number of certified copies (minimum six) of the test results as EMPLOYER may require.

1.10.3 Approval by EMPLOYER as to the placing of orders for materials or as to samples or tests shall not prejudice any of EMPLOYER's powers under the Contract.

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

1.10.5 If need arises, non destructive of the structural components shall be carried out by the agency as per directions of engineer in charge of client at his own cost.

1.11 Standards

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

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

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

1.11.4 In case of discrepancy between the Bid Specification and the Standards referred to herein, the Bid Specification shall govern.

a) Materials

IS : 269 Specification for 33 grade ordinary Portland cement

IS : 383 Specification for coarse and fine aggregates from natural sources for concrete IS : 428 Specification for distemper, oil emulsion, colour as required

IS : 432 Specification for mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement (Parts 1 & 2)

IS : 455 Specification for Portland slag cement

IS : 458 Specification for precast concrete pipes(with and without reinforcement) IS : 650 Specification for standard sand for testing of cement

IS : 651 Specification for salt glazed stoneware pipes and fittings IS : 777 Specification for glazed earthenware tiles

IS : 808 Specification for dimensions for hot rolled steel beam, column, channel and angle sections

IS : 814 Specification for covered electrodes for manual metal arc welding of Carbon and Carbon Manganese steel

IS : 1003 Specification for timber paneled and glazed shutters(Parts 1 & 2)

IS : 1038 Specification for steel doors, windows and ventilators

IS : 1077 Specification for common burnt clay building bricks

IS : 1398 Specification for packing paper, water proof, bitumen laminated

IS : 1489 Specification for Portland pozzolana cement (Parts 1 & 2)

IS : 1566 Specification for hard drawn steel wire fabric for concrete reinforcement

IS :1580 Specification for bituminous compounds for water proofing and caulking purposes

IS : 1786 Specification for high strength deformed steel bars and wires for concrete reinforcement

IS : 1852 Specification for rolling and cutting tolerances for hot rolled steel products IS : 1948 Specification for aluminium doors, windows and ventilators

IS : 1977 Specification for structural steel (ordinary quality) IS : 2062 Specification for steel for general structural purposes

IS : 2185 Specification for concrete masonry units (Parts 1 & 2)

IS : 2202 Specification for wooden flush door shutters (Parts 1 & 2) IS : 2645 Specification for integral cement water proofing compounds IS : 2750 Specification for steel scaffoldings

IS : 2835 Specification for flat transparent sheet glass

IS : 3384 Specification for bitumen primer for use in waterproofing and damp roofing IS : 3502 Specification for steel chequered plates

IS : 4021 Specification for timber door, window and ventilator frames IS : 4350 Specification for concrete porous pipes for under drainage IS : 4351 Specification for steel door frames

IS : 4990 Specification for plywood for concrete shuttering work IS : 8112 Specification for 43 grade ordinary Portland cement

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

IS : 10262 Recommended guidelines for concrete mix design IS : 12269 Specification for 53 grade ordinary Portland cement IS : 12330 Specification for sulphate resisting Portland cement

IS : 12709 Glass fibre reinforced plastics (GRP) pipes, joints and fittings for use for potable water supply

b) Tests

IS : 516 Method of test for strength of concrete

IS : 1182 Recommended practice for radiographic examination of fusion welded butt joints in steel plates

IS : 1199 Methods of sampling and analysis of concrete

IS : 2386 Methods of test for aggregates for concrete(Parts 1 to 8) IS : 2720 Methods of test for soils (Parts 1 to 39)

IS : 3025 Methods for sampling and test (physical and chemical) for water and wastewater (Parts 1 to 44)

IS : 3495 Method of test for burnt clay building bricks(Parts 1 to 4)

IS : 3613 Acceptance tests for wire flux combination for submerged arc welding IS : 4020 Methods of tests for wooden flush doors Type tests

IS : 4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)

IS : 5807 Method of test for clear finishes for wooden furniture (Parts 1 to 6)

IS : 7318 Approval tests for welders when welding procedure approval is not required (Parts 1 and 2)

c) Codes of Practice

IS :456 Code of practice for plain and reinforced concrete IS : 783 Code of practice for laying of concrete pipes

IS : 800 Code of practice for general construction in steel

IS : 806 Code of practice for use of steel tubes in general building construction

IS : 816 Code of practice for use of metal arc welding for general construction in mild steel

IS : 817 Code of practice for training and testing of metal arc welders

IS : 875 Code of practice for design loads (other than earthquake) for building structures(Parts 1 to 5)

IS : 1081 Code of practice for fixing and glazing of metal (steel and aluminum) doors, windows and ventilators

IS : 1172 Code of practice for basic requirements for water supply, drainage and sanitation

IS : 1477 Code of practice for painting of ferrous metals in buildings (Parts 1&2) IS : 1597 Code of practice for construction of stone masonry (Parts 1 &2)

IS : 1742 Code of practice for building drainage

IS : 1893 Criteria for earthquake resistant design of structures IS : 2065 Code of practice for water supply in buildings

IS : 2212 Code of practice for brickwork

IS : 2338 Code of practice for finishing of wood and wood based materials (Parts 1 & 2)

IS : 2394 Code of practice for application of lime plaster finish

IS : 2395 Code of practice for painting, concrete, masonry and plaster surfaces (Parts 1 & 2)

IS : 2470 Code of practice for installation of septic tanks (Parts 1 & 2)

IS : 2502 Code of practice for bending and fixing of bars for concrete reinforcement IS : 2571 Code of practice for laying in situ cement concrete flooring

IS : 2595 Code of practice for radiographic testing

IS : 2751 Recommended practice for welding of mild steel plain and deformed bars for reinforced construction

IS : 2974 Code of practice for design and construction of machine foundations (Parts 1 to 4)

IS : 3114 Code of practice for laying of Cast Iron pipes

IS : 3370 Code of practice for concrete structures for the storage of liquids (Parts 1 to 4)

IS : 3414 Code of practice for design and installation of joints in buildings

IS : 3558 Code of practice for use of immersion vibrators for consolidating concrete IS : 3658 Code of practice for liquid penetrant flaw detection

IS : 3935 Code of practice for composite construction

IS : 4000 Code of practice for High strength bolts in steel structures IS : 4014 Code of practice for steel tubular scaffolding (Parts 1 & 2)

IS : 4111 Code of practice for ancillary structures in sewerage system (Parts 1-4) IS : 13920 Code of practice for laying of glazed stoneware pipes

IS : 4326 Code of practice for Earthquake Resistant Design and Construction of Buildings

IS : 4353 Recommendations for submerged arc welding of mild steel and low alloy steels

IS : 5329 Code of practice for sanitary pipe work above ground for buildings IS : 5334 Code of practice for magnetic particle flaw detection of welds

IS : 5822 Code of practice for laying of welded steel pipes for water supply

IS : 7215 Tolerances for fabrication of steel structures

IS : 9595 Recommendations for metal arc welding of carbon and carbon manganese steels

IS : 10005 SI units and recommendations for the use of their multiples and of certain other units

d) Construction Safety

IS : 3696 Safety code for scaffolds and ladder (Parts 1 & 2) IS : 3764
Safety code for Excavation work

IS : 7205 Safety code for erection of structural steel work

1.12 Orientation

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

1.13 Buildings and Structures

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

1. All building works shall be of reinforced concrete framework.
 2. All external walls shall be in 230 mm thick brick masonry built cement mortar in 1:4. Transoms and mullions of 115 mm x 230 mm size with four numbers 6 mm bars and 6 mm links at 150 mm c/c shall be provided to form panels not exceeding 3500 mm x 3500 mm in size.
 3. All internal partition walls except for toilets and Residential units shall be in 230 mm thick brick masonry built in cement mortar 1:4 with transoms and mullions as in
 - (2) above. Toilet partition walls shall be in 115 mm thick brick masonry built in cement mortar 1:4 and shall have transoms and mullions as in (2) above and shall form panels not exceeding 1200 mm x 1200 mm in size.
- (a) Finishes to concrete liquid retaining structures (for details, refer clause 3.16 of this volume) shall be :
- | | | |
|----|---|---|
| F1 | - | External surfaces, buried |
| F2 | - | External surfaces exposed and up to 300 mm below ground level |
| F2 | - | Internal surfaces |
- (b) Finishes to other concrete structures (for details, refer clause 3.16 of this volume) shall be :
- | | | |
|----|---|--|
| F1 | - | Buried |
| F1 | - | Exposed, where plastering is specified |
| F2 | - | Exposed |

4. All internal masonry surfaces finish shall have 15 mm thick plain faced cement plaster in cement mortar (1:4) with neat lime or neeru finish on top. Over this, one coat of primer and two coats of plastic emulsion paint of approved quality and shade shall be provided.

5. All external masonry surfaces shall have 20 mm thick sand faced cement plaster in cement mortar (1:3) in two coats. Waterproofing compound of approved make and

quality shall be added to the cement mortar in proportions as specified by the manufacturer.

6. All external surfaces above ground level shall have one coat of primer and two coats of waterproof cement based paint of approved quality and shade. A coat of silicone water repellent paint shall also be applied thereon.

7. Toilet areas, walls and ceilings, shall have one coat of primer and two coats of plastic emulsion paint.

8. Toilet floor slab shall be filled with brick bat coba (broken bricks in lime) and provided with waterproofing as per the specifications of an approved specialist waterproofing company.

9. The finished floor level in toilet areas shall be 25 mm below general finished floor level elsewhere in the building.

10. The flooring in all areas except toilets and staircases shall be in 250 mm x 250 mm x 20 mm thick white cement based marble mosaic tiles or vitrified tiles of approved shade and pattern and placed in cement mortar or lime mortar to give overall thickness of 50 mm. Half tile skirting shall also be provided in these areas.

11. Toilet areas shall have 450 mm x 450 mm x 25 mm thick polished marble Kota stone tiles placed in cement mortar or lime mortar to give an overall thickness of 50 mm. 2200 mm high ceramic tile (size 200 mm x 200 mm x 6 mm thick) dado placed in cement mortar shall also be provided in these areas. In W.C. areas, the flooring and 2200 mm high dado shall be provided with 200 mm x 200 mm x 6 mm thick coloured ceramic tiles.

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

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

13 All floor cut-outs and cable ducts, etc. shall be covered with precast concrete covers in outdoor areas and mild steel chequered plates of adequate thickness in indoor areas. All uncovered openings shall be protected with M.S. hand railing of 32 NB (M).

14. All staircases shall be provided with 32 NB (M) galvanised M.S. pipe hand railing for protection.

15. The reinforced concrete roofs shall be made waterproof by application of an approved roof polythene / bitumen membrane. The finished roof surface shall have adequate slope to drain quickly the rain water to R.W dwtake inlet points.

16. For roofing drainage, cast iron/PVC rainwater dwtakes with bell mouth and C.I. grating at top shall be provided. For roof areas up to 100 sq.m minimum two nos. 100 mm diameter dwtake pipes shall be provided. For every additional area of 100 sq.m or part thereof, at least one no. 100 mm dia. dwtake pipe shall be provided.

17. Top surfaces of chajjas and canopies shall be made waterproof by providing a screed layer of adequate slope or application of an approved roof membrane and sloped to drain the rain water. Chajjas, canopies and roof projections shall have drip moulds.

18. Building plinth shall be minimum 600 mm above average finished ground level around building.

19. All doors, windows, rolling shutters shall have lintels above. Chajja protection to lintels on external walls shall be such as to prevent the rain water splashing into the building.

20. All windows and ventilators shall have 25 mm thick marble stone sills bedded in cement mortar (1:3)

21. All concrete channels and ducts used for conveying liquid shall have inside finish of type F2. The width of concrete channels shall not be less than 500 mm. All open channels shall be provided with handrailings.

22. Kerbs to be provided below the hand railing on the catwalks/pathways should be as per relevant sections of Factory Act.

23. All rooms in the buildings shall be provided with appropriate sign boards indicating the function of the rooms involved.

24. Wherever equipment and machinery are to be moved for inspection, servicing, replacement etc., suitable movable gantry in the form of EOT /

HOT crane shall be provided. Minimum capacity of 2 tonnes or more as required shall be provided for monorail.

25. The design of buildings shall be suitable for the climatic conditions existing on site. Buildings shall as far as is possible permit the entry of natural light.

26. Emergency exit doorways with Signboards shall be provided from all buildings in order to comply with local and international regulations. Stairways and paved areas shall be provided at the exit points.

27. The side walls of buildings shall, comprise at least 15% ventilated brickwork or louvers. Ventilating brickwork or louvers shall not be used where the ingress of driven rain could affect equipment or stored materials.

1.14 Roadways, & Pathways

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

1.15 Site Drainage

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

1.15.1 Storm Water Drainage

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

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

1.15.2 Foul Drainage

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

1.16 Cable and Pipework Trenches

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

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

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

1.17 Pipes and Ducts

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

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

1.18 Valve Chambers

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

1.19 Landscaping

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

1.19.2 Landscaping shall include planting of suitable trees and development of grassed areas. Landscaping in general shall meet ecological and environmental conditions of the site. Road

widths shall determine the size of the tree height and spread to be selected for planting. Trees suitable for local conditions shall be selected. Medicinal and fruit trees shall be avoided.

1.19.3 Tree Planting

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

1.20 Security Fencing and Gates

1.20.1 Compound wall for the WTP plot shall have to be provided as shown in the tender drawing.

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

1.20.3 4.5m wide x 2.2m high main steel gates and 1m wide x 2.2 m high steel wicket gate made out of tubular sections/square bars/flats of welded construction alongwith the locking arrangement and posts to match with security fencing shall be provided at appropriate places. Gates shall be painted with similar synthetic enamel paint.

1.20.4 Chain link fencing with gates around electrical installations shall be provided as per Power Supply Company's requirements.

2.0 EARTHWORKS

2.1 Applicable Codes

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

- a) IS 783 - 1985 - Code of practice for laying of concrete pipes.
- b) IS 3764 - 1992 - Excavation work - Code of Safety .
- c) IS 2720 - Methods of test for soils:
(Part-1) - 1983 - Part 1 Preparation of dry soil

samples for various tests. (Part-2) - 1986 - Part 2
Determination of

Water Content.

(Part-4) - 1985 - Part 4 Grain size analysis. (Part-5) - 1985 -
Part 5 Determination of

liquid and plastic limit.

(Part-7) - 1980 - Part 7 Determination of
water content - dry density relation using light compaction.

(Part-9) - 1971 - Part 9 Determination of dry
density - moisture content by constant weight of soil method.

(Part-14) - 1983 - Part 14 Determination of
density index (relative density) of cohesionless soils.

(Part-22) - 1978 - Part 22 Determination of
organic matter.

(Part-26) - 1987 - Part 26 Determination of
pH Value.

(Part-27) - 1987 - Part 27 Determination of
total soluble sulphates.

(Part-28) - 1974 - Part 28 Determination of
dry density of soils in place, by the sand replacement method.

(Part-33) - 1971 - Part 33 Determination of the
density in place by the ring and water replacement method.

(Part-34) - 1972 - Part 34 Determination of
density of soil in place by rubber balloon method.

(Part-38) - 1976 - Part 38 Compaction control
test (Hilf Method)

2.2 General

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

2.2.2 The Contractor shall survey the site before excavation and set out all lines and establish levels for various works such as grading, basement, foundations, plinth filling, roads, drains, cable trenches, pipelines etc. Such survey shall be carried out by taking accurate cross sections of the area

perpendicular to established reference/grid lines at 8m intervals or nearer, if necessary, based on ground profile and thereafter properly recorded.

2.2.3 The excavation shall be carried out to correct lines and levels. This shall also include, where required, proper shoring to maintain excavations and also the furnishing, erecting and maintaining of substantial barricades around excavated areas and warning lamps at night.

2.2.4 Excavated material shall be dumped in regular heaps, bunds, riprap with regular slopes within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the Employer's Representative. As a rule, all softer material shall be laid along the center of heaps, the harder and more weather resisting materials forming the casing on the sides and the top. Rock shall be stacked separately.

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

2.3 Clearing the site

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

2.4 Excavation

2.4.1 All excavation work shall be carried out by mechanical equipment unless, in the opinion of Employer's Representative, the work involved requires it to be carried out by manual methods.

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

2.4.3 To facilitate the permanent works the Contractor may excavate, and also backfill later, outside the lines shown on the drawings provided by the Contractor as agreed with the Employer's Representative. Should any

excavation be taken below the specified elevations, the Contractor shall fill it up with concrete of the same class as in the foundation resting thereon, upto the required elevation at no cost to the Employer.

2.4.4 All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the Employer's Representative shall be obtained by the Contractor in each individual case, for the method proposed for the excavation, including dimensions, side slopes, dewatering, disposal, etc. This approval, shall not in any way relieve the Contractor of his responsibility for any consequent loss or damage. The excavation must be carried out in the most expeditious and efficient manner. Side slopes shall be as steep as will stand safely for the actual soil conditions encountered. Every precaution shall be taken to prevent slips.

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

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

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

1. Removing all surface obstructions including shrubs, jungle etc.
2. Making all necessary excavations true to line and grade,
3. Furnishing and installing all shoring and bracing as necessary or as directed
4. Pumping and bailing out water to keep trenches free of water during pipe laying and jointing and thereafter until joints mature,
5. Providing for uninterrupted surface water flow during work in progress,
6. Providing for disposing off water flows from storm, drains, nallas or other sources, suitably,
7. Protecting all pipes, conduits, culverts, railway tracks, utility poles, wire fences, buildings, and other public and private property adjacent to or in the line of work,
8. Removing all shoring and bracing which is not ordered to be left in place or not required by the project plans or specifications to remain in place,

9. Hauling away and disposing of excavated materials not necessary or else unsuitable for back filling purpose. The extra excavated soil will have to be properly as directed,
10. Backfilling the trenches as directed or as per specifications,
11. Restoring all property injured or disturbed by these construction activities to the condition as near its original condition as possible,
12. Restoring the surface and repairing of all roads, streets, alleys, walks, drives, working spaces, and rights of way to a condition as good as prior to excavation.

2.4.7 Slips and Slides

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

2.5 Rock

2.5.1 General

'Rock' means a natural aggregate of mineral crystals which for its excavation would normally require the use of heavy pneumatic/hydraulic breaker and/or cutting equipment or explosives. The term shall exclude any material that can be removed by ordinary excavating machinery and which in any individual mass has a volume not exceeding 1m³ or 0.25m³ where the net width of excavation is less than 2 m. Ordinary excavating machinery means a hydraulic back hoe with rated output of 50 KW or less.

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

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

2.5.4 Excavation by the Use of Explosives

Unless otherwise stated herein, I.S. Specification "IS:4081: Safety Code for Blasting and related Drilling Operations" shall be followed. As far as possible all blasting shall be completed prior to commencement of construction. At all stages of excavation, precautions shall be taken to preserve the rock below and beyond the lines specified for the excavation, in the soundest possible

condition. The quantity and strength of explosives used, shall be such as will neither damage nor crack the rock outside the limits of excavation. All precautions, as directed by Employer's Representative, shall be taken during the blasting operations and care shall be taken that no damage is caused to adjoining buildings or structures as a result of blasting operations. In case of damage to permanent or temporary structures, Contractor shall repair the same to the satisfaction of Employer's Representative at his cost. As excavation approaches its final lines and levels, the depth of the charge holes and amount of explosives used shall be progressively and suitably reduced.

2.5.5 The contractor shall obtain a valid Blasting License from the authorities concerned. No explosive shall be brought near the work in excess of quantity required for a particular amount of firing to be done; and surplus left after filling the holes shall be removed to the magazine. The magazine shall be built as away as possible from the area to be blasted. Employer's Representative's prior approval shall be taken for the location proposed for the magazine.

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

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

- i) Contractor shall employ a competent and experienced supervisor and licensed blaster in-charge of each set of operation, who shall be held personally responsible to ensure that all safety regulations are carried out.
- ii) Before any blasting is carried out, Contractor shall intimate Employer's Representative and obtain his approval in writing for resorting to such operations. He shall intimate the hours of firing charges, the nature of explosive to be used and the precautions taken for ensuring safety.
- iii) Contractor shall ensure that all workmen and the personnel at site are excluded from an area within 200 m radius from the firing point, at least 15 minutes before firing time by sounding warning whistle. The area shall also be given a warning by sounding a distinguishing whistle.
- iv) The blasting of rock near any existing buildings, equipments or any other property shall be done under cover and Contractor has to make all such necessary muffling arrangements. Covering may preferably be done by MS plates with adequate dead weight over them. Blasting shall be done with small charges only and where directed by Employer's Representative, a trench shall have to be cut by chiseling prior to the blasting operation, separating the area under blasting from the existing structures.
- v) The firing shall be supervised by a Supervisor and not more than 6 (six) holes at a time shall be set off successively. If the blasts do not tally with the number fired, the misfired holes shall be carefully located after half an hour and when located, shall be exploded by drilling a fresh hole along the misfired hole (but not nearer than 600 mm from it) and by exploding a new charge.

- vi) A wooden tamping rod with a flat end shall be used to push cartridges home and metal rod or hammer shall not be permitted. The charges shall be placed firmly into place and not rammed or pounded. After a hole is filled to the required depth, the balance of the hole shall be filled with stemming which may consist of sand or stone dust or similar inert material.
- vii) Contractor shall preferably detonate the explosives electrically.
- viii) The explosives shall be exploded by means of a primer which shall be fired by detonating a fuse instantaneous detonator (F.I.D) or other approved cables. The detonators with F.I.D. shall be connected by special nippers.
- ix) In dry weather and normal dry excavation, ordinary low explosive gunpowder may be used. In damp rock, high explosive like gelatin with detonator and fuse wire may be used. Underwater or for excavation in rock with substantial accumulated seepage electric detonation shall be used.
- x) Holes for charging explosives shall be drilled with pneumatic drills, the drilling pattern being so planned that rock pieces after blasting will be suitable for handling without secondary blasting.
- xi) When excavation has almost reached the desired level, hand trimming shall have to be done for dressing the surface to the desired level. Any rock excavation beyond an overbreak limit of 75 mm shall be filled up as instructed by Employer's Representative, with concrete of strength not less than M10. Stopping in rock excavation shall be done by hand trimming.
- xii) Contractor shall be responsible for any accident to workmen, public or Employer's property due to blasting operations. Contractor shall also be responsible for strict observance of rules, laid by Inspector of explosives, or any other Authority duly constituted under the State and / or Union Government as applicable at the place of excavation.

2.6 Stripping Loose Rock

2.6.1 All loose boulders, detached rocks partially and other loose material which might move therewith not directly in the excavation but so close to the area to be excavated as to be liable, in the opinion of Employer's Representative, to fall or otherwise endanger the workmen, equipment, or the work shall be stripped off and removed from the area of the excavation. The method used shall be such as not to render unstable or unsafe the portion which was originally sound and safe.

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

2.7 Fill, Backfilling and Site Grading

2.7.1 General

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

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

2.7.3 Material

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

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

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

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

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

2.7.6 Plinth Filling

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

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

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

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

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

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

2.7.12 Sand Filling in Plinth and Other Places

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

2.7.13 Filling in Trenches

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

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

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

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

2.8 General Site Grading

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

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

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

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

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

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

2.9 Fill Density

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

2.10 Timber Shoring

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

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

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

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

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

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

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

2.11 Dewatering

2.11.1 The Contractor shall ensure that the excavation and the structures are free from water during construction and shall take all necessary precautions and measures to exclude ground/rain water so as to enable the works to be carried out in reasonably dry conditions in accordance with the construction programme. Sumps made for dewatering must be kept clear of the excavations/trenches required for further work. The method of pumping shall be approved by Employer's Representative, but in any case, the pumping arrangement shall be such that there shall be no movement of subsoil or blowing in due to differential head of water during pumping. Pumping arrangements shall be adequate to ensure no delays in construction. The dewatering shall be continued for at least (7) seven days after the last pour of the concrete. The Contractor shall, however, ensure that no damage to the structure results on stopping of dewatering.

2.11.2 The Contractor shall study the sub-soil conditions carefully and shall conduct any tests necessary at the site with the approval of the Employer's Representative to test the permeability and drainage conditions of the sub-soil for excavation, concreting etc., below ground level.

2.11.3 The scheme for dewatering and disposal of water shall be approved by the Employer's Representative. The Contractor shall suitably divert the water obtained from dewatering from such areas of site where a build up of water in the opinion of the Employer's Representative obstructs the progress of the work, leads to insanitary conditions by stagnation,

retards the speed of construction and is detrimental to the safety of men, materials, structures and equipment.

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

2.12 Rain Water Drainage

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

3.0 CONCRETE WORKS

3.1 Applicable Codes

3.1.1 Materials

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

12) IS:2645 Specification for integral cement water- proofing compounds.

13) IS:4990 Specification for plywood for concrete shuttering work.

3.1.2 Material Testing

1) IS.4031 Methods of physical tests for hydraulic cement (Parts 1 to 15)

2) IS:4032 Method chemical analysis of hydraulic cement.

3) IS:650 Specification for standard sand for testing of cement.

4) IS:2430 Methods for sampling of aggregates for concrete.

5) IS.2386 Methods of test for aggregates for concrete (Parts 1 to 8)

6) IS:3025 Methods of sampling and test (physical and chemical) for water used in industry.

7) IS:6925 Methods of test for determination of water soluble chlorides in concrete admixtures.

3.1.3 Material Storage

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

3.1.4 Concrete Mix Design

1) IS:10262 Recommended guidelines for concrete mix design.

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

3.1.5 Concrete Testing

1) IS.1199 Method of sampling and analysis of concrete.

2) IS:516 Method of test for strength of concrete.

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

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

- 5) IS:9284 Method of test for abrasion resistance of concrete.
- 6) IS:2770 Methods of testing bond in reinforced concrete.

3.1.6 Equipments

- 1) IS:1791 Specification for batch type concrete mixers.
- 2) IS:2438 Specification for roller pan mixer.
- 3) IS:4925 Specification for concrete batching and mixing plant.
- 4) IS:5892 Specification for concrete transit mixer and agitator.
- 5) IS:7242 Specification for concrete spreaders.
- 6) IS:2505 General Requirements for concrete vibrators: Immersion type.
- 7) IS:2506 General Requirements for screed board concrete vibrators.
- 8) IS:2514 Specification for concrete vibrating tables.
- 9) IS:3366 Specification for pan vibrators.
- 10) IS:4656 Specification for form vibrators for concrete.
- 11) IS:11993 Code of practice for use of screed board concrete vibrators.
- 12) IS:7251 Specification for concrete finishers.
- 13) IS:2722 Specification for portable swing weigh batchers for concrete (single and double bucket type).
- 14) IS:2750 Specification for steel scaffoldings.

3.1.7 Codes Of Practice

- 1) IS:456 Code of practice for plain and reinforced concrete.
- 2) IS:457 Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
- 3) IS:3370 Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
- 4) IS:3935 Code of practice for composite construction.
- 5) IS:2204 Code of practice for construction of reinforced concrete shell roof.

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

3.1.8 Construction Safety

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

3.2 General

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

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

3.3 Materials

3.3.1 Cement

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

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

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

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

3.3.5 Aggregates (General)

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

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

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

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

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

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

3.3.11 Water

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

3.3.12 Reinforcement

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

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

3.3.13 Admixtures

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

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

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

3.3.14 Wastage

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

3.4 Samples and Tests

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

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

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

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

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

3.5 Storing of Materials

3.5.1 All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS:4082 shall be complied with.

3.5.2 The Contractor will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by the EMPLOYER. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

3.5.3 Each size of coarse and fine aggregates shall be stacked separately and shall be protected from leaves and contamination with foreign material. The stacks shall be on hard, clean, free draining bases, draining away from the concrete mixing area.

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

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

3.6 Concrete

3.6.1 General

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

3.6.1 a Ready mix concrete

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

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

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

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

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

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

Suitable adjustments shall also be made in the weights of aggregates to allow for the variation in weights of aggregates due to variation in their moisture content.

The special Conditions / Specification regarding RMC are as follows.

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

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

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

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

All taxes for the RMC shall have to be borne by the contractor as per prevailing rates. RMC process shall be fully automatic and computerized

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

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

The contractor shall supply the following information for guidance of the manufacturer : The type of cement to be used

Details Specification of aggregates to be used. Type of admixture to be used. If specified.

Min. acceptable strength

Slump of concrete or compaction factor

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

Any other requirement.

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

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

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

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

3.6.2 Design Mix Concrete

3.6.2.1 Mix Design & Testing

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

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

Grade of Concrete Minimum Cement Content in Kg/Cu.m of Concrete

M15 M20 M25

M30 320

360

380

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

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

Grade of Concrete	Minimum Compressive Strength	Specified
	Characteristic Compressive Strength	

	N/sq. mm at 7 days	N/sq. mm at 28 days
M 15	10.0	15.0
M 20	13.5	20.0
M 25	17.0	25.0
M 30	20.0	30.0
M 35	23.5	35.0
M 40	27.0	40.0

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

Structure/Member Slump in millimeters

	Maximum	Minimum
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	100	25
Slabs, Beams and reinforced walls	75	25
Pump & miscellaneous Equipment Foundations	100	25
Building columns	50	25

Pavements 50 25

Heavy mass construction 50 25

3.6.2.2 Batching & Mixing of Concrete

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

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

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

3.6.3 Nominal Mix Concrete

3.6.3.1 Mix Design & Testing

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

3.6.3.2 Batching & Mixing of Concrete

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

3.7 Formwork

All formwork shall be designed as per IS-14687.

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

3.7.2 The design and engineering of the formwork as well as its construction shall be the responsibility of the Contractor. However, if so desired by the

EMPLOYER, the drawings and calculations for the design of the formwork shall be submitted to the EMPLOYER for approval.

Formwork shall be designed to fulfill the following requirements :

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

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

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

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

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

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

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

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

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

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

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

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

3.7.15 The striking time for formwork shall be determined based on the following requirements:

- (a) Development of adequate concrete strength;
- (b) Permissible deflection at time of striking form work;
- (c) Curing procedure employed - its efficiency and effectiveness;
- (d) Subsequent surface treatment to be done;

- (e) Prevention of thermal cracking at re-entrant angles;
- (f) Ambient temperatures; and
- (g) Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

3.7.16 Under normal circumstances (generally where temperatures are above 20oC) forms may be struck after expiry of the time period given in IS:456 unless approved otherwise by the EMPLOYER. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as approved by the EMPLOYER. It is the Contractor's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resist surface damage and any stresses arising during the construction period.

3.8 Reinforcement Workmanship

3.8.1 Reinforcing bars supplied bent or in coils shall be straightened cold without damage. No bending shall be done when ambient temperature is below 5oC. Local warming may be permitted if steel is kept below 10o C.

3.8.2 All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by EMPLOYER.

3.8.3 Re-bending or straightening incorrectly bent bars shall not be done without the approval of the EMPLOYER.

3.8.4 Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by the EMPLOYER prior to concrete placement. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

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

3.8.6 Substitution of reinforcement, laps/splices not shown on drawing shall be subject to EMPLOYER's approval.

3.9 Tolerances

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

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

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

(a) Deviation from specified dimensions of cross

section of columns and beams - 6 mm

+ 12 mm

(b) Deviations from dimensions of footings (Tolerances apply to concrete dimensions only, not to positioning of vertical reinforcing steel

or dowels

1) Dimension in plan - 12 mm

+ 50 mm

2) Eccentricity 0.02 times the width of the footing in the direction of deviation but not more than 50 mm

3) Thickness ± 0.05 times the specified thickness

3.10 Preparation Prior to Concrete Placement

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

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

3.11 Transporting, Placing and Compacting Concrete

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

3.11.2 In all cases concrete shall be deposited as nearly as practicable directly in its final position. To avoid segregation, concrete shall not be rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms the Contractor shall provide suitable drops and "Elephant Trunks". Concrete shall not be dropped from a height of more than 1.0m.

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

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

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

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

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

3.11.7 Except when placing with slip forms, each placement of concrete in multiple lift work, shall be allowed to set for at least 24 hours after the final set of concrete before the start of subsequent placement. Placing shall stop when concrete reaches the top of the opening in walls or bottom surface

of slab, in slab and beam construction, and it shall be resumed before concrete takes initial set but not until it has had time to settle as approved by the EMPLOYER. Concrete shall be protected against damage until final acceptance.

3.12 Mass Concrete Works

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

3.13 Curing

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

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

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

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

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

3.14 Construction Joints and Keys

3.14.1 Construction joints will be as shown on the drawing or as approved by the EMPLOYER. Concrete shall be placed without interruption until completion of work between construction joints. If stopping of

concreting becomes unavoidable anywhere, a properly formed construction joint shall be made with the approval of the EMPLOYER.

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

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

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

3.15 Foundation Bedding

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

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

3.16 Finishes

3.16.1 General

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

3.16.2 Surface Finish Type F1

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

3.16.3 Surface Finish Type F2

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

3.16.4 Surface Finish Type F3

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

3.16.5 Integral Cement Finish on Concrete Floor

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

3.17 Repair and Replacement of Unsatisfactory Concrete work

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

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

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

3.17.4 For patching of defective areas all loose materials shall be removed and the surface shall be prepared as approved by the EMPLOYER.

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

3.18 Vacuum Dewatering of Slabs

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

3.19 Hot Weather Requirements

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

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

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

3.20 Cold Weather Requirements

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

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

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

3.21 Liquid Retaining Structures

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

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

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

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

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

3.22 Testing Concrete Structures for Leakage

3.22.1 Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the EMPLOYER, as described below :

3.22.2 In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

3.22.3 In the case of structures whose external faces are buried and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling, the level of the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. over a period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the watertightness of the structure. The EMPLOYER shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

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

3.22.5 For structures such as pipes, tunnels etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and

subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

3.23 Optional Tests

3.23.1 If the EMPLOYER feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the Specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the EMPLOYER, as per relevant IS Codes. Contractor shall have to pay for these tests.

3.23.2 In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strengths, the EMPLOYER reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. The EMPLOYER also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work, at no cost to the Employer. Alternately EMPLOYER also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

3.24 Grouting

3.24.1 Standard Grout

Grout shall be provided as specified on the drawings.

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

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

3.24.2 Non-Shrink Grout

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

3.24.3 General

3.24.3.1 Inspection

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

3.24.3.2 Clean-Up

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

3.24.3.3 Acceptance Criteria

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

- a) properties of constituent materials;
- b) characteristic compressive strength;
- c) specified mix proportions;
- d) minimum cement content;
- e) maximum free-water/cement ratio;
- f) workability;
- g) temperature of fresh concrete;
- h) density of fully compacted concrete;
- i) cover to embedded steel;
- j) curing;
- k) tolerances in dimensions;
- l) tolerances in levels;
- m) durability;
- n) surface finishes;
- o) special requirements such as;
- i) water tightness

- ii) resistance to aggressive chemicals
- iii) resistance to freezing and thawing
- iv) very high strength
- v) improved fire resistance
- vi) wear resistance
- vii) resistance to early thermal cracking

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

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

3.25 Waterstops

3.25.1 Material

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

- a) Tensile strength : 3.6 N/mm² minimum
- b) Ultimate elongation : 300% minimum
- c) Tear resistance : 4.9 N/mm² minimum
- d) Stiffness in flexure : 2.46 N/mm² minimum
- e) Accelerated extraction
 - i) Tensile strength : 10.50 N/mm² 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 : $\pm 1\%$

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

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

3.25.4 Workmanship

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

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

3.25.4.3 Waterstops shall be placed at the correct location/level and suitably supported at intervals with the reinforcement to ensure that it does not deviate from its intended position during concreting and vibrating. Care shall also be taken to ensure that no honey-combing occurs because of the serrations/end grips, by placing concrete with smaller size aggregates in this region. Projecting portions of the waterstops embedded in concrete shall be thoroughly cleaned of all mortar/ concrete coating before resuming further concreting operations. The projecting waterstop shall also be suitably supported at intervals with the reinforcement to maintain its intended position during concreting so as to ensure that it does not bend leading to formation of pockets. In addition, smaller size aggregates shall be used for concreting in this region also.

3.26 Preformed Fillers and Joint Sealing Compound

3.26.1 Materials

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

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

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

3.26.2 Workmanship

3.26.2.1 The thickness of the preformed bitumen filler shall be 25mm for expansion joints and 50mm for isolation joints around foundation supporting rotatory equipment's. Contractor shall procure the strips of the desired thickness and width in lengths as manufactured. Assembly of small pieces/thicknesses of strips to make up the specified size shall not be permitted.

3.26.2.2 The concrete/masonry surface shall be cleaned free from dust and any loose particles. When the surface is dry, one coat of industrial blown type bitumen of grade 85/25 conforming to IS:702 shall be applied hot by brushing at the rate of 1.20 kg/sq.m. When the bitumen is still hot the preformed bitumen filler shall be pressed and held in position till it completely adheres. The surface of the filler against which further concreting/masonry work is to be done shall similarly be applied with one coat of hot bitumen at the rate of 1.20 kg/sq.m.

3.26.2.3 Sealing compound shall be heated to a pouring consistency for enabling it to run molten in a uniform manner into the joint. Before pouring the sealing compound, the vertical faces of the concrete joint shall be applied hot with a coat of bitumen primer conforming to IS: 3384 in order to improve the adhesive quality of the sealing compound.

3.26.2.4 Expansion joints between beams/slabs shall be provided with 100mm wide x 4mm thick mild steel plate at the soffit of RCC beams/slabs to support and prevent the preformed joint filler from dislodging. This plate shall be welded to an edge angle of ISA 50 x 50 x 6mm provided at the bottom corner, adjacent to the expansion joint of one of the beams/slabs, by intermittent fillet welding. Steel surfaces shall be provided with 2 coats of red oxide zinc chrome primer and 3 coats of synthetic enamel paint finish.

CONCRETE POUR CARD

Pour No.		Drawing No.	
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Concrete Grade / Quantity		Date	
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Structure			
Max. Aggregate Size		Slump	
Start Time		Completion Time	

PRE-CHECKS

Centre lines checked before concreting	YES	NO
Formwork & staging checked for accuracy, strength & finish	YES	NO
Reinforcement checked	YES	NO
Cover to reinforcement checked	YES	NO
Verified test certificates for Cement / Steel	YES	NO
Adequacy of materials & equipment for pour	YES	NO

EMBEDDED PARTS CHECK

Civil	YES	NO
Mechanical	YES	NO
Electrical	YES	NO

LEVEL CHECKS

Soffit Levels	Before (B)	After (A)
Pour Top Levels		

CONCRETING DETAILS

Construction Joints (Location & Time): _____
Cement Consumption (kg): _____

Number of Cubes & Identification Marks: _____
Test Cube Results - 7 Days: _____ 28 Days: _____
Concrete Condition on Form Removal: Very Good / Good / Fair / Poor

SIGNATURES

Contractor's Representative Name: _____ Signature: _____	Employer's Representative Name: _____ Signature: _____
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NOTES: 1. EACH POUR TO HAVE SEPARATE CARDS, IN TRIPLICATE ONE EACH FOR CLIENT, CONTRACTOR & SITE OFFICE.

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

4.0 STRUCTURAL STEEL WORK

4.1 Applicable Codes and Specifications

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

1. IS : 808 Dimensions for Hot Rolled Steel sections
2. IS : 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel
3. IS : 800 Code of Practice for General Construction in Steel
4. IS : 801 Code of Practice for Use of Cold Formed Light Gauge Steel Structural Members in General Building Construction

5. IS : 806 Code of Practice for Use of Steel Tubes in General Building Construction
6. IS : 7205 Safety Code for Erection of Structural Steel Work
7. IS : 7215 Tolerances for Fabrication of Steel Structures
8. IS : 4000 High Strength Bolts in Steel Structure – Code of Practice
9. AISC Specifications for Design, Fabrication and Erection of Buildings
10. IS : 1161 Steel Tubes for structural purposes
11. IS:102 Ready Mixed paint, Brushing, Red Lead, Non-setting, Priming.
12. IS:110 Ready Mixed paint, brushing, grey filler for enamels for use over primers.
13. IS:117 Ready Mixed paint, Brushing, Finishing, Exterior Semigloss for general purposes, to Indian Standard colours.
14. IS:158 Ready Mixed paint, Brushing, Bituminous, Black, Lead free, Acid, Alkali and heat resisting.
15. IS:159 Ready Mixed paint, Brushing, Acid resisting for protection against acid fumes, colour as required.
16. IS:341 Black Japan, Types A, B and C
17. IS:2339 Aluminium paint for general purposes, in Dual container
18. IS:2932 Specification for enamel, synthetic, exterior, type 1, (a) undercoating, (b) finishing
19. IS:2933 Specification for enamel, exterior, type 2, (a) undercoating, (b) finishing
20. IS:5905 Sprayed aluminium and zinc coatings on Iron and Steel.
21. IS:6005 Code of practice for phosphating of Iron and Steel.
22. IS:9862 Specification for ready mixed paint, brushing, bituminous, black, lead free, acid, alkali, water & chlorine resisting.
23. IS:13183 Aluminium paint, Heat resistant.
24. SIS-05-5900 (Swedish Standard)
25. IS : 1239 Mild steel tubes, tubulars and other Wrought steel fittings
Part 1 – Mild steel tubes
Part 2 – Mild steel tubulars and other wrought steel pipe fittings

26. IS : 1363
(Parts 1 to 3) Hexagon Head Bolts, Screws and Nuts of product Grade C
(Size range M5 to M64)
27. IS : 1367
(All parts) Technical Supply Conditions for Threaded Fasteners
28. IS : 1852 Rolling and Cutting Tolerances for Hot Rolled Steel Products
29. IS : 1977 Structural Steel (Ordinary Quality)
30. IS : 2062 Steel for General Structural Purposes
31. IS : 2074 Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming
32. IS : 3502 Steel Chequered Plate
33. IS : 3757 High Strength Structural Bolts
34. IS : 5369 General Requirements for Plain Washers and Lock Washers
35. IS : 5372 Taper Washers for Channels
36. IS : 5374 Taper Washer for 1 Beams
37. IS : 6610 Heavy Washers for Steel Structures
38. IS : 8500 Structural Steel-microalloyed (medium and high strength qualities)
39. IS : 803 Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks
40. IS : 816 Code of Practice for use of Metal Arc Welding for General construction in Mild Steel
41. IS : 822 Code of Procedure for Inspection of Welds
42. IS : 1182 Recommended Practice for Radiographic examination of Fusion – Welded Butt Joints in Steel Plates
43. IS : 1200 Method of Measurement in Building Civil Works
44. IS : 1477 Code of Practice for Painting of (Parts 1&2) Ferrous Metals in Buildings
45. IS : 2595 Code of Practice for Radiographic Testing
46. IS : 3658 Code of Practice for Liquid Penetrant Flaw Detection
47. IS : 5334 Code of Practice for Magnetic Particle Flaw Detection of Welds

48. IS : 9595 Recommendations for Metal Arc Welding of Carbon and Carbon

Manganese Steel

4.2 Steel Materials

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

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

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

Fe310-0(St 32-0) For general purposes such as door/window frames, grills, steel gates, handrails, fence posts, tee bars and other non-structural use.

Fe410-0(St 42-0) For structures not subjected to dynamic loading other than wind loads such as :Platform roofs, foot over bridges, building, factory sheds etc.

Fe510-0(St 42-0) Grade steel shall not be used

- a) If welding is to be employed for fabrication
- b) If site is in severe earthquake zone
- c) If plastic theory of design is used

4.2.4 Drawings prepared by the VENDOR/CONTRACTOR

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

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

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

4.2.4.4 Fabrication shall be started by the VENDOR/CONTRACTOR only after EMPLOYER's approval of fabrication drawings. Approval by the EMPLOYER of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering and design of connections, workmanship, fit of parts, details, material, errors or omissions or any and all work shown thereon. The EMPLOYER's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details.

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

4.3 Fabrication

4.3.1 General

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

4.3.2 Connections

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

4.3.2.2 In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be at least three times the pitch of the thread.

4.3.2.3 In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose.

4.3.2.4 All connections and splices shall be designed for full strength of members or loads. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice.

4.3.2.5 All bolts, nuts, washers, electrodes, screws etc., shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity.

4.3.2.6 All members likely to collect rain water shall have drain holes provided.

4.3.3 Straightening

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

4.3.4 Rolling and Forming

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

4.3.5 High Strength Friction Grip Bolting

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

4.3.6 Welding

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

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

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

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

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

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

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

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

4.6.3. The choice of the method adopted shall be agreed with the EMPLOYER.

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

4.4 Tolerances

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

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

4.5 End Milling

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

4.6 Inspection

4.6.1 General

4.6.1.1 The Contractor shall give due notice to the EMPLOYER in advance of the works being made ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the EMPLOYER's inspection. The fact that certain material has been accepted at the Contractor's shop shall not invalidate final rejection at site by the EMPLOYER if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevent proper assembly nor shall it invalidate any claim which the Employer may make because of defective or unsatisfactory materials and/or workmanship.

4.6.1.2 No materials shall be painted or despatched to site without inspection and approval by the EMPLOYER unless such inspection is waived in writing by the EMPLOYER.

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

4.6.1.4 For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the EMPLOYER.

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

4.6.2 Material Testing

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

4.6.3 Tests on Welds

4.6.3.1 Magnetic Particle Test

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

4.6.3.2 Liquid Penetrant Inspection

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

4.6.3.3 Radiographic Inspection

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

4.6.4 Dimensions, Workmanship & Cleanliness

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

4.6.5 Test Failure

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

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

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

4.7 Shop Matching

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

4.8 Drilling Holes for other works

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

4.9 Marking of Members

4.9.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with

figures at least 20 mm high and to such optimum depth as to be clearly visible.

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

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

4.10 Errors

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

4.11 Painting of Steel Works

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

4.11.1 Materials

4.11.1.1 Red-oxide – zinc chrome primer shall conform to IS:2074.

4.11.1.2 Synthetic enamel paint shall conform to IS : 2932.

4.11.1.3 Aluminium paint shall conform to IS:2339.

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

4.11.2 Workmanship

4.11.2.1 Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS:1477 (Part 2).

4.11.2.2 The type of paint, number of coats etc. shall be as specified in the respective items of work.

4.11.2.3 Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

4.11.2.4 All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS:1477 (Part – I) and as indicated in the item of work.

4.11.2.5 It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from 'holidays'.

4.11.2.6 After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

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

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

4.12 Acceptance of Steel, its Handling & Storage

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

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

such excavation and/or grading commences to a safe distance to avoid burial under debris.

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

4.13 Anchor Bolts & Foundations

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

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

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

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

4.14 Assembly & connections

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

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

4.14.3 All assembling shall be carried on a level platform.

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

4.14.5 Corrections of minor misfits and reasonable amount of reaming and cutting of excess stock from rivets shall be considered as a part of

erection. Any error in the shop, which prevents proper fit on a moderate amount of reaming and slight chipping or cutting, shall be immediately reported to the EMPLOYER.

4.15 Erection

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

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

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

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

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

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

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

4.15.7 Test certificates shall be furnished by the Contractor.

4.16 Inspection

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

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

4.17 Tolerances

4.17.1 General

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

4.17.2 Columns

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

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

Deviation in the level of bearing surface of columns at foundation top with respect to true level ± 5 mm

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

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

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

Difference in erected position of adjacent ± 10 mm pairs of columns along length or across

width of building prior to connecting trusses/beams with respect to true distance

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

Deviation in differences in bearing level ± 10 mm of a member on adjacent pair of columns

both across and along the building

4.17.3 Trusses And Beams

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

Lateral shift of top chord of truss at the centre of span from the vertical plane or ± 15 mm whichever is less passing through the centre of supports

of the truss

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

Lateral shift in location of purlin true position ± 5 mm

Deviation in difference of bearing i) ± 20 mm for trusses

levels of trusses or beams from ii) For beams :

the true difference Depth < 1800 mm : ± 6 mm Depth > 1800 mm : ± 10 mm

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

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

4.17.4 Crane Girders & Rails

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

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

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

apart along rail

Deviation in crane track with respect to True gauge

(a) For track gauges upto and

Including 15 metres ± 5 mm

(b) For track gauges more than $\pm [5 + 0.25 (S-15)]$

15 metres where S in metres is true gauge

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

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

along the rail length

Difference in levels between crane track Rails at

(a) Supports of crane girders ± 15 mm

(b) Mid span of crane girders ± 20 mm

Relative shift of crane rail surfaces at a joint in plane and elevation surfaces for smooth transition Relative shift in the location of crane 1/1000 of track gauge S in

stops (end buffers) along the crane tracks mm subject to maximum with track gauge S in mm of 20 mm

4.17.5 Painting

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

4.18 Clean up of Work site

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

5.0 PLUMBING WORKS FOR WATER SUPPLY AND SANITARY ARRANGEMENTS

5.1 Applicable Codes

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

IS : 210 : Specification for grey iron castings

IS : 269 : Specification for ordinary and low heat portland cement

IS : 383 : Specification for coarse and fine aggregates from natural sources for concrete

IS : 432 : Specification for mild steel and medium tensile steel bars and hard drawn

steel wire for concrete reinforcement

IS : 456 : Code of Practice for plain and reinforced concrete

IS : 458 : Concrete Pipes (with and without reinforcement).

IS : 516 : Methods of tests for strength of concrete

- IS : 554 : Dimensions for pipe threads where pressure tight joints are required on the threads.
- IS : 651 : Salt glazed stoneware pipes and fittings.
- IS : 774 : Flushing Cisterns for water closets and urinals (valveless siphonic type)
- IS : 775 : Cast iron brackets and supports for wash basins and sinks.
- IS : 781 : Sand-cast brass screw-down bib taps and stop taps for water services.
- IS : 783 : Code of practice for laying of concrete pipes.
- IS : 1068 : Electroplated coatings of nickel and chromium of iron and steel.
- IS : 1077 : Specification for common burnt clay building bricks
- IS : 1786 : Specification for high strength deformed steel bars and wires for concrete reinforcement
- IS : 1239 : Mild steel tubes (Part I) and mild steel tubulars and other wrought steel pipe fittings (Part II)
- IS : 1536 : Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
- IS : 1626 : Asbestos cement building pipes, gutters and fittings (spigot and socket types).
- IS : 1703 : Copper Alloy float valves (horizontal plunger type) for water supply purposes.
- IS : 1726 : Cast iron manhole covers and frames.
- IS : 1729 : Sand cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
- IS : 1742 : Code of practice for buildings drainage
- IS : 2116 : Specification for sand for masonry mortars
- IS : 2212 : Code of practice for brickwork
- IS : 2250 : Code of practice for preparation and use of masonry mortars
- IS : 2326 : Automatic flushing cisterns for urinals
- IS : 2470 : Code of practice for design and construction of septic tanks (Parts I & II)
- IS : 2556 : Vitreous sanitary appliances (Part I to Part XV)
- IS : 2963 : Specification for copper alloy waste fittings for wash basins and sinks

IS : 3006 : Specification for chemically resistant glazed stoneware pipes and fittings

IS : 3311 : Waste plug and its accessories for sinks and wash basins

IS : 5455 : Specification for cast iron steps for manholes

IS : 4127 : Code of Practice for laying of glazed stoneware pipes

IS : 3495 : Methods of tests of burnt clay building bricks

IS : 4111 : Code of practice for ancillary structures in sewerage system manholes

IS : 5382 : Specification for rubber sealing rings for gas mains, water mains and sewers

IS : 5329 : Code of practice for sanitary pipe work above ground for buildings

IS : 5434 : Non-ferrous alloy bottle traps for marine use

5.2 Sanitary Installation

5.2.1 The work shall be carried out complying in all respects with any specific requirements of the local body in whose jurisdiction the work is situated, and as approved by the Employer's Representative.

5.2.2 Any damage caused to the building, or to installations therein, either due to negligence on the part of the Contractor, or due to actual requirements of the work, shall be made good and the building or the installation shall be restored to its original condition by the Contractor.

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

5.2.4 All sanitary appliances including sanitary fittings, fixtures, toilet requisites shall be of size, and design as approved by the Employer's Representative.

5.2.5 All white glazed porcelain fixtures, such as wash basin, sink drain board, water closet pan, urinal, 'P' trap etc. shall have hard durable white glazed finish. They shall be free from cracks and other glazing defects. No chipped porcelain fixtures shall be used.

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

5.3 Indian Type Water Closet

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

5.4 European Type Water Closet

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

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

5.5 Urinals

5.5.1 Urinals shall be of the bowl pattern, either flat back or angle back type lipped in front. They shall be of white glazed earthenware, white glazed vitreous china or white glazed fire clay, and of size as specified conforming to IS.2556 (Part VI). The urinals shall be of one piece construction. Each urinal shall be provided with not less than two fixings holes of a minimum dia. of

6.5 mm on each side. Each urinal shall have an integral flushing box rim of suitable type and inlet or supply horn for connecting the flush pipe. The flushing rim and inlet shall be of the self-draining type. It shall have a weephole at the flushing inlet of the urinal. At the bottom of the urinal, an outlet horn for connecting to an outlet pipe shall be provided. The exterior of the outlet horn shall not be glazed and the surface shall be provided with grooves at right angles to the axis of the outlet to facilitate fixing to the uniform and smooth throughout to ensure efficient flushing. The bottom of pan shall have sufficient slope from the front, towards the outlet such that there is efficient draining of the urinal. The waste fittings shall be chromium plated.

5.6 Wash Basins

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

Type Size

Flat Back 630 x 450 mm

Flat Back 550 x 400 mm

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

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

5.7 Sinks

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

450 x 300 x 150 mm

600 x 450 x 200 mm

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

5.8 Flushing Cisterns

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

5.9 Cast Iron Soil Waste and Vent Pipes and Fittings

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

5.9.2 All plug bends of drainage pipes shall be provided with inspection and cleaning caps, covers, which shall be fixed with nuts and screws. Pipes shall be fixed to the wall by W.I. or

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

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

5.9.4 C.I. pipes and fittings which are exposed shall be first cleaned and then painted with a coat of red lead primer. Two coats of zinc paint with white base and mixed with pigment of required colour to get the approved shade shall be given over the base primer coat.

5.9.5 The thickness of fittings and their socket and spigot dimensions shall conform to the thickness and dimensions approved for the corresponding sizes of straight pipes.

5.9.6 The connection between the main pipe and branch pipes shall be made by using branches and bends with access for cleaning. Floor traps shall be provided with 25 mm dia. puff pipe where the length of the waste is more than 1800 mm or the floor trap is connected to a waste stack through bends.

5.9.7 All cast iron pipes and fittings including joints shall be tested by a smoke test to the satisfaction of the Employer's Representative and left in working condition after completion. The smoke test shall be carried out as stated under :

5.9.8 Smoke shall be pumped into the pipe at the lowest and from a smoke machine which consists of a bellow and a burner. The material usually burnt is greasy cotton waste which gives out a clear pungent smoke which is easily detectable by sight as well as by smell if there is a leak at any point of the pipeline.

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

5.10 Galvanised Mild Steel (G.I) Pipes

5.10.1 The pipes shall be galvanised mild steel welded pipes and seamless screwed and sockets tubes conforming to the requirements of IS.1239, for medium grade. They shall be of the diameter (nominal bore) approved. The sockets shall be designated by the respective nominal bores of the pipes for which they are intended. The pipes and sockets shall be finished neatly, well galvanised on both inner and outer surfaces, and shall be free from cracks, surface flaws, laminations and other defects. All screws, threads

shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

5.10.2 All screwed tubes and sockets shall have pipe threads conforming to the requirements of IS.554. Screwed tubes shall have taper threads while the sockets shall have parallel threads.

5.10.3 The fittings shall be of malleable cast iron or mild steel tubes complying with all the appropriate requirements as approved for pipes. The fittings shall be designated by the respective nominal bores of the pipes for which they are intended. The fittings shall have screw threads at the ends conforming to the requirements of IS.554. Female threads on fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered.

5.10.4 The pipes and fittings shall be inspected at site before use to ascertain that they conform to the specification. The defective pipes shall be rejected. Where the pipes have to be cut or rethreaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The ends of the pipes shall then be threaded conforming to the requirements of IS.554 with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening bent and damaged screw threads and shall not be used for turning of the threads so as to make them slack, water tight joint. The screw- thread of pipes and fittings shall be protected from damage until they are fitted.

5.10.5 The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped around the screwed end of the pipe. The end shall then be screwed in the socket, tee, etc., with the pipe wrench. Care should be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burrs from the joint shall be removed after screwing. After laying, the open ends of the pipes shall be temporarily plugged to prevent access of soil or any other foreign matter.

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

5.10.7 For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. Pipes and fittings shall be fixed truly vertical/horizontal. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts of recesses etc. provided there is sufficient space to work on the pipes with the usual tools.

The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage, but the joints in pipes shall not be buried. M.S. pipe sleeve shall be fixed at a place where a pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion/contraction and other movements/maintenance. In case the pipe is embedded in walls or floors it should be painted with anti-corrosive bitumastic paint of approved quality. The pipe should not come in contact with lime mortar or lime concrete as the pipe is affected by lime. Under the floors the pipes shall be laid in layer of sand filling or as approved by the Employer's Representative.

5.10.8 G.I. pipes with socket and spigot ends shall be provided with lead caulked joints wherever specified and the joints shall conform to the requirements of IS.3114.

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

5.10.10 The pipes shall be laid on a layer of 10.0 cm sand and filled upto 15 cm above the pipes. A sand cushion of 15cm on either side of the pipe shall also be provided. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be got rid of as directed. when excavation is done in rock the bottom shall be cut deep enough to permit the pipes to be laid on a cushion of sand 75 mm minimum.

5.10.11 The pipes and fittings after they are laid and jointed shall be subjected to hydrostatic pressure test as approved by the Employer's Representative and shall satisfactorily pass the test. Pipe line system shall be tested in sections as the work proceeds, keeping the joints exposed for inspection. Pipes shall be slowly and carefully charged with water allowing all air to escape. All draw off taps shall then be closed and water pressure gradually raised to test pressure. Care shall be taken to ensure that pressure gauge is accurate and preferably should have been recalibrated before the test. Pump used having been stopped, the section of the pipeline shall maintain the test pressure for at least half an hour. Any joints or pipes found leaking shall be removed and replaced by the Contractor.

5.10.12 The G.I. pipe line shall be cut to the required length at the position where the meter and stop cock are required to be fixed. The ends of the pipes shall be threaded. The meter and stop cock shall be fixed in position by means of connecting pipe, G.I. nuts, sockets, etc. The stop cock shall be fixed near the inlet of the water meter. The paper disc inserted in the ripples of

the meter shall be removed and meter installed exactly horizontally or vertically and with the arrow cast on the body of the meter pointing in the direction of flow. Care shall be taken that the factory seal of the meter is not

disturbed. Whenever the meter is to be fixed to a newly fitted pipe line, the pipe line will have to be completely washed before fixing the meter. For this purpose, a connecting piece of pipe equal to the length of the meter is to be fixed on the new pipe line. The water shall be allowed to flow completely to wash the pipe line and then the meter installed as described above by replacing the connecting piece.

5.11 Stoneware Pipes and Fittings

5.11.1 All pipes with spigot and socket ends shall conform to IS.651/3006 and shall be of grade

`A'. These shall be sound, free from visible defects such as fine cracks or hair cracks. The glaze of the pipes shall be free from crazing. The pipes shall give a sharp clear note when struck with a light hammer.

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

- (a) Internal diameter;
- (b) Grade;
- (c) Date of manufacture;
- (d) Name of manufacturer or his registered trade-mark or both. All pipes and fittings shall have ISI mark.

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

5.11.4 Spigot and Socket Joint (Cement Joint)

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

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

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

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

Nominal diameter of pipe (mm) Cement (kg)

150	1.5
200	2.0
250	2.5
300	3.25
350	4.5
400	5.5
450	6.5

5.11.5 Spigot and Socket Joint (Bituminous Joint)

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

5.11.6 Spigot and Socket Joint (Rubber Ring Joint)

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

5.11.7 Cleaning of Pipes

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

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

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

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

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

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

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

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

5.12 Stop Cock and Bib Cock

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

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

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

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

5.13 Soak Pit

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

filled within the chamber. Construction of pit lining and filling of the brick ballast shall progress simultaneously.

5.14 Manholes

5.14.1 Location

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

5.14.2 Excavation

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

5.14.3 Bed Concrete

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

5.14.4 Bricks

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

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

5.14.5 Cement Mortar

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

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

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

5.14.6 Brick Masonry

5.14.6.1 All bricks shall be thoroughly soaked in clean water for atleast one hour immediately before being laid. The cement mortar for brick masonry work of manholes shall be in the proportion specified in 5.14.5. Brick work 230 mm thick and over shall be laid in English Bond unless otherwise specified. 115 mm thick brick work shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Bricks shall be laid with frogs uppermost.

5.14.6.2 All brickwork shall be plumb and square unless otherwise shown on drawing and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. For walls of thickness greater than 230 mm both faces shall be kept in vertical planes unless otherwise specified. All interconnected brickwork shall be carried out at nearly one level (so that there is uniform distribution of pressure on the supporting structure) and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 degrees. But in no case the level difference between adjoining walls shall exceed 1.25 M. Workmanship shall conform to IS

: 2212.

5.14.6.3 Brick shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 12 mm by raking tools daily during the progress of work when the mortar is still green, so as to provide a proper key for the plastering to be done. When plastering is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be

cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top. If mortar in the lower courses has begun to set, the joints shall be raked out to a depth of 12 mm before another course is laid.

5.14.7 Cement Plaster

5.14.7.1 All joints in masonry shall be raked to a depth of 12 mm with hooked tool made for the purpose when the mortar is still green and in any case within 48 hours of its laying. The surface to be rendered shall be washed with fresh clean water free from all dirt, loose material, grease etc. and thoroughly wetted for 6 hours before plastering work is commenced. Concrete surfaces to be rendered will however be kept dry. The wall should not be too wet but only damp at the time of plastering. The damping shall be uniform to get uniform bond between the plaster and the wall.

5.14.7.2 The proportion of the cement mortar shall be as approved on relevant drawings. Cement shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water, sand and cement shall be as per relevant I.S. The mortar thus mixed shall be used immediately and in no case shall the mortar be allowed to remain for more than 25 minutes after mixing with water.

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

5.14.7.4 Plastering shall be done on both faces of brick masonry in cement mortar (1:2) and 20 mm thick unless otherwise specified.

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

5.14.8 Cement Concrete Channel

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

5.14.9 Pipe Entering or Leaving Manhole

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

5.14.10 Cast Iron Steps

5.14.10.1 Cast iron steps shall be as per IS : 5455. The steps shall be of grey cast iron of grade 15 as per IS : 210. The steps shall be clean, well cast and they shall be free from air and sand holes, cold shuts and warpings. The portion of the step which projects from the wall of the manhole shall have a raised chequered design to provide an adequate non-slip grip.

C.I. steps shall weigh not less than 4.5 kg each and shall be of 150 mm x 375 mm overall dimensions. These steps shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63 degrees C and shall not be brittle as to chip off at temperature of 0 degree C.

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

5.14.11 Frame and Covers

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

Year of manufacture,

Identification mark of the Employer: EMPLOYER Arrow showing direction of flow

5.14.11.2 Cast Iron Frame and Cover

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

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

5.14.11.3 Fibre Reinforced Concrete Frame and Cover

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

5.14.11.4 Reinforced Cement Concrete Frame and Cover

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

5.14.12 Drop Manhole

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

45 degrees or less to the direction of the flow in the main sewer. The pipe unless of cast iron should be surrounded with 150 mm thick concrete.

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

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

5.14.13 RCC Manhole

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

5.14.14 Vent Shafts

5.14.14.1 General

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

5.14.14.2 Mild Steel Vent Shaft

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

5.14.14.3 RCC Vent Shaft

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

5.14.15 Miscellaneous

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

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

6.0 APPROACH AS WELL AS INTERNAL ROAD WORKS

(Part A) Flexible Pavement

6.1 Applicable Codes and Client's Requirements

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

IS : 73 : Specification for Paving Bitumen

IS : 215 : Specification for Road Tar

IS : 217 : Specification for Cutback Bitumen

IS : 454 : Specification for Digboi type Cutback Bitumen IS : 460 :
Specification for Test sieves

(Parts 1 to 3)

IS : 1077 : Common burnt clay building bricks - Specification

IS : 1124 : Method of test for determination of water absorption, apparent specific gravity and porosity of building stones

IS : 1195 : Specification for Bitumen Mastic for Flooring

IS : 1196 : Code of Practice for Laying Bitumen Mastic Flooring

IS : 1834 : Specification for Hot Applied Sealing Compounds for Joints in Concrete

IS : 2386 : Methods of test for aggregates for concrete (Parts 1 to 8)

IS : 2720 : Method of Test for Soils

(Part 5) Determination of Liquid and plastic limit

IS : 6241 : Method of test for determination of stripping value of road aggregates.

IRC : 16 : Specification for priming of Base Course with Bituminous Primers. IRC : 17 : Tentative specification for Single Coat Bituminous Surface

Dressing

IRC : 19 : Standard specifications and code of practice for water bound macadam

IRC : 27 : Specification for bituminous macadam MoRTH :
Specifications for road and bridge works

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

6.1.1 Access to Abutting Properties

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

6.2 Road Construction

6.2.1 Road shall consist of the following :

- a) Well compacted sub-grade layer.
- b) Providing and laying sub-base of 260 mm thick with 40 mm to 90 mm size aggregates compacted to 200 mm thick in two layers with watering, rolling etc., as per specification complete.
- c) Providing and laying base course of 105 mm size with 40 mm to 60 mm size aggregates compacted to 75 mm thickness in one layer with watering, rolling etc., as per specifications.
- d) Providing and applying Prime Coat with bituminous emulsion (Slow Setting) at 7.5 kg/10Sqm
- e) Providing and applying Tack Coat with bituminous emulsion (Rapid Setting) at 2.5 kg/10Sqm
- f) Providing 70 mm compacted thickness of asphalt Macadam as per specification consisting of premixed asphaltic carpet and seal coat.

6.3 Materials

6.3.1 General

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

6.3.2 Soling Stone

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

6.3.3 Stone Aggregate/Metal

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

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

Sl.

No.	Test	Requirements	Test Method
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1.	Los Angeles Abrasion Value* Or Aggregate Impact Value* 50 percent (max.)		
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40 percent (max.) IS:2386 (Part – IV)

IS:2386 (Part – IV)

Or IS:5640***

2.	Flakiness Index ** 15 percent (max.) IS:2386 (Part I)		
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(*) Aggregate may satisfy requirements of either of two tests.

(**) Requirements of flakiness index shall be enforced only in case of crushed broken stone. (***) Aggregates like brick, metal, kankar, laterite etc., which get softened in presence of water

shall be tested for impact value under wet conditions in accordance with IS:5640.

Table – 6.2 Physical Requirements of Aggregates for Bituminous Wearing Course

Sl.No	Test	Requirements	Test Method
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1.	Los Angeles Abrasion Value* Or Aggregate Impact Value* 40 percent (max.)		
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30 percent (max.) IS:2386 (Part – IV)

IS:2386 (Part – IV)

2. Flakiness Index ** 35 percent (max.) IS:2386 (Part I)
3. Stripping Value 25 percent (max.) IS:6241
4. Water Absorption 2 percent (max.) IS:2386 (Part-III)
5. Soundness

Loss with Sodium Sulphate – 5 cycles Loss with Magnesium Sulphate – 5 cycles 12 percent (max.)

18 percent (max.) IS:2386 (Part-V)

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

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

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

6.3 below :

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

Grading No. Size Range Sieve Designation Percent by Weight Passing the Sieve

1.	90mm to 45mm	125 mm
90	mm	
63	mm	
40	mm	
22.4 mm	100	
90-100		
25-60		
0-15		
0-5		
2.	63mm to 45mm	90 mm
63	mm	
64	mm	
65	mm	

22.4 mm	100
90-100	
25-75	
0-15	
0-5	
3.	53mm to 22.4 mm 63 mm
64 mm	
65 mm	
22.4 mm	
11.2 mm	100
95-100	
65-90	
0-10	
0-5	

6.3.4 Screenings for Water Bound Macadam

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

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

Table –6.4 Gradings For Screenings

Grading No. Size Range Sieve Designation Percent by Weight Passing the Sieve

A	12.5 mm	12.5 mm
	10.0 mm	
	4.75 mm	

150 micron	100
90-100	
10-30	
0-8	
B	10 mm 10 mm
4.75 mm	
150 micron	100
85-100	
10-30	

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

6.3.5 Binding Material

6.3.5.1 Binding material shall comprise of a suitable material, approved by Employer's Representative, have plasticity index value of less than 6 as determined in accordance with IS : 2720 (Part - V)

6.3.5.2 Application of binding material may not be necessary, when the screenings used are of crushable type such as murum or gravel.

6.3.6 Murum/Kankar/Gravel/Sand

6.3.6.1 Murum shall contain low plasticity binder material mixed with hard granular particles such as sand and/or gravel. Murum shall be sound and hard of a quality not affected by weather, to be screened at the quarry and free from all impurities. Large lumps shall all be broken at the quarry and murum delivered at site must pass in every direction through a 63 mm ring. Murum shall not contain more than 5% to 8% of fines passing a 75 micron sieve.

6.3.6.2 Gravel shall be composed of large, coarse, silicious grains, sharp and gritty to the touch, thoroughly free from dirt, organic and deleterious matter. It shall be hard, tough, dense and shall not contain particles bigger than 12 mm and more than 10 percent silt.

6.3.6.3 Sand used for blinding the bituminous road surface, shall be coarse, sharp, gritty, clean, granular material. Only material passing through 4.75 mm sieve and retained on 75 micron sieve shall be used.

6.3.7 Bituminous Materials

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

6.4 Earth work

6.4.1 Earthwork in Excavation

6.4.1.1 In general the excavation shall be in accordance to Employer's Requirement specified elsewhere.

6.4.1.2 Profiles of road excavation shall be laid at 50 m intervals to conform to the required alignment, sections, grades and side slopes and the lines of cuts shall be clearly marked.

6.4.1.3 Contractor shall on no account excavate beyond the slopes or below the specified grade unless so approved by the Employer's Representative in writing. If excavation is done below the specified level or outside the section the Contractor shall be required to fill up with approved materials, in layers of 150 to 200 mm, watered and compacted as specified for the subgrade.

6.4.1.4 The excavation shall be finished neatly, smoothly and evenly to the correct lines, grades, sections and side slopes as shown in the drawings or approved by Employer's Representative.

6.4.2 Earthwork in Embankment

6.4.2.1 The embankment shall be formed of earth obtained from approved source.

6.4.2.2 The ground over which embankment is to be formed shall be cleared of all brushwood, loose stones, vegetation, bushes, stumps, and all other objectionable matter and materials so removed shall be burnt off or disposed off as approved by Employer's Representative.

6.4.2.3 Profiles of embankment shall be set up with stout poles to mark the centre and edges of the formation with the top levels of formation clearly marked by paint or cut and the slopes with strings and pegs at every 10 metres on straight portions. Toe line may be marked with pick marks.

6.4.2.4 Before placing any embankment material the top 150 mm of soil strata receiving it shall be scarified and watered and compacted with one pass of 8-10T roller.

6.4.2.5 Embankment material shall be placed in successive horizontal layers of 200 mm depth extending to the full width of the embankment including the slopes at the level of the particular layer and 300 mm more on both sides to allow compaction of the full specified section. Before placing the next layer the surface of the underlayer shall be moistured and scarified with pick axes or spades to provide a satisfactory bond with the next layer. The

extra loose stuff at the edges shall be trimmed later after completion of the bank work leaving the correct section fully compacted.

6.4.2.6 When boulders, broken stones and similar hard materials are mixed up with the embankment materials care shall be taken to see that they are distributed uniformly into the bank and that no hollows are left near them. No stone or hard material shall project above the top of any layer. Each layer of embankment shall be watered, leveled, and compacted as specified before the succeeding layer is placed. The surface of the embankment shall at all times during construction be maintained at such a cross fall as will shed water and prevent ponding.

6.4.2.7 If the bank materials contains less than the optimum moisture, water shall be added to the loose layers of the embankment to bring the moisture uniformly upto requirement. If the material contains more than the required moisture it shall be allowed to dry until the moisture is reduced to the required extent.

6.4.2.8 The moistured/dried loose layers shall be compacted with a power roller of 10 to 12 tonnes. The roller shall pass at least twice over the same area, once in the forward move and the second time in backward move.

6.4.2.9 To allow for subsequent settlement the finished level of the embankment shall be kept higher than the specified level by one centimetre for every metre of the height of the bank.

6.4.2.10 Embankment shall be finished and dressed smooth and even to conform to the alignment, levels, cross sections, and dimensions shown on drawings with due allowance for shrinkage. Any damage caused by rain, or due to any other reason shall be made good in the finishing operation.

6.5 Preparation of Subgrade

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

6.5.2 Immediately prior to the laying of the soling the subgrade shall be cleaned of all foreign substances, vegetation etc. Any ruts or soft yielding patches that appear shall be corrected and the subgrade dressed off parallel to the finished profile. The camber of subgrade shall conform in shape to that of the finished road surface. Camber boards shall be used to get the required section.

6.5.3 The prepared subgrade shall be lightly sprinkled with water, if necessary, and rolled with power roller of not less than 10 tonnes, till the soil is evenly compacted to 95% of Proctor density with 2% variation in optimum moisture content. Roller shall pass minimum 5 runs on the subgrade. Rolling shall commence at the edges and progress towards the centre longitudinally.

Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. Any undulations in the surface that develop due to rolling shall be made good with approved earth and subgrade rerolled.

6.6 Soling

6.6.1 Soling shall not be constructed on a wet subgrade.

6.6.2 Unless otherwise specified, the width of the soling shall be 230 mm more on either side than that of the waterbound macadam wearing course and the finished thickness of the soling course shall be 230 mm.

6.6.3 The soling stones shall be laid with the largest face downwards and in contact with each other. The stones shall break joint as far as possible. The height of the soling stone shall be equal to specified thickness of soling.

6.6.4 As the laying of rubble advances the soling shall be hand packed by wedging and packing with 80 mm metal in the joints of the soling and driving them by hammers in place so as to fill the voids as completely as possible. This operation of hand packing shall closely follow the rubble laying. The soling shall be laid and hand packed true to grade and section and these shall be often checked by boning rods, template boards and fish line etc. The grades, sections etc. of the soling shall correspond to those of the surfacing coming on it. The soling thus laid shall be finished by knocking out projecting stones and filling depressions by chips to come up to the grade and camber.

6.6.5 The quality of the 80 mm metal shall be same as specified for the soling and the longest dimension shall not be more than 100 mm and the shortest dimension not less than 50 mm.

6.6.6 The soling after it is properly laid and hand packed including filling of voids with 80 mm metal shall be rolled dry with 10 - 12 T power roller to refusal i.e., till the stones in the soling course cease to move under the roller and no more compaction can be achieved. Rolling shall start at the edges and work towards the centre. The roller shall run over the same surface of rolling for at least 8 times till the soling course is well consolidated. The surface shall be checked by templates and in case of unevenness high spots shall be knocked out and depressions filled by spalls and recompacted fully. Bunds shall be laid along the edges and compacted before starting rolling on soling to prevent spreading of stones.

6.6.7 Gravel shall be spread in thin layers over the above prepared soling surface, swept into the interstices with brooms, watered lightly to assist the filling of voids. Spreading of gravel, sweeping and watering shall continue till the interstices are completely filled. At all times only enough water shall be sprinkled to force the gravel into the voids and never so much as to soften the subgrade. The process of gravel filling shall be accompanied by rolling as for dry rolling of soling with a power roller weighing not less than 10 tonnes

starting at edge and working towards the centre. The roller shall run over the same surface for at least eight times. Each pass of the roller shall uniformly overlap not less than one third of the track made in the preceding pass. The surface shall be checked with templates of approved design (to be provided by Contractor) and high and low spots corrected by removing soling and repacking.

6.7 Water Bound Macadam Course

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

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

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

6.7.1 Spreading Coarse Aggregate

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

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

6.7.2 Rolling

6.7.2.1 Following the spreading of the coarse aggregate, rolling shall be started with three wheeled power rollers of not less than 10 tonne capacity or

tandem or vibratory roller of approved type. Rolling shall begin from the edges and gradually progress towards the centre. First the edges/edge shall be compacted with roller running forward and backward and then move inwards parallel to the centre line of the road, in successive passes uniformly lapping preceding tracks by at least one half width. Rolling shall be discontinued when the aggregates are partially compacted with sufficient void space in them to permit application of screenings. During rolling slight sprinkling of water may be done, if necessary. Rolling shall not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the subgrade or sub-base. The rolled surface shall be checked transversely and longitudinally with templates and all undulations shall be corrected by loosening the surface, adding or removing necessary amounts of aggregate and rerolling until the entire surface conforms to desired camber and grade. In no case shall the use of screenings be permitted to make up depressions. Material which crushed excessively during compaction or becomes segregated shall be removed and replaced with suitable aggregates. It shall be

ensured that shoulders are also built-up simultaneously alongwith water bound macadam course.

6.7.3 Application of Screening

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

6.7.4 Sprinkling and Grouting

6.7.4.1 After the screenings have been applied, the surface shall be copiously sprinkled with water, swept and rolled. Hand brooms shall be used to sweep the wet screenings into voids and to distribute them evenly. The sprinkling, sweeping and rolling operations shall be continued, with additional screenings applied as necessary, until the coarse aggregate has been thoroughly keyed, well bonded and firmly set in its full depth and a grout has been formed of screenings. Care shall be taken to see that the sub-grade or

sub-base does not get damaged due to the addition of excessive quantities of water during construction. In case the subgrade or sub-base gets damaged, the Contractor shall rectify the damaged portion.

6.7.5 Application of Binding Material

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

6.7.6 Setting and Drying

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

6.7.7 Multiple Layered Course

6.7.7.1 When the total consolidated thickness of the water bound Macadam course is more than 100 mm, it shall be constructed in layers. Each layer shall be constructed as per all the operations described above. The same degree of quality control and refinement shall be used for constructing each layer.

6.8 Premixed Asphaltic Carpet

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

6.8.1 Materials

(a) Binder

This shall be paving bitumen of penetration grade within the range S 35 to S 90 or A 35 to A 90 (30-40 to 80/100) as per Indian Standard for 'Paving Bitumen' IS : 73. The actual grade of bitumen to be used shall be decided by the Employer's Representative appropriate to the region, traffic, rainfall and other environmental conditions.

(b) Course Aggregate

It shall be crushed material retained on 2.36 mm (No. 8 ASTM) sieve and shall be crushed stone or gravel (shingle) and shall be as per Clause 6.3.3 and satisfy the physical requirements set forth in Table-6.2.

(c) Fine Aggregates

The fine aggregates shall be the fraction passing 2.8 mm sieve and retained on 90 micron sieve consisting of crusher run screenings, natural sand or mixture of both. These shall be clean, hard, durable, uncoated, dry and free from any injurious, soft or flaky pieces and organic or deleterious substances.

(d) Filler

The filler shall be an inert material, the whole of which passing 710 micron, sieve, at least 90 percent passing 180 micron sieve and not less than 70 percent passing 90 micron sieve. The filler shall be stone dust, cement, hydrated lime, fly ash or any other non-plastic mineral matter approved by the Employer's Representative.

6.8.2 COMPOSITION OF BITUMINOUS MACADAM

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

Table – 6.5 COMPOSITION OF BITUMINOUS MACADAM			
Mix designation		Nominal aggregate size	
Layer thickness	Grading 1		
40mm	8	80-100mm	Grading 2 19mm
50-75 mm			
IS Sieve (mm)	Cumulative % by weight of total aggregate passing		
45			
37.5	100		
90-100			
26.5	75-100	100	
19	-	90-100	
13.2	35-61	56-88	
4.75	13-22	16-36	
2.36	4-19	4-19	

0.3	2-10	2-10
0.075	0-8	0-8
Bitumen content, % by		
weight of total mixture	1 3.1-3.4	3.3-3.5
Bitumen grade	35 to 90	35 to 90

6.8.3 Mix Design

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

6.8.4 Weather and Seasonal Limitations

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

Table – 6.6 Requirement of Asphaltic Concrete Mix

Sr.No.Description Requirements

1. Number of compaction blows,each end of Marshalling specimen 50
2. Marshall stability (ASTM Designation-D-1559) determined on Marshal specimen 340 Kg. (min.)
3. Marshall flow (mm) 2-4
4. Percent Voids in mix 3-5
5. Percent voids in mineral aggregate filled with bitumen 75-85
6. Binder content percent by weight of mix 5-7.5

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

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

Binder As percentage by weight of total mix

Course aggregate As percentage by weight of total aggregate including mineral filler

Fine aggregate

Mineral filler

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

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

6.8.5 Preparation of Base

6.8.5.1 The base on which premix carpet is to be laid shall be prepared, shaped and conditioned to the specified lines, grade and cross section by repairing all potholes or patches and ruts. The potholes shall be drained of water and cut to regular shape with vertical sides. All loose and disintegrated material shall be removed. The pothole shall then be filled either with (i) Coarse aggregate and screenings conforming to Clause 3.0 and compacted with heavy hand rammers or approved mechanical tempers or (ii) premixed chippings binders (bitumen grade 80/100) content of 3 percent by weight of total mix, after painting the sides and bottom of the holes with a thin application of bitumen, or a combination of both (i), (ii) as approved by Employer/Employer's Representative. The surface shall be thoroughly swept and scraped clean and free of dust and other foreign matter.

6.8.6 Tack Coat

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

6.8.7 Preparation of Mix and Laying

6.8.7.1 Hot mix plant of adequate capacity and capable of producing a proper and uniform quality mix shall be used for preparing the mix. The plant

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

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

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

6.8.8 Rolling

6.8.8.1 Immediately after the spreading of mix it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km per hour. The initial or break down rolling shall be with 8-12 ton three wheel roller and the surface finished by final rolling with the 8-10 ton tandem roller. Preferably before finishing with tandem, breakdown rolling shall be followed by an intermediate rolling with a fixed wheel pneumatic roller of 15 to 30 ton having a tyre pressure of 7 kg. per sq.m. The joints and edges shall be rolled with a 8 to

10 ton three wheel roller. Any high spots or depressions which become apparent shall be corrected by addition or removal of mix material. The roller shall uniformly overlap not less than a third of the track made in the preceding pass. The wheels of the roller shall be moistened with gunny bags to prevent the mix sticking to the wheels while rolling, but in no case shall

fuel lubricating oil be used for this purpose. Rolling shall be continued till the mix is thoroughly compacted and all roller marks are eliminated.

6.8.9 Opening to Traffic

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

6.9 Seal Coat

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

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

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

6.9.1 Materials

6.9.1.1 Binder

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

6.9.1.2 Stone Chippings for Type A Seal Coat

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

6.9.1.3 Fine Aggregate for Type B Seal Coat

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

6.9.2 Preparation of Base

The seal coat shall be applied immediately after the laying of bituminous course which is required to be sealed. Before application of seal coat

materials the surface shall be cleaned free of any dust or other extraneous matter.

6.9.3 Construction of Type A Seal Coat

6.9.3.1 Application of Binder

Binder shall be heated in boilers to 163 deg. C to 171 deg. C, maintained at the temperature and sprayed on the dry surface in a uniform manner with the help of mechanical sprayers.

Excessive deposits of binder caused by stopping or starting of the sprayer through leakage or any other reason shall be suitably corrected before the stone chippings are spread.

6.9.3.2 Application of Stone Chipping

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

6.9.3.3 Rolling

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

6.9.4 Construction of Type B Seal Coat

6.9.4.1 Preparation of Mix and Laying

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

shall be immediately transported from the mixing plant to the point of use and spread uniformly on the bituminous surface to be sealed.

6.9.4.2 Rolling

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

6.9.4.3 Opening to traffic

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

6.10 Quality Control

6.10.1 General

6.10.1.1 All materials incorporated and all works performed shall be strictly in conformity with the Specification requirements. All works shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as approved by the Employer's Representative subject to the permitted tolerances described hereinafter. The contractor shall be fully responsible for the quality of the work in the entire construction within the Contract. He shall, therefore, have his own independent and adequate set-up for ensuring the same.

6.10.1.2 The Contractor shall carry out quality control tests on the materials and work to the frequency specified. In the absence of clear indications about method and/or frequency of tests for any item, the approval of the Employer's Representative shall be obtained and he shall provide necessary co-operation and assistance in obtaining the samples for test and carrying out the field test as required by the Employer's Representative from time to time. This may include provision of Labour, attendance, assistance in packing and dispatching and any other assistance considered necessary in connection with the test.

6.10.1.3 For the work of embankment, subgrade and construction of subsequent layer of same or other material over the finished layer shall be done after obtaining approval from the Employer's Representative. Similar approval from the Employer's Representative shall be obtained in respect of all other items of works prior to proceeding with the next stage of construction.

6.10.1.4 The Contractor shall carry out modification in the procedure of work, if found necessary, as approved by the Employer's Representative during inspection. Works falling short of quality shall be rectified by the Contractor as approved by the Employer's Representative.

6.10.2 Permitted Tolerances

6.10.2.1 Horizontal Alignments

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

6.10.2.2 Longitudinal Profile

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

Subgrade ± 15 mm

Sub-base ± 20 mm

Base Course ± 15 mm

Wearing Course ± 10 mm

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

6.10.2.3 Surface Regularity

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

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

6.10.2.4 Rectification

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

i) Subgrade

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

ii) Water Bound Macadam

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

iii) Bituminous Constructions

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

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

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

Sl. No Type of Construction Longitudinal profile with 3 Cross profile metre straight edge

Maximum permissible undulation
undulations permitted in any 300 metres length exceeding : mm
Maximum permissible variation from specified profile under comber
template :

mm									
1	2	3	4	5	6	7	8		
1.	Earthen subgrade			24	30	-	-	-	15
2.	Granular/Lime/Cement/								
	stabilised subbase			15	-	30	-	-	12
3.	Water bound macadam								
	with over size metal (45-90 mm size)			15	-	30	-	-	12
4.	Water Bound Macadam with normal size metal (22-4-53 mm and 45-63								

mm size) 12 - - 30 - 8

5. Bituminous macadam 8 - - - 10@@ 4

Notes :

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

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

6.11 Tests

6.11.1 General

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

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

6.11.2 Tests on earthwork for Embankment and Subgrade Construction

(a) Borrow material

(i) Sand content [IS:2720(Part IV)]

1-2 tests per 8000 cu. metres of soil

(ii) Plasticity Test [IS:2720(Part V)]

Each type to be tested , 1-2 tests per 8000 cu. metres of soil.

(iii) Density Test [[IS:2720(Part VII)].

Each soil type to be tested, 1-2 tests per 8000 cubic metres of soil.

(iv) Deleterious Content Test [IS:2720(Part XXVII)]

As and when required by the Employer's Representative.

(v) Moisture Content Test [IS:2720(Part II)] One test for every 250 cubic metres of soil.

(vi) CBR Test on materials to be incorporated in the subgrade on soaked/unsoaked samples [[IS:2720(part XVI)]

One test for every 3000 m³ at least or closer as and when required by the Employer's Representative.

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

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

6.11.3 Tests on Sub-bases and Bases (Excluding bitumen bound bases)

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

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

Sl.No Types of

ConstructionTest Frequency

1. Granular sub- base i) Gradation
- ii) Atterbergs limit
- iii) Moisture content prior to compaction
- iv) Density of compacted layer
- v) Deleterious constituents
- vi) C.B.R One test per 200 m³ One test per 200 m³ One test per 250 m²
One test per 500 m² As required

As required

2. Lime/Cement Stabilised (vii) Purity of lime (for lime-soil stabilization)

viii) Lime/Cement content

ix) Degree of pulverisation

x) CBR test on a set of 3 specimens

xi) Moisture content prior to compaction

xii) Density of compacted layer

xiii) Deleterious constituents One test for each consignment subject to a minimum of one test per 5 tonnes of lime.

Regularly, through procedural checks.

Periodically as considered necessary.

As required

One test per 250 m³. One test per 500 m² As required

3 Water Bound Macadam (xiv) Aggregate Impact Value

xv) Grading

xvi) Flakiness Index

xvii) Atterbergs limits of binding material. One test per 200m³ of aggregate

One test per 100 m³ of aggregate

One test per 200 m³ of aggregate

One test per 25 m³ of binding material

6.11.4 Tests on Bituminous Constructions

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

Table – 6.9 Control Tests and Their Frequency for Bituminous Works

Sl.

No.	Types of Construction	Test	Frequency
1.	Prime Coat/Track Coat	i)	Quality of binder
	Binder	temperature for	a application

iii) Rate of spread of binder As Required

As regular close intervals

Two tests per day

Sl.

No.	Types of Construction	Test	Frequency
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2.	Seal Coat/Surface Dressing	iii)	Quality of binder
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iv)	Aggregate Impact Value		
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v)	Flakiness Index		
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vi)	Stripping value of aggregates		
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vii)	Water absorption of aggregates		
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viii)	Grading of aggregates		
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ix)	Temperature of binder of application		
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x)	Rate of spread of materials	As required	
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One test per 50 m³ of aggregate One test per 50 m³ of aggregate Initially,
one set of 8 representative specimens for each source
of supply.

Subsequently when warranted by changes in the quality of aggregate

One test per 25 m³ of aggregate At regular close intervals

One test per 500 m³ of aggregate

3	Bituminous Concrete/Macadam	xi)	Quality of binder
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xii)	Aggregate impact value, flakiness index and stripping value of aggregates		
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xiii)	Mix-grading		
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xiv)	Control of temperature of binder in boiler, aggregate in the dryer and mix at the time of laying and rolling		
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xv) Stability of mix (vide ASTM:D-1559)

i) Binder content and gradation in the mix (Binder content test vide ASTM:D-2172)

ii) Rate of spread of mixed material

iii) Density of compacted layer As required

One test per 50-100m³ of aggregate

One set of test on individual constituents and mixed aggregates from the dryer for each 100 tonnes of mix subject to a maximum of two sets per plant per day.

At regular close interval.

For each 100 tonnes of mix produced, a set of three Marshall specimens to be prepared and tested for stability, flow value density, and void content, subject to a minimum of two sets being tested per plant per day.

One test for each 100 tonnes of mix subject to a minimum of two tests per day per plant.

Regular control through checks on the weight of mixed material and layer thickness.

One test per 500 m³ area

(Part B) C.C Pavement (Road)

Road shall consist of the following :

a) Well compacted sub-grade layer.

b) Providing and laying 100 mm thick PCC in M 10

- c) Providing and laying 200 mm thick Concrete in M 20
- d) TMT /Mild steel Reinforcement
- e) Providing and applying Trimix with dewatering machine and floater machine
- f) Groove Cutting & Filling with polysulfide selant

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

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

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

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

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

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

Concrete is submitted to a pressure of Air pressure .1N / mm²

Depression .01N/mm²

= Effective pressure .09 N/ mm²

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

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

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

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

Making groove in Pavement and filling it with polysulfide selant

General

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

Preparation of joint grooves for sealing

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

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

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

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

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

Sealing with sealants

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

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

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

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

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

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

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

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

7.0 BUILDING DETAILS

7.1 Applicable Codes and Specifications

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

IS:110 - Ready mixed paint, brushing, grey filler, for enamels for use over primers IS:269 - Specification for 33 grade ordinary portland cement

IS:280 - Specification for mild steel wire for general engineering purposes

IS:287 - Recommendations for maximum permissible moisture content of timber used for different purposes

IS:304 - High Tensile Brass Ingots and Castings. IS:337 - Varnish, finishing interior

IS:348 - French polish

IS:383 - Specification for coarse and fine aggregates from natural sources for concrete

IS:412 - Expanded metal steel sheets for general purposes IS:419 - Specification for putty for use on window frames IS:428 - Distemper, oil emulsion, colour as required

IS:459 - Specification for unreinforced corrugated and semi-corrugated asbestos cement sheets

IS:702 - Specification for industrial bitumen IS:710 - Specification for marine plywood IS:712 - Specification for building limes

IS:730 - Specification for hook bolts for corrugated sheet roofing

IS:733 - Wrought aluminium and aluminium alloys, bars, rods and sections for general engineering purposes

IS:777 - Specification for glazed earthenware tiles

IS:1003 - Specification for timber panelled and glazed shutters (Parts 1 & 2) IS:1038 - Specification for steel doors, windows and ventilators

IS:1077 - Specification for common burnt clay building bricks

IS:1081 - Code of practice for fixing and glazing of metal (steel & aluminium) doors, windows and ventilators

IS:1124 - Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones

IS:1237 - Specification for cement concrete flooring tiles IS:1322 - Bitumen felts for water proofing and damp proofing

IS:1346 - Code of practice for water proofing of roofs with bitumen felts IS:1361 - Specification for steel windows for industrial buildings IS:1397 - Specification for kraft paper

IS:1443 - Code of practice for laying and finishing of cement concrete flooring tiles IS:1477 - Code of practice for painting of ferrous metals in buildings (Parts 1 & 2) IS:1542 - Specification for sand for plaster

- IS:1580 - Specification for bituminous compounds for water-proofing and caulking purposes
- IS:1597 - Code of practice for construction of stone masonry : Part 1 Rubble stone masonry
- IS:1659 - Specification for block boards
- IS:1661 - Code of practice for application of cement and cement-lime plaster finishes
- IS:1834 - Specification for hot applied sealing compound for joint in concrete
- IS:1838 - Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type) : Part 1 Bitumen impregnated fibre
- IS:1948 - Specification for aluminium doors, windows and ventilators IS:1949 - Specification for aluminium windows for industrial buildings IS:2074 - Ready mixed paint, air drying, red oxide- zinc chrome, priming IS:2098 - Asbestos cement building boards
- IS:2114 - Code of practice for laying in-situ terrazzo floor finish
- IS:2116 - Specification for sand for masonry mortars
- IS:2185 - Specification for concrete masonry units (Parts 1,2 & 3)
- IS:2202 - Specification for wooden flush door shutters (Solid core type) : Parts 1 & 2
- IS:2212 - Code of practice for brickwork
- IS:2250 - Code of practice for preparation and use of masonry mortars
- IS:2338 - Code of practice for finishing of wood and wood based materials (Parts 1 & 2)
- IS:2339 - Aluminium paint for general purposes, in dual container
- IS:2395 - Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
- IS:2402 - Code of practice for external rendered finishes
- IS:2571 - Code of practice for laying in-situ cement concrete flooring
- IS:2572 - Code of practice for construction of hollow concrete block masonry IS:2645 - Specification of integral cement waterproofing compounds
- IS:2690 - Specification for burnt clay flat terracing tiles : Part 1 Machine made IS:2691 - Specification for burnt clay facing bricks
- IS:2750 - Specification for steel scaffoldings IS:2835 - Flat transparent sheet glass
- IS:2932 - Specification for enamel, synthetic, exterior type (a) undercoating, (b) finishing

IS:3007 - Code of practice for laying of asbestos cement sheets - corrugated and (Part 1 & 2) semi-corrugated sheets

IS:3036 - Code of practice for laying lime concrete for a water-proofed roof finish IS:3067 - Code of practice of general design details and preparatory work for damp-proofing and water- proofing of buildings

IS:3068 - Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete

IS:3384 - Specification for bitumen primer for use in water-proofing and damp- proofing

IS:3461 - Specification for PVC-asbestos floor tiles IS:3462 - Specification for unbacked flexible PVC flooring

IS:3495 - Method of test for burnt clay building bricks: Part 1 to 4

IS:3536 - Specification for ready mixed paint, brushing, wood primer, pink IS:3564 - Specification for door closures (hydraulically regulated)

IS:3614 - Specification for fire checks doors : Part –I Plate metal covered and (Part - 1) rolling type

IS:3614 - Specification for metallic and non-metallic fire check doors : Part-2 (Part – 2) - Resistance test and performance criteria

IS:3696 - Safety code of scaffolds and ladders (Parts 1 & 2) IS:4020 - Methods of test for wooden flush door : Type test

IS:4021 - Specification for timber door, window and ventilator frames IS:4351 - Specification for steel door frames

IS:4443 - Code of practice for use of resin type chemical resistant mortars IS:4457 - Specification for ceramic unglazed vitreous acid resisting tile IS:4631 - Code of practice for laying epoxy resin floor toppings

IS:4832 - Specification for chemical resistant mortars (Part II)

Specification for acid resistant bricks

Specification for welded steel wire fabric for general use

Code of practice for laying of flexible PVC sheet and tile flooring Cement paint, colour as required

Specification for plastic emulsion paint (Parts 1 & 2) Wired and figured glass

Code of practice for laying of in-situ granolithic concrete floor topping Code of practice construction of autoclaved cellular concrete block masonry

Code of practice for construction of light weight concrete block masonry

Specification for metal rolling shutters and rolling grilles

Specification for glass fibre base coal tar pitch and bitumen felts Specification for hot rolled steel sections for doors, windows and ventilators

Specification for white portland cement Methods of testing plastics

Specification for washers for corrugated sheet roofing

Specification for epoxy resin, hardeners and epoxy resin composites for floor topping

Specification for ready mixed paint, brushing, bituminous, black, lead- free, acid, alkali, water and chlorine resisting

Code of practice for provision of waterstops at transverse contraction joints in masonry and concrete dams

Methods for determination of the fire resistance of elements of construction (General Principles)

Methods for determination of the fire resistance of load bearing elements of construction

Methods for determination of the fire resistance of non-load bearing elements of construction

National Building code of India Fire Protection

7.2 Brickwork

7.2.1 Materials

7.2.1.1 Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work prepared by the Contractor.

7.2.1.2 The nominal size of the modular brick shall be 200mmx100mmx100mm with the permissible tolerances over the actual size of 190mmx90mmx90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mmx115mmx75mm with tolerance upto ± 3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.

7.2.1.3 Bricks shall be sound, hard, homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. Hand moulded bricks shall be moulded with a frog and those made by extrusion process may not be provided with a frog. Bricks shall give a clear ringing sound when struck and shall have a minimum crushing strength of 5N/sq.mm unless otherwise specified in the Items of work prepared by the Contractor.

7.2.1.4 The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.

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

7.2.1.6 Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work prepared by the Contractor. Sand for masonry mortar shall conform to IS:218. The sand shall be free from clay, shale, loam, alkali and organic matter and shall be of sound, hard, clean and durable particles. Sand shall be approved by EMPLOYER. If so directed by the EMPLOYER, sand shall be screened and washed till it satisfies the limits of deleterious materials.

7.2.1.7 For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the EMPLOYER. The mortar thus mixed shall be used as soon as possible, preferably within 30 minutes from the time water is added to cement. In case, the mortar has stiffened due to evaporation of water, this may be re-tempered by adding water as required to restore consistency, but this will be permitted only upto 30 minutes from the time of initial mixing of water to cement. Any mortar which is partially set shall be rejected and shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances. The Contractor shall arrange for test on mortar samples if so directed by the EMPLOYER.

7.2.2 Workmanship

7.2.2.1 Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean water for at least one hour immediately before being laid. The cement mortar for brick masonry work shall be as specified in the respective item of work prepared by the Contractor. Brick work 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm thick brickwork shall be laid with stretchers. For laying bricks, a layer of mortar shall be spread over the full width of suitable length of the lower course. Each brick shall be slightly pressed into the mortar and shoved into final position so as to embed the brick fully in mortar. Only full size bricks shall be used for the works and cut bricks utilised only as closers to make up required wall length or for bonding. Bricks shall be laid with frogs on top.

7.2.2.2 All brickwork shall be plumb, square and true to dimensions shown. Vertical joints in alternate courses shall come directly one over the other and be in line. Horizontal courses shall be levelled. The thickness of brick courses shall be kept uniform. In case of one brick thick or half brick thick wall, at least one face should be kept smooth and plane, even if the other is slightly rough due to variation in size of bricks. For walls of thickness

greater than one brick both faces shall be kept smooth and plane. All interconnected brickwork shall be carried out at nearly one level so that there is uniform distribution of pressure on the supporting structure and no portion of the work shall be left more than one course lower than the adjacent work. Where this is not possible, the work shall be raked back according to bond (and not saw toothed) at an angle not exceeding 45 deg. But in no case the level difference between adjoining walls shall exceed one metre. Brick work shall not be raised more than one metre per day.

7.2.2.3 Bricks shall be so laid that all joints are well filled with mortar. The thickness of joints shall not be less than 6 mm and not more than 10 mm. The face joints shall be raked to a minimum depth of 10mm/15mm by raking tools during the progress of work when the mortar is still green, so as to provide a proper key for the plastering/ pointing respectively to be done later. When plastering or pointing is not required to be done, the joints shall be uniform in thickness and be struck flush and finished at the time of laying. The face of brickwork shall be cleaned daily and all mortar droppings removed. The surface of each course shall be thoroughly cleaned of all dirt before another course is laid on top.

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

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

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

7.2.2.7 In the event of usage of traditional bricks of size 230 mm x115mm x75mm, the courses at the top of the plinth and sills as well as at the top of the wall just below the roof/floor slabs and at the top of the parapet shall be laid with bricks on edge.

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

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

7.2.2.10 For resting RCC slabs, the bearing surface of masonry wall shall be finished on top with 12 mm thick cement mortar 1:3 and provided with 2 layers of Kraft paper Grade 1 as per IS:1397 or 2 layers of 50 micron thick polyethylene sheets.

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

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

7.2.2.13 Bricks for partition walls shall be stacked adjacent to the structural member to pre-deflect the structural member before the wall is taken up for execution. Further, the top most course of half or full brick walls abutting against either a deshuttered slab or beam shall be built only after any proposed masonry wall above the structural member is executed to cater for the deflection of the structural element.

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

7.2.2.15 Where the drawings prepared by the Contractor indicate that structural steel sections are to be encased in brickwork, the brickwork masonry shall be built closely against the steel section, ensuring a minimum of 20mm thick cement-sand mortar 1:4 over all the steel surfaces. Steel sections partly embedded in brickwork shall be provided with bituminous protective coating to the surfaces at the point of entry into the brick masonry.

7.2.2.15 Facing bricks of the type specified conforming to IS:2691 shall be laid in the positions indicated on the Drawings prepared by the Contractor and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.

7.2.2.16 Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works prepared by the Contractor. The pattern of laying the bricks shall be as specifically indicated in the Drawings prepared by the Contractor. For facing brickwork, double scaffolding shall be used. Faced works shall be kept clean and free from damage, discoloration etc., at all times.

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

7.3.1 Materials

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

7.3.1.2 Cement-sand mortar for stone masonry works shall be in the proportion of 1:6. Materials and preparation of mortar shall be as specified in clause 7.2.1.

7.3.2 Workmanship

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

7.3.2.2 For all works above ground level and in superstructure the masonry shall be random rubble uncoursed, well bonded, faced with hammer dressed stones with squared quoins at corners. The bushings on the face shall not be more than 40 mm on an exposed face and on the face to be plastered it shall not project by more than 12 mm nor shall it have depressions more than 10 mm from the average wall surface.

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

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

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

20 mm by a raking tool during the progress of the work while the mortar is still green.

7.3.2.6 Through or bond stones shall be provided in walls upto 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150 mm shall be provided in a line from face to back. In case of highly absorbent types of stones (porous lime stone and sand stone, etc.) the bond stone shall extend about two-thirds into the wall and a set of two or more bond stones overlapping each other by at least 150 mm shall be provided. Each bond stone or a set of bond stones shall be provided for every 0.5 sq.m of wall surface.

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

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

7.3.2.9 Type of scaffolding to be used shall be as specified in clause 7.2.2.

7.4 Coursed Rubble Masonry (First Sort) for Superstructure

7.4.1 Materials

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

7.4.2 Workmanship

7.4.2.1 All Courses shall be laid truly horizontal and shall be of the same height in any course. The height of course shall not be less than 150 mm and not more than 300 mm. The width of stone shall not be less than its height.

7.4.2.2 Face stones shall tail into the work for not less than their height and atleast 1/3rd the number of stones shall tail into the work for a length not less than twice their height but not more than three-fourths the thickness of the wall whichever is smaller. These should be laid as headers and stretchers alternately to break joints by atleast 75 mm.

7.4.2.3 The face stones shall be squared on all joints and beds; the bed joints being hammer or chisel dressed true and square for at least 80 mm back from the face and the side joints for atleast 40 mm. The face of the stone shall be hammer dressed so that the bushing shall not be more than 40

mm on an exposed face and 10 mm on a face to be plastered. No portion of the dressed surface shall show a depth of gap more than 6 mm from a straight edge placed

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

7.4.2.4 No spalls or pinnings shall be allowed on the face. All bed joints shall be horizontal and side joints shall be vertical and no joints shall be more than 10 mm in thickness. When plastering or pointing is not required to be done, the joints shall be struck flush and finished as the work proceeds. Otherwise, the joints shall be raked to a minimum depth of 20 mm by a raking tool, during the progress of the work while the mortar is still green.

7.4.2.5 Hearting shall consist of flat bedded stones carefully laid on their proper beds and solidly bedded in mortar. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10 percent of the quantity of the stone masonry. Care shall be taken so that no hollow spaces are left anywhere in the masonry.

7.4.2.6 The requirement regarding through or bond stones shall be as specified in clause 7.3.2 with the further stipulation that these shall be provided at 1.5 m to 1.8m apart clear in every course but staggered at alternate courses.

7.4.2.7 The quoins which shall be of the same height as the course in which they occur, shall not be less than 450 mm in any direction. Quoin stones shall be laid as stretchers and headers alternately. They shall be laid square on their beds, which shall be rough chisel dressed to a depth of at least 100 mm from the face. These stones shall have a minimum uniform chisel drafts of 25mm width at four edges, all the edges being in the same plane.

7.4.2.8 Type of scaffolding to be used shall be as per Clause 7.2.2. Requirements of execution of the work and curing shall be as stipulated in clause 7.3.2 .

7.5 Concrete Block Masonry

7.5.1 Materials

7.5.1.1 Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS

: 2185 (Part I).

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

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

7.5.1.4 The height of the concrete masonry units shall not exceed either its length or six times its width.

7.5.1.5 The nominal dimensions of concrete block shall be as under.

- a) Length 400, 500 or 600 mm
- b) Height 100 or 200 mm
- c) Width 100 to 300 mm in 50 mm increments

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

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

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

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

7.5.1.10 Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square.

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

7.5.1.12 The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.

7.5.1.13 Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. Contractor shall furnish the test certificates and also supply the samples for the approval of EMPLOYER.

7.5.2 Workmanship

7.5.2.1 The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.

7.5.2.2 The workmanship shall generally conform to the requirements of IS:2572 for concrete block masonry, IS:6042 for light weight concrete block masonry and IS:6041 for autoclaved cellular concrete block masonry works.

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

7.5.2.4 Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 7.2.1.

7.5.2.5 The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.

7.5.2.6 Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.

7.5.2.7 As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either

from mild steel wires conforming to IS:280 or welded wire fabric/high strength deformed basis.

7.5.2.8 For jambs of doors, windows and openings, should concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.

7.5.2.9 At intersection of walls, the courses shall laid up at the same time with a true masonry bond between atleast 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 7.2 for the brick work.

7.5.2.10 Curing of the mortar joints shall be carried out for atleast 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

7.5.2.11 Double scaffolding as per clause 7.2.2 shall be adopted for execution of block masonry work.

7.5.2.12 Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.

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

7.6 Damp - Proof Course

7.6.1 Materials and Workmanship

7.6.1.1 Where Specified, all the walls in a building shall be provided with damp-proof course cover plinth to prevent water from rising up the wall. The damp-proof course shall run without a break throughout the length of the wall, even under the door or other openings. Damp-proof course shall consist of 50 mm thick cement concrete of 1:2:4 nominal mix with approved water-proofing compound admixture conforming to IS: 2645 in proportion as directed by the manufacturer. Concrete shall be with 10 mm down graded coarse aggregates.

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

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

7.7 Miscellaneous Inserts, Bolts etc.

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

7.8 Wood Work for Doors, Windows, Ventilators & Partitions

7.8.1 Materials

7.8.1.1 Timber To be used shall be first class Teak wood as per IS:4021. Timber shall be of the best quality and well-seasoned by a suitable process before being 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 percent of timber less than 50mm in thickness for different regions of the country as stipulated in IS:287. Timber shall be close grained, of uniform colour and free from decay, fungal growth, boxed heart, pitch pockets or streaks on the exposed edges, borer holes, splits and cracks.

7.8.1.2 Flush door shutters of the solid core type with plywood face panels shall conform to IS:2202 (Part 1) and with particle board/hard board face panels shall conform to IS:2202 (Part 2).

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

7.8.1.4 Builder's hardware for fittings and fixtures shall be of the best quality from approved manufacturers.

7.8.2 Workmanship

7.8.2.1 The workmanship and finish of wood work in doors, windows, ventilators and partitions shall be of a very high order. Contractor shall ensure that work is executed in a professional manner by skilled carpenters for good appearance, efficient and smooth operation of the shutters.

7.8.2.2 All works shall be executed as per the detailed Drawings prepared by the Contractor and/or as directed by the EMPLOYER.

7.8.2.3 All members of the door, window, and ventilator shall be straight without any warp or bow and shall have smooth well planed faces. The right

angle shall be checked from the inside surfaces of the respective members of the frame. Frames shall have mortice and tenon joints which shall be treated with an approved adhesive and provided with metal or wood pins. The vertical members of the door frame shall project 50 mm below the finished floor level. The finished dimension of frames shall be rebated on the solid for keying with the plaster and for receiving the shutters. The depth of rebate for housing the shutter shall be 15 mm. The size of the frames shall be as specified in the respective items of work prepared by the Contractor. The workmanship shall generally conform to the requirements specified in IS:4021.

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

7.8.2.5 Three hold fasts using 25 mm x 6 mm mild steel flats 225 mm long with split ends shall be fixed on each side of door and window frames, one at the centre and the other two at 300

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

7.8.2.6 Timber panelled shutters for doors, windows and ventilators shall be constructed in the form of framework of stiles and rails with panel insertion. The panels shall be fixed by either providing grooves in the stiles and rails or by beading. Glazing bars shall be as detailed in the Drawings prepared by the Contractor. The stiles and rails shall be joined by mortice and tenon joints at right angles. All members of the shutter shall be straight without any warp or bow and shall have smooth, well planed faces at right angles to each other. The right angle for the shutter shall be checked by measuring the diagonals and the difference shall not be more than ± 3 mm. Timber panels made from more than one piece shall be jointed with a continuous tongued and grooved joint, glued together and reinforced with metal dowels. The workmanship shall generally conform to the requirements specified in IS:1003 (Parts 1 & 2). The thickness of the shutter, width/thickness of the stiles/rails/panel type shall be as specified. Marine plywood panels conforming to IS:710 shall be used for doors where specified.

7.8.2.7 Details of the wooden flush door shutters, solid core type with specific requirement of the thickness, core, face panels, viewing glazed panel, venetian louvre opening, teak wood lipping etc. shall be as specified. Panels of shutter shall be of marine plywood conforming to IS:710. Flush door shutters shall be from reputed manufacturers and Contractor shall submit test results as per IS:4020, if so desired by the EMPLOYER.

7.8.2.8 Glazing of door, window, ventilator and partitions shall be with either flat transparent sheet glass, wired or figured glass. Transparent sheet glass shall be of 'B' quality as per IS:2835. The thickness and type of glazing to be provided shall be as specified.

7.8.2.9 The material of the fittings and fixtures either of chromium plated steel, cast brass, copper oxidised or anodised aluminum shall be as specified. The number, size and type of the fittings and fixtures shall be as specified.

7.8.2.10 Woodwork shall not be provided with the finishes of painting/varnishing etc. unless it has been approved by the EMPLOYER. The type of finish and the number of coats shall be as stipulated in the respective items of work prepared by the Contractor. Preparation of the wood surfaces and application of the finishes shall be in accordance with clause 7.32.

7.8.2.11 Wooden hand railing and architrave's shall be of the size and shape with the fixing arrangement as indicated in the Drawings prepared by the Contractor.

7.8.2.12 The framework of the partitions with mullions and transoms shall be with the sections of dimensions as specified. Panels of double/single glazing/plywood shall be fixed as per details specified. Partitions shall be fixed rigidly between the floor and structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction Drawings prepared by the Contractor.

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

7.9 Steel Doors, Windows and Ventilators

7.9.1 Materials

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

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

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

7.9.1.4 Builder's hardware of fittings and fixtures shall be of the best quality from the approved manufacturers.

7.9.2 Workmanship

7.9.2.1 All steel doors, windows and ventilators shall be of the type as specified in the respective items of work prepared by the Contractor and of sizes as indicated in the Drawings prepared by the Contractor prepared by the Contractor. Steel doors, windows and ventilators shall conform to the requirements as stipulated in IS : 1038. Steel windows shall conform to IS : 1361, if so specified.

7.9.2.2 Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the unit shall be with rolled section, cut to correct lengths and metered. Corners shall be welded to form a solid fused welded joint conforming to the requirements of IS : 1038. Tolerance in overall dimensions shall be within $\pm 1.5\text{mm}$. The frames and shutters shall be free from warp or buckle and shall be square and truly plain. All welds shall be dressed flush on exposed and contact surfaces. Punching of holes, slots and other provisions to install fittings and fixtures later shall be made at the correct locations as per the requirements. Samples of the units shall be got approved by the EMPLOYER before further manufacture/purchase by the Contractor.

7.9.2.3 Type and details of shutters, hinges, glazing bar requirement, couplings, locking arrangement, fittings and fixtures shall be as described in the respective items of work and / or as shown in the Drawings prepared by the Contractor for single or composite units.

7.9.2.4 For windows with fly proof mesh as per the item of work prepared by the Contractor, rotor operator arrangement, for the operation of the glazed shutters from the inside shall be provided.

7.9.2.5 Pressed steel door frames shall be provided with fixing lugs at each jamb, hinges, lock- strike plate, mortar guards, angle threshold, shock-absorbers of rubber or similar material as per the requirements of IS : 4351. Pressed steel doorframes shall be fixed as 'built-in' as the masonry work proceeds. After placing it plumb at the specified location, masonry walls shall be built up solid on either side and each course grouted with mortar to ensure solid contact with the doorframe, without leaving any voids. Temporary struts across the width shall be fixed, during erection to prevent bow/sag of the frame.

7.9.2.6 Door shutters of flush welded construction shall be 45mm thick, fabricated with two outer skins of 1.25mm thick steel sheets, 1mm thick steel sheet stiffeners and steel channels on all four edges. Double shutters shall have meeting stile edge beveled or rebated. Provision of glazed viewing panel, louvers shall be made as per the items of works and/or Drawings prepared by the Contractor. Shutters shall be suitably reinforced for lock and other surface hardware and to prevent sagging/twisting. Single sheet steel door shutters shall be fabricated out of 1.25mm thick steel sheets, mild steel angles and stiffeners as per the Drawings prepared by the Contractor.

7.9.2.7 Doors, windows and ventilators shall be fixed into the prepared openings. They shall not be 'built-in' as the masonry work proceeds, to avoid distortion and damage of the units. The

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

7.9.2.8 Glazing of the units shall be either with flat transparent glass or wired / figured glass of the thickness as specified in the items of works prepared by the Contractor. All glass panels shall have properly squared corner and straight edges. Glazing shall be provided on the outside of the frames.

7.9.2.9 Fixing of the glazing shall be either with spring glazing clips and putty conforming to IS:419 or with metal beads. Pre-formed PVC or rubber gaskets shall be provided for fixing the beads with the concealed screws. The type of fixing the glazing shall be as indicated in the items of work and/or in Drawings prepared by the Contractor.

7.9.2.10 Steel doors, windows and ventilators shall be provided with finish of either painting as specified or shall be hot dip galvanised with thickness of the zinc coating as stipulated all as described in the respective items of works prepared by the Contractor.

7.9.2.11 The material of the Builders hardware of fittings and fixtures of chromium plated steel, cast brass, brass copper oxidised or anodised aluminium shall be as specified in the items of works prepared by the Contractor. The number , size and type of fittings and fixtures shall be as in the Drawings /items of works prepared by the Contractor.

7.9.2.12 Installation of the units with fixing lugs, screws, mastic caulking compound at the specified locations shall generally conform to the requirements of IS:1081. Necessary holes etc required for fixing shall be made by the Contractor and made good after installation. Workmanship expected is of a high order for efficient and smooth operation of the units.

7.10 Aluminum Doors, Windows, Ventilators & Partitions

7.10.1 Materials

7.10.1.1 Aluminum alloy used in the manufacture of extruded sections for the fabrication of doors, windows, ventilators shall conform to designation HE9-WP of IS:733.

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

7.10.1.3 Builder's hardware of fittings & fixtures shall be of the best quality from approved manufacturers.

7.10.2 Workmanship

7.10.2.1 All aluminum doors, windows, ventilators and partitions shall be of the type and size as specified. The doors, windows, ventilators shall conform to the requirements of IS:1948. Aluminum windows, shall conform to IS:1949, if so specified.

7.10.2.2 All aluminum units shall be supplied with anodized finish. The minimum anodic film thickness shall be 0.015 mm.

7.10.2.3 Doors, windows and ventilators shall be of an approved manufacture. Fabrication of the units shall be with the extruded sections, cut to correct lengths, mitred and welded at the corners to a true right angle conforming to the requirements of IS:1948. Tolerance in overall dimensions shall be within $\pm 1.5\text{mm}$. 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.

7.10.2.4 Aluminium swing type doors, aluminum sliding windows, partitions shall be as specified.

7.10.2.5 IS:1948 and IS:1949 referred to incorporates the sizes, shapes, thicknesses and weight per running metre of extruded sections for the various components of the units. However, new sizes, shapes, thicknesses with modifications to suit snap-fit glazing clips etc. are being continuously being added by various leading manufacturers of extruded sections, which are available in the market. As such, the sections of the various components of the unit proposed by the Contractor, will be reviewed by the EMPLOYER and will be accepted only if they are equal to or marginally more than that given in the codes/as specified.

7.10.2.6 The framework of the partitions with mullions and transomes shall be with anodised aluminium box sections. Anodised aluminium box sections shall be in-filled with timber of class 3 (silver oak or any other equivalent) as per IS:4021. Panels of double/single glazing/plywood shall be fixed as per details indicated in the Drawings to be prepared by the Contractor. Partitions shall be fixed rigidly between the floor and the structural columns/beams including provision of necessary shims for wedging etc. Finished work shall be of rigid construction, erected truly plumb to the lines and levels, at locations as per the construction Drawings to be prepared by the Contractor.

7.10.2.7 Specific provisions as stipulated for steel doors, windows, ventilators under clause 7.9.2 shall also be applicable for this item work.

Glazing beads shall be of the snap-fit type suitable for the thickness of glazing proposed as indicated in the items of works prepared by the Contractor. A layer of clear transparent lacquer shall be applied on aluminium sections to protect them from damage during installation. This lacquer coating shall be removed after the installation is completed.

7.11 Steel Rolling Shutters

7.11.1 Materials and Workmanship

7.11.1.1 Rolling shutters shall be of an approved manufacture, conforming to the requirements specified in IS:6248.

7.11.1.2 The type of rolling shutter shall be self coiling type (manual) for clear areas upto 12 sq.m, gear operated type (mechanical) for clear areas upto 35 sq.m and electrically operated type for areas upto 50 sq.m. Mechanical type of rolling shutters shall be suitable for operation from both inside and outside with the crank handle or chain gear operating mechanism duly considering the size of wall/column. Electrical type of rolling shutter shall also be provided with a facility for emergency mechanical operation.

7.11.1.3 Rolling shutters shall be supplied duly considering the type, specified clear width/height of the opening and the location of fixing as indicated in the Drawings prepared by the Contractor.

7.11.1.4 Shutters shall be built up of interlocking laths 75 mm width between rolling centres formed from cold rolled steel strips. The thickness of the steel strip shall not be less than 0.90 mm for shutters upto 3.50 m width and not less than 1.20 mm for shutters above 3.50 m width. Each lath section shall be continuous single piece without any welded joint.

7.11.1.5 The guide channels out of mild steel sheets of thickness not less than 3.15 mm shall be of either rolled, pressed or built up construction. The channel shall be of size as stipulated in IS:6248 for various clear widths of the shutters.

7.11.1.6 Hood covers shall be of mild steel sheets not less than 0.90 mm thick and of approved shape.

7.11.1.7 Rolling shutters shall be provided with a central hasp and staple safety device in addition to one pair of lever locks and sliding locks at the ends.

7.11.1.8 All component parts of the steel rolling shutter (excepting springs and insides of guide channels) shall be provided with one coat of zinc chrome primer conformity to IS:2074 at the shop before supply. These surfaces shall be given an additional coat of primer after erection at the site

along with the number of coats and type of finish paint as specified in the respective items of works prepared by the Contractor. Painting shall be carried out as per clause 7.33.

7.11.1.9 In case of galvanised rolling shutter, the lath sections, guides, lock plate, bracket plates, suspension shaft and the hood cover shall be hot dip galvanised with a zinc coating containing not less than 97.5 percent pure zinc. The weight of the zinc coating shall be atleast 610gms/sq.m.

7.11.1.10 Guide channels shall be installed truly plumb at the specified location. Bracket plate shall be rigidly fixed with necessary bolts and holdfasts. Workmanship of erection shall ensure strength and rigidity of rolling shutter for trouble free and smooth operation.

7.12 Rubble Sub-Base

7.12.1 Materials

7.12.1.1 Stones used for rubble packing under floors on grade, foundations etc., shall be clean, hard, durable rock free from veins, flaws, laminations, weathering and other defects. Stones shall generally conform to the requirements stipulated in IS: 1597 (Part I).

7.12.1.2 Stones shall be as regular as can be obtained from quarries. Stones shall be of height equal to the thickness of the packing proposed with a tolerance of ± 10 mm. Stones shall not have a base area less than 250 sq cm nor more than 500 sq.cm, and the smallest dimension of any stone shall not be less than half the largest dimension. The quality and size of stones shall be subject to the approval of the EMPLOYER.

7.12.2 Workmanship

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

7.12.2.2 The laid rubble packing shall be sprinkled with water and compacted by using suitable rammers.

7.13 Base Concrete

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

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

7.14 Terrazzo and Plain Cement Tiling Work

7.14.1 Materials

7.14.1.1 Terrazzo tiles and cement tiles shall generally conform in all respects to standards stipulated in IS:1237. Tiles shall be of the best quality manufactured adopting hydraulic pressure of not less than 14N/mm².

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

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

1.75 parts by volume, if the chips are between 1mm to 6mm and 1.50 parts by volume if the chips are between 6mm to 25mm.

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

7.14.2 Workmanship

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

7.14.2.2 Tiling work shall be commenced only after the door and window frames are fixed and plastering of the walls/ ceiling is completed. Wall

plastering shall not be carried out upto about 50mm above the level of proposed skirting/dado.

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

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

7.14.2.5 Neat cement slurry using 4.4 kg of cement per sq.m of floor area shall be spread over the hardened mortar bedding over such an area at a time as would accommodate about 20 tiles. Tiles shall be fixed in this slurry one after the other, each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be in straight lines and shall normally be 1.5mm wide. On completion of laying of the tiles in a room, all the joints shall be cleaned and washed fairly deep with a stiff broom/wire brush to a minimum depth of 5mm. The day after the tiles have been laid, the joints shall be filled with cement grout of the same shade as the colour of the matrix of the tile. For this purpose white cement or grey cement with or without pigments shall be used. The flooring should be kept moist and left undisturbed for 7 days for the bedding/joints to set properly. Heavy traffic shall not be allowed on the floor for atleast 14 days after fixing of the tiles.

7.14.2.6 About a week after laying the tiles, each and every tile shall be lightly tapped with a small wooden mallet to find out if it gives a hollow sound; if it does, such tiles along with any other cracked or broken tiles shall be removed and replaced with new tiles to proper line and level. The same procedure shall be followed again after grinding the tiles and all damaged tiles replaced, properly jointed and finished to match. For the purpose of ensuring that such replaced tiles match with those laid earlier, it is necessary that the Contractor shall procure sufficient quantity of extra tiles to meet this contingency.

7.14.2.7 Wherever a full tile cannot be provided, tiles shall be cut to size and fixed. Floor tiles adjoining the wall shall go about 10mm under the plaster, skirting or dado.

7.14.2.8 Tile skirting and dado work shall be executed only after laying tiles on the floor. For dado and skirting work, the vertical wall surface shall be thoroughly cleaned and wetted. Thereafter it shall be evenly and uniformly covered with 10mm thick backing of 1:4 cement sand mortar. For this work the tiles as obtained from the factory shall be of the size required

and practically full polished. The back of each tile to be fixed shall be covered with a thin layer of neat cement paste and the tile shall then be gently tapped against the wall with a wooden mallet. Fixing shall be done from the bottom of the wall upwards. The joints shall be in straight lines and shall normally be 1.5mm wide. Any difference in the thickness of the tiles shall be evened out in the backing mortar or cement paste so that the tile faces are in conformity & truly plumb. Tiles for use at the corners shall be suitably cut with bevelled edges to obtain a neat and true joint. After the work has set, hand polishing with carborundum stones shall be done so that the surface matches with the floor finish.

7.14.2.9 Wall plastering of the strip left out above the level of skirting/dado shall be taken up after the tiles are fixed.

7.14.2.10 Chequered terrazzo tiles for flooring and for stair treads shall be delivered to site after the first machine grinding.

7.14.2.11 Machine grinding and polishing shall be commenced only after a lapse of 14 days of laying. The sequence and three numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pin holes, watering etc. shall be carried out all as specified in IS:1443.

7.14.2.12 Tiles shall be laid to the levels specified. Where large areas are to be tiled the level of the central portion shall be kept 10mm higher than that at the walls to overcome optical illusion of a depression in the central portion. Localised deviation of $\pm 3\text{mm}$ in any 3m length is acceptable in a nominally flat floor.

7.15 In-Situ Terrazzo Work

7.15.1 Materials

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

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

7.15.2 Workmanship

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

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

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

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

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

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

7.15.2.7 Terrazzo topping shall be laid while the under layer is still plastic and normally between 18 to 24 hours after the under layer is laid. Cement slurry of the same colour as the topping shall be brushed on the surface immediately before laying is commenced. The terrazzo mix shall be laid to a uniform thickness and compacted thoroughly by tamping and with a

minimum of troweling. Straight edge and steel floats shall be used to bring the surface true to the required level in such a manner that the maximum amount of marble chips come up and spread uniformly all over the surface.

7.15.2.8 The surface shall be left dry for air-curing for a period of 12 to 18 hours. Thereafter it shall be cured by allowing water to stand in pools for a period of not less than 4 days.

7.15.2.9 Machine grinding and polishing shall be commenced only after a lapse of 7 days from the time of completion of laying. The sequence and four numbers of machine grinding operations, usage of the type of carborundum stones, filling up of pinholes, wet curing, watering etc shall be carried out all as specified in IS: 2114.

7.16 Shahabad / Tandur/ Kota Stone Slab work

7.16.1 Materials

7.16.1.1 The slabs shall be of approved selected quality, hard, sound, dense and homogenous in texture, free from cracks, decay, weathering and flaws. The percentage of water absorption shall not exceed 5 percent as per test conducted in accordance with IS : 1124.

7.16.1.2 The slabs shall be hand or machine cut to the required thickness. Tolerance in thickness for dimensions of tile more than 100mm shall be $\pm 5\text{mm}$. This shall be $\pm 2\text{mm}$ on dimensions less than 100mm.

7.16.1.3 Slabs shall be supplied to the specified size with machine cut edges or fine chisel dressed to the full depth. All angles and edges of the slabs shall be true and square, free from any chipping giving a plane surface. Slabs shall have the top surface machine polished (first grinding) before being brought to site. The slabs shall be washed clean before laying.

7.16.2 Workmanship

7.16.2.1 The type, size, thickness and colour/shade etc. of the slabs for flooring/dado/skirting shall be as specified in the respective items of works prepared by the Contractor.

7.16.2.2 Preparation of the concrete base, laying and curing shall be as per clause 7.14.2.

7.16.2.3 Dado / skirting work shall be as per clause 7.14.2. The thickness of the slabs for dado/skirting work shall not be more than 25mm. Slabs shall be so placed that the back surface is at a distance of 12mm. If necessary, slabs shall be held in position temporarily by suitable method. After checking for verticality, the gap shall be filled and packed with cement sand mortar of proportion 1:3. After the mortar has acquired sufficient strength, the temporary arrangement holding the slab shall be removed.

7.16.2.4 Grinding and polishing shall be as per clause 7.14.2 except that first grinding with coarse grade carborundum shall not be done and cement slurry with or without pigment shall not applied before polishing.

7.17 Carborundum Tile Finish

7.17.1 Materials

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

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

7.17.2 Workmanship

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

7.18 Glazed Tile Finish

7.18.1 Materials

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

7.18.2 Workmanship

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

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

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

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

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

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

7.18.2.7 All the joints shall be cleaned of grey cement with wire brush to a depth of at least 3mm and all dust, loose mortar etc. shall be removed. White cement with or without pigment shall then be used for flush pointing the joints. Curing shall then be carried out for a minimum period of 7 days for the bedding and joints to set properly. The surface shall then be cleaned using a suitable detergent, fully washed and wiped dry.

7.18.2.8 Specials consisting of coves, internal and external angles, cornices, beads and their corner pieces shall be of thickness not less than the tiles with which they are used.

7.19 In-Situ Cement Concrete Floor Topping

7.19.1 Materials

7.19.1.1 The mix proportion for the in-situ concrete floor topping shall be 1:2.5:3.5 (one part cement

: two and half parts sand : three and half parts coarse aggregates) by volume unless otherwise specified.

7.19.1.2 The aggregates shall conform for the requirements of IS:383.

7.19.1.3 Coarse aggregates shall have high hardness surface texture and shall consist of crushed rock of granite, basalt, trap or quartzite. The aggregate crushing value shall not exceed 30 percent. The grading of the aggregates of size 12.5mm and below shall be as per IS:2571.

7.19.1.4 Grading of the sand shall be within the limits indicated in IS:2571.

7.19.2 Workmanship

7.19.2.1 The thickness of the floor topping shall be as specified in the items of work prepared by the Contractor. The minimum thickness of the floor topping shall be 25mm.

7.19.2.2 Preparation of base concrete/structural slab before laying the topping shall be as per clause

7.13. The surface shall be rough to provide adequate bond for the topping.

7.19.2.3 Mixing of concrete shall be done thoroughly in a mechanical mixer unless hand mixing is specifically permitted by the EMPLOYER. The concrete shall be as stiff as possible and the amount of water added shall be the minimum necessary to give just sufficient plasticity for laying and compacting. The mix shall be used in the work within 30 minutes of the addition of water for its preparation.

7.19.2.4 Floor finish shall be laid in suitable panels to reduce the risk of cracking. No dimension of a panel shall exceed 2 meters and the length of a panel shall not exceed one and a half times its breadth. Topping shall be laid in alternate panels, the intermediate panels being cast after a gap of at least one day. Construction joints shall be plain vertical butt joints.

7.19.2.5 Screed strips shall be fixed dividing the area into suitable panels. Immediately before depositing the concrete topping, neat cement slurry at 2.75 kg/sq.m of area shall be thoroughly brushed into the prepared surface. Topping shall then be laid, very thoroughly tamped, struck off level and floated with wooden float. The surface shall then be tested with a straight edge and mason's spirit level to detect any inequalities and these shall be made good immediately.

7.19.2.6 Finishing of the surface by troweling shall be spread over a period of one to six hours depending upon the temperature and atmospheric conditions. The surface shall be trowelled 3 times at intervals so as to produce a smooth uniform and hard surface. Immediately after

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

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

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

7.20 In-Situ Granolithic Concrete Floor Topping

7.20.1 Materials and Workmanship

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

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

7.21 Floor Hardener Topping

7.21.1 Materials & Workmanship

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

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

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

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

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

7.22 PVC Sheet/Tile Flooring

7.22.1 Materials

7.22.1.1 PVC floor covering shall be of either unbacked homogeneous flexible type in the form of sheets/tiles conforming to IS:3462 or homogeneous PVC asbestos tiles conforming to IS:3461.

7.22.1.2 The surface of the sheets/tiles shall be free from any physical defects such as pores, blisters, cracks etc. which affects the appearance and serviceability. Tiles/ sheets shall meet with the tolerance limits in dimensions specified in the IS. Contractor shall submit the test certificates, if so desired by the EMPLOYER.

7.22.1.3 Each tile/sheet shall be legibly and indelibly marked with the name of the manufacturer or his trade mark, IS certificate mark, and batch number.

7.22.1.4 The adhesive to be used for laying the PVC flooring shall be rubber based and of the make as recommended and approved by the manufacturer of PVC sheets/tiles.

7.22.1.5 The type, size, colour, plain or mottled and the pattern shall be as specified in the respective items of work prepared by the Contractor.

7.22.2 Workmanship

7.22.2.1 PVC Floor covering shall be provided over an under bed of cement concrete floor finish over the base concrete or structural slab. It is essential that the sub-floor and the under bed are perfectly dry before laying the PVC flooring. This shall be ensured by methods of testing as stipulated in Appendix-A of IS:5318.

7.22.2.2 The surface of the under bed shall have trowelled finish without any irregularities, which creates poor adhesion. Surface shall be free of oil or grease and thoroughly cleaned of all dust, dirt and wiped with a dry cloth.

7.22.2.3 PVC sheets/tiles shall be brought to the temperature of the area in which they are to be laid by stacking in a suitable manner within or near the laying area for a period of about 24 hours. Where air-conditioning is installed, the flooring shall not be laid on the under bed until the A/C units have been in operation for at least 7 days. During this period, the temperature range shall be between 20deg.C and 30deg.C and this shall be maintained during the laying operations and also for 48 hours thereafter.

7.22.2.4 Layout of the PVC flooring shall be marked with guidelines on the under bed and PVC tiles/sheets shall be first laid for trial, without using the adhesive, according to the layout.

7.22.2.5 The adhesive shall be applied by using a notched trowel to the surface of the under bed and to the backside of PVC sheets/tiles. When the adhesive has set sufficiently for laying, it will be tacky to the touch, which generally takes about 30 minutes. The time period need be carefully monitored since a longer interval will affect the adhesive properties. Adhesive shall be uniformly spread over only as much surface area at one time which can be covered with PVC flooring within the stipulated time.

7.22.2.6 PVC sheet shall be carefully taken and placed in position from one end onwards slowly so that the air will be completely squeezed out between the sheet and the background surface and no air pockets are formed. It shall then be pressed with a suitable roller to develop proper contact. The next sheet shall be laid edge to edge with the sheet already laid, so that

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

7.22.2.7 Tiles shall be laid in the same manner as sheets and preferably, commencing from the centre of the area. Tiles should be lowered in position and pressed firmly on to the adhesive with minimum gap between the joints. Tiles shall not be slid on the surface. Tiles shall be rolled with a light wooden roller of about 5kg to ensure full contact with the underlay. Work should be constantly checked to ensure that all four edges of adjacent tiles meet accurately.

7.22.2.8 Any excess adhesive which may squeeze up between sheets/tiles shall be wiped off immediately with a wet cloth. Suitable solvents shall be used to remove hardened adhesive.

7.22.2.9 A minimum period of 24 hours shall be given after laying for the development of proper bond of the adhesive. When the flooring is thus completed, it shall be cleaned with a wet cloth soaked in warm soap solution.

7.22.2.10 Metallic edge strips shall be used to protect the edges of PVC sheets/tiles which are exposed as in doorways/ stair treads.

7.22.2.11 Hot sealing of joints between adjacent PVC sheet flooring to prevent creeping of water through the joints shall be carried out, using special equipment as per manufacturer's instructions.

7.23 Acid Resisting Brick/Tiling Work

7.23.1 Materials

7.23.1.1 The ceramic unglazed vitreous acid resisting tiles shall conform to the requirements of IS:4457. Acid resistant bricks shall conform to the requirements of IS:4860.

7.23.1.2 The finished tile/brick when fractured shall appear fine grained in texture, dense and homogeneous. Tile/brick shall be sound, true to shape, flat, free from flaws and any manufacturing defects affecting their utility. Tolerance in dimensions shall be within the limits specified in the respective IS.

7.23.1.3 The tiles/bricks shall be bedded and jointed using chemical resistant mortar of the resin type conforming to IS:4832 (Part II). Method of usage shall generally be as per the requirements of IS:4443.

7.23.2 Workmanship

7.23.2.1 The resin shall have viscosity for readily mixing with the filler by manual methods. The filler shall have graded particles which permit joint thickness of 1.5 mm.

7.23.2.2 The base concrete surface shall be free from dirt and thoroughly dried. The surface shall be applied with a coat of bitumen primer conforming to IS:3384. The primed surface shall then be applied with a uniform coat of bitumen conforming to IS:1580. Tiles or bricks shall be laid directly without the application of bitumen, if epoxy or polyester resin is used for the mortar.

7.23.2.3 Just adequate quantity of mortar which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for bedding and jointing. Rigid PVC/Stainless steel/chromium plated tools shall be used for mixing and laying.

7.23.2.4 For laying the floor 6 to 8 mm thick mortar shall be spread on the back of the tile/brick. Two adjacent sides of the tile/brick shall be smeared with 4 to 6 mm thick mortar. Tile/brick shall be pressed into the bed

and pushed against the floor and with the adjacent tile/ brick, until the joint in each case is 2 to 3 mm thick. Excess mortar shall then be trimmed off and allowed to harden fully. Similar procedure shall be adopted for the work on walls by pressing the tile/brick against the prepared wall surfaces and only one course shall be laid at a time until the initial setting period.

7.23.2.5 The mortar joints shall be cured for a minimum period of 72 hours with 20 to 25% hydrochloric acid or 30 to 40% sulphuric acid. After acid curing, the joints shall be washed with water and allowed to thoroughly dry. The joints shall then be filled with mortar to make them smooth and plane. Acid curing is not required to be carried out if epoxy or polyester resin is used for the mortar.

7.23.2.6 Resin mortars are normally self curing. The area tiled shall not be put to use before 48 hours in case epoxy, polyester and furane type of resin is used for the mortar. If phenolic or cashewnut shell liquid resin is used for the mortar, the area tiled shall not be put to use for 7 to 28 days respectively, without heat treatment. This period shall be 2 to 6 days respectively, if heat treatment is given with infrared lamp.

7.24 Epoxy Lining Work

7.24.1 Materials

7.24.1.1 The epoxy resin and hardener formulation for laying of jointless lining work in floors and walls of concrete tanks/trenches etc shall be as per the requirements of IS:9197.

7.24.1.2 The epoxy composition shall have the chemical resistance to withstand the following conditions of exposure:

- a) Hydrochloric acid upto 30% concentration
- b) Sodium hydroxide upto 50% concentration
- c) Liquid temperature upto 60deg.C
- d) Ultraviolet radiation
- e) Alternate wetting and drying

7.24.1.3 Sand shall conform to grading zone III or IV of IS:383.

7.24.1.4 The hardener shall be of the liquid type such as Aliphatic Amine or an Aliphatic/Aromatic Amine Adduct for the epoxy resin. The hardener shall react with epoxy resin at normal ambient temperature.

7.24.1.5 Contractor shall furnish test certificates for satisfying the requirements of the epoxy formulation if so directed by the EMPLOYER.

7.24.2 Workmanship

7.24.2.1 The minimum thickness of epoxy lining shall be 4 mm. It is essential that the concrete elements are adequately designed to ensure that water is excluded to permeate to the surface, over which the epoxy lining is proposed.

7.24.2.2 The epoxy lining shall be of the trowel type to facilitate execution of the required thickness for satisfactory performance.

7.24.2.3 The concrete surfaces over which epoxy lining is to be provided shall be thoroughly cleaned of oil or grease by suitable solvents, wire brushed to remove any dirt/dust and laitance. The

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

7.24.2.4 Just adequate quantity of epoxy resin which can be applied within the pot life as specified by the manufacturer shall be prepared at one time for laying and jointing.

7.24.2.5 Rigid PVC/stainless steel/chromium plated tools shall be used for laying. Trowelling shall be carried out to obtain uniformly the specified thickness of lining.

7.24.2.6 Lining shall be allowed to set without disturbance for a minimum period of 24 hours. The facility shall be put to use only after a minimum period of 7 days of laying of the lining.

7.25 Water-Proofing

7.25.1 General

7.25.1.1 The work shall include waterproofing for the building roofs, terraces, toilets, floor slabs, walls, planters, chajjas, sills and any other areas and at any other locations and situations as directed by the Employers Representative.

7.25.1.2 The waterproofing treatment shall be carried out on top of lime concrete (brick bat coba) laid to slope on roof surfaces. The brick bat coba shall be covered as specified below.

7.25.1.3 The work shall be carried out by an experienced specialist Sub-Contractor who shall be appointed only after prior approval of the EMPLOYER.

7.25.2 Modified Bituminous Membrane

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

7.25.3 Waterproofing of Roofs with Lime Concrete

7.25.3.1 Materials

a) Broken brick coarse aggregates prepared from well/over burnt bricks shall be well graded having a maximum size of 25mm and shall generally conform to IS:3068.

b) Lime shall be class C lime (fat lime) or factory made hydrated lime conforming to IS:712.

7.25.3.2 Workmanship

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

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

7.25.3.2.2 The roof surface over which the water-proof treatment is to be carried out shall be cleaned of all foreign matter by wire brushing, dusting and made thoroughly dry. Preparation of surfaces shall be as stipulated in IS:3067.

7.25.3.2.3 The slope of the finished waterproofing treatment shall be not less than 1 in 60 for efficient drainage. This shall be achieved either wholly in the lime concrete layer.

7.25.3.2.4 The average thickness of lime concrete, slope and the finish on top of machine made burnt clay flat terracing tiles conforming to IS:2690 (part I) shall be as specified in the items of work to be prepared by the Contractor. Cement concrete flooring tiles in lieu of clay terracing tiles shall be provided if so specified in the items of work prepared by the Contractor, duly considering the traffic the terrace will be subjected to.

7.25.3.2.5 The minimum compacted thickness of lime concrete layer shall be 75mm and average thickness shall not be less than 100mm. In case, the thickness is more than 100mm, it shall be laid in layers not exceeding 100mm to 125mm.

7.25.3.2.6 Laying of lime concrete shall be commenced from a corner of the roof and proceeded diagonally towards centre and other sides duly considering the slopes specified for effectively draining the rain-water towards the downtake points.

7.25.3.2.6 Lime concrete fillet for a minimum height of 150mm shall be provided all along the junction of the roof surface with the brick masonry wall/parapet/column projections. These shall then be finished on top with provision of clay terracing tiles/cement concrete tiles.

7.25.3.2.7 After the lime concrete is laid it shall be initially rammed with a rammer weighing not more than 2 Kg and the finish brought to the required evenness and slope. Alternatively, bamboo strips may be used for the initial ramming. Further consolidation shall be done using wooden THAPIES with rounded edges. The beating will normally have to be carried on for at least seven days until the THAPI makes no impression on the surface and rebounds readily from it when struck. Special care shall be taken to properly compact the lime concrete at its junction with parapet walls or column projections.

7.25.3.2.8 During compaction by hand-beating, the surface shall be sprinkled liberally with lime water (1 part of lime putty and 3 to 4 parts of water) and a small proportion of sugar solution for obtaining improved water-proofing quality of the lime concrete. On completion of beating, the mortar that comes on the top shall be smoothened with a trowel or float, if necessary, with the addition of sugar solution and lime putty. The sugar solution may be prepared in any one of the following ways as directed by the EMPLOYER.

a) By mixing about 3 Kg of Jaggery and 1.5 Kg of BAEL fruit to 100 litres of water.

b) By mixing about 600 gm of KADUKAI (the dry nuts shall be broken to small pieces and allowed to soak in water), 200 gm of jaggery and 40 litres of water for 10 sq.m of work. This solution shall be brewed for about 12 to 24 hours and the resulting liquor decanted and used for the work.

7.25.3.2.9 The lime concrete after compaction shall be cured for a minimum period of seven days or until it hardens by covering with a thin layer of straw or hessian which shall be kept wet continuously.

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

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

7.25.4 Waterproofing of Roofs/Terraces etc.

(a) Water proofing of Horizontal Surfaces

7.25.4.1 The waterproofing shall be applied as follows:

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

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

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

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

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

7.25.4.7 Top of membrane finally shall be painted with antiglouse reflective paint.

(b) Waterproofing of Vertical Surfaces at Roof Level and Gutters

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

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

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

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

7.25.5 Khurras and Rainwater Down Pipes

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

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

7.25.6 Testing

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

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

7.26 Cement Plastering Work

7.26.1 Materials

7.26.1.1 The proportions of the cement mortar for plastering shall be 1:3 (one part of cement to three parts of sand). Cement and sand shall be mixed thoroughly in dry condition and then just enough water added to obtain a workable consistency. The quality of water and cement shall be as per

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

7.26.2 Workmanship

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

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

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

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

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

7.26.2.5 Plain Faced Ceiling plaster - This plaster shall be applied in a single coat of 6mm thickness. Application of mortar shall be as stipulated in above paragraph.

7.26.2.6 Exterior plain faced plaster - This plaster shall be applied in 2 coats. The first coat or the rendering coat shall be approximately 14mm thick. The rendering coat shall be applied as stipulated above except finishing it to a true and even surface and then lightly roughened by cross scratch lines to provide bond for the finishing coat. The rendering coat shall be cured

for at least two days and then allowed to dry. The second coat or finishing coat shall be 6 mm thick. Before application of the second coat, the rendering coat shall be evenly damped. The second coat shall be applied from top to bottom in one operation without joints and shall be finished leaving an even and uniform surface. The mortar proportions for the coats shall be as specified in the respective item of work. The finished plastering work shall be cured for at least 7 days.

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

7.26.2.8 Exterior Sand Faced Plaster- This plaster shall be applied in 2 coats. The first coat shall be approximately 14mm thick and the second coat shall be 6mm thick. These coats shall be applied as stipulated above. However, only approved quality white sand shall be used for the second coat and for the finishing work. Sand for the finishing work shall be coarse and of even size and shall be dashed against the surface and sponged. The mortar proportions for the first and second coats shall be as specified in the respective items of work.

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

7.26.2.10 In the case of pebble faced finish plaster, pebbles of approved size and quality shall be dashed against the final coat while it is still green to obtain as far as possible a uniform pattern all as directed by the EMPLOYER.

7.26.2.11 Where specified in the Drawings to be prepared by the Contractor prepared by the Contractor, rectangular grooves of the dimensions indicated shall be provided in external plaster by means of timber battens when the plaster is still in green condition. Battens shall be carefully removed after the initial set of plaster and the broken edges and corners made good. All grooves shall be uniform in width and depth and shall be true to the lines and levels as per the Drawings to be prepared by the Contractor prepared by the Contractor.

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

7.26.2.13 For waterproofing plaster, the Contractor shall provide the water-proofing admixture as specified in manufacturers instruction while preparing the cement mortar.

7.26.2.14 For external plaster, the plastering operations shall be commenced from the top floor and carried downwards. For internal plaster, the plastering operations for the walls shall commence at the top and carried downwards. Plastering shall be carried out to the full length of the wall or to natural breaking points like doors/windows etc. Ceiling plaster shall be completed first before commencing wall plastering.

7.26.2.15 Double scaffolding to be used shall be as specified in clause 7.2.2.

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

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

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

b) Steel wire fabric shall be provided at the junction of brick masonry and concrete to overcome reasonably the differential drying shrinkage/thermal movement.

c) Ceiling plaster shall be done, with a trowel cut at its junction with wall plaster. Similarly trowel cut shall be adopted between adjacent surfaces where discontinuity of the background exists.

7.27 Cement Pointing

7.27.1 Materials

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

7.27.2 Workmanship

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

7.27.2.2 Any dust/dirt in the raked joints shall be brushed out clean and the joints shall be washed with water. The joints shall be damp at the time of pointing. Mortar shall be filled into joints and well pressed with special steel trowels. The joints shall not be disturbed after it has once begun to set. The joints of the pointed work shall be neat. The lines shall be regular and

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

7.27.2.3 The work shall be kept moist for at least 7 days after the pointing is completed. Whenever coloured pointing has to be done, the colouring pigment of the colour required shall be added to cement in such proportions as recommended by the manufacturer and as approved by the EMPLOYER.

7.28 Water-Proofing Admixtures

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

7.29 Painting of Concrete, Masonry & Plastered Surfaces

7.29.1 Materials

7.29.1.1 Oil bound distemper shall conform to IS:428. The primer shall be alkali resistant primer of the same manufacture as that of the distemper.

7.29.1.2 Cement paint shall conform to IS:5410. The primer shall be a thinned coat of cement paint.

7.29.1.3 Lead free acid, alkali and chlorine resisting paint shall conform to IS:9862.

7.29.1.4 Colour wash shall be made by addition of a suitable quantity of mineral pigment, not affected by lime, to the prepared white wash to obtain the shade/tint as approved by the EMPLOYER.

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

7.29.2 Workmanship

7.29.2.1 Contractor shall obtain the approval of the EMPLOYER regarding the readiness of the surfaces to receive the specified finish, before commencing the work on painting.

7.29.2.2 Painting of new surfaces shall be deferred as much as possible to allow for thorough drying of the sub- strata.

7.29.2.3 The surfaces to be treated shall be prepared by thoroughly brushing them free from dirt, mortar droppings and any loose foreign materials. Surfaces shall be free from oil, grease and efflorescence. Efflorescence shall be removed only by dry brushing of the growth. Cracks shall be filled with Gypsum. Workmanship of painting shall generally conform to IS:2395.

7.29.2.4 Surfaces of doors, windows etc. shall be protected suitably to prevent paint finishes from splashing on them.

7.29.3 White Wash

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

7.29.4 Colour Wash

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

7.29.5 Cement Paint

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

7.29.6 Oil bound Distemper

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

7.29.7 Acid, Alkali Resisting Paint

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

7.29.8 Plastic Emulsion Paint

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

7.29.9 Acrylic Emulsion Paint

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

7.30 Painting & Polishing of Wood Work

7.30.1 Materials

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

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

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

7.30.2 Workmanship

7.30.2.1 The type of finish to be provided for woodwork of either painting or polishing, the number of coats, etc. shall be as specified in the respective items of work to be prepared by the Contractor.

7.30.2.2 Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

7.30.2.3 Painting shall be either by brushing or spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirements of IS:2338 (Part I).

7.30.2.4 All the wood surfaces to be painted shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it across the grains and dusted off. Wood primer coat shall then be applied uniformly by brushing. The number of primer coats shall be as specified in the item of work to be prepared by the Contractor. Any slight irregularities of the surface shall then be made- up by applying an optimum coat of filler conforming to IS:110 and rubbed down with an abrasive paper for obtaining a smooth surface for the undercoat of synthetic enamel paint conforming to IS:2932. Paint shall be applied by brushing evenly and smoothly by means of crossing and laying off in the direction of the grain of wood. After drying, the coat shall be carefully rubbed down using very fine grade of sand paper and wiped clean before the next coat is applied. At least 24 hours shall elapse between the application of successive coats. Each coat shall vary slightly in shade and this shall be got approved by the EMPLOYER. The number of coats of paint to be applied shall be as specified in the item of work to be prepared by the Contractor.

7.30.2.5 All the wood surfaces to be provided with clear finishes shall be thoroughly dry and free from any foreign matter. Surfaces shall be smoothened with abrasive paper using it in the direction of the grains and dusted off. Any slight irregularities of the surface shall be made up by applying an optimum coat of transparent liquid filler and rubbed down with an abrasive paper for obtaining a smooth surface. All dust and dirt shall be

thoroughly removed. Over this prepared surface, varnish conforming to IS:337 shall be applied by brushing. Varnish should not be retouched once it has begun to set. Staining if required shall be provided as directed by the EMPLOYER. When two coats of varnish is specified, the first coat should be a hard-drying undercoat or flattening varnish which shall be allowed to dry hard before applying the finishing coat. The number of coats to be applied shall be as specified. For works where clear finish of French polish is specified the prepared surfaces of wood shall be applied with the polish using a pad of woolen cloth covered by a fine cloth. The pad shall be moistened with polish and rubbed hard on the surface in a series of overlapping circles to give an even finish over the entire area. The surface shall be allowed to dry before applying the next coat. Finishing shall be carried out using a fresh clean cloth over the pad, slight dampening with methylated spirit and rubbing lightly and quickly in circular motions. The finished surface shall have a uniform texture and high gloss. The number of coats to be applied shall be as specified.

7.31 Painting of Steel Work

7.31.1 Materials

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

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

7.31.2 Workmanship

7.31.2.1 Painting work shall be carried out only on thoroughly dry surfaces. Painting shall be applied either by brushing or by spraying. Contractor shall procure the appropriate quality of paint for this purpose as recommended by the manufacturer. The workmanship shall generally conform to the requirement of IS:1477 (Part 2).

7.31.2.2 The type of paint, number of coats etc. shall be as specified in the respective items of work.

7.31.2.3 Primer and finish paint shall be compatible with each other to avoid cracking and wrinkling. Primer and finish paint shall be from the same manufacturer.

7.31.2.4 All the surfaces shall be thoroughly cleaned of oil, grease, dirt, rust and scale. The methods to be adopted using solvents, wire brushing, power tool cleaning etc., shall be as per IS:1477 (Part – I) and as indicated in the item of work.

7.31.2.5 It is essential to ensure that immediately after preparation of the surfaces, the first coat of red oxide-zinc chrome primer shall be applied by brushing and working it well to ensure a continuous film without holidays. After the first coat becomes hard dry, a second coat of primer shall be applied by brushing to obtain a film free from `holidays`.

7.31.2.6 After the second coat of primer is hard dry, the entire surface shall be wet rubbed cutting down to a smooth uniform surface. When the surface becomes dry, the undercoat of synthetic enamel paint of optimum thickness shall be applied by brushing with minimum of brush marks. The coat shall be allowed to hard-dry. The under coat shall then be wet rubbed cutting down to a smooth finish, taking adequate care to ensure that at no place the undercoat is completely removed. The surface shall then be allowed to dry.

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

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

7.32 Flashing

7.32.1 Materials

7.32.1.1 Anodised Aluminium sheets shall be 1.00mm thick with anodic film thickness of 0.025 mm.

7.32.1.2 Galvanised mild steel sheets shall be 1.00mm thick with zinc coating of 800 gms/sq.m.

7.32.1.3 Bitumen felt shall be either Hessian base self finished bitumen felt Type-3 Grade I conforming to IS:1322 or glass fibre base self finished felt Type-2 Grade 1 conforming to IS:7193.

7.32.2 Workmanship

7.32.2.1 The type of the flashing and method of fixing shall be as specified.

7.32.2.2 Flashing shall be of the correct shape and size as indicated in the construction Drawings to be prepared by the Contractor and they shall be properly fixed to ensure their effectiveness.

7.32.2.3 Flashing shall be of long lengths so as to provide minimum number of joints. The minimum overlap at joints shall be 100mm.

7.32.2.4 Fixing of the flashing shall be either by bolting with bitumen washers or by tucking into the groove 75 mm wide x 65 mm deep in masonry/concrete along with cement mortar 1:4 filletting as indicated in the Drawings to be prepared by the Contractor. Curing of the mortar shall be carried out for a minimum period of 4 days.

7.32.2.5 Bitumen felt flashing of the type as specified shall be provided with 2 coats of bituminous paint at the rate of 0.10 litre/sq.m after the installation.

7.33 Thermal Insulation For Ceiling

Thermal insulation shall be "Thermocole" TF type or similar approved or Resin bonded fibre glass boards.

7.33.1 Fixing

7.33.2 "Thermocole" Boards

7.33.2.1 Soffit of R.C.Slab shall be thoroughly cleaned with wire brush and 85/25 industrial grade hot bitumen conforming to IS:702 shall be applied uniformly over the surface at the rate of

1.5 Kg/m².

7.33.2.2 Thermocole boards (T.F. variety) of 50mm thickness shall be stuck by means of the same grade of hot bitumen.

7.33.2.3 The boards shall be further secured with screws, washers and plugs.

7.33.2.4 The joints of the boards shall be sealed with bitumen.

7.33.3 Fibre Glass Boards

7.33.3.1 Timber pegs 50mm x 50mm x 50mm shall be fixed to the slab at 600mm centres with 6mm x 65mm long wood screws. 20 gauge G.I. lacing wire shall be tied to the pegs.

7.33.3.2 'Crown' 200 fibre glass boards 50mm thick shall be stuck to the pegs with CPRX compound or any other suitable adhesive and be held in position by the 20 gauge G.I. lacing wires.

7.33.3.3 The insulation boards shall be covered with 20mm – 24 gauge hexagonal G.I. chicken wire mesh, nailed to the timber pegs and 30 gauge aluminium sheets shall be fixed over the chicken wire mesh with 50mm overlap and secured to the timer pegs by screws.

7.33.3.4 If the insulation is specified to rest on top of the false ceiling, it shall be properly installed and anchored to the framework. In case additional battens are required for proper installation, Contractor shall include its cost in the rate for insulation.

7.34 Plaster of Paris Board for False Ceiling

7.34.1 Materials

7.34.1.1 Plaster of Paris Boards

a) The plaster of paris boards to be used in the false ceiling shall be of an approved manufacture or manufactured at site by methods and materials approved by EMPLOYER.

b) The plaster of paris shall be of the calcium-sulphate hemi-hydrate variety and shall contain not less than 35 percent sulphur trioxide and other requirements as per IS:2547 (Part I) However, its fineness shall be such that the residue, after drying, and sieving on

I.S. sieve designation 3.35mm for 5 minutes shall not be more than 1 percent by weight. Initial setting time shall not be less than 13 minutes. The average compressive strength of plaster determined by testing 5 cm cubes 24 hours after removal from moulds and drying in an oven at 40 Deg. C till the weight of the cubes is constant, shall not be less than 84 Kg per sq.cm.

c) The plaster of paris boards reinforced with hessian cloth or coir shall be prepared in suitable sizes as shown on the drawings or as directed by EMPLOYER. Wooden forms of height equal to the thickness of boards shall be placed on truly level and smooth surface such as a glass sheet. The edges of the boards shall be truly square. The glass sheet or surface on which form is kept and the form sides shall be given a thin coat of non-staining oil to facilitate the easy removal of the board. Plaster of paris shall be evenly spread into the form upto about half the depth and hessian cloth or coir shall be pressed over the plaster of paris layer. The weight of hessian cloth or coir in the board shall be 250 gm per sq.m. The ends of the hessian/coir reinforcement shall be turned over at all edges to form a double layer for a width of 50mm. The hessian cloth shall be of an open web texture so as to allow the plaster below and above to intermix with each other and form an integral board. The form shall then be filled with plaster of paris which shall be uniform pressed and then wire cut to an even and smooth surface. The board shall then be allowed to set initially for an hour or so and then removed from the form and allowed to dry and harden for about a week. The board after drying and hardening shall give a ringing sound when struck. The boards shall be true and exact to shape and size and the exposed face shall be truly plane and smooth.

d) The size of boards shall generally be 600mm x 600 mm x 12 mm thick. Boards shall be kept dry in transit and stored flat in a clean dry place and

shall not be exposed to moisture. The boards shall always be carried on edges.

7.34.2 Timber Frame Work

7.34.2.1 Timber for frame work of false ceiling grid and hangers shall be of good quality and well seasoned. It shall have uniform colour, reasonably straight and close grains and shall be free from knots, cracks and sapwood. It shall be treated with approved anti-termite preservative as directed by the EMPLOYER. Extreme care shall be taken so that the preservative treatment does not stain the ceiling boards. In case metal hangers are used, these shall be M.S. flats or bars, having two coats of red oxide zinc chromate paint primer, as shown on drawings or as approved by EMPLOYER.

7.34.3 Metal Frame Work

7.34.3.1 The metal frame work may be made of sections of light metal, such as anodised aluminium, mild steel or as shown on the drawings. The shape of cross-section shall be such as to

facilitate proper suspension and proper fixing of the ceiling boards covering them and shall be structurally sound and rigid.

7.35 Construction

a) Contractor shall ensure that the frame to support the ceiling is designed for structural strength and the sizes, weight and strength of ceiling boards to be fixed and other loads due to live load, air-conditioning ducts, grills, electrical wiring and lighting fixtures, thermal insulation, etc. as shown on the drawings. Contractor shall also submit a detailed drawing to show the grid work, sizes of grid members, method of suspension, position of openings for air-conditioning and lighting, access doors, etc.

b) Structural design of timber member for the frame shall be in accordance with IS : 883, and metal sections shall be of appropriate size and thickness and shall be of approved manufacture, all as approved by EMPLOYER.

c) The false ceiling grid work shall be carried out as per the approved drawings or as directed by EMPLOYER. In case of timber grid work, the grid work shall consist of teak wood runners of minimum size 60mm deep x 40mm wide along one direction at

1.2m centre to centre and secondary runners of size 50mm deep x 40 mm wide at 60mm centre to centre perpendicular to the main runners.

d) The timber grid work shall be suspended with the help of wooden hangers or metal hangers at 1.2m centre to centre in both the directions. Wooden hangers shall be adopted for flat R.C. roof slab structures whereas metal hangers for flat R.C. roof or structural steel floors / tresses. Metal

hangers shall be fabricated from mild steel / galvanised flats of 35mm x 6mm size or bars of 10mm dia. Threaded at the lower end and anchored securely in the roof concrete or welded to inserts provided on the underside of slabs, beams etc. All M.S. hangers shall be given two coats of red oxide zinc chromate paint primer. In case the roof work is of A.C. sheeting supported on purlins and trusses, hangers shall be suspended from roof steel work. The arrangement of metal hangers shall be such that the level of false ceiling can be adjusted during fixing of the ceiling frame work. The ceiling frame work shall be secured to hangers by means of washers and nuts. The ends of main runners shall preferably be embedded into the masonry work.

e) The metal frame work when it is anodised aluminium false ceiling grid system shall consist of aluminium main member of special T-Profile of 38mm x 38mm x 1.5mm thick, interlocking with each other to form frames of various sizes, 600mm x 600 mm or as shown on the drawing. The main members shall be suspended from the roof structures by means of steel hangers as described for timber frame work and supported at the walls by means of anodised aluminium wall angles.

f) In the case of timber frame work, all the edges of the plaster of paris board shall be fixed to frame members by means of counter sunk and rust less screws of 2.74 mm size, 40mm long at a spacing of 100mm to 150 mm c/c and 12mm from the edge of the board. Holes for screws shall be drilled and screws slightly countersunk into the boards. The boards shall be fixed to wooden framework with a joint clearance of about 3mm. The joints shall always be in perfect line and plane.

g) In case of aluminium grid system, boards shall be just placed into the frames formed by the main 'T' members and the cross members fitted with the clips for locking boards. Contractor shall take utmost care so as not to force the boards in position and a slight gap shall be provided so as not to make a tight joint. The boards shall be cut with a saw, if required, to any shape and size.

h) As the work of false ceiling may be inter-connected with the work of air-conditioning ducts and lighting, Contractor shall fully co-operate with the other agencies entrusted with the above work, who may be working simultaneously . Contractor shall provide necessary openings in the false ceiling work for air-conditioning, lighting and other fixtures. Additional framing, if required, for the above opening shall also be provided at no extra cost to Employer. Removable or hinged type inspection or access trap doors shall be provided at locations specified by EMPLOYER.

7.35.1 Finishing

7.35.1.1 It is essential that false ceiling work should be firm and in perfect line and level and all boards free from distortion, bulge, and other defects. All defective boards and other material shall be removed from site immediately and replaced, and ceiling restored to original finish to the satisfaction of EMPLOYER.

7.35.1.2 The workmanship shall be of highest order and all joinery work for timber work shall be in the best workmanship manner. The joints for

aluminium frame work shall be of inter- locking type so that when the cross member is in place, it cannot be lifted out.

7.35.1.3 The countersunk heads of screws and all joints shall be filled with plaster of paris and finished smooth. After filling the joints, a thick skin of the finishing material shall be spread about 50mm wide on either side of the joint and on to it shall be trowelled dry a reinforcing scrim cloth about 10mm wide. If metal scrim is used, a stiffer plaster will be necessary to enable the trowelling of the scrim down to the board.

7.35.2 Fire Stopping

7.35.2.1 In case of fire protective ceilings, fire resisting barriers at suitable intervals shall be provided. These shall completely close the gap between the false ceiling and soffit of the structural slab. The material of the barrier shall be as indicated by EMPLOYER (Reference may be made to the British Standards Institutions CP 290: Code of Practice for suspended ceiling and lining of dry construction using metal fixing system, ` for guidance).

7.36 False or Cavity Floor

7.36.1 Frame Work

7.36.1.1 The false floor shall consist of a framework of suitable structural member designed to carry the loads specified. This frame work shall be supported on suitably designed stools placed at 600mm centre to centre in both directions. The stools shall consist of a mild steel base plate with a mild steel stud having adjustable lock nut and coupling at the centre and another mild steel plate at top serving as a prophead. The above framework shall be suitably designed to accommodate 35mm thick, 600mm square panels. The base plate shall be fixed to the reinforced concrete floor with an approved adhesive compound or with 4 Nos. 6mm dia. anchor fasteners. Bedding of 1:2 or richer cement sand mortar shall be provided locally under the base plates of stools to provide a level surface.

7.36.1.2 The prophead shall be provided with mild steel lugs welded on top and each placed perpendicular to the other for proper positioning and supporting the main and cross members. The stools shall be capable of adjustment to accommodate concrete floor level irregularities upto plus or minus 15mm. The framing members shall be completely removable and shall remain in position without screwing or bolting to the propheads. All steel framework including steel stools shall be given a coat of zinc chromate primer and two coats of enamel paint of approved colour and shade.

7.36.2 Floor Panels

7.36.2.1 The floor panels shall be made of 600mm x 600mm x 35 mm thick medium density unveneered/ non-prelaminated teak wood particle boards having a density of not more than 800 kg/cu.m bonded with boiling

water proof phenol formaldehyde synthetic resin and shall be of fire resistant, termite resistant and moisture proof quality, generally conforming to IS:3087-specification for wood particle boards (Medium Density)for general purposes.

7.36.2.2 The thermal conductivity of the boards shall not exceed 0.12 kCal/hr/sq.m/deg./C/m.

7.36.2.3 The panel size given above may be suitably modified near electrical panel/equipment and also to suit room dimensions with panel size not more than 600mm under any circumstances. Exposed 2mm thick vinyl edging shall be provided on all edges of individual panels. Each panel shall be given a coat or primer and two coats of approved fire resistant paint from underside.

7.36.2.4 The particle boards shall be faced with 600mm x 600 mm x 2mm thick approved make flooring tiles conforming to IS:3462 – “Specification for unbacked flexible PVC flooring” and of approved colour and shade. The completed panel shall be completely removable and shall remain in position without screwing or bolting to the on the inner side with stickers for easy identification and reassembly whenever required.

7.36.2.5 Suitable backing material shall be provided on the underside of the particle board to prevent warping and / or to cater to specified loading.

7.36.2.6 Suitable removable covers shall be provided to serve as outlets for the cables.

7.36.3 Imposed Loading

7.36.3.1 The finished floor shall be capable of supporting a uniformly distributed load of 500 to 1000 Kg. per sq.metre of floor area as specified in data sheet. A point load of 450 Kg on 600 sq.mm on any part of the panel or a line load of 725 Kg on 100mm strip across the panel length shall not result in a deflection greater than 2.5mm.

7.36.4 Finish

7.36.4.1 The finished floor shall be true to lines and levels and present a neat flush surface.

7.36.5 Vendor Drawing

7.36.5.1 Vendor shall prepare and submit a layout drawing for false floor giving all details including supporting system for approval. If so called for, vendor shall also submit his calculations for the supporting system with all relevant data assumed, to the EMPLOYER for his approval. Work shall be carried out on approved drawings only.

7.37 Fire Proof Doors

7.37.1 Material and Workmanship

7.37.1.1 The design of fire proof doors and the materials to be used in their fabrication have to be such that they shall be capable of providing the effective barrier to the spread of fire. The materials, fabrication and erection of fire proof doors shall confirm to IS:3614 (Part – I). The fire proof doors shall be obtained from an approved manufacturer. Specific approval for such purchase shall be obtained before hand. Sample approval shall also be obtained from testing authority as per the standard IS : 3614 (Part – 2) for the specified degree of fire rating in hours. All fire proof doors shall have specified sizes and confirm to the description in the respective items of work.

7.37.1.2 Fire proof door shutters shall be of zinc coated weldable steel (confirming to BS:6687) or stainless steel (conforming to IS:304) sheet (18G minimum) fixed in a frame work of rolled channel. The shutter shall consist of an insulating material like mineral wool in required thickness to satisfy the specified fire rating. Normally the thickness of door shutter shall not be less than 35mm for two hour fire rating and 46 mm for four hour fire rating.

7.37.1.3 The shutter with the required insulating material shall be mounted on angle iron frame or the special made frame from zinc coated (16G minimum) weldable steel sheet. The shutter shall be fixed to frame by means of suitable hinges and shall have a three way latching system. All the doors shall be provided with a coat of primer and one coat of synthetic enamel paint to attain the specified fire rating. All other accessories like hinges, door lock, hold fasts, etc. shall be provided as approved by TAC (Tariff Advisory Committee). All these accessories shall be compatible with the material used for door and shutter.

Item No.36, 106:

Providing and casting in situ C.C. in grade M-15 (approx. corresp. To prop. 1:2:4) (proportions as per mix design or as per Table 9 of IS456 2000 in masses by weigh batching) using granite, quartzite trap metal of size 6 mm to 20 mm for RCC work, including scaffolding centering, form work, needle vibrated consolidation, curing comp. up to 6 meter depth or height (excluding cost of reinforcement and neat finishing) with centering and shuttering / deshuttering etc. comp for structure for other than water retaining. (with form work)

Thrust Block

Anchorage in the form of a thrust block at each deflection in the horizontal and/or in vertical alignment of the pipeline shall be provided as per the design requirements to resist any unbalanced pressure at the bends. Gravity type thrust blocks shall be provided at horizontal and vertical deflections in the pipeline, which shall be designed according to the test pressure and the soil conditions at the site of the thrust block. Before designing the thrust blocks the Contractor shall assess the stability of the soil considering erosion due to wind and water. The general guidelines to be followed for providing and designing of thrust blocks shall be as under:

The thrust blocks may not be required for bend angles up to 5%. However, necessary calculations shall be submitted by the Contractor for approval by Employer to establish that the thrust shall be taken care by pipe itself and that it is safe not to have the thrust block.

The thrust shall be designed according to the field test pressure of the pipe.

For above ground pipelines, thrust blocks shall be designed to take 100% thrust.

For buried pipelines, thrust blocks on continuous pipe line sections shall be designed considering 50% thrust to be taken by block and balance by pipe as per CPHEEO manual.

For buried pipelines, thrust blocks near valve chambers and/or any other dismantling joints shall be designed to take 100% thrust.

In rock the passive pressure of rock shall be considered for thrust block design

The thrust blocks shall be of concrete M20, cast in-situ, with minimum surface reinforcement of 5 kg/m². No formwork is required to be used for construction of thrust blocks in buried conditions, unless desired by the Contractor. The calculations for the dimensioning and the shape of the thrust blocks shall be approved by the Employer.

Anchor blocks shall also be located wherever there is a transition between above ground and buried pipelines. All such anchor blocks shall have flexible joints at either end to allow for small amounts of settlement to occur.

The Contractor shall construct the thrust blocks as early in the program of work as is practical, and at least six months prior to installation of the above

ground pipeline in order to reduce the risk of settlement imposing additional loads on the pipeline supports. All thrust blocks are to be completed on each section before the sectional hydraulic testing is conducted.

Where possible, the base of the thrust block shall be cast against solid rock in order to prevent any settlement. Any material overlying the rock shall be excavated and replaced with class M15 mass concrete. In the event of no rock being encountered, the base of the thrust block shall be cast against undisturbed ground. Any ground, which in the Employer opinion is unsuitable, shall be excavated and replaced with class M15 mass concrete.

1.0 Materials:

Water shall conform to M-1, cement shall conform to M-2, Sand shall conform to M-4, Grit shall conform to M-8. Graded stone aggregate 20 mm, nominal size shall conform to M-12.

2.0 General:

- 2.1 The concrete mix is not required to be designed by preliminary tests. The proportion of concrete mix shall be 1:1:2 (1 Cement: 1 coarse sand: 2 graded stone aggregate) 20 mm nominal size) by volume. Concrete work shall have exposed concrete surface or as specified in the item.
- 2.2 The designation ordinary M-100, M-150, M-200, M-250 specified as per IS correspond approximately to 1:3:6, 1:2:4, 1:1 1/2:3 and 1:1:2 nominal mix of ordinary concrete by volume respectively.
- 2.3 The ingredients required for ordinary concrete containing one bag of cement of 50 Kg by weight (0.0342 Cu.M) for different proportions of mix shall be as under:

Grade of concrete	Total quantity of dry aggregate by volume per 50 kgs of cement to be taken as the sum of individual volume of fine and coarse aggregates, max.	Proportion of fine aggregate to coarse aggregate	Quantity of water per 50 Kgs of cement maximum
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M-100 (1:3:6)	300 Litres	Generally 1.2 for fine aggregate to coarse aggregate by volume but subject to an upper limit of 1:1 1/2 and lower limit 1:3	34 Litres
M-150 (1:2:4)	220 Litres		32 Litres
M-200 (1:1 1/2:3)	160 Litres		30 Litres
M-250 (1:1:2)	100 Litres		27 Litres

- 2.4 The water cement ratio shall not be more than specified in the above table. The cement concrete of the mix specified in the Table shall be increased if the quantity of water in mix has to be increased to

overcome the difficulties of placements and compaction so that water cement ratio specified on the table is not exceeded.

- 2.5 Workability of the concrete shall be controlled by maintaining a water cement ratio that is found to give a concrete mix which is just sufficient wet to be placed and compacted without difficulty with the means available.
- 2.6 The maximum size of coarse aggregate shall be as large as possible within the limits specified but in no case greater than one fourth of minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and to fill the corners of the form.
- 2.7. For reinforced concrete work, coarse aggregates having a nominal size of 20 mm, are generally considered satisfactory.
- 2.8 For heavily reinforced concrete members as in the case of ribs main beams, the nominal maximum size of coarse aggregate should usually be restricted to 5 mm, less than the minimum the distance between the main bars, or 5 mm less than the minimum cover to the reinform or whichever is smaller.
- 2.9 Where the reinforcement is widely spaced as in solid slabs, limitations of size of the aggregate may not be so important, and the nominal maximum size may sometimes be as greater as or greater than the minimum cover.
- 2.10 Admixture may be used in concrete only with approval of engineer-in-charge based upon the evidence that with the passage of time, neither the compressive strength of concrete is reduced nor are other requisite qualities of concrete and steel impaired by the use of such admixtures.

3.0

Workmanship:

3.1

Proportioning:

Proportioning shall be done by volume, except cement which shall be measured in terms of bags of 50 kg. weight the volume of one such bag being taken as 0.0342 cu.metre. Boxes of suitable size shall be used for measuring sand aggregate. the size of boxes (internal) shall be 35 x 25 cms, and 40 cms deep while measuring the aggregate and sand the boxes shall be filled without shaking ramming or hammering. The proportioning of sand shall be on the basis of its dry volume and in case of damp sand, allowances for bulkage shall be made.

3.2

Mixing:

- 3.2.1 For all work, concrete shall be mixed in a mechanical mixer which along with other accessories shall be kept in first class working condition and so maintained throughout the construction. Measured quantity of aggregate, sand and cement required for each batch shall be poured into the drum of the mechanical mixer while it is continuously running. After about half a minute of dry mixing measured quantity of water required for each batch of concrete mix shall be added gradually and mixing continued for another one and a half minute. Mixing shall be

continued till materials are uniformly distributed and uniform color of the entire mass is obtained and each individual particle of the coarse aggregate shows complete coating of mortar containing its proportionate amount of cement. In no case shall the mixing be done for less than 2 minutes after all ingredients have been put into the mixer.

3.2.2 When hand mixing is permitted by the engineer-in-charge for small jobs or for certain other reasons, it shall be done on the smooth water tight platform large enough to allow efficient turning over the ingredients of concrete before and after adding water. Mixing platform shall be so arranged that no foreign material gets mixed with concrete nor does the mixing water flow out. Cement in required number of bags shall be placed in a uniform layer on top of the measured quantity of fine and coarse aggregate, which shall also be spread in a layer of uniform thickness on the mixing platform. Dry coarse and fine aggregate and cement shall then be mixed thoroughly by turning over to get a mixture to uniform color. Specified quantity of water shall then be added gradually through a rose can and the mass turned over till a mix of required consistency is obtained. In hand mixing quantity of cement shall be increased by 10 percent above that specified.

3.2.3 Mixers which have been out of use for more than 30 minutes shall be thorough cleaned before putting in a new batch. Unless otherwise agreed to by the engineer-in-charge the first batch of concrete from the mixture shall contain only two thirds of normal quantity of coarse aggregate. Mixing plant shall be thoroughly cleaned before changing from one type of cement to another.

3.3 Consistency:

3.3.1 The degree of consistency which shall depend upon the nature of the work and the methods of vibration of concrete, shall be determined by regular slump tests in accordance with IS 1199 - Latest edition. The slump of 10 mm to 25 mm shall be adopted when vibrators are used and 80 mm when vibrators are not used.

3.4 Inspection:

3.4.1 Contractor shall give the engineer-in-charge due notice before placing any concrete in the forms to permit him to inspect and accept the false work and forms as to their strength, alignment, and general fineness but such inspection shall not relieve the contractor of his responsibility for the safety of men, machinery, materials and for results obtained. Immediately before concreting, all forms shall be thoroughly cleaned.

3.4.2 Centering design and its erection shall be got approved from the engineer-in-charge. One carpenter with helper shall invariably kept present throughout the period of concreting. Movement of labor and other persons shall be totally prohibited for reinforcement laid in position. For access to different parts suitable mobile platforms shall be provided so that steel reinforcement in position is not disturbed. For ensuring proper cover, mortar blocks of suitable size shall be cast and tied to the reinforcement. Timber, kapachi or metal pieces shall not be used for this purpose.

3.5. Transporting and Laying:

- 3.5.1 The method of transporting and placing concrete shall be as approved. Concrete shall be so transported and placed that no contamination, segregation or loss of its constituent material takes place. All form work shall be cleaned and made free from standing water dust, snow or ice immediately before placing of concrete. No concrete shall be placed in any part of the structure until the approval of the engineer-in-charge has been obtained.
- 3.5.2 Concreting shall proceed continuously over the area between construction joints. Fresh concrete shall not be placed against concrete which has been in position for more than 30 minutes unless a proper contraction joint is formed. Concrete shall be compacted in its final position within 30 minutes of its discharge from the mixer. Except where otherwise agreed to by the engineer-in-charge concrete shall be deposited in horizontal layers to a compacted depth of not more than 0.45 meter when internal vibrators are used and not exceeding 0.30 meter in all other cases.
- 3.5.3 Unless otherwise agreed to by the engineer-in-charge, concrete shall not be dropped in to place from a height exceeding 2 meters. When trunking or chutes are used they shall be kept close and used in such a way as to avoid segregation. When concreting has to be resumed on a surface which has hardened it shall be roughened swept clean, thoroughly wetted and covered with a 13 mm thick layer of mortar composed of cement and sand in the same ratio as in the concrete mix itself. This 13 mm layer of mortar shall be freshly mixed and placed immediately before placing of new concrete. Where concrete has not fully hardened all laitance shall be removed by scrubbing the wet surface with wire of bristle brushes care being taken to avoid dislodgement of any particles of coarse aggregate. The surface shall then be thoroughly wetted all free water removed and then coated with neat cement grout the first layer of concrete to be placed on this surface shall not exceed 150 mm in thickness and shall be well rammed against old work particular attention being given to corners and close spots.
- 3.5.4 All concrete shall be compacted to produce a dense homogenous mass with the assistance of vibrators unless otherwise permitted by the engineer-in-charge for exceptional cases such as concreting under water where vibrators cannot be used. Sufficient vibrators in serviceable condition shall be kept at site so that spare equipment is always available in the event of breakdowns. Concrete shall be judged to be compacted when the mortar fills the spaces between the coarse aggregate and begins to cream up to form an even surface mixture. During compaction, it shall be observed that needle vibrators are not applied on reinforcement which is likely to destroy the bond between concrete and reinforcement.

3.6 Curing:

Immediately after compaction, concrete shall be protected from weather including rain running water shocks vibration traffic rapid temperature changes frost and drying out process. It shall be covered with wet sacking hessian or other similar absorbent material approved soon after the initial set and shall be kept continuously wet for a period of not

less than 14 days from the date of placement. Masonary work over foundation concrete may be started after 48 hours of its laying but curing of concrete shall be continued for a minimum period of 14 days.

3.7 Sampling and testing of concrete:

- 3.7.1. Samples from fresh concrete shall be taken as per IS 1199 - Latest edition, and cubes shall be made cured and tested at 7 days of 28 days as per requirements in accordance with IS 516 - Latest edition. A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested i.e. the sampling should be spread over the entire period of concreting and cover all mixing units. The minimum frequency of sampling of concrete of each grade shall be in accordance with following:

Quantity of concrete in the Work	No. of samples	Quantity of concrete in the work.	No. of samples
1-5 cmt	1	16-30 cmt	3
6-15 cmt	2	31-50 cmt	4
51 and above		4 ± one additional for each additional 50 m or part thereof	

NOTE:- At least one sample shall be taken from each shift. Ten test specimens shall be made from each sample five for testing at 7 days and the remaining five at 28 days. The samples of concrete shall be taken on each days of the concreting as per above frequency. The number of specimens may be suitably increased as deemed necessary by the engineer-in-charge when procedure of tests given above reveals a poor quality of concrete and in other special cases.

- 3.7.2. The average strength of the group of cubes cast for each day shall not be less than the specified cube strength of 150 Kg/Cm² at 28 days. 20% of the cubes cast for each day may have value less than the specified strength. Such concrete shall be classified as belonging to the appropriate lower grade. Concrete made in accordance with the proportion given for a particular grade shall not, however, be placed in a higher grade on the ground that the test strength are higher than the minimum specified.

3.8 Stripping:

- 3.8.1. The engineer-in-charge shall be informed in advance by the contractor of his intention to strike the form work. While fixing the time for removal of form, due consideration shall be given to local conditions, character of the structure, the weather and other conditions that influence the setting of concrete and of the materials used in the mix. In normal circumstances (generally where temperatures are above 20°C) and where ordinary concrete is used, forms may be struck after expiry of periods specified below for respective item of work.

Stripping Time:

In normal circumstances and where ordinary cement is used forms may be struck after expiry of following periods:

- a) Side of walls, columns and vertical faces of beams - 24 to 48 hours.
- b) Beam soffits (props left under) - 7 days
- c) Removal of props slabs:
 - i) Slabs spanning upto 4.5 m - 7 days
 - ii) Spanning over 4.5 m - 14 days
- d) Removal of props for beams and arches
 - i) Spanning upto 6 m - 14 days
 - ii) Spanning over 6 m - 21 days

3.8.2. All form work shall be removed without causing any shock or vibration as would damage the concrete. Before the soffit and struts and struts are removed, the concrete surface shall be gradually exposed, where necessary in order to ascertain that concrete has sufficiently hardened. Centering shall be gradually and uniformly lowered in such a manner as to permit the concrete to take stresses due to its own weight uniformly and gradually. Where internal metal ties are permitted, they or their removable parts shall be extracted without causing any damage to the concrete and remaining holes filled with mortar. No permanently embedded metal part shall have less 25 mm cover to the finished concrete surface. Where it is intended to re-use the form work, it shall be cleaned and made good to the satisfaction of the engineer-in-charge. After removal of work and shuttering, the City Engineer shall inspect the work and satisfy by random checks that concrete produced is of good quality.

3.8.3. Immediately after the removal of forms, all exposed bolts etc. passing through the cement concrete member and used for shuttering or any other purpose shall be cut inside the cement concrete member to a depth of at least 25 mm below the surface of the concrete and the resulting holes be filled by cement mortar. All fins caused by form joints, all cavities produced by the removal of form ties and all other holes and depressions, honeycomb spots, broken edges or corners and other defects, shall be thoroughly cleaned, saturated with water and carefully pointed and rendered true with mortar of cement and fine aggregate mixed in proportions used in the grade of concrete that is being finished and of as dry consistency as is possible to use. Considerable pressure shall be applied in filling and pointing to ensure thorough filling in all voids. Surfaces which are pointed shall be kept moist for a period of 24 hours. If pockets / honeycombs in the opinion of the engineer-in-charge are of such an extent or character as to affect the strength of the structure materially or to endanger the life of the steel reinforcement, he may declare the concrete defective and require the removal and replacement of the portions of structure affected.

(a) the bars shall be kept in position by the following methods :

- (i) In case of beam and slab construction, sufficient number of precast cover blocks in cement mortar 1 : 2 (1 cement : 2 coarse sand) about 4 x 4 cms. section and of thickness equal to the specified cover shall be placed between the bars and shuttering as to secure and maintain the requisite cover of concrete over the reinforcement. In case of cantilevered or doubly reinforced beams or slabs, the main reinforcing

bars shall be held in position by introducing chain spacers or supports bars at 1.0. to 1.2 metres centers.

- (ii) In case of columns and walls, the vertical bars shall be kept in position by means of timber templates slots accurately cut in them, the templates shall be removed after concreting has been done below it. The bars shall also suitably be tied by means of annealed steel wires to the shuttering to maintain position during concreting.

- 1.2. All bars, projecting from pillars, Columns beams, slabs etc, to which other bars and concrete are to be attached or bounded to later on, shall be protected with a coat of thin neat cement grout, if the bars are not likely to be incorporated with succeeding mass of concrete within the following 10 days, This coat of thin neat cement shall be removed before concreting.

4.0. Mode of measurements & payment.

- 4.1. The consolidated cubical contents of concrete, work as specified in item shall be measured. The concrete laid in excess of sections shown on drawing or as directed shall not be measured. No deduction shall be made for (a) Ends of dissimilar materials such as joints, beams, posts, girders, rafters, purline trusses, corbels and steps etc. upto 500 sq.cm. in section, (b) Opening upto 0.1 Sq. M.
- 4.2. The rate includes cost of all materials labour, tools and plant required for mixing, placing in position, vibrating and compacting, finishing, as directed. curing and all other incidental expenses for producing concrete of specified strength. The rate excludes the cost of form work.
- 4.3 The rate shall be for a unit of one cubic meter.

Item 107:

Water Bound Macadam (Providing, laying, spreading and compacting stone aggregates of specific sizes to water bound macadam specification including spreading in uniform thickness, hand packing, rolling with vibratory roller 8-10 tonnes in stages to proper grade and camber, applying and brooming requisite type of screening/ binding Materials to fill up the interstices of coarse aggregate, watering and compacting to the required density.) The grading of metal should be in uniform layers with the size between 40 to 63 mm. using screening type A, 13.20 mm size aggregate and 7% stone dust as filler including spreading watering and consolidation by vibratory roller etc complete.

The contractor shall furnish, lay, spread and compact Water Bound Macadam (WBM) comprising clean, crushed stone aggregates of size 40–63 mm, mechanically interlocked by hand-packing and compacted in layers using an approved 8–10 tonne vibratory roller. Aggregates shall be hard, durable, cubical, free from clay and deleterious substances, and shall conform to the IRC grading for WBM base layers (e.g., passing 100% at 63 mm, 90–100% at 53 mm, 25–75% at 45 mm, and 0–10% at 22.4 mm sieve). Screenings of Type A (nominal 13.2 mm) shall be uniformly spread and broomed to fill interstices; their gradation shall comply with IRC “Table 3” limits (e.g., 100% through 13.2 mm, 95–100% through 11.2 mm, 1–10% through 5.6 mm and 0–10% through 80 μ m)

A filler binder comprising mineral dust (stone dust, kankar, or limestone dust), passing the 75 μ m sieve, shall be added at approximately 7% by weight of coarse aggregate or at rates of 0.06–0.09 m³ per 10 m² for each 75 mm compacted thickness, to prevent raveling; such material shall have a Plasticity Index below 6 as per IS:2720 (Part 5). Clean water suitable for construction shall be applied during screeding and compaction to ensure a tight, dense matrix.

All aggregates, screenings, and binders shall be tested in accordance with Indian Standards: sieve analysis (IS 2386 Part I), specific gravity and water absorption (IS 2386 Part III), Los Angeles abrasion and aggregate impact values (IS 2386 Part IV) – with permissible maximum values of 40% LA abrasion and 30–40% aggregate impact for surface/base layers. Flakiness index for crushed stone used in base and surfacing layers shall not exceed 15%

Execution shall proceed on a thoroughly prepared subgrade or existing pavement that has been trimmed, cleaned, proof-rolled, and deemed firm. The 40–63 mm aggregate shall be laid in uniform loose layers (thickness per design), hand-packed, lightly watered, and compacted using vibratory rolling in longitudinal and transverse passes until achieving a minimum 95% of Modified Proctor’s maximum dry density. The 13.2 mm screenings and 7% stone dust shall then be spread, brushed in, lightly water-sprayed, and compacted further until the voids are completely filled and the surface is dense and even.

The completed WBM layer thickness (compacted) shall be within ± 6 mm of the design thickness (typically 75 mm); it shall exhibit proper grade, camber, and a smooth finish free from undulations. In-situ density tests (sand replacement or nuclear density gauge) shall be performed to verify compaction, with records of layer-by-layer moisture, roller passes, and density results maintained. Curing shall be achieved by periodic moistening for a minimum of three days post-compaction. Any sections failing to meet grading,

density, or surface tolerances shall be ripped, re-laid, re-compacted, and re-tested as directed.

Payment shall be measured in cubic meters of compacted WBM including materials, labor, equipment, testing, and curing. This specification references IRC WBM code (IRC 19-2005, MORTH Section 400) and relevant BIS and IRC standards.

Item 108:**Providing and casting in situ controlled cement concrete M-200 for R.C.C. solid slab including centering, scaffolding, curing and finishing complete**

The contractor shall **provide and cast in situ-controlled cement concrete of grade M-200** (minimum characteristic cube strength 20 MPa at 28 days), using Portland cement conforming to IS:8112 or IS:12269, combined with clean, well-graded coarse aggregate (maximum 20 mm size) conforming to IS:383, and fine aggregate (zone II or washed sand). The mix proportions shall be based on a laboratory-approved mix design targeting the required strength, slump (designated for

ease of placement), and durability. Batching, mixing, and transportation shall be done in a mechanical mixer or approved ready-mix plant, ensuring homogeneous mixing and minimal segregation. Concrete shall be placed in one continuous operation into accurately set, rigid centering and shuttering of required levels and alignment, and compacted thoroughly using internal or surface vibrators to achieve a dense, void-free finish. The top surface shall be finished smooth and even, with either a steel-trowelled or broomed non-slip texture, as specified in the drawings.

Following finishing, the concrete surface shall be cured immediately by continuous wet curing (e.g., water spraying, covering with wet hessian), or an approved curing compound, for a minimum of **seven days** to ensure adequate hydration and strength gain. The completed slab thickness (typically 150–200 mm as per design) shall be uniform and within ± 5 mm of specified levels, camber, and cross-fall. Tolerances for surface undulation shall comply with IRC or MORTH standards. Any honeycombing, segregation, surface defects, or areas failing to meet strength or finish requirements shall be rectified or replaced at contractor's cost. All work shall

include excavation or preparation of the subgrade/sub-base, use of cover blocks for reinforcement placement, dewatering if required, and integration of reinforcement or dowel bars as per structural drawings. Rates shall include all materials, labor, equipment, formwork, compaction, finishing, curing, testing, and disposal of surplus material, excluding reinforcement steel unless specified. Mix design certification, trial mix test reports, slump records, and cube strength test results shall be submitted for engineer's approval prior to commencement of bulk work.

GENERAL

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

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

MATERIALS

Cement

Unless otherwise specified or called for by the Engineer, cement shall be Ordinary Portland cement (latest edition)/SRC for entire work.

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

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

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

Aggregates (General)

General

"Aggregate" in general designates both fine and coarse inert materials used in the manufacture of concrete (vide BIS 456 & BIS 383) and conforming to tests as per BIS 2386 (Part I to VI).

"Coarse Aggregate" is aggregate most of which is retained when passed through on 4.75 mm BIS sieve.

All fine and coarse aggregates proposed for use in the works shall be subject to the Engineer-in-Charge's approval and after specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer-in-charge.

Aggregates shall consist of crushed stone from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, non-flaky, strong, hard, durable against weathering, or limited porosity and free from deleterious materials that may cause corrosion of the reinforcement or may impair the strength and or durability of concrete. The grading of aggregates shall be such as to produce a dense concrete of specified strength and consistency that will work readily into position without segregation and shall be based on the "mix design" and preliminary tests on concrete specified later. The aggregates shall be brought from the source as mentioned in Volume-I Clause C.1.39.

Sampling and testing

Samples of the aggregates for mixed design and determination of suitability shall be taken under the supervision of the Engineer-in-charge and delivered to the laboratory, well in advance of the scheduled placing of concrete. Records of tests, which have been made on proposed aggregates and on concrete made from this source of aggregates shall be furnished to Engineer-in-charge in advance of the work, for use in determining aggregate suitability. The costs of all such tests, sampling etc. shall be borne by the contractor.

Storage of aggregates

All coarse and fine aggregates shall be stacked separately in stock piles in the material yard near the work site in bins properly constructed to avoid inter mixing of different aggregates. Contamination with foreign material and earth during storage and while heaping the materials shall be avoided. The aggregates must be of specified quality not only at the time of receiving at site but more so at the time of loading into mixer. Rakers shall be piled in layers not exceeding 1.20 m in height to prevent coning or segregation. Each layer shall cover the entire area of stock pile before succeeding layers are started. Aggregates that have become segregated shall be rejected.

Specific Gravity

Aggregates having a specific gravity below 2.4 (saturated surface dry basis) shall not be use

Fine Aggregate

Fine aggregate shall consist of natural or crushed sand conforming to IS 383 conforming to tests as per IS 2386 part I to IV. The sand shall be clean, sharp, hard, strong and durable and shall be free from dust, vegetable substances, adherent coating, clay, alkali, organic matter, mica, salt or other deleterious substances, which can be injurious to the setting qualities / strength/ durability of concrete.

Screening and Washing : Sand shall be prepared for use by such screening or washing, or both, as necessary, to remove all objectionable foreign matter while separating the sand grains to the required size fraction.

Foreign Material limitations : The percentage deleterious substances in sand delivered to the mixer shall not exceeding the following :

Sr. No.	Foreign Material	Percentage by weight	
		Uncrushed	Crushed
1	Material finer than 75 micron IS sieve	3.0	15.0
2	Shale	1.0	-
3	Coal and Lignite	1.0	1.0
4	Clay Lumps	1.0	1.0

Gradation : Unless otherwise directed or approved by the Engineer-in-charge, the grading of sand shall be within the limits indicated hereunder.

IS : Sieve Designation	Grading Zone-I	Grading Zone-II	Grading Zone-III	Grading Zone-IV
10 mm	100	100	100	100
4.75 mm	99 – 100	90 – 100	90 – 100	95 – 100
2.36 mm	60 – 95	75 – 100	85 – 100	95 – 100
1.18 mm	30 – 70	55 – 90	75 – 100	90 – 100
600 microns	15 – 34	35 – 59	60 – 79	80 – 100
300 microns	5 – 20	8 – 30	12 – 40	15 – 50
150 microns	0 – 10	0 – 10	0 – 10	0 – 15

Where the grading falls outside the limits of any particular grading zone of sieves, other than 600 microns IS sieve, by total amount not exceeding 5%, it shall be regarded as falling within that grading zone. This tolerance shall not be applied to percentage passing the 600 micron IS sieve or to percentage passing any other sieve on the coarser limit of grading zone I or the finer limit of grading zone IV. Fine aggregates conforming to grading zone IV shall not be used. Mix designs and preliminary tests shall show its suitability for producing concrete of specified strength and workability.

Fineness Modulus

The sand shall have a fineness modulus of not less than 2.2 or more than 4.2. The fineness modulus is determined by adding the cumulative percentages retained on the following IS sieve sizes (4.75 mm, 2.35 mm, 1.18 mm, 600 microns and 150 microns) and dividing the sum by 100.

Coarse Aggregate

Coarse aggregate for concrete, except as noted above, shall conform to IS 383 and IS 2386. This shall consist of crushed stone and shall be clean and free from elongated, flaky or laminated pieces, adhering coatings, clay lumps, coal residue, clinkers, slag, alkali, mica, organic matter or other deleterious matter.

Screening and Washing : Crushed rock shall be screened and or washed for the removal of dirt or dust coating, if so requested by the Engineer-in-charge.

Grading

Coarse aggregate shall be either in single size or graded, in both cases the grading shall be within the following limits :

IS Sieve Size(mm)	Percentage passing for single sized aggregate of normal size					Percentage passing for graded aggregate of normal size			
	40 mm	20 mm	16 mm	12.5 mm	10 mm	40 mm	20 mm	16 mm	12.5 mm
63	100	-	-	-	-	-	-	-	-
40	85-100	100	-	-	-	95-100	100	-	-
20	0-20	85-100	100	-	-	30-70	95-100	100	100
16	-	-	85-100	100	-	-	-	90-100	-
12.5	-	-	-	85-100	100	-	-	-	90-100
10	0-5	0-20	0-30	0-45	85-100	10-35	25-55	30-70	40-85
4.75	-	0-5	0-5	0-10	0-20	0-5	0-10	0-10	0-10
2.36	-	-	-	-	0-5	-	-	-	-

The pieces shall be angular in shape and shall have granular or crystalline surfaces. Friable, flaky and laminated pieces, mica and shale, if present, shall be only within tolerance limits which will not affect adversely the strength and or durability of concrete. The maximum size of coarse aggregate shall be 40 mm for M7.5 and M10 and 20 mm for M15 to M20 concrete, or as directed by the Engineer-in-charge or specified otherwise. The maximum size of coarse aggregate shall be the maximum size specified above but in no case greater than $\frac{1}{4}$ th of the minimum thickness of the member, provided that the concrete can be placed without difficulty so as to surround all reinforcement thoroughly and fill the corners of the form. For plain concrete the maximum size of aggregate shall be of 40 mm. for heavily reinforced concrete members, the nominal maximum size of the aggregate shall be 5 mm less than the minimum clear distance between the reinforcing main bars or 5 mm less than the minimum cover reinforcement whichever is smaller.

Foreign material limitations

The percentage of deleterious materials in the aggregate delivered to the mixer shall not exceed the following :

Sr. No.	Foreign Material	Percentage by weight	
		Uncrushed	Crushed
1	Material finer than 75 micron IS sieve	3.0	15.0
2	Shale	1.0	-
3	Coal and Lignite	1.0	1.0
4	Clay Lumps	1.0	1.0

Water

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

Reinforcement

Reinforcement bars shall conform to IS : 432, IS : 226 or IS : 1786 and the welded wire fabric to IS : 1566 as shown or specified on the drawings. Only T.M.T. bars as for specification will be followed

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

If permitted by Engineer, welding of reinforcement shall be done in accordance with IS : 2751 or IS : 9417 as applicable.

Admixtures

Plasticizer, water-reducing admixture and concrete water proofer shall conform to IS : 9103 and integral water proofing admixtures to IS : 2645. Dosage of plasticizer used in concrete work shall be 300 ml / 50 kg of cement. Manufacturer must comply ISO-9002 specifications.

Admixtures may be used in concrete as per manufacturer's instructions only with the approval of Engineer based upon evidence that with the passage of time neither the compressive strength nor its durability is reduced. An admixture's suitability and effectiveness shall be verified by trial mixes with the other material used in the works. If two or more admixtures are to be used simultaneously in the same concrete mix, their interaction shall be checked and trial mixes done to ensure their compatibility. There should also be no increase in risk of corrosion of the reinforcement or other embedments.

Calcium chloride shall not be used for accelerating set of the cement for any concrete containing reinforcement or embedded steel parts. When calcium chloride is permitted 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 wastage allowance for cement and steel shall be considered and paid for.

SAMPLES AND TESTS

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

Manufacturer's test certificate shall be furnished, for each batch of cement / steel and when directed by Engineer samples shall also be got tested by the Contractor in a laboratory approved by Engineer at no extra cost to Client. However, where material is supplied by Client, all testing charges shall be borne by Client; but transportation of material samples to the laboratory shall have to be done by Contractor at no extra cost.

Sampling and testing shall be as per IS : 2386 under the supervision of Engineer. The cost of all tests, sampling etc. shall be borne by Contractor.

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

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

STORING OF MATERIALS

All material 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.

Contractor will have to make his own arrangements for the storage of adequate quantity of cement even if cement is supplied by Client. Cost of such rejected cement, where cement is supplied by Client, shall be recovered at issue rate or open market rate which ever is higher. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by Engineer. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order or 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.

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 shall be stacked separately.

CONCRETE

General

Concrete grade shall be as designated on drawings. In concrete grade M15, M20, M25 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 **"Normal Mix Concrete"**. All concrete works of **grade M5, M7.5 and M10 shall be Nominal whereas all other grades, M15 and above, shall be Design Mix Concrete.**

Design Mix Concrete

Mix Design and Testing

For Design Mix Concrete, the mix shall be designed according to IS : 10262 and SP: 23 to provide the grade of concrete having the required workability and characteristics strength not less than appropriate values given in IS : 456. The design mix shall in addition be such that it is cohesive and does not segregate and should result in 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.

Unless otherwise specifically mentioned, the minimum cement content for Design Mix Concrete shall be as given below.

Grade of Concrete	Minimum Cement Content in Kg/Cu.m of concrete
M15	290
M20	360
M25	380
M30	410
M35	425

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

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

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

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

Structure / Member	Slump in millimeters	
	Maximum	Minimum
Reinforced foundation walls and footings	75	25
Plain footings, caissons and substructure walls	75	25
T.G. and massive compressor foundations	50	25
Slabs, beams and reinforced walls	100	25
Pumps and miscellaneous equipment foundations	75	25
Building columns	100	25
Pavements	50	25
Heavy mass construction	50	25

Batching and Mixing of Concrete

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

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

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

Nominal Mix Concrete

Mix Design and 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 **water / cement ratio may** be adopted as per Table 3 of IS : 456. However it will be Contractor's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

Batching and Mixing Concrete

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

FORM WORK

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

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

Formwork shall be designed to fulfill the following requirements :

- a) Sufficiently rigid and tight to prevent loss of grout or mortar from the concrete at all stages and appropriate to the methods of placing and compacting.
- b) Made of suitable materials.
- c) Capable of providing concrete of the correct shape and surface finish within the specified tolerance limits.

- d) Capable of withstanding without deflection the worst combination of self weight, reinforcement and concrete weight, all loads and dynamic effects arising from construction and compacting activities, wind and weather forces.
- e) Capable of easily striking without shock, disturbance or damage to the concrete.
- f) Soffit forms capable of imparting a camber if require
- g) Soffit forms and supports capable of being left in position if require
- 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, plywood, steel, plastic or concrete depending upon the type of finish specified. Sliding forms and slip for may be used with the approval of Engineer. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, work holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structures shall be sufficiently tight to prevent loss of slurry from concrete, using seals if necessary.

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

Forms intended for reuse shall be treated with care. Forms that have deteriorated shall not be use Before reuse, all forms shall be thoroughly scraped, cleaned, nails removed, holes suitably plugged, joints repaired and warped lumber replaced to the satisfaction of Engineer. 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 capability 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 allowe In their placed bolts passing through sleeves shall be use 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 or moisture.

For liquid retaining structures sleeves shall not be provided for through bolts or shall through bolts be removed if provide 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 or shown on drawings, all corners and angles exposed in the finished structure shall have chamfers or fillets of 20 mm x 20 mm size.

Forms for substructure may be omitted when, in the opinion of Engineer, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavations shall be slightly larger, as directed by Engineer, 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 limit the drop of concrete to 1.0 m or as directed by Engineer. The Contractor shall temporarily and securely fix items to be cast in (embedments / inserts) in a manner that will not hinder the striking of forms or permit loss of grout.

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

The striking time for formwork shall be determined based on 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 temperature; and
- 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 Deg. C) forms may be struck after expiry of the time period given in IS : 456, unless directed otherwise by Engineer. For portland pozzolona / slag cement the stripping time shall be suitably modified as directed by the Engineer. 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 stressed arising during the construction period.

Reinforcement Workmanship

Reinforcing bars supplied bent or in coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 Deg. C. Local warming may be permitted if steel is kept below 100 Deg. 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.

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

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 Engineer 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 wire. 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's approval.

TOLERANCES

Tolerance for formed 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.

PREPARATION PRIOR TO CONCRETE PLACEMENT

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

All arrangements formwork, equipment and proposed procedure, shall be approved by Engineer. **The Contractor shall maintain separate Pour Card for each pour as per the format enclosed** and shall produce before commencement of concreting to Engineer-in-charge.

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 rehandled or caused to flow. For locations where direct placement is not possible and in narrow forms. The Contractor shall provide suitable drops and 'Elephant Trunks'. Concrete shall not be dropped from a height of more than 1.0 m as stipulated in clause 13.8.13.

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 predetermined abutments.

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

Concrete shall normally be compacted in its final position within thirty minutes of leaving the mixer. Concrete shall be compacted during placing with approved vibrating equipment without causing segregation until it forms a solid mass free from voids thoroughly worked around reinforcement and embedded fixtures and into all corners of the formwork. Immersion vibrators shall be inserted vertically at points not more than 450 mm apart and withdrawn slowly

till air bubbles cease to come to 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 Engineer. The slump shall be held to the minimum necessary for conveying concrete by this method. When concrete is to be pumped 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 determined by Engineer. Concrete shall be protected against damage until final acceptance.

MASS CONCRETE WORKS

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

CURING

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

- (a) premature drying out, particularly by solar radiation and wind;
- (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 of frost;
- (f) vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

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

Where a curing membrane is directed to be used by the Engineer, 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 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.

Extra precautions shall be exercised in curing concrete during cold and hot weather.

CONSTRUCTION JOINTS AND KEYS

Construction joints will be as shown on the drawing or as approved by Engineer. 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 approved of Engineer.

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

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 a 15 mm thick layer of cement sand mortar for horizontal layers, the ratio of cement and sand being the same as in the concrete mix.

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.

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 area shall be cleaned out and back filled with either soil cement mixture, lean concrete or clean sand compacted as directed by Engineer. 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.

FINISHES

General

The formwork for concrete works shall be such as to give the finish as specified. The Contractors shall make good as directed any unavoidable defects 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.

Surface finish Type F1

This type of finish shall be for non-exposed concrete surface against which back fill or concrete is to be placed. 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 could interfere with proper and effective application of waterproofing material specified for use.

Surface finish Type F2

This type of finish shall be for all concrete work which will be exposed to view upon completion of the job. 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.

Surface finish Type F3

This type of finish shall be for concrete work which will be exposed to view but to give an appearance of smooth, dense, well-compacted concrete with no shutter marks, stain free and with no discoloration, blemishes, arrises, 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 Contractor.

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 screened 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 shall be supplied and used as recommended by the manufacturer.

REPAIR AND REPLACEMENT OF UNSATISFACTORY CONCRETE

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, holes left by form bolts etc. shall be brought to the notice of Engineer 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 Contractor at no additional cost to Client.

For patching of defective areas all loose materials shall be removed and the surface shall be prepared as directed by the Engineer.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the Engineer as to the method of repairs to be adopted shall be final and binding on the Contractor and no extra claim shall be entertained on this account. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh concrete shall be carried out as directed by Engineer.

VACUUM DEWATERING OF SLABS

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

HOT WEATHER REQUIREMENTS

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

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

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

COLD WEATHER REQUIREMENTS

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

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

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

LIQUID RETAINING STRUCTURES

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

The minimum level of surface finish for liquid retaining structures shall be type F2. All such structures shall be hydro-teste

The Contractor shall include in his price of hydro-testing of structure, all arrangements for testing such as temporary bulk heads, pressure gauges, pumps, pipelines etc.

Any temporary arrangements that may have to be made to ensure stability of the structures shall also be considered to have been taken into account while quoting the rates.

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

TESTING CONCRETE STRUCTURES FOR LEAKAGE

Hydro-static test for water tightness shall be done at full storage by Engineer, as described below :

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 submerged 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 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 hydro-static 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.

OPTIONAL TESTS

If Engineer feels that the materials i.e. cement, sand coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the Engineer, as per relevant IS Codes. Client shall pay only for the testing of material supplied by the Client, otherwise Contractor shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the Contractor at no extra cost to Client.

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, Engineer reserves the right to order the Contractor to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, etc. All these tests shall be carried out by Contractor at no extra cost to the Client. Alternatively Engineer also reserves the right to ask the Contractor to dismantle and re-do such unacceptable work at the cost of Contractor.

If the structure is certified by Engineer as having failed, the cost of the test and subsequent dismantling / reconstruction shall be borne by Contractor.

The quoted unit rates / prices of concrete shall be deemed to provide for all tests mentioned above.

GROUTING

Grout shall be provided as specified on the drawings. The proportion of standard Grout shall be such as to produce a flowable mixture consistent with minimum water content and shrinkage. Surface 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 ENGINEER. The grout proportions shall be limited as follows :

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

Non Shrink Grout

Non-shrink grout where called for in the Schedule of Quantities or specified on the drawings shall be provided in strict accordance with the manufacturer's instructions/ specifications on the drawings.

INSPECTION

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of Engineer. Materials rejected by Engineer shall be expressly removed from site and shall be replaced by Contractor immediately at no extra cost to Client.

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 :
 - i) water tightness;
 - ii) resistance to aggressive chemicals
 - iii) resistance to freezing and thawing
 - iv) very high strength
 - v) improved fire resistance
 - vi) wear resistance
 - vii) resistance to early thermal cracking

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

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

MODE OF MEASUREMENT AND PAYMENT

The unit rate for concrete work under various categories shall be all inclusive and no claims for extra payment on account of such items as leaving holes, embedding inserts, etc. shall be entertained unless separately provided for in the schedule of quantities. No extra claim shall also be entertained due to change in the number, position and / or dimensions of holes, slots or openings, sleeves, inserts or on account of any increased lift, lead of scaffolding etc. All these factors should be take into consideration while quoting the unit rates. Unless provided for in the Schedule of Quantities the rates shall also include fixing insets in all concrete work, whenever require

Payments for concrete will be made on the basis of unit rates quoted for the respective items in the Schedule of Quantities. No deduction in the concrete quantity will be made for reinforcements, inserts etc. and opening less than 0.100 of a sq.m in areas where concrete is measured in sq.m and 0.010 cu.m where concrete is measured in cu.m. Where no such deduction for concrete is made, payment for shuttering work provided for such holes, pockets, etc. will not be made. Similarly the unit rates for concrete work shall be inclusive or exclusive of shuttering as provided for in the Schedule of Quantities.

Payment for beams will be made for the quantity based on the depth being reckoned from the underside of the slabs and length measured as the clear distance between supports. Payment for columns shall be made for the quantity based on height reckoned upto the underside of slab / beams.

The unit rate for precast concrete members shall include formwork, mouldings, finishing, hoisting and setting in position including setting mortar, provision of

lifting arrangement etc. complete. Reinforcement and inserts shall be measured and paid for separately under respective item rates.

Only the actual quantity of steel embedded in concrete including laps as shown on drawings or as approved by Engineer shall be measured and paid for, irrespective of the level or height at which the work is done. The unit rates for reinforcement shall include lap chairs, spacer bars etc.

Where the formwork is paid for separately, it shall be very clearly understood that payment for formwork is inclusive of formwork, shuttering, shoring, propping scaffolding etc. complete. Only the net area of concrete formed (shuttered) shall be measured for payment.

CONCRETE POUR CARD				
Client :				
Date : Project :				
Structure :s				
Contractor :		Max. Aggregate size slump : mm/ mm/		
Drg. NO. :		Start/ Completion Time :		
Concrete Grade :		Mixing Time :		

Sr. No.	Item		Contractor's Rep. Signature	Engineer's Signature	Remarks
1	Centre lines Checked				
2	Form work and Staging checked for				
3	Accuracy, Strength & finish				
4	Cover to Reinforcement Checked				
5	Verified test certificate for cement / steel		Yes / No	Yes / No	
6	Adequacy of Materials / Equipment		Yes / No	Yes / No	
7	Embedded Parts checked (Location and Plumb)	Civil			
		Mechanical			
		Electrical			

Pour Authorised site Engineer

8	Soffit(S) and pour top (T) levels checked before (B) and after (A) from removal (Only of Beams of over 1 M. span & Important structures link T.G etc.)	S(B) S(A)	T(B) T(A)	
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9	Construction joint location & time (If not as per Drawing)			
10	Cement Consumption in Kgs.			
11	Numbers of cubes and identification mark			
12	Test cube results (7 Days / 28 Days)			
13	Concrete Condition on Form removal	Very Good/ Good / Fair / Poor		

**Engineer-in-Charge
Contractor**

PMC/TPI

Notes :

1. Each item to be checked & signed by the respective engineers.
2. Item 8 to 13 (Both inclusive) to be filled by only engineers of the client.
3. Each pour to have separate cards in triplicate one each for client & site office.
4. Under remarks indicate deviations from drawings & specifications congestion in reinforcement if any unusual occurrences such as failure of equipment sinking of supports / props, heavy rain affecting reasonable. Poor compaction improper curing other deficiencies observations etc.

MATERIALS : STRUCTURAL STEEL

All structural steel shall be complied with the requirements of IS 226-1961 and structural steel work IS 1915-1962 specifications for structural steel.

Steel for Pins and Rollers

Rolled steel pins and rollers, shall comply with requirements of the IS specifications appropriate for the work. Steel casting for cast steel pins shall conform to grade 1 or 3 of IS 1030-1956 specifications for steel casting (for general engineering purposes as appropriate).

Bolts and Nuts

Mild steel for bolts and nuts when tested shall comply with IS 1608-1960 and shall have tensile strength of not less than 2500 Kg/cm². Plain washers shall be made of steel.

Welding Electrode

Mild steel electrodes shall comply with requirements of IS 814-1957 specification for covered electrodes for metal arc welding of mild steel.

Workmanship

All work shall be in accordance with the drawings and shall satisfy IS specification No. 1915-1961. Care shall be taken to ensure that all parts in assembly fit accurately together. Notes or specifications on the drawings supplied by the Engineer-in-Charge/consulting Engineer, are to be constructed as superseding or cancelling any clause of this specifications with which they conflict. On all drawings dimensions shown in figures shall be acted in preference to measurement by scale.

Straightening

All structural steel members and parts shall have straight edges. All straightening shaping and levelling etc. shall be done by pressure only and not by hammering. All joggles and knees shall be formed by pressure and where practicable in making these, the metal shall not be cut and welded.

Cutting

All structural steel parts where required shall be sheared, cropped sawn or flame cut and ground accurately to the required dimensions and shape.

Bolts Holes

The diameter of bolts holes shall be 1.5 to 2.0 mm. larger than the nominal diameter of bolt. All holes for bolts shall be drilled unless permitted by Engineer-in-Charge for punching the holes. Care shall be taken, such as surrounding material is not deformed or damaged in case of punching the hole is allowed

Welding

Welding of steel conforming to relevant IS specifications shall be in accordance with general requirements of metal arc welding. In addition to general requirement, the following care shall be taken :-

- (a) The welding shall be positioned for downward welding wherever practicable.
- (b) The welding current shall conform with respect of voltage and empear to the recommendations of the manufacturers of the electrode being use. The arc length, voltage and empear shall be suited to the thickness of material, type of groove and other circumstances of the work.
- (c) The surface to be welded and surrounding material for a distance of atleast 155 mm shall be free from scale, dirt, grease, paint, heavy rust or other surface deposit.
- (d) Members to be welded shall be held in correct position by holes, clamps, wedges, jigs or other suitable devices or by tack welding until welding has been completed, such fastening as may be used shall be adequate to ensure safety. Suitable allowance shall be made for war page and shrinkage.
- (e) Tack welds located where the final welds will later be made shall be subject to the same quality requirements as final welds. Defective and broken tack welds shall be removed before final welding.
- (f) Fusion faces shall be made or cut by shearing, chipping, machining or by gas cutting.
- (g) Exposed faces of welds shall be made reasonably smooth and regular so as to conform as closely as practicable to design requirements and shall not be of less than the required cross section.

- (h) Finished welds and adjacent parts shall be protected with clean boiled linseed oil after all slag has been removed

Safety Precautions

- (a) Operators of welding and cutting equipment shall be protected from the rays of the arc flame gloves and by helmet, hand shields, or goggles equipped with suitable filter lenses.
- (b) Closed space shall be ventilated properly while welding is being done therein.
- (c) Welders should be provided with such staging as will enable them to perform the welding operation. For site welding shelter should be provided to protect welders and the parts to be welded from the weather.

The Constructor shall employ a competent welding supervisor to ensure that the standard of workmanship and the quality of materials comply with requirements laid in these specifications.

The Constructor shall provide free access to the representative of Engineer-in-Charge/Consulting Engineer to the work being carried out at all reasonable times and facilities shall be provided so that during the course of welding he may be able to inspect any layer of weld metal. He shall be at liberty to reject any material that does not conform to the terms of the specifications and to require any defective welds to be cut out and welded. The representative of the Engineer-in-Charge/Consulting Engineer shall be notified in advance of any welding operations.

Inspection and testing of welds shall be done as laid down in IS 822 and IS 11017.

No welder shall be employed in any position except those who are fully qualified to welding. Qualification for welders shall be as laid down in IS 812.

Joints

All steel work intended to be bolted together must be in contact over the whole surface. Joints which have to take compressive stress and the ends of all stiffeners shall meet truly over the whole of the butting surface.

Assembling

All member shall be so arranged that they can be accurately assembled, without being unduly packed, strained or forced into position and when built shall be true and free from twist kinks, buckles or open joints between component pieces. Work shall be kept properly bolted together and no drifting shall be allowed except for the purpose of drawing assembled sections together in accuracy's in matching of holes may be corrected But drifting to enlarge holes is prohibited. Failure in any of the above respect will involve the rejection of defective members.

Mode of Measurement and Payment

Measurement of this item shall be as per IS 1200(Part VIII) - 1974 or as per its latest revision so far as applicable.

The contract rate shall be suitable for unit of one metric tonne of structural steel.

MATERIALS : REINFORCEMENT

Specification for TMT bars reinforcement

Scope of work : The scope of work consists of providing and laying mild steel reinforcement and TMT Fe-500 reinforcement for RCC works of various components of the structure. This may be Tiscon or any other approved manufacturer brand and corrosion resistant steel bars approved by the Engineer-in-charge. This includes cuttings, bending, binding, placing, with all equipments and labour required for the work as directed by the Engineer in charge, MMC, Morbi and all operations covered within the intent and purpose of the specification.

Bending of Reinforcement : Reinforcing steel shall conform accurately to the dimensions shown on relevant drawings and conforming to the relevant IS codes (latest revision) Bars shall be bent cold to the specified shape and dimensions or as directed by the Engineer in charge, MMC, Morbi using a proper bar bender, operated by hand or power to attain proper radii of bends. Bars shall not be bent or straightened in a manner that will cause injury to the material. Bars bent during transport or handling shall be straightened before being used on work; they shall not be heated to facilitate bending.

The bending of the TMT bars shall be carried out as per the following :

Sr. No.	Operation	Size	TMT Fe-500
1	Bend	Upto 22 mm dia.	3d
		Over 22 mm dia.	4d
2	Rebend	Upto 10 mm dia.	4d
		Over 10 mm dia.	5d

Placing of Reinforcement :

All reinforcing bars shall be accurately placed in the exact position shown on the drawings, and shall be securely held in position during placing of concrete by annealed binding wire not less than 1 mm. in size and conforming to IS : 280 and by using stays blocks or metal chairs, spacer, metal hangers, supporting wires or other approved devices at sufficiently close intervals. Bars will not be allowed to sag between supports nor displaced during concreting or any other operation over the work. All devices used for positioning shall be of noncorrodible material. Wooden and metal supports will not extend to the surface of concrete, except where shown on the drawings, Placing bars on layers of freshly laid concrete as the work progresses for adjusting bar spacing will not be allowed. Pieces of broken stone, brick or wooden blocks shall not be used. Layers of bars shall be separated by spacer bars, precast mortar blocks or other approved devices.

Reinforcement after being placed in position shall be maintained in a clean condition until completely embedded in concrete. Special care shall be exercised to prevent any displacement of reinforcement in concrete already placed. To protect reinforcement from corrosion, concrete cover shall be provided as indicated on the drawings. All bars protruding from concrete to which other bars are to be spliced and which are likely to be exposed for an indefinite period

shall be protected by a thick coat of neat cement grout. In the case of columns and walls, vertical bars shall be kept in normal position with timber templates having slots accurately cut in for bar position. Such templates shall be removed after the concreting has progressed upto a level just below them. Bars crossing each other, where required, shall be secured by binding wire (annealed) of size not less than 1 mm and conforming to IS : 280 in such a manner that they do not slip over each other at the time of fixing and concreting. As far as possible, bars of full length shall be used. In case this is not possible, overlapping of bars shall be done as directed by the Engineer in charge, MMC, Morbi. When practicable, overlapping bars shall not touch each other, but be kept apart by 25 mm or 1 1/4 times the maximum size of the coarse aggregates whichever is greater, by concrete between them. Where this is not feasible, overlapping bars shall be bound with annealed steel wire, not less than 1mm thickness twisted tight in eight shape around the lapped bars. The overlaps shall be staggered for different bars and located at fixed locations only along the span where neither shear nor bending moment is maximum.

Welding of Bars Welding of TMT bars can be permitted if specified on the drawings, joints of reinforcement bars shall be butt welded so as to transmit their full strength. Welded joints shall preferably be located at points where steel will not be subject to more than 75 percent of the maximum permissible stresses and welds so staggered that at any one section, not more than 33 per cent of the rods are welded. No pre-warming or post heat treatment is necessary. Interpass temperature should be limited to 200°C with low heat input and equivalent strength low hydrogen type electrode. Suitable means shall be provided for holding the bars securely in position during welding. It must be ensured that no voids are left in welding and when welding is done in 2 or 3 stages, previous surface shall be cleaned properly. Ends of the bars shall be cleaned of all loose scale, rust, grease, paint and other foreign matter before welding. Only competent welders shall be employed on the work. Welded pieces of reinforcement shall be tested. Specimens shall be taken from the actual site and their number and frequency of tests shall be as directed by the Engineer in charge, MMC, Ahmedabad

The TMT bars shall be tested for any or all of the following tests as directed by the Engineer-in-charge.

- (1) Alternate immersion test
- (2) Salt spray test
- (3) Atmospheric exposure test
- (4) Sulphur dioxide test
- (5) Potentio dynamic test

Item 79:

Manufacture, Supply & Delivery of Electric Resistance Welded (Up to 400mm)/Submerged Arc Welded(Above 400mm) M.S.Pipe having beveled ends plate or coil conforming to IS-3589-2001 or its latest revision/ ammendment for following thickness outside diameter at GWSSB store or site anywhere in Gujarat State including all taxes, insurance, transportation, freight charges, octroi, inspection charges, loading, unloading conveyance to Departmental stores, stacking etc. all complete. (Rate for MS Pipe based on the ex. works price of HR Coil as Rs.58500 per MT - withouth GST (Above 3.15 mm to 10 mm) & Rs. 59000.00 per MT without GST (Above 10 mm) as onJan-23.(WPI Index of H. R Coil of Dec-22 is 144)

MS PIPE SPECIFICATION

Applicable Codes & Specifications

The following specifications, standards and codes are made a part of the specification. All standards, tentative specifications, 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.:

- IS: 2062 Steel for general structural purposes.
- IS : 808 Dimensions for hot rolled steel beam, column, channel and angle sections.
- IS : 814 Covered Electrodes for manual Metal Arc Welding of carbon and C-Mn steel.
- BS EN 499: Welding Consumables. Covered Electrodes for Manual Metal Arc Welding of Non Alloy and Fine Grain Steel. Classification
- AWS: A-5.17: Specification for Mild Steel Covered Arc Welding Electrodes.
- IS : 3613: Acceptance Tests for Wire Flux combinations for Submerged – Arc Welding.
- AWS:A-5.17: Specification for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding
- IS: 1367: Technical Supply Conditions for Threaded Fasteners (Parts 1 to 3).
- IS: 2016: Plain Washers.
- IS: 2074: Ready Mixed Paint, Red Oxide Zinc Chrome and Priming.
- IS: 102 Ready Mixed Paint, Brushing, Red Lead, no setting, Priming.
- IS: 1786 High Strength Deformed Steel Bars and Wires for Concrete Reinforcement
- IS : 432 Specification for Mild Steel & (Part-I) Medium Tensile bars and hard drawn steel wire for concrete reinforcement : mild Steel & Medium tensile steel bars.
- IS.432 Specification for mild steel & (Part-II) Medium Tensile steel bars and hard drawn steel wires for concrete reinforcement : Hard drawn steel wire
- IS : 269 Specification for Ordinary and Low heat Portland cement
- IS : 8041 Specification for Rapid hardening Portland Cement
- IS : 383 Specification for coarse and fine aggregate from natural source for concrete
- IS :12330 Specification for Sulphate Resisting Portland Cement
- IS : 456 Code of practice for plain and reinforced concrete

IS : 800	Code of practice for General Construction in Steel.
IS : 816	Code of practice for use of Metal Arc Welding for General Construction in mild steel.
IS : 4353	Submerged Arc Welding of Mild Steel & Low Alloy Steels – Materials Recommendations.
IS: 817	Code of practice for Training and Testing of Metal Arc Welders.
IS: 1182	Recommended practice for Radiographic examination of Fusion – Welded Butt Joints in steel plants
IS: 2595	Code of Practice for Radiographic Testing.
IS: 3658	Code of Practice for Liquid Penetrate Flaw Detection
IS: 5334	Code of practice for Magnetic Particle Flaw Detection of welds.
ASTM E 94	Guide for Radiographic Testing
ASTM E 709	Guides for Magnetic Particle Examination.
ASTM E 165	Test Method for Liquid Penetrate Examination.
IS: 3600	Methods of Testing Fusion Welded Joints and weld metal in steel (Parts 1 to 9)
IS: 4853	Recommended Practice for Radiographic Inspection of Fusion Welded Butt Joints in Steel Pipes.
IS: 1239	Seamless or Electrically welded steel pipes for Water Gas and Sewage (Up to 166.5 mm Outside Diameter)
IS: 3589	Seamless or Electrically welded steel pipes for Water Gas and Sewage (168.3 to 2540 Outside Diameter)
IS: 6631	Steel pipes for Hydraulic Purposes
IS: 7343	Code of practice for ultrasonic Testing of Ferrous Welded Pipes and Tubular Products
IS: 2598	Safety Code for Industrial Radiographic Practice
IS: 5822	Code of Practice for Laying of Electrically Welded steel pipes for water supply
IS: 1608	Mechanical testing of Metals.
IS: 9595	Metal Arc welding of Carbon and Carbon-Manganese Steels.
IS: 2825	Code of unfired Pressure Vessels
IS: 5504	Code for Spiral Welded PIPES(457mm to 3250mm Outside Diameter)
IS: 10748	Requirements for Weldable Hot Rolled Carbon Steel Strip in Coils.
IS: 10234	Recommendation for radiography for general pipeline welding.
API-1104	Welding of pipeline & related facilities
ASME Section V	Non-Destructive Examination

1.0 MATERIALS

- Steel Coils - The raw material of H.R. steel Coils used for pipes, fittings, specials and stiffeners shall be conforming to IS: 10748 grade III and shall bear ISI mark. The HR Coils older than 6 months from date of its manufacturing shall not be allowed to manufacture pipes.
- Welding Consumables - such as electrodes, filler rods and wires shall conform to IS:814, IS: 3613, IS: 6419 and IS: 7280 and shall be of RMC approved make.
- Before fabrication of pipes and specials/fittings is commenced, the copies of the mill sheets and the manufacturer's test certificates for Coils and other materials required for the fabrication shall be submitted by the Contractor to the Engineer for his approval.
- When requested by the Engineer, the Contractor shall supply free of charge to the Employer, for testing suitable samples of the materials to be used/used in the Works. The cost of such tests shall be borne by the Contractor and shall be included in his item rates.

2.0 INSPECTION

- All works and material under specification will be rigidly inspected during all phases of manufacture and testing and such inspection shall not relieve the Contractor of his responsibility to furnish materials and performed work in accordance with this specification.
- The Contractor shall notify the Engineer, in advance of the production of materials and fabrication thereof, in order that the Employer may arrange for mill and shop inspection.
- The Engineer may reject any or all materials or works that do 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.
- The Engineer 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.
- The Contractor shall supply free of cost required specimen of materials for testing by the Owner at any time during the progress of work and shall bear the cost of all such tests or retests to the satisfaction of Engineer.
- The Contractor shall provide 2 (two) sets of accurate 'Go' and 'No Go' ring gauges to measure the diameter of pipes specials and fitting for the use of the Engineer at no extra cost.

3.0 FABRICATION OF PIPE

GENERAL

- All pipes and specials shall be manufactured as per IS: 1239 part 1/ IS: 3589 and IS: 5504 out of new mild steel HR Coils (IS: 10748 grade-III) (as mentioned above) which shall be free from any cracks, surface flaws, laminations, excessive fittings or any other defects. 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, for a length of 200 mm. No extra cost shall be charged by the Contractor for this grinding work. However, the pipe shall be manufactured as per tender specification.
- Minor repair by welding or otherwise shall be permitted at the discretion of the Engineer, 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.
- Permissible Stress : The permissible stress in the pipe shell shall be related to yield stress of pipe material making due allowance for weld efficiency of the joint.
- working stress for combined bending and direct tensile stress shall not exceed 60% of yield stress of the material making due allowance for efficiency of welded joint (as per IWWA M-1).
- Working stress for combined bending and direct compressive stress shall not exceed 50% of yield stress making due allowance for weld efficiency (as per IWWA M-1).
- It is also necessary to check the shell thickness for adequate factor of safety against failure by buckling (as per IWWA M-11).

- For field welded joint, efficiency factor of 80% is generally adopted, while for shop welding joint 90% efficiency is allowed (as per IS 5822).

FABRICATION

- The Contractor shall get the fabrication work done in a duly valid licensed factory of his own or that of an approved nominated sub-contractor. This factory meant for fabrication of pipes, specials etc. shall also be involved with testing etc., machining as well as painting. For completing the work under the present contract within the contract period, the factory shall be equipped with adequate number of various equipment and plant such as :

- I. Plate bending machines for rolling of pipe drums
- II. Automatic welding machines (suitable for circumferential welding)
- III. Hydraulic Testing Machines
- IV. Travelling gantry or crane of capacity 10 Tones or above.
- V. Mobile cranes for loading/unloading of Coils, pipes etc. 15 tones capacity each
- VI. Lathe for machining of the flanges rings, Coils etc.
- VII. Equipment for sand blasting and applying paint by spray gun.
- VIII. Equipment for cold pressing of Coils up to 25 mm thick to the required curvature (specials, plug Coils etc.)
- IX. Bending machine of adequate capacity for manufacturing ring girders and other necessary equipment.

- The factory shall have adequate area, and shall also have stacking yard for the stacking of Coils, structural, fabricated pipes etc. and the scrap.

- The Bidder may establish pipe fabrication factory within the project site for minimizing the transportation of pipes after fabrication to bring the pipes to the trench where pipes are to be laid. Contractor shall furnish with his bid the details of the factory where he intends to get the fabrication done, such as its location within the project site and the equipment, plant and other facilities available in the factory for the manufacture of M.S. Pipes and special required under this contract. This shall be as per the MOU executed with the pipe manufacturer.

CUTTING OF COILS or FROM COIL ROLLED AS PER REQUIRED SIZES

- The Coils shall be indented in such length as to have minimum wastage and so as to make the pipe as far as possible.
- Before cutting, all the edges of the Coils shall be cleaned by brushing/grinding on both the sides.
- After the Coils 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 Coils 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.

ROLLING OF COILS

- The Coils prepared as mentioned above are cut to the exact size shall be put into a rolling machine to form a pipe of the required diameter as under :
- 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.
- Heating of Coils to obtain the desired curvature shall not be permitted.

WELDING

- All components of a standard shell, either straight or bent etc. shall be welded, wherever possible by use of automatic arc welding machine by Submerged Arc Welding Process with alternating current. Generally hand welding shall not be permitted except specific cases, where it is absolutely necessary. This should be done in consent with client's representative. Hand welding shall also not be permitted except for sealing runs 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 electrodes of RMC/GWIL approved make and size, the size depending on the thickness of coil and the type of joint. It shall also be used with standard current and arc voltage required for the machine in use with such modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer 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.
- All the shop and field joints shall be welded, all welding shall conform to the requirements of IS 9595 and IS 4353.
- All 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 Coils of unequal thickness shall be so kept that the inside surfaces of Coils 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 be tested by the Contractor with prior intimation to the client 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). 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. All such check tests and rectification 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. Specially selected welders shall do site welds.
- 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 (parallel welding putting two welders at a time both will be working in diametrically opposite side of the curvature. Welding shall be divided into 4 quadrants shall be welded simultaneously, 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.

➤ 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 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 for his approval. Manual welding shall be adopted only when machine welding is not possible.

4.0 ULTRASONIC & RADIOGRAPHIC TEST OF WELDED JOINTS MANUFACTURED IN SITE FACTORY/WORKSHOP

➤ For the mild steel pipes manufactured in site factory/workshop, fabricated from mild steel Coils, 100 % of weld length of each pipe shall be subjected to Ultrasonic Test either on line or off line. (As per API 5L or ASME SECTION V or API 1104)

➤ For the mild steel pipes manufactured in site Factory/Workshop fabricated from mild steel coils, 15% of weld length of each pipe shall be subjected to Radiography Test by Digital Image/ X-Ray Film Method. (As per API 5L or ASME SECTION V or API 1104)

➤ 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 Engineer based on the latest standards prescribed by Indian Standard specification will judge the radiographs as acceptable or unacceptable.

➤ 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. The Contractor shall provide for the use of the Engineer 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, the Radiographer at the discretion of the Engineer shall perform such inspection.

5.0 RADIOGRAPHIC INSPECTION

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 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 shall ensure himself that only qualified welders and welding operators have been used.
- The Contractor shall make available to the Engineer a certified copy of the records of the qualification tests of each welder and welding operator. The Engineer 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.

RADIOGRAPHIC INSPECTION OF WELDED JOINTS

- All welded joints to be radiographed shall be examined in accordance with IS : 2595- Code of Practice for Radiographic Testing
 - IS : 4853 : Recommended Practice for Radiographic Inspection of Fusion Welded Butt joints in Steel Pipes.
 - IS : 1182 : Recommended Practice for Radiographic Examination of Fusion Welded Butt- Joints in steel Coils.
- 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 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 pentameter image and the specified hole.
- The acceptance criteria for radiography of the joint shall be as per API 5L or as per API -1104 standard.

6.0 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.
- Machined parts shall be within the limits specified by IS 3589.
- Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2 mm on either side of the plane. Pipe ends shall be bevelled as per IS: 3589. The pipes shall be supplied in length of 10.5 meters to 12.5 meters.
- For the Pipe thickness, no negative tolerances are acceptable.
- All dimensions of pipe like Outside Diameter, thickness, out of roundness, length, straightness, bevel angle, weld bead height shall be as per IS 3589.

7.0 SHOP TESTING

- After fabrication, but before application of protective coatings all pipes and specials shall be subjected to a shop hydraulic test (100%). 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.

- Each pipe shall be filled with water and the pressure slowly and uniformly increased until the required test pressure is reached.
- The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe No. Shell thickness, diameter, length etc. as directed. It shall be entered in the register to be maintained by the Contractor.
- 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 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 a period of 5 Second. 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 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. The Engineer shall be supplied with two copies of the results of all the tests carried out.
- The Mechanical Tests for Pipe material at Manufacturers work shall be carried as per approved Quality Assurance Plan (QAP) and tests shall be as per IS:1239/IS:3589/IS:5504.

8.0 TESTING OF SITE WELDED JOINTS

- The welded joints at site shall be tested for Tensile test and Bend test in accordance with procedure laid down in as per the latest edition of IS 3600 “code of procedure for testing of fusion welded joints and weld metals in steel”.
- Test pieces shall be taken by the contractors from the welded joints at the position on fabricated pipes pointed out by the Engineer in-charge.
- 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. All the work up to and including machining and arranging for test shall be done by the contractors.

9.0 SUBMISSION OF DAILY PROGRESS REPORT

- The Contractor shall submit to the Engineer a daily progress report in the proforma approved by the Engineer, 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 who shall initial the entries after verification.

➤ Contractor shall maintain instruction register along with site and outside (Private - NABL approved laboratory and govt. laboratories) test register and excel sheet for the records.

10.0 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. Only blunt nose punches should be used.

➤ The Coils 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 the 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 Performa 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
- X. Name of Welder's

➤ A copy of these details shall be furnished to the owner 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.

11.0 EXTERNAL COATING: 3-LAYER POLYETHYLENE (3LPE) SCOPE

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

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

CODES AND STANDARDS

➤ This latest edition of the following codes and standards shall establish the minimum standards for the work :

ANSI/AWWA C213	Standard for Fusion-bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
ASTM D149	Standard test method for dielectric breakdown voltage and dielectric strength of solid electrical insulating materials at commercial power frequencies.
ASTM D257	Test methods for dc resistance or conductance of insulating materials.
ASTM D570	Standard test method for water absorption of plastics
ASTM D638	Standard test method for tensile properties of plastics
ASTM D746	Standard test method for brittleness temperature of plastics and elastomers by impact.
ASTM D790	Standard test method for flexural properties of unreinforced and reinforced plastics and electrical insulating materials.
ASTM D1238	Standard test method for melt flow rates of thermoplastics by extrusion plastometer.
ASTM D1505	Standard test method for Density of plastics by the Density Gradient Technique.
ASTM D1525	Standard test method for Vicat softening temperature of plastics.
ASTM D1531	Standard test methods for relative permittivity (dielectric constant) and dissipation factor by fluid displacement procedures.
ASTM D1603	Standard test method for carbon black in define plastics
ASTM D1928	Standard practice for preparation of compression-molded polyethylene test sheets and test specimens.
ASTM D2240	Standard test method for rubber property – durometer hardness.
ASTM D3417	Standard test method for enthalpies of fusion and Crystallization of polymers by differential scanning calorimetry (dsc)
ASTM D4703	Standard test practice for compression Molding Thermoplastic Materials into Test Specimen, Plaques or Sheets.
ASTM F372	Standard test method for water vapor transmission rate of flexible barrier materials using an infrared detection technique.
AWWA C 200-97	Steel water pipe line
ASTM G8	Standard test method for Cathodic Dis-bonding 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 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 760 µm (10 to 30 mils)
NACE RP-01-75	Recommended practice : control of Internal corrosion in steel pipe lines and Piping system.
SIS 05-5900	Preparation of steel substrates before application of paints and related products – visual assessment of surface cleanliness – PT 1 : grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous.

GENERAL

Environmental Conditions

- The environmental conditions operating conditions, product data, etc. under which the pipes shall operates and defined in Documents. Scope of Work, Project Design Data and Site Conditions and Specification for Pipeline construction.

Definitions

- The terms “Contractor”, “Pipe Supplier”, “Pipe Coating Contractor”, “Engineer”, etc. used in this specification shall have the meanings defined in the General and Special Conditions of Contract.

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.

Conflicting Requirements, Exceptions

- The Pipe Coating Contractor shall notify the Engineer of any conflict between this specification, the codes and standards and any other specifications included as part of the contract documents related with line pipes and coating.
- Any exceptions to this specification and referenced documentation shall be raised by the Pipe Coating Contractor and approved by the Engineer in writing.

TECHNICAL REQUIREMENTS

HANDLING OF COATING MATERIALS :

General :

- Materials shall be brought from the RMC approved vendor list only and shall be handled and stored in accordance with the material manufacture’s recommendations, which shall be available for review by the Engineer at the Pipe Coating Contractor’s premises. Materials shall be stored in temperature controlled environment until required for use.
- Coating materials shall be segregated by type and batch during storage and handling. Materials from damaged containers shall be rejected unless otherwise agreed with the Engineer.
- As a minimum, all packages of the coating materials shall be marked with the following data:
- a) Name of manufacturer
 - b) Complete material identification – trade name, chemical name and
 - c) style 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

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 Addltions from fresh or cleaned stock at a rate sufficient to refurnish consumption. Blasting and other dust producing areas shall be kept separate from coating application areas. The surface cleaning shall be degree of cleanliness as per SA 21/2 & ISO 8502-3.

FBE Powder

- The FBE powder selected shall be suitable for use at the design temperatures in the proposed environment and be suitable for a three layer polyethylene coating system. The FBE shall be endorsed by the Pipe Coating contractor of the adhesive and Polyethylene as being compatible with these products under the specified service conditions.
- Each batch of FBE shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specifications;
 - Gel Time
 - Cure Time
 - Moisture content
 - Thermal analysis

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:
 - Melt flow rate
 - Vicat softening point
 - Specific gravity

Polyethylene

- The polyethylene selected shall be or high density and shall be completely suitable for use at the design temperatures in the described environment. The polyethylene shall be suitable for a three-layer polyethylene can be stabilized against UV-rays before or after granulating the material.
- Each polyethylene batch shall be accompanied by a certificate stating the following tests have been carried out on every batch and results are in accordance with the coating material manufacturer's product specification:
 - Melt flow rate

- Specific gravity
- Moisture content
- Vicat softening point
- oxidation induction time

12.0 PROPERTIES OF EPOXY POWDER, ADHESIVE & POLYETHELENE

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

SR.NO	PROPERTIES	UNIT	REQUIREMENTS	TEST METHOD
A	Gel Time	Second	24.0 seconds min	CSA-Z245
B	Density	g/L	1410 min	CSA-Z245
C	Particle Size Distribution			CSA-Z245
D	Moisture Content	%	Max 0.6	CSA-Z245
E	Thermal Analysis		Degree C	CSA-Z245
F	Infrared Scan			CSA-Z245
G	Cure Time	Second	Max. 120 sec.	CSA-Z245

➤ Adhesive shall have shall have the following properties.

Sr. No.	Properties	Unit	Requirement	Test Method
a.	Adhesion	--	As per raw material manufacturer recommendation.	--
b.	Melt Flow Rate (190°C / 2.16 kg)	g/10 Minutes	Minimum 1.0 g/10 min.	ASTM D 1238 or DIN 53735
c.	Specific Gravity + 25°C	-	0.926 minimum	ASTM D 792
d.	Vicat Softening Point	0c	100 0c minimum	ASTM D 1525

➤ Properties of Polyethylene Compound

Sr. No.	Properties	Unit	Requirements	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 mz.	ASTM D 570
f.	Volume Resistivity @ + 25 °C	Ohm-cm	10 ¹⁵ min.	ASTM D 257
g.	Dielectric Volt/sec rise @ + 250C	Volts/m m	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 2200C, Aluminum pan, no screen	Minutes	10 min.	ASTM D 3895
k.	Environmental Stress Crack Resistance (ESCR) (for F50) - Medium Density, Condition "C" - High Density, Condition "B"	Hours	300 300	ASTM D 1693
l.	Carbon Black Content	%	2 min.	ASTM D 1603

- In Addition to vendor's certificate, the MANUFACTURER shall draw samples from each batch of epoxy, adhesive and polyethylene in the presence of PURCHASER and the test for the following properties at the coating yard at least one week prior to its use, to establish compliance with the Manufacturer's test certificates.
- (A) Epoxy Powder: Gel Time, Cure Time, Moisture content, Thermal Characteristics (Tg1, Tg2, ΔH)
- (B) Adhesive: Specific gravity, Melt Flow Rate, Vicat Softening Point
- (C) Polyethylene: Melt Flow Rat, Specific Gravity, Vicat Softening Point, Moisture content, Oxidative Induction Time.
- In Case of the failure of any of the above tests in a batch, that batch of material shall be tested for all other tests required including the tests which failed. If all tests pass, the batch shall be accepted for coating. If any of the tests fail, entire batch of material shall be rejected and shall not be used for the coating.
- MANFUCATURER shall ensure that all coating materials are properly stored in accordance with the Manufacturer's recommendation at all times, to prevent damage and deterioration in quality prior to use. Properties of coating System :

Sr. No.	Properties	Unit	Requirement	Test Method
a.	Bond Strength (using Type 2 Test assembly i.e. Dynamometer) - @ 20+ /- 50C - @ 65 +/- 50C	Kg/cm	8.0 min 50 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 +/- 20C - @ 70 +/- 20C	mm	0.2 max 0.3 max	DIN 30670
d.	Elongation at Failure	%	300 min	DIN 30670
e.	Coating Resistivity (*)	Ohm-m ²	10 ⁸ min.	DIN 30670
f.	Heat Ageing (*)	-	Melt Flow rate	DIN 30670
g.	Light Ageing (*)	-	shall not deviate by more than	DIN 30670

			35% of original value Melt flow rate shall not deviate by more than 35% of original value.	
h.	Cathodic Disbondment - @ + 650C after 30 days -@ + 650C after 48 hrs	Minimum radius of disbondment (**)	15 max 7 max	ASTM G42
i.	Degree of Cure of Epoxy - Percentage Cure, ΔH - ΔT_g	% 0C	95 +3/-2	CSA Z 245.20 - 98 (***)

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

Acceptance of Pipe Materials

Identification and Tracking

- Upon receipt at the coating factory, the Pipe Coating Contractor shall record the following pipe information:
- The unique pipe identification number, measured length, and measured weight (both to be found stenciled in paint on one end 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 Pipe Coating Contractor shall identify (or maintain identification of) every coated item, by using a weatherproof mark on the inside of the pipe and on the outside of the coated item. The pipe identification shall be the unique pipe identification number (the number required by the applicable pipes specification). The pipe coating contractor may use Additional tracking numbers at his discretion but these shall relate simply to the unique pipe number in the QC documentation.
- Pipe tracking shall be carried out in accordance with approved procedures.

Preliminary Inspection

- The Pipe Coating Contractor shall carry out visual inspection of all pipes.
- The Pipe Coating Contractor shall record all external damage on pipes against the unique item serial number. This damage shall be brought to the attention of the Engineer and the Pipe shall not be coated without prior release by Engineer.
- Bevel protectors at each end of every pipe joint shall not be removed unless showing signs of damage or if removal is required to facilitate surface preparation, or

they would be damaged by coating operations. If the protectors are removed the conditions of the bevel shall be recorded against the pipe serial number and any damage shall be brought to the attention of the Engineer.

Damage to Pipe and Pipe Ends and Repair

- No repair work shall proceed until a written procedure has been prepared by the Pipe Coating Contractor and approved by the Engineer.
- Minor damage to pipe and pipe ends/bevels, identified either at time of receipt or after abrasive blasting shall be repaired by grinding. The number of such damages shall be not more than 3 per pipe. Repair by grinding on the pipe or pipe ends/ bevels outside diameter shall not reduce the wall thickness to less than the minimum requirements of the line pipe specification, when measured using ultrasonic thickness measurement equipment.
- All other damage to pipe ends/bevels shall be advised to the Engineer for review. Subject to Engineer's approval, these defects may be repaired by removal of damaged pipe material and re-beveling. No welding on the pipe surface shall be allowed.
- Pipe identification numbers shall be preserved during repair. Any reduction in pipe lengths shall be recorded in the relevant forms and files.

Prior to Coating Application Stages

- The principle stages of pipe coating shall be as follows:
 - Solvent cleaning followed by steam or hot bath cleaning (if required)
 - Abrasive blasting
 - Application of fusion bond epoxy (FBE) layer
 - Application of adhesive layer
 - Application of polyethylene layer

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.
- Following the steam or hot bath cleaning the pipe shall be tested for salt and chloride contamination in accordance with the requirements of DIN EN ISO 8502-2, ISO 8502-5 or DIN EN ISO 8502-9.
- The removal of hydrocarbon contamination shall be confirmed by a water spray test, where a fine spray is applied to the surface and uniform wetting confirms the removal. This check shall be performed before and after blasting, as a pre-qualification test and as a minimum, once per 100 items during production, or when necessary.
- Items found to be contaminated shall be cleaned as above and re-blasted if testing after blasting establishes that salt, chloride or hydrocarbon contamination is still present. The remainder of the batch concerned shall all be checked individually.
- All water used for rinsing or cleaning purposes shall be potable with less than 200 ppm total dissolved solids and 50 ppm chlorides.

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, and grease and free from other foreign materials.

- Abrasive and dust, which entered the inside of the pipe during blasting operation, shall be removed by suitable means.
- Weld joints, sharp-edge projections; weld spatter and slag etc. shall be dressed prior to blast cleaning.
- Using dry blasting techniques only, the exterior surface of the pipe joints shall be abrasively cleaned to remove all mill scale, and other impurities from the surface.
- No blast cleaning shall take place when the prevailing relative humidity is higher than 85 percent unless pipe is preheated to at least 3° C above the dew point.
- Twice per shift, samples of the abrasives mixture shall be removed from the hopper and checked for hydrocarbon contamination. The sample shall be placed in a beaker to which de-ionized water is added. The beaker shall then be sealed and shaken vigorously. Once the grit has settled the surface of the water shall be examined for signs of hydrocarbon contamination. If any signs are found all the abrasive in the hopper shall be rejected and not re-used.
- Additionally, abrasive materials shall be checked at least once per shift to ensure that only uncontaminated angular grit with an acceptable size distribution is used.
- As a minimum the following shall be carried out.
 - Correct abrasive size distribution shall be carried out by sieve analysis.
 - Placing a sample of abrasive on a clean, dry sheet of absorbent paper to determine water contamination.
- The surface of the pipes shall be blasted until a finish of Grade 2.5 to DIN EN ISO 8501-1 is attained. The surface profile shall be between 50 to 75 microns, measured in accordance with DIN EN ISO 8503-2. Profile measurements shall be made with a Keane Tator Profile Comparator, Testex Press –O-Film or other Engineer approved method suitable for the abrasive being used.
- Following abrasive blasting, the surface shall not be contaminated with dirt, dust, metal particles, hydrocarbons, water, chlorides, sulphates or any other foreign matter, which would be detrimental to the coating.
- Prior to the coating application, the exterior surface shall be thoroughly inspected under adequate lighting. Any damage such as surface imperfections, slivers, scabs, burrs, gouges, or sharp edged defects, shall be repaired in accordance with this specification. Pipes that have damage repaired by grinding and have ground areas greater than 50 mm diameter shall be re-blasted to meet the requirements. After grinding or mechanical repairs the wall thickness shall be ultrasonically examined and compared with the minimum requirements of the applicable code / standard.
- Any dust or loose residue that has accumulated during blasting and/ or grinding operations shall be removed by the use of clean compressed air or by vacuum extraction. Alternative methods for removing dust and lint shall require approval of the Engineer.
- The elapsed time between the start of blasting and the heating of pipe shall be indicated in the application procedure submitted by the Pipe Coating Contractor and shall be reflected on his plant scheme.
- The total elapsed time between the start of blasting of any pipe and the heating of that pipe to the specified temperature shall not exceed the following time-humidity table:

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.
- Note : The Method of Blasting will be finalized at the time of execution based on site condition.

13.0 COATING APPLICATION

General

- The application of the coating shall be in accordance with the material manufacturer recommendations and the procedure outlined below.
- The Pipe Coating Contractor shall perform coating procedure qualification testing (PQT) prior to commencing production or on his own risk at the start of production in accordance with this specification.
- 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 off.

FBE Layer

- The FBE shall be applied to a minimum thickness of 200 microns.
- The pipe shall be uniformly preheated in accordance with the FBE manufacturer's instructions. This temperature shall have been confirmed during PQT. The surface temperature shall not exceed 260 deg C in accordance with AWWA C213.
- Pipe temperature shall be checked periodically using pyrometer. The pyrometer shall be checked for error not less than every four hours against a calibrated temperature measuring instrument.
- The coating shall be applied by electrostatic spray with the pipe at earth potential and the epoxy powder charged to high potential.
- The use of reclaimed FBE powder is only permitted if the reclaimed powder is screened to remove foreign or deleterious material before being reintroduced into the powder application system.
- The clean reclaimed powder up to a maximum of 20% shall be introduced back into the fresh virgin material by means of proportional weight.
- During application, the beveled ends and pipe bore shall be protected against mechanical damage and from contamination with coating material.

Adhesive Layer

- The adhesive shall be applied to a thickness of 200 microns.
- The adhesive layer shall be applied before gel time of the FBE has expired. Application of the adhesive shall not be permitted after the FBE has fully cured. The Pipe Coating Contractor shall establish to the satisfaction of the Engineer that the adhesive is applied within gel time window of the FBE and at the temperature recommended by the adhesive manufacturer. The Pipe Coating Contractor shall state the proposed minimum and maximum time interval between FBE and adhesive applications at the proposed pre-heat temperature.

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.

Nominal Size	Minimum Thickness in mm
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	Normal (n)	Increased (v)
≤ DN 100	1.8	2.5
> DN 100 to ≤ DN 250	2.0	2.7
> DN 250 to < DN 500	2.2	2.9
≥ DN 500 to < DN 1016	3.0	3.7

- A polyethylene layer cutback of 150 mm (+10/-10mm) 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 deg C before handling.
- The ends of the coating shall be chamfered and beveled to 30 to 45 deg
- Immediately after the coating is fully cured, pipe identification marks shall be re-applied o the coated pipe using a method approved by Engineer.

14.0 INSPECTION, TESTING AND CERTIFICATION

GENERAL

- In order to demonstrate that the manufacturer's proposed coating procedure is capable of meeting the specification, the Pipe Coating Contractor shall undertake coating procedure qualification testing (PQT) prior to commencing production, or at his own risk at the start of production. The pipe coating Contractor shall also be required to test the finished coating during production to demonstrate continued compliance with this specification. Details of all inspections and testing shall be fully documented in accordance with this section.
- All states of the surface preparation, coating and testing shall be subject to 100% inspection by the Pipe Coating Contractor. The Engineer shall be informed at least two weeks prior to the start of surface preparation to allow scheduling of inspection supervision work.

Coating Procedure Qualification Testing (PQT)

- Prior to commencing or at the start of full production five pipe joints of each diameter coated with FBE only, five pipe joints of each diameter with the full coating system amd one pipe partially coated with epoxy and adhesive shall be selected for PQT. All coating shall be in accordance with the coating procedure specifications and shall be witnessed by the Engineer or its representative.
- The produced pipes will not be released until the successful results of the PQT can be provided. In case of long-term tests the PQT report shall be updated once the results can be provided. Any failure in meeting the specified acceptance criteria for the PQT will result in rejection of the coated pipes. Engineer shall approve any remedial action, repairs or re-use.
- The test methods for all tests required for PQT on the FBE and the complete coating system shall be performed in the same manner as the production tests described in this specification.
- Pipes selected for PQT testing shall pass all the criteria containing before production commences.
- Any change in the coating material or coating procedure shall require re-qualification.

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

PQT Inspection and Test Summary

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

Sr. No.	Property	Acceptable Values	Frequency of tests
1	On arrival		
	Visual inspection	No defect and damage	Each pipe
	Oil contamination	No oil contamination	Each pipe
2	After abrasive blasting		
	Degree of cleanliness	SA 2.5	Each pipe
	Surface roughness profile	50 – 75 μm	Each pipe
	Chloride test	2 mg/cm ²	Each pipe
	Dust contamination	Maximum rating 3	Each pipe
	Quality of abrasive mix	No hydrocarbon	Twice per day
3	FBE and Adhesive		
	FBE Layer thickness	Min 200 micron	Once in party coated
	Adhesive layer thickness	Min 200 micron	Once in partly coated
	Holiday test	No holiday	Each pipe
	'X' cut adhesion test	Any disbondment shall be ignored	Each pipe
4	3LPE Coating		
	Coating thickness	Min. 3 mm on body and 2.7 mm on weld	Each pipe
	Visual inspection	Free from any scratches and pin holes	Each pipe

		having uniform color finish	
	Holiday inspection	No holiday	Each pipe
	Impact strength	No holiday on impact area	Each pipe
	Elongation	Min 300 %	2 nos per pipe
	Cathodic disbondment	As specified	2 nos per pipe
	Indentation hardness	Maximum 0.2mm at 23±5°C & Maximum 0.3mm at 70±2°C	2 nos per pipe
	Peel test at both end	>100 N/cm minimum at 23±5°C >50 N/cm minimum at 50±5°C	2 nos per pipe

PRODUCTION TESTING

- Production testing shall be performed at the frequency shown below:

Sr. No.	Property	Acceptable Values	Frequency of tests
1	On arrival		
	Visual inspection	No defect and damage	Each pipe
	Oil contamination	No oil contamination	1 in 50 pipes
2	After abrasive blasting		
	Degree of cleanliness	SA 2.5	Each pipe
	Surface roughness profile	50 – 75 μm	1 in 20 pipes
	Chloride test	2 mg/cm^2	Each pipe
	Dust contamination	Maximum rating 3	1 in 20 pipes
	Quality of abrasive mix	No hydrocarbon	Twice per day
3	FBE and Adhesive		
	FBE Layer thickness	Min 200 micron	Twice per shift
	Adhesive layer thickness	Min 200 micron	Twice per shift
	Holiday test	No holiday	Twice per shift
	'X' cut adhesion test	Any	Twice per

		disbondment shall be ignored	shift
4	3LPE Coating		
	Coating thickness	Min. 3 mm on body and 2.7 mm on weld	Each pipe
	Visual inspection	Free from any scratches and pin holes having uniform color finish	Each pipe
	Holiday inspection	No holiday	Each pipe
	Impact strength	No holiday on impact area	Each pipe
	Elongation	Min 300 %	2 nos per pipe
	Cathodic disbondment	As specified	1 pipe last pipe and 1 in 500 pipes
	Indentation hardness	Maximum 0.2mm at 23±5°C & Maximum 0.3mm at 70±2°C	Twice per day
	Peel test at both end	>100 N/cm minimum at 23±5°C >50 N/cm minimum at 50±5°C	1 in 25 pipes at both end

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

HOLIDAY DETECTION

FBE Layer:

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

FINAL COATING:

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

➤ The detector shall be a type, which maintains complete contact with the coating. It may be either constant or pulsed voltage type. If constant voltage type, holiday

detection shall be carried out on a dry coating. The operating voltage between electrode and pipe shall be checked at least twice per working shift, and shall be maintained at 10 kilovolt/mm of coating thickness.

- The Pipe Coating Contractor shall demonstrate to the Engineer that the setting of the detector is satisfactory for detecting pinhole defects. This setting shall be checked once every two hours. The correct travel speed shall be determined by consistent detection of an artificial pinhole made in a good coating sample but shall not exceed 300 mm/s.
- All holidays and other defects shall be marked for subsequent repair and re-testing. On retesting, no holidays shall be permitted in the final coating.
- The number of holidays for each pipe length shall be recorded. Coated pipe having holidays in excess of 1 per 1 square meter shall be stripped and re-coated.
- If there is an excess occurrence of holidays on successive pipes, the Pipe Coating Contractor shall immediately stop the coating operation to determine the cause and remedy it.

15.0 ADHESION (PEEL) TEST

FBE Layer:

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

Final Coating:

- The adhesion for the complete coating shall be determined in accordance with the requirements for bond strength in DIN 30670. The relevant test temperature and acceptance criteria for these tests shall be as specified. Automatic chart recording equipment shall be used and the average peeling force shall be recorded.
- The failure mode shall be recorded. The failure should occur at the adhesive/polyethylene interface or adhesive/FBE interface or cohesively in the polyethylene layer. If failure should occur at the FBE/steel interface this will be considered a total failure of the system.

Impact Test

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

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 $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and $70^{\circ}\text{C} \pm 2^{\circ}\text{C}$) in accordance with DIN 30670

- Indentation depth shall not exceed 0.2mm at 23°C ± 5°C or 0.3mm at 70°C ± 2°C.

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 300% - on each of the full system pre-qualification pipes, 2 samples per pipe to the requirements of DIN 30670.

Other DIN 30670 Tests

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

CATHODIC DISBONDMENT TEST

- Cathodic Disbondment testing shall be conducted:
- As a pre-qualification test - 48 hours duration at 65 +/- 2°C as a pre-qualification test - 28 days duration at 23 +/- 2°C
- As a production test - 48 hours duration, at the frequency of one test per 50D coated pipes at 65 +/- 2°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 +/- 2°C and the 2 days test at 65 +/- 2°C.
- The Pipe Coating Contractor may propose alternative Cathodic disbondment test standards provided the essential requirements of this specification are retained. Any such alternatives shall be submitted to the Engineer for review and approval.
- Every 24 hours the applied voltage and current flow shall be recorded. Any drift from the specified voltage setting shall be corrected.

COATING REPAIRS

- The Pipe Coating Contractor shall submit detailed coating repair procedures for approval by Engineer. These shall include procedures for repair or 'pin-hole', 'small area' and 'large area' defects. The minimum and maximum areas for which each type of repair is applicable shall be stated taking into consideration the below mentioned requirements.
- The maximum number of coating defects allowable, before a joint of pipe shall be classed as rejected and recoated, shall not exceed 1 per 1 square meter (exclusive of damage caused by testing).

Repair areas of sizes < 5 mm²

- 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.

Repair areas of sizes > 5 mm² up to < 250 mm²

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

Repair areas of sizes 250 mm² up to 625 mm²

- Heat shrink-wrapping pipe sleeves shall be used for repair according to the following procedure:
- Thoroughly clean the area to be coated
- Bevel the extremities of the mill-coating with a rasp Pre-heat the area to be coated to a temperature of approximately 700C.
- Install the sleeve over the area to be coated
- Warm the shrink sleeve to a temperature above 150OC with a propane torch or a warm-air ring.

Repair areas of sizes exceeding 625 mm²

- No single defect shall exceed an area or 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 in accordance as specified.
- The Pipe Coating Contractor shall submit coating stripping procedure for pipes rejected for coating quality. The rejected coating may be stripped by heating in an oven. Under these circumstances, the temperature of the pipe joint shall not be allowed to rise above 400 OC.

16.0 HANDLING, TRANSPORT AND STORAGE

- The Manufacture shall be responsible for any damage occurring to the pipes from unloading to reloading on the relevant transportation means.
- The Manufacturer shall consequently:
 - inspect the bare pipes upon delivery to check that they have suffered no previous damage,
 - take all necessary precautionary measures to prevent any deterioration during the following operations:
 - handling,
 - transfer tot storage yards.
 - storage,
 - loading of pipes for shipment.
- All repairs and inspections shall be at the Manufacturer's expense.

Handling

- The pipes shall be handled without causing damage to the pipe bevels and coating.
- Direct contact steel or hamp slings or with any material whose shape or nature may deteriorate the pipe coating shall be strictly prohibited. Polyamide slings or hooks fitted with thermoplastic protection may be used.
- Use of electromagnetic device is recommended.

Transfer to Storage Yard

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

Storage Yard of the Manufacturer

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

Pipe Loading for Shipment

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

End Caps

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

REPAIR OF COATING

- MANUFACTURER shall submit to PURCHASER, its methods and materials proposed to be used for executing a coating repair and shall receive approval from PURCHASER prior to use. In open storage the repair materials must be able to withstand a temperature of at least (+) 800C without impairing its serviceability and properties. MANUFACTURER shall furnish manufacturer's test certificates for the repair materials clearly establishing the compliance of the repair materials with the applicable coating requirements indicated in this specification.
- All repair material will be of Class C.70 as specified in the relevant DIN Standard.
- All pipe coating plan, shall have sound external with no holiday or porosity on 100% of the surface.
- Defects, repairs and acceptability criteria shall be as follows:
- Pipes showing porosities or very small damage not picked up during holiday test and having a surface less than 0.5 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 rebuilt as per approved method and without exposing to bare metal.
- Defects of size exceeding the above and mentioned area of or holidays of width less than 300 mm shall be repaired as per approved method by exposing the bare metal surface.
- Defect exceeding the above and in number not exceeding 2 per pipe and their length not exceeding 500 mm shall be repaired as per approved method.
- Pipes with bigger damage shall be stripped and recoated.
- In case of coating defect close to coating cut back, MANUFACTURER shall remove the coating throughout the entire circumference of the pipe down to the steel

surface and increase the coating cut back length. Now, if the coating cut back exceeds by 30 mm than the specified cut back length, then the coating shall be repaired as per approved method thereby making up the coating cut back length as per specification.

- In case the defect exceeds 70 mm from the original coating cut back length, the entire coating shall be removed and the pipe shall be recycled through the entire coating procedure.
- Irrespective of type of repair, the maximum number of repair of coating shall be as follows:
 - Holiday repair of size $\leq 100 \text{ cm}^2$ 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 MANUFACTURER.
 - Cosmetic damages occurring in the polyethylene layer only need not be repaired by exposing up to steel surface, as deemed fit by the PURCHASER. In any case the MANUFACTURER shall establish his material, methods and procedure of repair that result in an acceptable quality of product by testing and shall receive approval from PURCHASER prior to use.
 - Testing of repairs shall be in the same form as testing coating. All repairs shall result in a coating thickness no less than the parent coating thickness.
 - MANUFACTURER shall test repairs to coating as and when required as and when required by PURCHASER.

REPAIR MATERIAL

- 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 Purchaser.
- Any combination of epoxy, adhesive and polyethylene shall be tested and certified by an internationally recognized agency.
- In case the MANUFACTURER 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 PURCHASER. Such materials shall not be used for coating and shall be removed from site and replaced by MANUFACTURER at his expense.

17.0 INTERNAL COATING: SOLVENT FREE FOOD GRADE EPOXY LININGS

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 in accordance with BS 6920/NACE RP-01-75/AWWA C210-97/CAN-CSA Z 245:21 or clients specifications.

Internal coating system

➤ The internal food grade solvent free epoxy coating system of chemically cured resin(epoxy) & hardener(curing agent) mixed in the ratio as recommended by the manufacturer and applied to a dry film thickness of minimum 406 micron. Physical properties of internal coating material as follows.

Sr. No.	Property	Requirement	Test method
1	Long term contact with potable water	Long term contact with potable water. No effects for human consumption as certified by NSF	NSF/ANSI 61
2	Thickness	406 micron min.	SSPC-PA-2
3	Dielectric strength	450 V/mil	ASTM D149
4	Hardness shore D	85 min.	ASTM D2240
5	Adhesion to steel	800 psi min.	ASTM D4541
6	Tabor abrasion	1560 cycles/min	ASTM D4060
7	Compressive strength	70 Mpa	ASTM C109

Coating Application

General

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

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

➤ Pipe Preparation 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 pipes 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 μ m to 75 μ m) measured in accordance with ASTM D-4417 and/or ISO 8503-4. For consistent surface finish, a stabilized working mix shall be maintained in abrasive recycling blasting machines by frequent small Addltions of new grit, shot infrequent large Addltions shall be avoided. The abrasive working mix, abrasive recycling blasting machines shall be maintained clean of contaminants by continuous effective operation of blasting machine scalping and air-wash separators. The cleaned interior pipe surface shall be inspected for adequate surface preparation. Surface imperfections such as slivers, scabs, burrs, weld spatter and gouges shall be removed by hand filing or grinding if necessary to prevent holidays. Blast-cleaned pipe surfaces shall be protected from conditions of high humidity, rainfall or surface moisture. No pipe shall be allowed to flash rust before coating. To ensure a dry pipe surface at the time of liquid epoxy application, the minimum steel substrate temperature shall be 10°C and at least 3°C above the dew point.

Coating Application A. Main Pipe Line

➤ 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 predetermined 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 150 mm.

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 deg C. Coating materials shall be of RMC approved make only.

➤ 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.

➤ 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

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

- A visual examination of the surface to be coated shall be carried out and any slivers or similar deposits removed.
- Prior to blasting all oil and grease shall be removed from the surface to be coated.
- Preparation of steel surfaces for both factory and site application shall be to a minimum of Sa 2.5 accordance with BS 7079/ ISO 8501-1:2007 specifications /or as per client specifications and roughness should be 50-75 micron.
- 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.
- 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.
- The coating shall have a minimum DFT (Dry Film Thickness) of 406 microns.
- Coatings shall be used within the pot life specified by the manufacturer.

- 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.
- Inspection and testing shall be detailed in the contractors Quality Plan and as a minimum undertaken to the following frequencies:
 - Visual Inspection of blasted profile on every pipe to be coated.
 - Visual inspection of finished coating on every pipe.
 - Measurement of coating thickness at four points on each pipe.
 - Each completed pipe shall be subjected to holiday detection tests which shall be carried out to the satisfaction of the Engineer. The applied voltage shall be those appropriate to the coating under test as recommended by the coating material manufacturer.
- Peel Test as per Manufacturers standard specification shall also carried out.

PRESERVATION, MARKING AND SHIPPING PRESERVATION

Preservation

- Cutback of minimum 150 mm +/- 10mm shall be provided over both ends of pipes on internal coating . The bare ends of each pipe shall be painted outside with a removable vanish as temporary corrosion protection during transportation.
- Spiders and/or Bevel protectors of a type to be approved by the Engineer shall protect the bare ends of each pipe. Spiders shall be welded with pipes in such a way that inside coating do not get burnt.

Marking

- In Addltion 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 color coding etc. shall be agreed upon with the Engineer.
- The marking shall have at least a distance or 150 mm to the pipe end.

Shipping

- Shipping and Loading preparation shall be in accordance with API Specification 5L or otherwise stated in the contract documents.
- The Pipe Coating Contractor shall submit detailed loading, stacking- and shipping procedures for approval by the Engineer.

18.0 DOCUMENTATION

Pre-Production Documentation

- The Pipe Coating Contractor shall submit the following documents to the Engineer for approval prior to commencing production:
 - The manufacturer's trade name and data sheets for all proposed coating Materials. This includes cleaning and abrasive blasting consumables.
 - Procedure for identifying or maintaining the identification of each coated item.
 - Handling procedure.
 - Stacking procedure.
 - Materials control and traceability procedure for the batches of coating materials.
 - Materials storage procedure (pipe and coating materials)
 - Procedure for steel surface preparation including materials, cleaning, inspection, verification of cleanliness and surface profile.
 - Coating application procedures, including fusion bonded epoxy (FBE). Adhesive and polyethylene layers.
 - The results of the batch tests for batches to be used for pre-qualification tests.
 - Details of testing methods including instrument types and copies or current calibration certificates.
 - Details of inspection methods for bare and coated pipe.
 - Full test results from the coating Procedure Qualification Test (PQT).
 - Repair procedure and results or tests on demonstration of repairs.
 - Project specific Quality Plan.
 - Work shall not commence until these procedures have been reviewed and approved by the Engineer.
 - The selection of proposed coating materials shall be subject to Engineer's approval.

Production Records

- A daily log containing the following data shall be maintained and be available for inspection by the Engineer 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
 - e) Tests for cleanliness of blast surface
 - f) Tests for cleanliness or blast medium
 - g) Film thickness measurements
 - h) Average, maximum and minimum coating thickness during each shift
 - i) Details of any coating defects recorded and defect density on respective pipe lengths
 - j) Details of any coating repairs
 - k) The unique identification number of all items that are stripped for recoating

- l) Pipe coating test results
- This log shall be available to the Engineer throughout all coating operations

Release Documentation

- The Pipe Supplier and/or Pipe Coating Contractor shall submit to the Engineer the following documentation in hard copy and softcopy (format to be agreed upon with the Engineer) with each batch of pipes released:
 - a) Mill certificates for line pipe
 - b) Production listing for each batch
 - c) Unique pipe identification numbers
 - d) Unique coating identification number (if different)
 - e) Pipe length
 - f) Length of the coated portion of each pipe and total coated lengths of all pipes.
 - g) Reductions in lengths due to use in tests, damage or repairs, recorded against pipe unique identification number
 - h) Date of coating
 - i) 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.

19.0 TRANSPORTING OF PIPES, SPECIALS etc.

- All pipes and specials fabricated in the site factory / workshop 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 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 shall be adopted. The material stacked at site shall be jointly inspected by the Engineer and the Contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is admitted.
- Props of approved designs for maintaining circularity having M.S. Angle/Pipe at both ends to avoid metal to metal contact shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props should be retained till pipes are joined in trenches and then props are re-used for subsequent similar 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 Coils 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.

➤ 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 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 specials, 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.

20.0 PROCEDURE FOR RECEIVING STEEL PIPES

General

➤ To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug Coils, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

Stacking of Pipes, etc. and Inspection

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

Handling of Pipes, Special 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 as described earlier 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 and welded. 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. No defective or damaged pipe or special shall be allowed to be used in the work without rectification to the satisfaction of the Engineer. Any damage to the coating shall be repaired by the Contractor at his own cost to the satisfaction of the Engineer.

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 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.

Item 80:

Lowering, laying, jointing & welding in position to correct line & level M.S Pipe with outside 3 LPE coating & inside solvent free liquid epoxy lining on pedestal or chairs upon prepared formation or prepared bedding in trenches the rated include conveyance from store to site of work loading, unloading, heat shrink sleeve jointing hydrotesting etc. complete

General

- 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 outside coating of pipe is not damaged in anyway during the lowering and assembling
- After the pipe is lowered into the trench, it shall be laid in correct line and level by using the leveling instruments, sight rails, theodolite, etc. Care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends in perfect contact and alignment. It may also be necessary to use jacks for this purpose. In no case shall hammering or longitudinal slitting be permitted. When the pipe is properly assembled and checked for correct line and level, it shall be firmly supported on wooden beams and wedges and tack welded. Some portion of the trench may be refilled at this stage so as to prevent the pipeline from losing its alignment. The tack welded circumferential joints shall then be welded fully. Only experienced welders, who shall be tested from time to time shall be permitted to carry out the welding work.
- On completion of the pipe jointing and external protection, the trench shall be cleaned of outside coating rebound. The welding shall be filled and compacted in 150mm layers with the bedding material. Backfilling shall be carried out as detailed here under.

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.
- 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.

CLEANING, DISINFECTIONING AND COMMISSIONING OF THE PIPELINE

- Upon completion of a newly laid main, the main shall be disinfected as directed by the Engineer.
- The main shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solution may be fed with a hand pump.
- In the case of main of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipeline is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'Slug' of chlorinated water that will as it passes along the line expose all interior surfaces to a concentration of at least 300 mg/l. for at least 3 hours. As the chlorinated water flows past tees and crosses related valves and hydrants shall be operated so as to disinfect the appurtenances.
- In the case of newly laid mains in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for at least 24 hours.
- After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the mains is not higher than that generally prevailing in the system or less than 1 mg/l.
- After final flushing and before the water main is placed in service, a sample or samples of water shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to

produce satisfactory samples, disinfection shall be repeated until satisfactory, samples are obtained before the main is placed in service.

- The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works till the main is placed in service, unless otherwise specified in the schedule.
- Unless specified otherwise, the pipeline shall be buried with minimum cover at top, directed by Engineer-in-charge. No material shall be erected unless it has been previously passed by the Engineer.
- Inspection and Test plan for Laying of Pipeline shall be approved before start of Laying work.
- Pipe shall be protected from outside with rock shield mesh/soft murrum/Sand wherever required/as directed by Engineer-In -Charge. In such cases, the depth of soft murrum/sand shall be 300mm above top of pipe.
- 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.

Field Welded Joints

- Before Start of Laying of Pipeline, WPS/PQR/WPQ shall be approved as per ASME SECTION X Latest edition for welding of Pipeline.

Welding

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

Field Welded Joint UT/RT Test:

- For Field welded joints, 100% of each welded joint shall be examined by Ultrasonic Test. The ultrasonic test shall be conducted as (As per API 5L or ASME SECTION V or API 1104). The person who conducts the test shall have certificate of ASNT Level-2 as per SNT-TC-1A for Ultrasonic testing and 15% (Or as required by Engineer-in-charge) weld length of each welded joint shall be examined by Radiography Test (As per API 5L or ASME SECTION V or API 1104)
- In case of failure of any of the joint during RT, the contractor is to carry out radiography of thrice the number of field joints which includes 1 Repair and 2 Penalty shots.

- Subsequent to RT of thrice the number of field joints, if anyone of the joint fails the contractor has to carry out RT of all field welded joints i.e. 100 % basis. All these testing's shall be carried out by the contractor at his own risk and cost
- 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 Engineer based on the latest standards prescribed by Indian Standard specification will judge the radiographs as acceptable or unacceptable.
- 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. The Contractor shall provide for the use of the Engineer 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, the Radiographer at the discretion of the Engineer shall perform such inspection.

Radiographic Inspection

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 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 shall ensure himself that only qualified welders and welding operators have been used.
- The Contractor shall make available to the Engineer a certified copy of the records of the qualification tests of each welder and welding operator. The Engineer 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.

Radiographic Inspection of welded joints

- All welded joints to be radiographed shall be examined in accordance with IS : 2595- Code of Practice for Radiographic Testing

- IS : 4853 Recommended Practice for Radiographic Inspection of Fusion Welded Butt joints in Steel Pipes.
- IS :1182 Recommended Practice for Radiographic Examination of Fusion Welded Butt-Joints in steel Coils.
- 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 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 pentameter image and the specified hole.
- The acceptance criteria for radiography of the joint shall be as per API 5L or as per API -1104 standard.

Testing of Site Welded Joints

- The welded joints at site shall be tested for Tensile test and Bend test in accordance with procedure laid down in as per the latest edition of IS 3600 "code of procedure for testing of fusion welded joints and weld metals in steel".
- Test pieces shall be taken by the contractors from the welded joints at the position on fabricated pipes pointed out by the Engineer in-charge.
- 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. All the work up to and including machining and arranging for test shall be done by the contractors.

Field Destruction Test

- Contractor shall perform destruction test of any section of MS Pipeline which Engineer selects at every 5 KM pipeline laid and shall submit its result to him. The testing shall be done in the NABL approved laboratory in the presence of representative of the employer.

Temperature

- The components of the pipeline such as base Coils, top Coils and pedestals have been so designed that the centres of the Coils and pedestals shall coincide at the Mean Temperature (30o).
- For this reason, all works such as fixing flanges, base plate etc. in true alignment and in correct position and tack welding pipes shall be done at the mean temperature.
- For ascertaining the temperature, the Contractor shall provide mercury cups and fix them to the pipe shell from outside and shall also provide thermometers of the required type and range. No extra payment shall be made for this.

Saddle supports

- Unless otherwise specified pipeline shall be underground. However at unavoidable reaches it shall be on R.C.C. saddles spaced at about 6 m center to center. 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. 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.

Erection of Shells

- The erection shall be true to position, lines and grade of the trench prepared or as modified by the Engineer. 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 shells 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	<u>Lesser of 0.0625 t or 10 mm</u>	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 shells. 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.

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 specified. The distance between successive fixity points shall not exceed 300 m.
- Thrust and 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.
- 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 strakes shall be assembled in position on the saddles either by the cranes, portable gantries, shear legs or any other equipment approved by the Engineer. 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 strakes 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.

Fixing Expansion Joint

- The work of laying pipeline at above the ground, 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 strake 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 strake 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.
- 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 turn buckles. 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 as specified .

➤ (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 600 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.

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 Performa;

Reading No.	Time	Shell temp on upstream side	Shell temp on Downstream side	Atmospheric Temperature	Dist. between edge of gland and marking
1	2	3	4	5	6

- In case the pipeline is laid in trenches as shown on the drawing, after welding and field testing, the trench shall be filled with selected material up to 300 mm above pipes. This backfill shall be provided in layers not more than 150 mm, with a density more than 70 to 80% of the standard proctor density. Samples shall be tested as directed by the Engineer. Remaining depth of trenches shall be filled with ground backfill material.

Specials

General

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

Bends

- Bends shall be fabricated taking into account the vertical and horizontal angles for each case.
- The bends shall have welded joints and the upstream and downstream ends of each bend shall have a straight piece of variable lengths as required.
- Bends shall be designed with deflection angle of maximum 10 deg. 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 Coils should be furnished together with full specifications in Contractor's fabrication drawing.

Manholes

- Manholes of 750-mm dia shall be provided at both the sides of butterfly valves and as directed by Engineer-In-Charge. Manholes in the pipeline shall be placed in suitable position in the top quadrant.
- The Contractor shall fabricate different parts of manhole in conformity with relevant IS Specification, well-established practices and as directed by the Engineer.

Closing or Make up sections

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

Heads

- Test heads may be ellipsoidal, standard dished as per ASME code or hemispherical heads. They shall be welded in the shop and removed after the test. Allowance should be made in the length of the pipe section receiving the test head for the welding and removal of the head and preparation of the plate edges for the final weld after testing.
- No separate payment will be made for such test heads. The rate quoted for the hydraulic test shall be deemed to cover the cost of such installations.

Walkways, Stairs, Ladders, Hand Rails etc.

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

Flanges

- Flanges shall be provided at the end of pipes or special where 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 sluice 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, the Contractor shall provide and weld gusset stiffeners, as directed on site. The drilling pattern shall be matching with the drilling pattern of flanges of valves.

Blank Flanges

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

Stiffener Rings

- The Contractor shall provide stiffener rings wherever required by design. The Contractor shall weld the same to the pipes with one circumferential run on each side.
- All fillet welds shall have a throat thickness of not less than 0.7 times the width of welding.

Field Joint Coating : Heat Shrink Sleeve (HSS)

Scope

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

Reference Documents

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

a)	ISO 8502-3	Preparation of Steel Substrates before Application of Paints and Related Products – Part 3 – Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure Sensitive Tape Method)
b)	ISO 8503-1	Part 1 Specification and definitions for ISO surface profile comparator for the assessment of abrasive blast cleaned surfaces
c)	ISO 8503-4	Part 4: Methods for calibration of ISO surface profile Comparator and for the determination of surface profile - Stylus instrument procedure.
d)	SIS 055900	Pictorial Surface Preparation Standard for Painting Steel Surfaces.
e)	SSPC- SP1	Steel Structure Painting Council
f)	ASTM D149	Standard Test Method for Dielectric Breakdown Voltage & Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

g)	ASTM D257	Standard Test Methods for DC Resistance or conductance of Insulating Materials
h)	ASTM D570	Standard Test Methods for Water Absorption of Plastics

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

Materials And Equipment

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

Heat shrinkable wraparound sleeves:

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

Pipe size (specified outside diameter)	Thickness (mm)
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	On Pipe Body	On Weld Bead
	Min	Min.
<30" (762.0mm)	2.5	2.0
>32" (813.0mm)	3.3	3.0

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

Functional Requirements of Field Joint Coating

- Properties of the PE backing shall be as follows:

Sr. No.	Properties	Unit	Requirement	Test Std.	Method
a.	Tensile Strength @ +25° C	N/mm2	≥15	ISO 527-3	
b.	Ultimate Elongation @ +25° C	%	≥400	ISO 527-3	
c.	Dielectric withstand with 1000 Volts/Sec	kV	≥30	ASTM D149	
d.	Water absorption @ +25° C for 24 hours	%	≤0.05	ISO 62	
e.	Electrical Volume Resistivity @ +25° C	Ohm-cm	≥10 ¹⁵	ASTM D257	

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

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

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

Cut back

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

Application Procedure

General

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

- Relative Humidity (RH) >80% - 2 hours
- Relative Humidity (RH) 70-80% - 3 hours

- Relative Humidity (RH) <70% - 4 hours

- Pipes delayed beyond this point or pipes showing any visible rust stain, shall be blast cleaned again.
- The field joint surface shall be inspected immediately after blast cleaning and any feature of the steel surface such as weld spatter, scabs, laminations or other imperfections considered injurious to the coating integrity, made visible during blast cleaning, shall be reported to the Company Representative and on permission from Company Representative, such defects shall be removed by filling or grinding. Pipes affected in this manner shall be then re-blasted cleaned if the defective area is larger than 50mm in diameter.
- The ends of existing pipe protective coating shall be inspected and chamfered. Unbounded portions of the coating shall be removed and then suitably trimmed. Portions where parent coating is removed shall be thoroughly cleaned as specified. The adjacent chamfered areas of the line pipe coating shall be cleaned and abraded, to expose a clean uniform fresh surface of uncontaminated factory applied coating.
- All steel joint surfaces shall be thoroughly examined before the application of the coating in order to ensure the surfaces are free of oil, grease, rust, mud, earth or any other foreign matter. All these substances shall be removed before coating, to the procedures herein described.
- Protection coating shall be applied on the joints immediately after the completion of cleaning operation.

Application Procedure for Heat Shrink Wraparound/Sleeves

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

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

➤ A heat shrinking procedure shall be applied to shrink the sleeve in such a manner to start shrinkage of the sleeve beginning from the centre of the sleeve and heat circumferentially around the pipe. Continue heating from the centre towards one end of the sleeve until recovery is completed. In a similar manner, heat and shrink the remaining side. Shrinking has been completed when the adhesive begins to ooze at the sleeve edges all around the circumference.

➤ The complete shrinking of the entire sleeves shall be obtained without undue heating of the existing pipe coating and providing due bonding between pipe, sleeve and pipe coating. The installed sleeve shall not be disturbed until the adhesive has solidified.

➤ The joint coating application shall be done under supervision of the manufacturer's personnel during the field trial demonstration and testing work. Presence of manufacturer's representative is a mandatory requirement and bidders are required to furnish specific commitment to this. Minimum 50 (fifty) field joint coating to be carried 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

➤ If a field joint is detected to be unacceptable after testing as per relevant QA section of this specification the Contractor shall, at his own cost:

➤ Determine the cause of the faulty results of the field coating.

➤ Mobilize the expert of manufacturer, if required.

➤ Test to the complete satisfaction of Company, already completed field coatings.

➤ Stop the field coating works until remedial measures are taken against the causes of such faults, to the entire satisfaction of the Company.

➤ Contractor shall replace all joint coating found or expected to be unacceptable as per relevant section of this specification.

➤ Contractor shall, at his own cost, repair all areas where the coating has been removed for testing by the Company.

➤ After the coating work on welded joints and repairs to the coating have been completed the coating as a whole shall be tested with a spark-tester before lowering or jacking the pipeline.

➤ Employer shall be entitled to check the coating on buried pipelines or parts of pipelines 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

➤ Prior to procurement of coating materials, Contractor shall furnish the following information for qualification of the Manufacturer and material.

➤ Complete information as per DIN EN 12068 along with descriptive technical catalogues.

➤ Test certificates and results of previously conducted tests, for all properties listed.

➤ Reference list of previous supplies, in last 5 years, of the similar material indicating the project details such as diameter, quantity, operating temperature, year of supply, project name, contact person and feedback on performance.

➤ Once the Employer's approval has been given, 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.

➤ Prior to shipment of materials from the Manufacturer's Works, Contractor shall furnish the following documents:

➤ Test certificates/results as per Manufacturer's Quality Control Procedure for each batch of material.

➤ Specific application instructions with pictorial illustrations.

➤ Specific storage and handling instructions.

➤ All documents shall be in English language only.

Specification For External Coating For Special Sections, Connections & Fittings Of Buried Steel Pipelines:

General:

➤ Special sections, miter bends, tees, connections, fittings in buried steel pipeline network shall be coated externally, with prefabricated polyolefin tape coating as per AWWA C 209-00. 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.

Referenced 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.

➤ ANSI/AWWA C209 - Standard for Cold Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

➤ ANSI/AWWA C214 - Standard for Tape Coating Systems for the Exterior of Steel Water Pipelines

➤ SSPC-SP 1 - Solvent Cleaning

➤ SSPC-SP 6/NACE No. 3 - Commercial Blast Cleaning

General:

➤ The buried steel pipeline special sections shall be protected with hand or manual machine applied cold applied tape protective coating conforming to AWWA C209 - 00 (Cold Applied Tape Coating Systems for Exterior of Steel Water Pipelines).

- Protective coating shall consist of a coating system consisting of primer, inner - layer tape and outer-layer tape. Work or material that fails to conform to this standard may be rejected at any time before final acceptance.

Coating system:

- The pre-fabricated polyolefin tape coating system shall consist of the following layers to provide an applied coating system thickness of 100 mils (2.5mm) on the exterior of the special sections of steel pipes.
- A liquid adhesive layer.
- An inner-layer tape for corrosion protection having thickness of 30mils and applied with 50% overlap
- An outer-layer tape for mechanical and UV protection having thickness of 20mils and applied with 50% overlap.

Liquid Adhesive layer:

- The liquid adhesive layer shall consist of a mixture of suitable rubber and synthetic compounds and solvent. The liquid adhesive layer shall be brush applied to the abrasive blasted prepared pipe surface before application of the inner-layer tape. The function of the liquid adhesive is to provide a bonding medium between the pipe surface and the inner-layer tape.
- The liquid adhesive shall be supplied by the manufacturer that supplies the inner-layer tape. The liquid adhesive shall not settle in the container forming a cake or sludge that cannot be easily mixed by hand or mechanical agitation and it shall have good machine-application properties.

Inner-layer tape:

- The inner-layer tape shall be a two-layer tape consisting of a polyolefin backing layer with a laminated butyl- based adhesive layer. The inner tape shall be compatible with the liquid adhesive. The manufacturer shall certify that the backing material shall be polyolefin only, containing not more than 3.5 percent, by weight, of non- polyolefin material consisting of carbon black and antioxidants. The inner-layer tape shall be applied after the liquid adhesive and before the outer-layer tape.
- The backing and adhesive shall be made from materials that provide high electrical resistivity, resistance to corrosive environments, low moisture absorption and permeability, and shall provide an effective bond to a primed steel surface. The inner-layer tape shall be of material that will resist excessive mechanical damage during normal application operations and shall be sufficiently pliable for the intended use. The inner-layer tape shall withstand, without tearing, the tensile force necessary to obtain a tightly wrapped inner coating free of voids. The inner- layer tape shall be supplied in roll form wound on hollow cores with a minimum inside diameter of 38mm.
- The thickness of the inner tape shall be 30mils.

- To ensure a proper smooth coating by hand or by manual hand wrapping machine, the inner-layer tape shall be provided in standard widths of 4” or 6” as per manufacturer recommendations consistent with the pipe diameter.

Outer-layer tape:

- The outer-layer tape shall be a two-layer tape consisting of a polyolefin backing layer with a laminated butyl adhesive layer. The manufacturer shall certify that the backing material shall be polyolefin only containing not more than 3.5 percent, by weight, of non-polyolefin material consisting of pigments, antioxidants and stabilizers. The outer layer shall be compatible with the inner-layer tape. The primary function of the outer tape layer is to provide mechanical protection to mechanical and outdoor weathering (UV) protection to the tape system, and secondarily, to contribute to the overall corrosion-protection properties of the system. The outer-layer tape backing shall be compounded so that it will be resistant to outdoor weathering.

- The outer-layer should be of suitable quality for the local environment, as follows:

- Storage Temperature : 0 to 500C.
- Over-ground Condition : 0 to 600C.
- Under-ground Condition : 70C to 350C.
- Ultraviolet-ray Protection : Required in outer layer.

- Materials used in the outer-layer tape shall have high electrical resistivity, low moisture absorption and permeability, and shall provide mechanical protection during handling and outdoor storage. The outer-layer tape shall be sufficiently pliable for normal application operations by hand or by manual hand wrapping machine and shall form an effective bond to the inner-layer tape. The outer-layer tape shall be supplied in roll form wound on hollow cores with a minimum inside diameter of 38mm. The thickness of the outer-layer tape shall be 20mils.

- To ensure a proper smooth coating by hand or by manual hand wrapping machine, the outer-layer tape shall be provided in standard widths of 4” or 6” as per manufacturer recommendations consistent with the pipe diameter.

Coating-system Thickness:

- The installed coating system thickness shall not be less than 100 mils (2.5mm) and shall comprise of the following.

- liquid adhesive layer (50-75 microns)
- An inner-layer tape (Nominal 30 mils i.e. 0.75mm) applied with 50% overlap
- An outer-layer tape (Nominal 20 mils i.e. 0.50mm) applied with 50% overlap

- The properties of the tape & coating system shall conform to the following requirements.

- Table– I - Physical Properties of Total System

Property	Requirement	
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	Minimum	Maximum
Thickness 100 mil, nominal	95 mil	105 mil
Dielectric breakdown	400v/mil	
Water-vapor transmission, max.	0.25 perms ([1.44ng/(Pa.s.m2)])	
Insulation resistance	500,000 mega ohms (min)	
Adhesion to Primed Steel	20 ozf/inch	

Coating Application

General:

The coating application shall be a manual operation starting with properly abrasive blasted pipe surface.

- Longitudinal & spiral welds of the pipe shall not exceed a height of 3/32 inch (2.4mm) above the pipe surface and shall be ground flush a full 18 inch (450mm) along the length of the pipe from both ends prior to the coating process.
- Steps, which shall be performed consecutively, shall consist of (1) liquid adhesive application by brush; (2) application of the inner-layer tape directly onto the prepared pipe surface with 50% overlap; and (3) application of the outer-layer tape directly on top of inner-layer tape with 50% overlap.

Pipe preparation:

Metal surface condition:

- Bare pipe shall be free from mud, mill scale, mill lacquer, wax, coal tar, asphalt, 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 sand to achieve a surface preparation at least equal to that specified in SSPC:SP6/NACE3. The blast anchor pattern or profile depth shall be 1 mil to 3 mils (25 µm to 75 µm) measured in accordance with ASTM D-4417.

- The cleaned exterior 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 adhesive application, the minimum steel substrate temperature shall be 21°C and at least 3°C above the dew point.

Coating Application:

Liquid adhesive application:

- The liquid adhesive shall be applied in a uniform thin film at the coverage rate recommended by the manufacturer. The liquid adhesive shall be thoroughly and continuously mixed and agitated during application to prevent settling. The liquid adhesive shall be applied to the entire exterior surface of the pipe by brush to cover the entire exterior surface of the pipe.
- The liquid adhesive coat shall be uniform and free from floods, runs, sags, drips, or bare spots. The liquid adhesive-coated pipe surface shall be free of any foreign substances, such as sand, grease, oil, grit, rust particles, or dirt.
- Before applying the inner-layer tape, the liquid adhesive layer shall be allowed to touch dry in accordance with the manufacturer's recommendation.

Application of inner-layer tape:

- The inner-layer tape shall be applied directly onto the prepared pipe surface by manual tape coating machine.
- When applied to spirally welded pipe, the direction of the tape spiral shall be generally parallel to the weld spiral. The minimum overlap shall not be less than 50%. When a new roll of tape is started, the ends shall be overlapped at least 150 mm measured circumferentially.

Application of outer-layer tape:

- The outer-layer tape shall be applied over the inner-layer tape using the same type of manual tape coating machine used to apply the inner layer tape. The overlap of the outer-layer tape shall not coincide with the overlap of the inner-layer tape. The minimum overlap shall not be less than 50%. When a new roll of tape is started, the ends shall be overlapped at least 150 mm measured circumferentially.

Material acceptance:

- Acceptance of the proposed coating materials shall be approved by the Owner / Owner's representative.
- The tape manufacturer proposed by the Contractor should have supplied at least 30% quantity of tape required for this project and as per this specification in a single contract for pipe diameter $\geq 900\text{mm}$ in the last five years.

- Work completing certificates from End User & coating applicator will be submitted by the Contractor while submitting credentials of the proposed tape manufacturer to the employer for approval.

Coating repair in field:

- All holidays visually or electrically discovered either at the coating plant or in the field shall be repaired by peeling back and removing the outer and inner layers from the damaged area. The exposed areas shall then be coated with liquid adhesive and either (1) a length of inner-layer tapes shall be wrapped around the pipe to cover the defective area; or (2) a patch of inner-layer tape shall be applied directly to the defective area as specified by the Owner's Representative. 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. If holidays are not found, the repaired area shall be covered with the outer-layer tape with a minimum over-lap of 100 mm beyond the inner-tape patch.

FIELD WELDED JOINT INTERNAL COATING: SOLVENT FREE FOOD GRADE EPOXY COATING

- All steel pipes welded joints 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 in accordance with BS 6920/NACE RP-01-75/AWWA C210-97/CAN-CSA Z 245:21 or clients specifications.

Internal coating system

- The internal food grade solvent free epoxy coating system of chemically cured resin(epoxy) & hardener(curing agent) mixed in the ratio as recommended by the manufacturer and applied to a dry film thickness of minimum 406 micron.
- Quality assurance Plan shall be submitted by agency for approval prior to Coating application started.
- Physical properties of internal coating material as follows.

Sr. No.	Property	Requirement	Test method
1	Long term contact with potable water	Long term contact with potable water. No effects for human consumption as	NSF/ANSI 61

		certified by NSF	
2	Thickness	406 micron min.	SSPC-PA-2
3	Dielectric strength	450 V/mil	ASTM D149
4	Hardness shore D	85 min.	ASTM D2240
5	Adhesion to steel	800 psi min.	ASTM D4541
6	Tabor abrasion	1560 cycles/min	ASTM D4060
7	Compressive strength	70 Mpa	ASTM C109

General

- All internal epoxy lining work for pipe welded joint shall be done at site using spray/ brush applied two component or by manual spray applied.
- Pipe Preparation Internal surface of the pipe shall be free from mud, mill scale, mill lacquer, wax, oil, grease or any other foreign material.
- The cleaned interior pipe joint 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.
- To ensure a dry pipe joint surface at the time of liquid epoxy application, the minimum steel substrate temperature shall be 10°C and at least 3°C above the dew point.

Coating Application:

- 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. Application of epoxy shall be applied directly to the MS pipe welded joint using spray/ brush applied two component or by manual spray applied with all necessary ancillary equipment.
- 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.
- The coating shall have a minimum DFT (Dry Film Thickness) of 406 microns. As per instructions of Engineer in charge, the internal coating of Field joint test must be carried out at site.

Field Hydraulic Test:

- After erection at site and after the concrete Thrust/anchor blocks have been constructed, the pipeline shall be subjected to a 100% hydraulic test. The pressure test shall be conducted in as per IS-5822.
- The Pipeline after lying at site shall be subjected to 100% Hydro testing. The test pressure shall be 1.5 times working pressure or 6 kg/cm² whichever is higher. The pressure

shall be maintained for a period of 24 hours/as per mentioned in relevant IS. The length of pipe for hydro testing shall be generally in full length or as directed by Engineer-In-Charge.

➤ During the test, the pipe shall be struck sharp blows with 1 Kg hammer. 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 Coils and other raw materials shall be carried out by the Contractor at his own cost. If any leakages are observed during the defects liability period due to defective workmanship or material supplied by the Contractor, he shall repair the same to the entire satisfaction of the Employer, at his own cost.

➤ Client shall assist the contractor in identifying the source & in obtaining permission for drawl of water for field-testing of pipe. The contractor shall pay for the water and carry the water to the test location at his cost. The cost of hydraulic testing of the installation by providing necessary testing equipment, pumping the water, creating and maintaining pressure, and the necessary bulk heads and their fixtures, and their subsequent removal and restoring the installation to working trim shall be included in the rate for laying and testing of the pipe.

Progress in Laying:

➤ The tenderer shall submit along with the tender his detailed bar chart for manufacturing and laying of the pipeline. While preparing his bar chart, the tenderer shall plan his 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 two months.

➤ It is mandatory that he shall submit an approach note on how he will carry out this Work within the contractual period and on the compatible resources in terms of construction equipment and other facilities that he shall utilize to complete the tendered Work.

Connection of Pipeline:

➤ Contractor shall carry out connection work of new laid pipeline with existing pipeline at both end in such a way that there is no obstruct in flow . Generally connection shall be “Y” type manner so that water flow divert easily in new pipeline. Necessary protection like thrust block shall be cast at both end connection for preventing pipeline from damage. Contractor also repair outside gunniting of old pipeline after connecting with new one.

DISTANCE INDICATORS AND MARKINGS

➤ The Contractor shall supply and fix indicators on either side of major crossings along the buried pipe line. Indicators shall consist of 10 cm x 10 cm precast concrete posts 1.25 meter long, set 0.75 meter into the ground and painted white above ground level. The description shall be written in blue at one face of the precast post.

- In case of the pipeline laid above ground details such as chain age, 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 color. The Bidder / Contractor shall include the cost of this in his rates for the other items.

Marking

- All field welded joints should be marked with KM No, Welder No, Joint No for identification with Yellow paint.

Item 50, 82:**C.I. D/F VALVES: BUTTERFLY VALVE:**

Providing and supplying ISI mark CI / D/F Butterfly Valves as per IS:13095 (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

Manually Operated Butterfly Valve:**General**

- This specification covers the design, engineering, manufacturer, transportation to site, installing, testing double flanged and wafer type of metal seated, dual eccentricity cast iron manually operated butterfly valves.
- Valves covered under this specification are manually operated. Fabricated valve will not be considered.

Design Criteria

- Butterfly valve shall be as per IS 13095 (ISI Marked).
- 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.
- 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.
- 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. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.
- Valve shall be suitable for throttling purpose. All valve, spindles and hand wheels shall be positioned to give good access for operational personnel.
- 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.

Service Applications

- Valves shall be suitable for one or more of the following applications. Tight Shut off- A valve having no visible leakage on the disc in closed position under test conditions.
- Regulating a valve intended for regulating purpose and which may have a Clearance between the disc and the body in close position.

Nominal Pressures

- Valve shall be designated by nominal pressure PN – 1.6 at ambient temperature respectively.

Body Ends

Double Flanged Body Ends

- The dimensions of flanged body ends and drillings shall be in accordance with the IS 1538 (latest). Flanges as per any other specific requirements of the Owner may also be given “As Agreed” between the manufacturer and the Owner. 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.

Face to Face Dimension

- Face to face dimensions of double flanged types of valve shall be as per design standard.

Bodies

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

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.

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.

Bearings

- The bearings shall be suitable for the maximum loads imposed by the shaft during testing and in service. b. For valves DN 350 and above, a bearing shall be provided to take the axial thrust; spring retaining clips shall not be used as thrust bearing. Suitable sealing shall be provided for the shaft where it passes outside the pressure containing encloser.

Operation

- Electrically and Manually Operated a. 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.

Testing

- All valves shall hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. There shall be no air entrapped within the part of the valves subjected to test pressure. Test pressure as per IS 13095.

Performance Test

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

Body Test

- Completely assembled valve shall be tested as follows:
- The valve disc shall be in slightly open position and pressure equivalent to 1.5 (15 Kg/Cm²) times the maximum permissible working pressure shall be applied with water.

Seat Test

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

Disc Strength Test

- The test shall be conducted with the body flanges in horizontal position. The test pressure shall be 1.5 times the maximum permissible pressure at 20°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. 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.

Positive material Identification (PMI Test)

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

Test Certificates

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

Marking

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

Painting

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

Lowering, Laying and Jointing of Valve

Supply Of Material

- Cast iron double-flanged sluice valve/butterfly valves with two tailpieces suitable to pipe shall be supplied and carted by the contractor as per latest IS. The rate shall include loading, unloading and stacking at site.
- The sluice valve/butterfly valves and tailpieces shall be examined before laying for cracks and other flows. They shall be undamaged in all respect.
- The sluice valves/butterfly valves shall be operated before laying.
- All grits and foreign materials shall be removed from the inside of the valves before placing.
- All the four faces shall be thoroughly cleaned and coated with a thin layer of mineral grease.
- The tightening of gland shall be checked with a pair of inside-calipers. Clearance between the top of stuffing box and the underside of the gland shall be uniform all the sides.

Jointing Material

- The contractor shall provide all necessary jointing materials such as nuts bolts, rubber packing white zinc jute lead wool, C.I. tailpiece etc.
- All tools and plant required for installation of sluice valve shall be provided by the contractor.
- All jointing materials shall be approved from the engineer-in-charge before use.
- The nut and bolts shall conform to specification of materials.
- The rubber packing shall conform all specifications as narrated in Specifications of materials.

Installation

- The sluice valve/butterfly valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.
- If necessary, tailpieces shall be fitted with sluice valve first outside the trench and then lowered in to the trench.
- The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the sluice/butterfly valve bore. It shall be even at both the inner and outer edges.
- The flange faces thoroughly greased.
- If flange faces are not free, the contractor shall use thin fibers of lead wool.
- After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.
- The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.
- Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.
- The sluice valve/butterfly valve shall be installed in such a way that its Spindle shall remain in truly vertical position.

- The other end of tailpiece shall be fitted with pipes so that continuous lines can work.
- Extra excavation required for facility of lowering and fixing sluice valve shall not be paid for.

Testing

- After installation of sluice valve/butterfly valve the same is tested to 1.5 times of its test pressure.
- The joints sluice valve/butterfly valve shall withstand the test pressure of pipelines.
- Defects noticed during test and operation of sluice valve shall be rectified by the contractor at his own cost without any extra claim to the entire satisfaction of the Engineer-in-charge.

Item 52, 84:

AIR VALVE:

Providing & Supplying of C.I Air valves of approved make & quality of following class and diameter including all taxes, insurance, transportation, freight charges, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.

General

- Tamper proof air valve confirming to AWWA C 512, having outlet for admission and release of bulk volume of air during emptying and filling of the pipeline. 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.

Testing

- All valves shall hydrostatically tested by the manufacturer before dispatch. The pressure shall be obtained without any significant hydraulic shock. Testing shall be carried on before application of paint. 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.

Positive material Identification (PMI Test)

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

Test Certificates

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

Marking

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

Painting

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

Air Valve Installation

- The air valve shall be lowered in to the trench carefully, so that no part is damaged during lowering operation.
- The rubber packing shall be three ply and of approved thickness. The packing shall be of full diameter of the flange with necessary holes and the air valve bore. It shall be even at both the inner and outer edges.
- The flange faces thoroughly greased.
- If flange faces are not free, the contractor shall use thin fibers of lead wool.
- After placing the packing, nuts and bolts shall be inserted and tightened to make the joint.
- The valve shall be tightly closed when being installed to prevent any foreign materials from getting in between the working parts of the valve.
- Each flange bolt shall be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively.
- Extra excavation required for facility of lowering and fixing air valve shall not be paid for.

Item 54, 86, 105:

Full Bore Electromagnetic Flow Meter- Regular Power operated Design, Supply, Installation, Testing, Commissioning of Full Bore Electromagnetic flow meter with factory calibration, Inbuilt Battery Power Operated, flanged connection, Flow sensor, Indicator, transmitter and totaliser with all accessories viz. surge arrestor, associated cables, cabinets, hardwares, etc complete as per following specifications Flow Meter/ Sensor:DC pulsed type, IP 68 Protection, Flanged process connection as per IS 1538 or equivalent standard, SS304/ Metallic Alloy Flow Tube, SS316/ SS 316 L/ Hastelloy Sensor, SS316/ Hastelloy Grounding Ring/ Inbuilt Grounding Electrode, Neoprene/Polyurethane/ Hard Rubber/ Rilsan lining, SS304/ Die Cast Aluminium/ Carbon steel with Anticorrosive Paint Coil Housing with Junction Box, CS flanges. Flow Transmitter/ Converter (Remote Field Mounted):Microprocessor based, Modular design, 2 line LCD for indication of actual flow rate, forward, reverse, sum totaliser display, $\pm 0.5\%$ accuracy at 0.3 to 4 m/sec velocity, 4 to 20 mA with HART/Modbus output, one scalable pulse, one status output, IP 67 protection, Die cast aluminium/ polycarbonate/ SS316 with Anticorrosive Paint/ PU finish with glass window enclosure, Inbuilt EEPROM and Data Logger, 20 meters cable length for sensor to transmitter communication etc alongwith wall mounted/ stand mounted cabinet.

1. Scope of Work

The work includes **Design, Supply, Installation, Testing and Commissioning (DSITC)** of a **Full Bore Electromagnetic Flow Meter** complete with flow sensor, transmitter, indicator, totaliser, flanged connection, surge arrestor, associated cabling, cabinets, hardware, earthing, and all required accessories for reliable and accurate measurement of water flow as per specifications.

2. General Requirements

- The flow meter shall be factory calibrated, tested, and supplied with calibration certificate traceable to NABL/NPL or international standards.
- Flow meter shall be inbuilt battery-powered (minimum battery life: 5 years or as per manufacturer's guarantee).
- Installation shall include all required fittings, gaskets, nuts, bolts, earthing arrangements, and protective enclosures.
- Meter shall be suitable for continuous operation in outdoor conditions (IP68 for sensor and IP67/IP68 for transmitter).

3. Technical Specifications

a. Flow Sensor

- Type: Full Bore Electromagnetic Flow Sensor.
- Sizes: As per BOQ/site requirement.
- Body Material: Carbon steel / SS 304 with epoxy coating (WRAS/NSF approved epoxy).
- Lining: Hard rubber / Polyurethane / PTFE (as per water quality).

- Electrodes: SS 316L / Hastelloy C / Platinum-Iridium as per manufacturer's standard.
- End Connection: Flanged, conforming to IS:1538 / IS:6392 / ANSI B16.5.
- Protection Class: IP68 (fully submersible).

b. Transmitter / Converter

- Type: Microprocessor-based, battery powered.
- Display: LCD/LED type, backlit, indicating instantaneous flow (m³/hr), velocity, and totalised volume (m³).
- Totaliser: Forward and reverse flow registration.
- Accuracy: $\pm 0.5\%$ of measured value or better.
- Outputs:
 - Optional GSM/GPRS/RS-485 Modbus for SCADA integration.
 - Pulse output (if specified).
- Enclosure: Weatherproof, IP67 / IP68.

c. Power Supply

- Inbuilt Lithium Battery Pack – Minimum 5 years operational life.
- Provision for external DC supply (if required).

d. Accessories

- Surge arrestors, earthing kit, stainless steel hardware, cables, and suitable weatherproof cabinet (lockable).
- All accessories for proper installation including gaskets, nuts, bolts, washers, and earthing.

4. Standards & Compliance

- Conforming to **IS/IEC 60041**, ISO 6817, and OIML R49 standards for electromagnetic flow meters.
- Calibration certificate traceable to NABL/NPL or equivalent international standard shall be provided.
- BIS/CE/ISO certification from manufacturer.

5. Installation & Methodology

1. **Site Preparation:** Marking, alignment, and excavation (if required) for installation.
2. **Pipe Cutting & Flange Matching:** Ensure proper alignment with existing DI/MS/HDPE pipeline.
3. **Mounting of Flow Meter:** Install using supplied flange kit with rubber gaskets and proper torque tightening of nuts and bolts.
4. **Earthing & Cabling:** Connect sensor body and transmitter to earth pit via copper earthing strip. Lay cables in protective conduit up to cabinet/control room.
5. **Accessory Fixing:** Surge arrestor, weatherproof cabinet, and all accessories shall be installed.
6. **Testing & Calibration:** Conduct site testing, verification with reference flow,

and integrate with SCADA (if required).

7. **Commissioning:** Final testing in presence of Engineer-in-Charge with performance demonstration.

6. Documentation & Handover

- Manufacturer's Test Certificate.
- Factory Calibration Certificate.
- Operation & Maintenance (O&M) Manual.
- As-built drawings with wiring details.

7. Measurement & Payment

- Payment shall be made **per number of flow meter sets installed, tested, and commissioned**, including all accessories, cabling, surge arrestors, civil supports (if any), and integration with system.

Item 41, 55, 88:

HORIZONTAL CENTRIFUGAL PUMPS (HSCF)

Supply, installation, testing & commissioning of horizontal split casing centrifugal pump motor set of specified duty parameters & guaranteed efficiency of following MOC with specified capacity, horizontal foot mounted TEFC squirrel cage induction motor (with minimum IE-3 efficiency class), working on three phase AC supply with 50 Hz \pm 3%, 415 V \pm 10%, rated speed 1450 RPM along with fabricated MS base frame, coupling, coupling guard, foundation bolts etc. as per relevant IS. M.O.C.: Impeller & Wearing Rings: Bronze LTB II IS: 318, Casing: CI FG 260 IS: 210, Shaft: SS 410, Shaft Sleeve: Bronze LTB II IS: 318 or SS 410, Mechanical Seal (Above 30 kW), Base Frame: MS. (3w+1s)

Capacity- 32.37 MLD

pump discharge = 490 m³/hr

Pump Head 50 M

Eff. Of pump - 80%

Required Motor Rating -112 HP >>>>RPM

Required Motor Rating - 84 KW

Sp gravity - 1.00

&

pump discharge = 1360 m³/hr

Pump Head 47 M

Eff. Of pump - 85%

Required Motor Rating -275 HP >>>>RPM

Required Motor Rating - 205 KW

Sp gravity - 1.00

&

Capacity- 12 MLD

pump discharge = 500 m³/hr

Pump Head 14 M

Eff. Of pump - 80%

Required Motor Rating -35 HP >>>>RPM

Required Motor Rating - 26 KW

Sp gravity - 1.00

A. GENERAL

The Pump shall be Centrifugal, Horizontal shaft, Horizontal split case type designed and manufactured for pumping liquid like raw / potable water. Pump shall be directly coupled to motor through coupling, mounted on common base plate with foundation bolts and all other required accessories.

The pump shall be designed to operate satisfactorily without detrimental surges, vibration, noise or dynamic imbalance over the required Head-Capacity range. The head-capacity curve of the pump shall have continuously rising head characteristics with decreasing capacity over the whole performance range of pump. The shut off head of the pump shall be at least 120% of the total head.

The pump shall be selected in such a way so that operating point shall lie on best efficiency point (BEP) or within 15 % of BEP flow on either side meeting NPSH requirement. Pump selected with duty point lying on right side of BEP beyond 15 % limit shall not be accepted.

The pump shall be selected with intermediate diameter of Impeller. The rated impeller diameter shall be at least 10 mm smaller than the maximum Impeller dia. possible for the offered pump model. The pump selected for rated performance below minimum Impeller diameter shall not be accepted.

The manufacturer shall ensure while selecting pump that required Net Positive Suction Head (NPSHR) is less than available NPSH (NPSHA) to ensure pump's operation without cavitation's under the worst operating condition. The required NPSH at duty point and throughout the range shall be at least 1.0 m and 0.5 m, less than the available NPSH respectively at the lowest water level in the sump. However, the NPSHR of the offered pump shall not be more than 7.5m (meeting flooded suction conditions) or lower as per the design requirement / as per the conditions indicated in tender drawings.

Each pump must be capable of running satisfactorily in parallel with other sets in the system without throttling and by itself, without cavitation's or overload under all operating conditions within the system resistance indicated. All pump shall have identical performance.

The pump shall be designed to start with delivery valve fully open.

The unit shall be designed to operate safely at the maximum speed attainable in the reverse direction of rotation due to water returning through the pump at times when the power supply to the motor is interrupted and the discharge valve fails to close.

Pump's rotating assembly shall be statically and dynamically balanced as per ISO standards and shall run smooth without undue noise and vibration. The velocity of vibration shall be within the 4.5 mm/sec. Noise level shall be limited to 85 dB A at a distance of 1.0 m

The power rating of motors to drive pumps shall be suitable to meet maximum requirement of power for the rated impeller throughout its' performance range.

B. FEATURES OF CONSTRUCTION

PUMP:

Pump shall be horizontal centrifugal, single / double stage; Horizontal split case Type suitable for dry-pit installation with wearing rings. The pump shall have side suction and side discharge nozzle located in lower part of delivery casing.

The SS heavy duty strainer shall be provided at pump suction so as to restrict the entry of oversize solids / floating material in order to run pump set without clogging and interruption. The strainer shall have sufficient suction area and openings throughout its surface to let water in easily. The size of the holes on strainer shall not be more than max. permissible solid handling size/capacity of pump or lower as per the permissible solid handling capacity of pump and as recommended by pump vendor. The strainer shall be supplied by pump vendor

only as per the area of opening and opening requirement to suit the offered pump design.

CASING:

Pump casing shall be of robust construction. Liquid passages shall be designed to allow free passage and finished smooth. The tongue shall be straight across and filed to a smooth rounded edge. Casing shall be provided with wearing rings. Casing drain connection with collard plug shall be provided at lowest part of casing. Tapping shall be provided at side center of suction and discharge nozzles for pressure gauge connection. These tapping shall be plugged by collard plugs.

IMPELLER:

Impeller shall be enclosed, single or double suction type or as per manufacturer design with smooth and large ways so as to allow free passage to the fluid being pumped. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials. Impeller shall be statically and dynamically balanced at rated speed as per applicable standard so as to avoid vibration.

SHAFT SLEEVE:

Replaceable shaft sleeves shall be provided and shall be securely locked or keyed to the shaft to prevent loosening. Necessary rubber 'O' ring or CAF / Teflon gaskets shall be provided between impeller and shaft sleeve to prevent liquid passage between shaft and sleeve. In no case shaft shall be in contact with liquid. The surface hardness of the shaft sleeve shall be minimum 250 BHN.

STUFFING BOX:

Pump shall be provided with stuffing box arrangement as mentioned in specific requirement for shaft sealing.

Pump when required with gland packed Stuffing box; same shall be of such design that they can be repacked without removal of any part other than gland and lantern ring. Stuffing box drain with pipe connection shall be provided at the lowest point so that no leakage accumulates in it. Lantern ring shall be sandwiched between packing and shall be easily removable. Lantern ring shall be of axially split type and shall be sealed with self-liquid being pumped or as recommended by the pump manufacturer. Necessary pipe connections and piping for this shall be provided by pump manufacturer. Gland shall be of split type. Gland bolts and nuts shall be of SS.

Pumps required with Mechanical Seals shall be provided with necessary piping for cooling, flushing and lubrication of seal faces as recommended by seal manufacturer. Seal shall be designed and selected for the specified application in order to perform the equipment trouble free and working life not less than 40,000 hours of operation. Seals shall be covered with SS 304 mechanical seal cover and shall be tightened with SS fasteners as per the specifications.

Pumps shall be supplied with Rubber liquid deflector to prevent liquid entry to bearings, in case of failure of mechanical seal / leakage through stuffing box.

BEARINGS:

Pump shall be provided with anti-friction grease lubricated bearings. The whole rotating assembly of pump shall rest between minimum two bearings for

smooth operation. Bearings shall be easily accessible for inspection and maintenance. Bearings shall be of SKF / FAG make only.

COUPLING:

The pump shall be coupled with electric motor mounted on a common base plate using pin bush type of KTR / Rathi / Fenner make only. Coupling shall be statically and dynamically balanced at rated speed.

COUPLING GUARD:

A stationary coupling guard shall be provided for the coupling conforming to all relevant safety codes and regulations. Coupling guard design shall be such that coupling is covered from both the sides as well apart from top cover. Guard shall be designed for easy installation and removal, complete with necessary support, accessories and SS fasteners.

BASE PLATE:

The pumping unit shall be provided with a common drain rim type base plate with 25mm dia. drain pipe, terminated to nearest drain pit/trench. The base plate shall be of sufficient size and rigid sufficient to maintain the pump and motor in proper alignment and position. Base plate shall be supplied by pump manufacturer only. The base plate shall be grouted on the RCC foundation with the help of "J" type foundation bolts of manufacturer's recommended / approved size.

C. MATERIAL OF CONSTRUCTION:

The specific requirement shall be considered as under:

Pump Casing	CI IS210 Gr. FG 260
Casing / Impeller wear ring	CF8M / Bronze, IS 318, Gr. LTB
Shaft	AISI 410
Shaft sleeve	AISI 410
Impeller	CF8M / Bronze, IS 318, Gr. LTB
Shaft Seal	Gland Packed. / Mechanical Seal
Lantern Ring	Bronze, IS 318, Gr LTB
Liquid Deflector	Natural Rubber
Gland	CI IS210 Gr. FG 260
Base Plate (Drain Rim type)	CI / MS - Epoxy Coated
Suction Strainer	SS 304
Bolts, Nuts, Fasteners, etc.	Wetted - SS 304, Non-Wetted - GI

The above MOC is min. requirement and if process requirement is higher as indicated in process data sheet the stringent MOC to be provided.

Item 56, 89, 104:

Supply, testing & commissioning 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; Weldends: IS 2062 Gr. B; Flanges: IS 2062 Gr. B (Drilling as per IS 1538 /IS 6392) & Limit Rods & Nuts: CS - IS 1367.

Metallic Expansion Bellow:

General

- Design, fabrication, testing and installation of metallic expansion bellows with necessary hardware have to be provided at delivery side of each pump. Expansion joint shall be a metallic flexible connector fabricated of plies of metal corrugation to provide stress relief in piping systems due to thermal, mechanical and other moments and movements. It provides flexibility and concurrent movements.
- Expansion bellows shall be designed as per the details furnished in the data sheet and shall be in accordance with the EJMA standard. All expansion bellows shall be free from dirt, moisture, grease, oil, etc. and all reports for hydrostatic test shall be furnished. The bellows shall be metallic corrugated design and shall have double flange. The material for Bellows shall be SS 304.
- In order to avoid pipe buckling, guide collars must be provided regularly along the pipe length. A guide collar must also be provided on either side of the SS Expansion Joint. Maximum service life depends on careful and correct installation. Transport Expansion Joints to area of installation in packed condition. Flange face of companion flanges in pipeline should be smooth and without any sharp edges.
- For large size of Expansion Joints installed in horizontal ducts, lifting lugs welded to flanges should be used to hoist joint in position. Joints should only be fitted after all work on the pipeline and flanges have been complete and anchors and supports have been established. This is to avoid any accidental damage due to welding splatter or sharp objects and to ensure that the joints are not overstressed. The bolts on the flanges must be tightened evenly. Uneven tightening may lead to hazardous leakage. Faulty fitting may lead to failure of the expansion joints.

Operating Principal

- Expansion Joints are flexible, reinforced bellows which are used in piping systems to meet the following major needs.
- To protect piping by absorbing any difference in dimension due to temperature variation or line movement. It shall be protect equipment such as supports & anchors, pumps & valves etc., other equipment.
- It shall be useful for simple connection of misaligned pipes. Movement Accommodation. Expansion and contraction, as well as rapid movements (dynamic stresses), are absorbed multidirectional and often simultaneous deflections.

Tests and Inspection

- Bellows shall be tested as per the relevant Standards with latest revisions.
- Bellows shall be offered for visual inspection and dimensional checks.
- The hydrostatic and water tightness testing of one of each size shall be witnessed.

- Compression and expansion test shall be offered for one no. for each size and to be witnessed.

Positive material Identification (PMI Test)

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

Test Certificates

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

Marking

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

Painting

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

Item 57, 90:

PRESSURE MEASURING SYSTEM

Supply, installation, testing & commissioning of Diaphragm Type pressure guage having 150 mm dial with isolation ball valve in SS 316, necessary fittings / accessories in SS 316 (3 way 2 valve manifold, nipples, coupling etc.) complete in all respects and as per specification.

Range : 0 - 6 Kg/cm² (at each pump's delivery side)

The scope of work includes the design, supply, installation, testing, and commissioning of Bourdon Type Pressure Gauges with the following specifications:

The pressure gauge shall have an accuracy of $\pm 1\%$ of the full-scale reading to ensure reliable and precise measurement within the operating range of 0 to 20 Kg/cm². The dial size shall be 150 mm, providing clear visibility of pressure readings, and the pressure range shall be calibrated from 0 to 20 Kg/cm² to meet operational requirements.

The case of the pressure gauge shall be constructed from SS304 (Stainless Steel 304) for superior corrosion resistance, strength, and durability, ensuring long-lasting performance even in harsh environments. The Bourdon tube shall be made of SS316L (Stainless Steel 316L), which is specifically chosen for its excellent resistance to corrosion, making it suitable for high-pressure applications in challenging conditions. The gauge movement shall be crafted from SS316 for superior strength and resistance to wear.

The gauge shall feature glycerine filling, which serves to dampen vibrations and oscillations of the needle for stable, accurate readings in fluctuating conditions. The connection type shall be direct bottom 1/2" NPT (M) process connection, ensuring a secure, leak-proof interface between the gauge and the installation pipeline or equipment with manifold valve provision. The dial shall be aluminium with a white background and black graduations, ensuring clear visibility, while the pointer shall be micro-zero adjustable, providing the flexibility to make fine adjustments for calibration.

The gauge shall have a shatter-proof glass window, safeguarding the internal mechanism and offering additional protection against accidental impacts. It shall be equipped with a neoprene gasket to prevent leaks and ensure proper sealing between the gauge and the connected pipeline. A bayonet-type bezel shall be used for easy opening and maintenance, allowing quick access to the internal components without special tools. Additionally, a blow-out disc shall be incorporated to provide relief in the event of excessive pressure buildup, thus ensuring safe operation.

For easy identification and traceability, the gauge shall feature an SS tag plate. The Ingress Protection (IP) rating of the gauge shall be IP 67, making it dust-tight and capable of withstanding temporary immersion in water, ensuring reliability in both indoor and outdoor environments.

All materials used in the manufacture of the pressure gauge shall be compliant with IS 3624, the Indian Standard for Bourdon tube pressure gauges, ensuring the highest quality and conformity to safety and performance standards. The scope of work also includes installation, calibration, hydraulic testing, and commissioning of the pressure gauges to confirm their operational performance.

The contractor shall be responsible for the full installation, including the proper calibration, leak testing, and operation of the gauges. All necessary documentation, including test reports, calibration certificates, and commissioning records, shall be provided to the satisfaction of the Engineer-in-Charge.

Item 76:

DETAILED TECHNICAL SPECIFICATIONS FOR GRID-CONNECTED SOLAR PV POWER PLANT

1. GENERAL SCOPE OF WORK

The scope of work under this tender shall include the complete design, detailed engineering, manufacturing, procurement, supply, transportation, unloading, storage, installation, testing, commissioning, and performance demonstration of a Grid-Connected Solar Photovoltaic (SPV) Power Plant of specified capacity. The contractor shall be responsible for delivering a fully operational system on a turnkey basis, including all associated civil, structural, electrical, and instrumentation works required for safe, reliable, and efficient operation.

The bidder shall carry out site assessment, shadow analysis, layout optimization, and generation estimation using industry-standard tools. The system shall be designed to ensure maximum energy yield, long-term reliability, and compliance with applicable national and international standards. All materials supplied shall be new, unused, and of the latest design and proven technology. The contractor shall also be responsible for obtaining all statutory approvals, permits, and clearances required from concerned authorities such as State Nodal Agencies, DISCOM, and CEIG.

2. SOLAR PHOTOVOLTAIC MODULES

The solar photovoltaic modules proposed shall be listed under the Approved List of Models and Manufacturers (ALMM) and shall conform to the latest editions of applicable IEC/IS standards such as IEC 61215, IEC 61730, and IEC 62804. The modules shall be of crystalline silicon technology (Mono PERC or higher efficiency variants preferred), designed for high performance under Indian climatic conditions.

Each module shall consist of high-efficiency solar cells encapsulated within a durable laminate structure comprising low-iron, high-transmission tempered glass with anti-reflective coating on the front side and a weather-resistant backsheet. The module frame shall be constructed of anodized aluminum alloy with twin wall profile, providing high mechanical strength and corrosion resistance suitable for long-term outdoor exposure.

The modules shall have a minimum efficiency in the range of 18% to 21%, with a guaranteed positive power tolerance of 0 to +5 Wp, ensuring no negative deviation in output. The temperature coefficient of maximum power (P_{max}) shall be equal to or better than -0.45% per degree Celsius, ensuring stable performance under high-temperature conditions. The Nominal Operating Cell Temperature (NOCT) shall be approximately 45°C or lower, indicating efficient thermal performance.

Each module shall be equipped with a junction box of IP67 protection class, containing adequately rated bypass diodes to minimize power losses due to partial

shading. The junction box shall be compatible with MC4 or equivalent connectors, ensuring reliable electrical connections.

All modules must undergo 100% Electroluminescence (EL) testing to detect micro-cracks and internal defects, along with flash test verification. The modules shall be free from visual defects such as bubbles, delamination, or discoloration. The minimum fill factor shall be 75%, ensuring high conversion efficiency.

The modules shall be warranted for a minimum of 10 years against manufacturing defects, and a 25-year linear performance warranty shall be provided, guaranteeing at least 80% of the rated output at the end of 25 years. The expected energy generation shall be in the range of 4 to 5 kWh per kWp per day on an annual average basis, subject to site conditions.

3. SOLAR INVERTERS

The inverter shall be of grid-interactive type, designed to convert DC power generated by the PV modules into AC power compatible with the utility grid. The inverter shall be string type or central type as per system design, with preference given to high-efficiency transformerless string inverters.

The inverter shall have a wide Maximum Power Point Tracking (MPPT) voltage range of 80V to 1000V, enabling efficient energy harvesting under varying irradiance conditions. The maximum efficiency of the inverter shall be in the range of 97.5% to 98.9%, with low internal losses.

The output frequency shall be 50 Hz (or 60 Hz if required), synchronized with the grid supply. The inverter shall operate at a power factor close to unity (~ 1) and shall have a Total Harmonic Distortion (THDi) of less than 3%, ensuring high power quality.

The inverter shall be capable of operating under a wide temperature range of -25°C to +60°C and shall be suitable for installation at altitudes up to 4000 meters above mean sea level without derating (or with specified derating factors).

The inverter shall incorporate comprehensive protection features, including but not limited to anti-islanding protection, input reverse polarity protection, insulation resistance monitoring, residual current monitoring unit (RCMU), output overcurrent protection, short circuit protection, and overvoltage protection. The enclosure shall have a minimum protection degree of IP65, making it suitable for outdoor installation.

The inverter shall be equipped with an intuitive LCD display and user interface, along with advanced monitoring capabilities through mobile applications or web portals. Data logging and communication shall be facilitated through GPRS, Wi-Fi, or Ethernet, enabling remote monitoring, fault detection, and performance analysis.

4. MODULE MOUNTING STRUCTURE (MMS)

The module mounting structure shall be designed to provide robust mechanical support to the solar PV modules while ensuring optimal tilt angle for maximum solar energy capture. The structure shall be fabricated using hot-dip galvanized

steel sections, such as seamless box pipes or 'C' channels, with adequate thickness and structural strength.

The galvanization shall be performed as per relevant IS standards, with a minimum coating thickness of 80 microns or higher, ensuring long-term corrosion resistance. The structure shall be designed to withstand wind loads, dead loads, and seismic forces as per IS 875 (Part III) and other applicable standards.

All structural components shall be designed to ensure easy installation, maintenance, and module replacement. Provision shall be made for thermal expansion and proper drainage to prevent water accumulation.

The mounting structure shall be anchored securely to the roof or foundation using suitable base plates, anchor bolts, or J-bolts, depending on site conditions. The design shall ensure that the structure can safely bear the load of modules, cabling, and additional accessories such as walkways or sprinkler systems, if required.

All fasteners used in the installation, including nuts, bolts, and washers, shall be of stainless steel (SS 304 grade) to prevent corrosion and ensure durability.

5. BALANCE OF SYSTEM (BoS)

The Balance of System shall include all electrical and auxiliary components necessary for the complete functioning of the solar PV plant. This includes DC and AC distribution boards (DCDB and ACDB), which shall be designed with appropriate ratings and equipped with protective devices such as isolators, circuit breakers, surge protection devices, and fuses.

All cables used in the system shall be of high quality, UV-resistant, flame-retardant, and low smoke (FRLS) type, suitable for outdoor installation. Proper cable management systems, including cable trays, conduits, and clamps, shall be provided to ensure safe and व्यवस्थित routing.

The earthing system shall be designed as per IS 3043, with separate earthing arrangements for modules, inverters, and lightning protection systems. Adequate number of earth pits shall be installed, ensuring low earth resistance values.

A comprehensive lightning protection system shall be provided in accordance with relevant IS/IEC standards to safeguard the installation against lightning strikes.

6. INSTALLATION, TESTING, AND COMMISSIONING

The installation of the solar PV system shall be carried out by qualified personnel in accordance with best engineering practices and manufacturer guidelines. Proper alignment, orientation, and tilt of modules shall be ensured for optimal performance.

Upon completion of installation, the system shall undergo rigorous testing, including insulation resistance tests, continuity checks, and functional verification of all components. The system shall be commissioned only after successful completion of all tests and approval by the concerned authorities.

7. LIAISONING AND STATUTORY APPROVALS

The contractor shall be responsible for all liaisoning activities required for project execution, including obtaining approvals from State Nodal Agencies, DISCOM, and CEIG. This includes submission of necessary documents, drawings, and test reports, as well as coordination for inspections and approvals.

The contractor shall also facilitate grid synchronization and net metering arrangements, ensuring compliance with local regulations and utility requirements.

8. DOCUMENTATION AND HANDOVER

Upon completion of the project, the contractor shall submit comprehensive documentation, including as-built drawings, test certificates, warranty documents, operation and maintenance manuals, and system performance reports. The plant shall be handed over to the client in a fully operational condition.

9. OPERATION AND MAINTENANCE

The contractor may be required to provide operation and maintenance services for a specified period, including routine inspections, preventive maintenance, module cleaning, and performance monitoring. The objective shall be to ensure sustained performance and maximum energy generation.

10. PERFORMANCE GUARANTEE

The contractor shall guarantee the performance of the solar PV system in terms of energy generation and system efficiency. Any shortfall in performance shall be addressed by the contractor through corrective measures at no additional cost to the client.

Item No: 42,43,44

Demolition And Dismantling Work.

1. GENERAL SCOPE

The scope of work under this section shall include the **complete demolition, dismantling, removal, stacking, segregation, transportation, and disposal** of existing structures and materials as specified in the Bill of Quantities (BOQ) and drawings. The contractor shall execute the work in a **systematic, safe, and controlled manner**, ensuring minimal disturbance to adjacent structures, utilities, and the environment.

The work shall include all necessary arrangements for **labour, tools, plants, equipment, scaffolding, safety measures, temporary supports, barricading, and debris handling**. The contractor shall be responsible for compliance with all applicable **IS codes, safety regulations, environmental norms, and local authority guidelines**.

All demolished materials shall be carefully segregated into **serviceable and unserviceable materials**. Serviceable materials shall be stacked neatly at designated locations as directed by the Engineer-in-Charge, while unserviceable materials shall be removed from site and disposed of at approved dumping locations with **all leads and lifts included in the quoted rate**.

2. DEMOLITION OF BRICK WORK AND STONE MASONRY (IN CEMENT MORTAR)

The demolition of brick masonry and stone masonry in cement mortar shall be carried out manually or mechanically, depending upon site conditions and approval of the Engineer-in-Charge. The work shall include careful dismantling to recover **maximum quantity of reusable bricks and stones** without causing excessive breakage.

Prior to commencement, the contractor shall ensure that all **services such as electrical, plumbing, and embedded fixtures are disconnected or removed**. The demolition shall proceed in a **top-down sequence**, ensuring structural stability at all stages. Adequate temporary supports and shoring shall be provided wherever required.

Serviceable materials such as bricks and stones shall be cleaned of mortar, sorted, and stacked properly within the site as directed. Unserviceable materials, including broken bricks, mortar debris, and waste, shall be **collected, loaded, transported, and disposed of** at designated dumping yards.

The rate shall include all operations such as **wetting, dust suppression, cutting, chiseling, breaking, loading, unloading, stacking, and disposal with all leads and lifts**, complete in all respects.

3. DEMOLITION AND DISPOSAL OF PCC / LIME CONCRETE

The demolition of Plain Cement Concrete (PCC) or lime concrete shall be executed using appropriate tools such as **jack hammers, chisels, breakers, or mechanical equipment**, depending on thickness and location.

The contractor shall ensure that demolition is carried out without causing damage to adjoining structures or underground utilities. In confined or sensitive areas, manual demolition methods shall be preferred.

All debris generated shall be segregated into reusable aggregates (if applicable) and waste material. However, unless specifically instructed, all demolished PCC/lime concrete shall be treated as **unserviceable material** and disposed of accordingly.

The scope shall include **breaking, removal, loading, transportation, and disposal of debris with all leads and lifts**, including leveling and cleaning of the site after completion.

4. DEMOLITION OF REINFORCED CEMENT CONCRETE (RCC) WORK

The demolition of RCC structures shall be carried out with utmost care using suitable mechanical means such as **hydraulic breakers, concrete cutters, or controlled dismantling techniques**, depending on structural conditions and safety requirements.

The contractor shall prepare a **demolition methodology statement** prior to execution, detailing sequence, equipment, safety measures, and debris handling procedures. RCC demolition shall be performed in a **controlled manner to avoid sudden collapse**, ensuring safety of personnel and nearby structures.

Reinforcement steel shall be separated from concrete during demolition. Concrete debris shall be broken into manageable sizes for easy handling and transportation.

Serviceable reinforcement steel shall be cleaned of concrete and rust (if required) and stacked separately at designated locations. Concrete debris shall be disposed of as unserviceable material unless otherwise specified.

The rate shall include **cutting, breaking, separation of steel, stacking of usable materials, and disposal of debris with all leads and lifts**, along with necessary safety precautions.

5. DISMANTLING OF STRUCTURAL STEEL WORK

The dismantling of structural steel elements shall include removal of all steel components such as **beams, columns, trusses, purlins, bracings, and connections**.

Prior to dismantling, all connections shall be identified and safely disengaged. Cutting of steel members, if required, shall be carried out using **gas cutting or mechanical cutting tools** with proper safety precautions.

All dismantled steel members shall be handled carefully to avoid damage and shall be stacked systematically for reuse or disposal as directed. Surface cleaning, including removal of paint (distempering) or coatings, shall be carried out if specified.

The contractor shall ensure safe handling, lifting, and lowering of steel members using appropriate lifting equipment such as cranes, chain pulleys, or hoists.

The scope includes **dismantling, cutting, lowering, stacking, loading, transportation, and disposal with all leads and lifts**, complete in all respects.

6. REBATE FOR REINFORCEMENT STEEL

The reinforcement steel recovered from RCC demolition shall be measured separately and accounted for as per tender provisions. A **rebate shall be applicable for the recovered reinforcement steel**, which shall be deducted from the payable amount as per the rates specified in the BOQ.

The contractor shall ensure proper **cleaning, straightening (if required), bundling, and stacking** of reinforcement steel at designated locations. The quantity shall be measured based on actual weight or theoretical weight, as specified.

No separate payment shall be made for extraction, cleaning, or stacking of reinforcement steel, as the same shall be deemed included in the demolition rates.

7. SAFETY AND ENVIRONMENTAL REQUIREMENTS

The contractor shall strictly adhere to all safety norms, including:

- Provision of **personal protective equipment (PPE)** such as helmets, gloves, safety shoes, goggles, and harnesses
- Installation of **barricades, warning signs, and safety nets**
- Dust suppression measures such as **water sprinkling**
- Noise control measures as per environmental regulations

All debris shall be transported in covered vehicles to prevent spillage and dust pollution. The contractor shall ensure compliance with **local municipal regulations and environmental guidelines** for waste disposal.

8. MEASUREMENT AND PAYMENT

The measurement of demolition works shall be carried out as per relevant **IS codes or standard specifications**, based on:

- Volume (cubic meters) for masonry and concrete
- Weight (kg/MT) for steel

The quoted rates shall be **inclusive of all operations**, including labour, tools, plants, scaffolding, safety measures, stacking of serviceable materials, and disposal of unserviceable materials with all leads and lifts.

No extra payment shall be made for incidental works unless explicitly specified in the contract.

Item 94:

WATER HAMMER CONTROL DEVICE:

Providing, supplying and delivery of Water Hammer Control Devices for use on various pumping main of following class and diameter including all taxes, insurance, transportation, freight charges, inspection charges, loading, unloading, conveyance to departmental stores, stacking etc. complete.

The item includes the providing, supplying, lowering, laying, and jointing of a Zero Velocity Valve (ZVV) with a bypass arrangement, suitable for use on pumping mains of diameter above 300 mm, specifically for a 1000 mm diameter main. The valve shall be fabricated from Mild Steel (MS) and designed to withstand a pressure rating of Class-15 (15 kg/cm²). It shall function as an effective water hammer control device, preventing reverse flow and ensuring safe shutdown of pumping systems by automatically closing at zero flow conditions. The valve shall be provided with an integrated bypass system, complete with isolating valves and piping, to facilitate controlled line filling, pressure equalization, and maintenance operations.

The scope of work includes the supply of all required jointing materials, including MS flanges, rubber gaskets (IS 638 or equivalent), galvanized/stainless steel nuts and bolts, and any other necessary accessories. The valve must be suitable for horizontal installation and shall have flanged ends conforming to IS:1538 or equivalent standards. Internal surfaces shall be food grade epoxy coated or suitably protected against corrosion as per relevant standards.

The contractor shall ensure safe transportation, including loading, unloading, stacking, and delivery to the departmental stores or site as directed, with all associated charges such as freight, transit insurance, octroi, inspection charges, and applicable taxes included in the quoted rate. After installation, the valve shall be subjected to hydraulic pressure testing at 1.5 times the working pressure in the presence of the Engineer-in-Charge, and performance must meet the required standards.

All materials must be new and conform to relevant IS/ISO standards, and the valve shall be installed as per standard engineering practices to the satisfaction of the competent authority.

Item 81:

Pump House Designing (Aesthetically) and constructing RCC frame structure of pump room with positive suction/Negative suction With gantry Structure (Min Height 4.5 m) upto 6.00 m plinth level to top slab bea, bottom (10*12.5=125 Sqmt.) With Gantry Structure Min Height 4.5 Mtr

1. Scope of Work

The work shall include architectural designing, structural designing, construction, finishing, electrification, earthing, gantry installation, and all allied civil works for a Pump House building of size 10.0 m × 10.0 m (100 Sq.m) internal floor area.

The structure shall be an RCC framed structure with minimum 4.5 m clear internal height suitable for installation and maintenance of pumps, motors, valves, and crane/gantry operation. The total height from plinth level to bottom of roof slab shall be approximately 6.0 m.

The work shall include arrangements for positive suction or negative suction systems as per approved drawings and site conditions.

All works shall conform to relevant IS codes, CPWD/GWSSB specifications (where applicable), and good engineering practices.

Contactor has to submit the detailed General Arrangement drawings (GAD) along with detailed structural drawings for various components with Electro-Mechanical Arrangement drawings with all allied components. Agency has to approve the drawings before starting the work at site from PMC and Client.

- **2. Design Requirements**

- **2.1 Structural Design**

- The structure shall be designed as an RCC framed structure consisting of:
 - Isolated/combined raft foundation (as per SBC)
 - RCC columns
 - RCC beams
 - RCC roof slab
- Structural design shall be based on:
 - Soil Bearing Capacity (based on geotechnical investigation)
 - Seismic Zone (as per IS 1893)
 - Wind Load (IS 875 Part III)
 - Dead & Live loads (IS 875 Part I & II)
 - Crane/Gantry load
 - Codes to be Followed
- IS 456 – Plain & Reinforced Concrete
- IS 800 – Steel Structures (for gantry)
- IS 875 – Loads
- IS 1893 – Seismic design
- IS 3370 – Concrete structures for water retaining (if sump integrated)
- NBC (Latest Revision)

- **3. Site Preparation and Earthwork**

- Site clearing, leveling and removal of debris.
- Excavation for foundation including shoring if required.
- Dewatering if required.
- Disposal of surplus excavated material within 50 m lead.
- Backfilling with selected excavated material and compaction in layers.

- **4. Foundation Works**

- PCC 1:4:8 (minimum 100 mm thick) below footings.
- RCC footings of minimum grade M30.
- Reinforcement: Fe-500 TMT bars.
- Anti-termite treatment before foundation concreting.
- Proper curing minimum 14 days.
- If negative suction system is provided, foundation shall accommodate:
- Pump sump well (RCC watertight structure)
- Thrust blocks for pipeline

- **5. RCC Superstructure**

- **5.1 Columns**

- RCC columns designed for structural loads.
- Concrete Grade: M25
- Reinforcement: Fe-500 TMT
- Proper cover blocks as per IS 456.

- **5.2 Beams**

- RCC beams at lintel and roof level.
- Gantry beam provision integrated structurally.
- Designed for crane load including impact factor.

- **5.3 Roof Slab**

- RCC slab minimum thickness 150 mm (or as per design).
- Designed for:
 - Maintenance load
 - Crane support (if required)
- Waterproofing treatment with polymer-modified membrane.
- Proper rainwater drainage slope.

- **6. Flooring**

- Floor finished with:
 - Heavy-duty industrial IPS flooring OR
 - VDF flooring (minimum 100 mm thick)
- Non-slip finish.
- Proper slope towards drainage channel.
- Chemical-resistant epoxy coating (if specified).

- Masonry & Finishing
- **7.1 Walling**
- External walls: 230 mm thick brick masonry / AAC block.
- Internal walls: 150 mm thick.
 - Plaster
- Internal plaster: 12 mm thick 1:6 cement mortar.
- External plaster: 15 mm thick 1:4 cement mortar with waterproof compound.
 - Painting
- Internal: Primer + 2 coats acrylic emulsion.
- External: Weatherproof exterior paint.
- Structural steel: 1 coat red oxide primer + 2 coats enamel paint.
-
- **Doors & Windows**
- Main entry: MS double-leaf door (min 2.5 m width for equipment movement).
- Ventilators with louvers.
- Aluminum/UPVC windows with safety grills.
- Proper natural ventilation provision.
-
- **Gantry Structure**
- **9.1 General**
- Structural steel gantry system with minimum clear height of 4.5 m.
- Capacity: As per pump weight (minimum 2–5 Ton, unless specified).
- Includes:
 - Gantry beam (ISMB/ISWB section)
 - End carriage
 - Manual/Electric chain pulley block
 - Travel mechanism
-
- **9.2 Design**
- Designed as per IS 800.
- Load consideration:
 - Dead load
 - Live load
 - Impact load
- Anchor bolts embedded in RCC.
 - Corrosion Protection
- Two coats epoxy paint.
- Anti-rust treatment.
- **10. Pump Installation Provisions**
- 10.1 Positive Suction Arrangement
- Pump installed above sump level.
- Proper suction pipeline with foot valve.
- Thrust block.
- Air release valve provision.
 - Negative Suction Arrangement
- Wet well construction.
- RCC sump chamber.
- Adequate submergence depth.
- Access ladder (SS).
- **11. Electrification Works**
- 11.1 Internal Wiring

- Concealed copper wiring (FRLS).
- PVC conduits.
- Industrial type switches.
- Distribution Board (DB) with MCB/MCCB.
 - Lighting
- LED industrial fixtures.
- Emergency light provision.
- External flood light.
 - Power
- Cable tray system.
- Proper gland & termination.
- Panel foundation block.
- **Earthing System**
- Minimum 2 Nos. GI/Copper plate earthings.
- Earth pit size: 600 × 600 × 3000 mm.
- Filled with charcoal and salt.
- Earth resistance less than 5 ohms.
- Separate earthing for:
 - Electrical panel
 - Motor body
 - Gantry structure
- **Plumbing & Drainage**
- Floor drain connected to storm water drain.
- Gully trap.
- Pipe sleeves in slab.
- **Ventilation & Safety**
- Exhaust fan provision.
- Fire extinguisher (ABC type).
- Safety signage.
- Rubber mat near panel board.
- **External Development**
- PCC apron 1.5 m wide around building.
- Proper storm water drainage.
- Plinth protection.
- **Quality Control**
- Cube testing for concrete.
- Steel test certificates.
- Slump test during concreting.
- Third-party inspection if required.
- **Measurement & Payment**
 - Design
 - Drawings
 - Structural proof check
 - All materials, labour, T&P
 - Testing & commissioning
- No extra payment shall be made for minor variations required for functional completion.
- **Completion Requirements**
- As-built drawings submission.
- Structural stability certificate.
- Electrical safety certificate.
- Earthing resistance test report.

- Trial run of gantry system.

Item 109:

Construction of 200mm thick Granular Sub Base (Grading I) by providing coarse graded Black Trap material, mixing by mechanical means / rotavator, spreading in uniform layers with motor grader as per required slope and gradient on prepared surface and compacting with vibratory roller at OMC to achieve the desired compaction complete as per MORT & H clause 401

Materials :-

Maximum particle size of the corresponding grading for the natural sand, gravel materials are given at Table 9-1. The grading to be adopted for a project shall be as specified in the Contract. If the thickness of GSB layer is more than 150 mm then the sub-base is required to laid in two layers as upper sub-base and lower sub-base.

Table 9-1 : Grading for Granular Sub-base Materials

IS Sieve Designation	Percent by Weight Passing the IS Sieve					
	Grading I	Grading II	Grading III	Grading IV	Grading V	Grading VI
75.0 mm	100	-	-	-	100	-
53.0 mm	80-100	100	100	100	80-100	100
26.5 mm	55 –90	70-100	55-75	50-80	55-90	75-100
9.50 mm	35-65	50-80	–	–	35-65	55-75
4.75 mm	25 – 55	40-65	10-30	15-35	25-50	30-55
2.36 mm	20- 40	30-50	–	–	10-20	10-25
0.85 mm	–	–	–	–	2-10	–
0.425 mm	10-15	10- 15	–	–	0-5	0-8
0.075 mm	<5	< 5	< 5	< 5	–	0-3

Table 9-2 : Physical Requirements for Materials for Granular Sub-base

Aggregate Value (AIV)	Impact	IS:2386(Part4) or IS:5640	Maximum 40
Liquid Limit		IS:2720 (Part 5)	Maximum 25
Plasticity Index		IS:2720 (Part 5)	Maximum 6
CBR at 98% dry density (at IS:2720-Part 8)		IS:2720 (Part 5)	Minimum 30

Construction Operations :-**Preparation of Sub-grade**

Immediately prior to the laying of sub-base, the subgrade already finished shall be prepared by removing all vegetation and other extraneous matter, lightly sprinkled with water, if necessary and rolled with two passes of 80-100 kN smooth wheeled roller.

Spreading and Compacting

The sub-base material of the grading specified in the Contract shall be spread on the prepared sub grade with the help of a motor grader of adequate capacity, its blade having hydraulic controls suitable for initial adjustment and for maintaining the required slope and grade during the operation, or other means as approved by the Engineer.

Manual mixing shall be permitted only where the width of laying is not adequate for mechanical operations as in small sized jobs. The equipment used for mix-in-place construction shall be a rotavator or similar approved equipment capable of mixing the material to the desired degree. If so desired by the Engineer, trial runs with the equipment shall be carried out to establish its suitability for the work.

Moisture content of the 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 so that, at the time of compaction, it is from 1 per cent above to 2 per cent 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 after spreading the mix, rolling shall be done by an approved roller. 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 upto 200 mm the compaction shall be done with the help of a vibratory roller of minimum 80 to 100 kN static weight 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 or on super elevation. For carriageway having cross fall on both sides, rolling shall commence at the edges and progress towards the crown.

Each pass of the roller shall uniformly overlap not less than one-third of the track made in the preceding pass. During rolling, the grade and cross fall (camber) shall be checked and any high spots or depressions which become apparent, corrected by removing or adding fresh material. The speed of the roller shall not exceed 5 km per hour.

Rolling shall be continued till the density achieved is at least 98 percent 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.

Surface Finish and Quality Control of Work :-

CONTROL OF ALIGNMENT, LEVEL AND SURFACE REGULARITY

General

All works performed shall conform to the lines, grades, cross sections and dimensions shown on the drawings or as directed by the Engineer, subject to the permitted tolerances described herein-after.

Horizontal Alignment

Horizontal alignment shall be reckoned with respect to the centre line of the carriageway as shown on the drawings. The edges of the carriageway as constructed shall be correct within a tolerance of ± 10 mm therefrom. The corresponding tolerance for edges of the roadway and lower layers of pavement shall be ± 25 mm.

Surface Levels

The levels of the subgrade and different pavement courses as constructed, shall not vary from those calculated with reference to the longitudinal and cross-profile of the road shown on the drawings or as directed by the Engineer beyond the tolerances mentioned in below Table.

Table: Tolerances in Surface Levels

1)	Subgrade	±20 mm
2)	Sub-base a) Flexible pavement b) Concrete pavement	±10 mm ±6 mm
3)	Base-course for flexible pavement a) Bituminous Base/Binder course b) Granular i) Machine laid ii) Manually laid	±6 mm ±10 mm ±15 mm
4)	Wearing course for flexible pavement a) Machine laid b) Manually laid	±6 mm ±10 mm
5)	Cement concrete pavement	±5 mm

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

- 4 mm for bituminous wearing course of thickness 40 mm or more
- 3 mm for bituminous wearing course of thickness less than 40 mm
- 5 mm for concrete pavement slab

For checking compliance with the above requirement for subgrade, sub-base and base course, measurements of the surface levels shall be taken on a grid of points placed at 6.25 m longitudinally and 3.5 m transversely. For any 10 consecutive measurements taken longitudinally or transversely, not more than one measurement shall be permitted to exceed the tolerance as above, this one measurement being not in excess of 5 mm above the permitted tolerance.

For checking the compliance with the above requirement for bituminous wearing courses and concrete pavements, measurements of the surface levels shall be taken on a grid of points spaced at 6.25 m along the length and at 0.5 m from the edges and at the centre of the pavement. In any length of pavement, compliance shall be deemed to be met for the final road surface, only if the tolerance given above is satisfied for any point on the surface.

Surface Regularity of Pavement Courses

The longitudinal profile shall be checked with a 3 metre long straight edge/moving straightedge as directed by the Engineer at the middle of each traffic lane along a line parallel to the centre line of the road.

The maximum permitted number of surface irregularities shall be as per given Table

Table : Maximum Permitted Number of Surface Irregularities

	Surfaces of Carriageways and Paved Shoulders		Surfaces of Laybys, Service Areas and all Bituminous Base Courses	
Irregularity	4 mm	7 mm	4 mm	7 mm

Length (m)	300	75	300	75	300	75	300	75
Number of Surface Irregularities on National Highways/ Expressways*	15	9	2	1	40	18	4	2
Number of Surface Irregularities on Roads of lower Category*	40	18	4	2	60	27	6	3

* Category of each section of road as described in the Contract.

The maximum allowable difference between the road surface and underside of a 3 m straightedge when placed parallel with, or at right angles to the centre line of the road at points decided by the Engineer shall be:

for pavement surface (bituminous and cement concrete)	3 mm
for bituminous base courses	6 mm
for granular sub-base/base courses	8 mm
for sub-bases under concrete pavements	10 mm
for subgrade	15 mm

Rectification

Where the surface regularity of subgrade and the various pavement courses fall outside the specified tolerances, the Contractor shall be liable to rectify these in the manner described below and to the satisfaction of the Engineer.

- i) Subgrade: Where the surface is high, it shall be trimmed and suitably compacted. Where the same is low, the deficiency shall be corrected by scarifying the lower layer and adding fresh material and recompacting to the required density. The degree of compaction and the type of material to be used shall conform to the requirements of tender document.
- ii) Granular Sub-base: Same as at (i) above, except that the degree of compaction and the type of material to be used shall conform to the requirements of tender document.

- iii) **Lime/Cement Stabilized Soil Sub-base:** For lime/cement treated materials where the surface is high, the same shall be suitably trimmed while taking care that the material below is not disturbed due to this operation. However, where the surface is low, the same shall be corrected as described herein below. For cement treated material, when the time elapsed between detection of irregularity and the time of mixing of the material is less than 2 hours, the surface shall be scarified to a depth of 50 mm, supplemented with freshly mixed materials as necessary and recompacted as per the relevant specification. When this time is more than 2 hours, the full depth of the layer shall be removed from the pavement and replaced with fresh material to Specification. This shall also apply to lime treated material except that the time criterion shall be 3 hours instead of 2 hours.
- iv) **Water Bound Macadam /Wet Mix Macadam Sub-base/Base:** Where the surface is high or low, the top 75 mm shall be scarified, reshaped with added material as necessary and recompacted
- v) **Bituminous Constructions:** For bituminous construction other than wearing course, where the surface is low, the deficiency shall be corrected by adding fresh material over a suitable tack coat, if needed, and recompacting as per specifications. Where the surface is high, the extra thickness in the affected layer shall be removed and replaced with fresh material and compacted to Specifications. For wearing course, where the surface is high or low, the full depth of the layer shall be removed and replaced with fresh material and compacted to specifications. In all cases where the removal and replacement of a bituminous layer is involved, the area treated shall not be less than 5 m in length and not less than 3.5 m in width

If deemed necessary by the Engineer, any section of the slab which deviates from the specified levels and tolerances shall be demolished and reconstructed at the Contractor's cost.

Riding Quality

The riding quality of bituminous concrete wearing surface, as measured by a standard towed fifth wheel bump integrator, shall not be more than 2000 mm per Km.

Control on the quality of materials and works shall be exercised by the Engineer as per

Table 9-3 : Test and Frequency for Materials for Granular Sub-base

Type of Construction	Test	Frequency (As per Circular No. 66)	IS Code
Granular	Gradation	One test per 400 Cu.m.	IS:2386, Part-I-

Sub- Base			1963
	Atterberg Limits (Liquid Limit, Plasticity Index)	One test per 400 Cu.m.	IS:2720, Part-V
	Moisture content prior to compaction	One test per 400 Cu.m.	IS:2720, Part-II
	Density of compacted layer	One test per 1000 sq.m	IS:2720, Part- VIII
	CBR	As required	IS:2720, Part- XVI

Arrangements for Traffic

During the period of construction, arrangements for the traffic shall be provided. The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, marking, flags, lights and flagmen as per instruction of the Engineer-in-charge.

Measurements for Payment

The rate shall be for a unit of one cubic meter.

Item 110:

Providing, laying, spreading and compacting graded stone aggregates to Wet Mix Macadam in 150 mm thickness as per MORT & H specification including premixing the material with water at OMC in mechanical mix plant, carriage of mixed material by tippers to site, laying in uniform layers with paver or motor grader in sub base / base course on well prepared surface and compacting with vibratory roller to achieve the desired density complete as per MORT & H clause 406

This work shall consist of laying and compacting clean, crushed, graded aggregate and granular material, premixed with water, to a dense mass on a prepared sub-grade/sub- base/ base or existing pavement as the case may be in accordance with the requirements of these Specifications. The material shall be laid in one or more layers as necessary to lines, grades and cross-sections shown on the approved drawings or as directed by the Engineer.

The thickness of a single compacted Wet Mix Macadam layer shall not be less than 75 mm. When vibrating or other approved types of compacting equipment are used, the compacted depth of a single layer of the sub-base course may be upto 200 mm with the approval of the Engineer.

Materials**Physical Requirements**

Coarse aggregates shall be crushed stone. The aggregates shall conform to the physical requirements set forth in Table 10-1. **Beti, Rampar special aggregate is only acceptable.**

If the water absorption value of the coarse aggregate is greater than 2 percent, the soundness test shall be carried out on the material delivered to site as per IS:2386 (Part-5).

Table 10-1 : Physical Requirements of Coarse Aggregates for Wet Mix Macadam for Sub-base/Base Courses

S. No.	Test	Test Method	Requirements
1.	Los Angeles Abrasion value or Aggregate Impact value	IS:2386 (Part-4)	40 percent (Max.)
		IS:2386 (Part-4) or IS:5640	30 percent (Max.)
2.	Combined Flakiness and Elongation indices (Total)	IS:2386(Part-1)	35 percent (Max.)*

* To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up

Grading Requirements

The aggregates shall conform to the grading given in Table 10-2.

Table 10-2 : Grading Requirements of Aggregates for Wet Mix Macadam

IS Sieve Designation	Percent by weight passing the IS Sieve
53.0 mm	100
45.0 mm	95-100
26.5 mm	-
22.40 mm	60-80
11.20 mm	40-60
4.45 mm	25-40
2.36 mm	15-30
600 micron	8-22
75 micron	0-5

Material finer than 425 micron shall have Plasticity Index (PI) not exceeding 6.

The final gradation approved within these limits shall be graded from coarse to fine and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve or vice versa.

Construction Operations:-

Preparation of Base

The surface of the sub-grade/sub-base/base to receive the Wet mix macadam course shall be prepared to the specified grade and camber and cleaned of dust, dirt and other extraneous material. Any ruts or soft yielding places shall be corrected in an approved manner and rolled until firm surface is obtained.

Where the Wet mix macadam is to be laid on an existing metalled road, damaged area including depressions and potholes shall be repaired and made good with the suitable material. The existing surface shall be scarified and re-shaped to the required grade and camber before spreading the coarse aggregate for Wet mix macadam.

Preparation of Mix

Wet Mix Macadam should be prepared in an approved mixing plant of suitable capacity having provision for controlled addition of water and forced/positive mixing arrangement like pugmill or pan type mixer or concrete batching plant. For small quantity of wet mix work, the Engineer may permit the mixing to be done in concrete mixers.

Quantity of water should not vary from OMC determined as per IS : 2720 (part VIII) by more than agreed limit. The mixed material should be uniformly wet and no segregation should be permitted.

Spreading of mix

Immediately after mixing, the aggregates shall be spread uniformly and evenly upon the prepared sub grade/sub-base/base in required quantities. In no case should these be dumped in heaps directly on the area where these are to be laid nor shall their hauling over a partly completed stretch be permitted.

The mix may be spread either by a paver finisher or motor grader. For portions where mechanical means cannot be used, manual means as approved by the Engineer shall be used. The motor grader shall be capable of spreading the material uniformly all over the surface. Its blade shall have hydraulic control suitable for initial adjustments and maintaining the same so as to achieve the specified slope and grade.

The paver finisher shall be self-propelled, having the following features:

- (i) Loading hoppers and suitable distribution mechanism

(ii) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface profile.

(iii) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

The surface of the aggregate shall be carefully checked with templates and all high or low spots remedied by removing or adding aggregate as may be required. The layer may be tested by depth blocks during construction. No segregation of layer and fine particles should be allowed. The aggregates as spread should be of uniform gradation with no pockets of fine materials.

Compaction:

After the mix has been laid to the required thickness, grade and cross fall/camber the same shall be uniformly compacted, to the full depth with suitable roller. If the thickness of single compacted layer does not exceed 100 mm, smooth wheel 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 static weight of 80 to 100 KN or equivalent capacity roller. The speed of the roller shall not exceed 5 km/h.

In portions having unidirectional cross fall/super elevation, rolling shall commence from the lower edge and progress gradually towards the upper edge. Thereafter, roller should progress parallel to the centre line of the road, uniformly over-lapping each preceding track by at least one third width until the entire surface has been rolled. Alternate trips of the roller shall be terminated in stops at least 1 m away from any preceding stop.

In portions in camber, rolling should begin at the edge with the roller running forward and backward until the edges have been firmly compacted. The roller shall then progress gradually towards the centre parallel to the centre line of the road uniformly overlapping each of the preceding track by at least one-third width until the entire surface has been rolled.

Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good.

Along forms, kerbs, walls or other places not accessible to the roller, the mixture shall be thoroughly compacted with mechanical tampers or a plate compactor. Skin

patching of an area without scarifying the surface to permit proper bonding of the added material shall not be permitted.

Rolling should not be done when the subgrade is soft or yielding or when it causes a wave-like motion in the sub-base/base course or subgrade. If irregularities develop during rolling which exceed 12 mm when tested with a 3 metre straight edge, the surface should be loosened and premixed material added or removed as required before rolling again so as to achieve a uniform surface conforming to the desired grade and cross fall. In no case should the use of unmixed material be permitted to make up the depressions. Rolling shall be continued till the density achieved is at least 98 per cent of the maximum dry density for the material as determined by the method outlined in IS : 2720 (Part-8).

After completion, the surface of any finished layer shall be well-closed, free from movement under compaction equipment or any compaction planes, ridges, cracks and loose material. All loose, segregated or otherwise defective areas shall be made good to the full thickness of the layer and recompact.

Setting and drying:

After final compaction of wet mix macadam course, the road shall be allowed to dry for 24 hours.

Opening to Traffic

Preferably no vehicular traffic of any kind should be allowed on the finished wet mix macadam surface till it has dried and the wearing course laid.

Surface Finish and Quality Control of Work

Quality control:

Control on the quality of materials and works shall be exercised by the Engineer as per Table 10-3.

Table 10-3 : Test and Frequency for Materials for Wet Mix Macadam

Type of Construction	Test	Frequency (As per Circular No. 66)	IS Code
Wet Mix Macadam	Gradation	One test per 200 Cu.m.	IS:2386, Part-I-1963
	Aggregate Impact Value	One test per 1000 Cu.m.	IS:2386, Part-IV
	Combined Flakiness and Elongation Indices	One test per 500 Cu.m.	IS:2386, Part-I
	Atterberg Limits of portion of aggregates passing 425-micron sieve	One test per 200 Cu.m.	IS:2720, Part-V
	Density of compacted layer	One set of three tests per 1000 sq.m	IS:2720, Part-VIII

Rectification of Surface Irregularity

Where the surface irregularity of the wet mix macadam course exceeds the permissible tolerances or where the course is otherwise defective due to subgrade soil getting mixed with the aggregates, the full thickness of the layer shall be scarified over the affected area, reshaped with added premixed material or removed and replaced with fresh premixed material as applicable and recompact. The area treated in the aforesaid manner shall not be less than 5 m long and 2 m wide. In no case shall depressions be filled up with unmixed and ungraded material or fines.

Arrangement for Traffic

During the period of construction, arrangements for the traffic shall be provided. The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, marking, flags, lights and flagmen as per instruction of the Engineer-in-charge.

Measurements for Payment

The rate shall be for a unit of **one cubic meter**.

Item 111:

Providing and laying 50 mm thick compacted bitumenous macadam (BM) with Emulsion tack coat @ 2.50 Kg./ 10 Sqmt using crushed stone aggregate as per MORT & H gradation VG-30 grade bitumen at the rate of 3.40% by weight of total mix (i.e. 34kg/mt by wt. of total mix) for binding including heating and mixing the asphalt and aggregates by continuous batch mix plant and transporting the mix and spreading the same by paver finisher and consolidation with vibratory road roller including using all necessary equipments, tools, plants, including cost of all materials, firewood, oil, lubricants, labour charges etc. complete.

Materials**Bitumen**

The bitumen shall be viscosity grade (VG-40) paving bitumen complying with the Indian Standard Specification IS:73.

Coarse Aggregates

The coarse aggregates shall consist of crushed rock, crushed gravel or other hard material retained on 2.36 mm sieve. They shall be clean, hard, durable, of cubical shape, free from dust and soft or friable matter, organic or other deleterious substances. The aggregates shall satisfy the requirements specified in Table 13-1 and these property of aggregate should be checked by the Engineer in charge in the Mix Design submitted by the contractor.

Table 13-1 : Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS: 2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS: 2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 35% Max 27%	IS: 2386 Part IV
Durability	Soundness either :Sodium Sulphate or	Max 12%	IS: 2386 Part V

	Magnesium Sulphate	Max 18%	
Water Absorption	Water Absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength**	Min 80%	AASHTO 283

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.

If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement.

Where crushed gravel is proposed for use as aggregate, not less than 90 percent by weight of the crushed material retained on the 4.75 mm sieve shall have at least two fractured faces.

Fine Aggregates

Fine aggregates shall consist of crushed or naturally occurring mineral material, or a combination of the two, passing the 2.36 mm sieve and retained on the 75 micron sieve. These shall be clean, hard, durable, dry and free from dust, and soft or friable matter, organic or other deleterious matter. Natural sand shall not be allowed in binder courses. However, natural sand upto 50 percent of the fine aggregate may be allowed in base courses.

Filler

Filter shall consist of finely divided mineral matter such as rock dust, hydrated lime or cement approved by the Engineer. The filler shall be graded within the following limits :-

Table 13-2 : Grading Requirements for Mineral Filler

IS sieve (mm)	Cumulative Percent Passing by Weight of Total Aggregate
0.6	100
0.3	95-100
0.075	85-100

The filler shall be free from organic impurities and have a plasticity Index not greater than 4. The Plasticity Index requirement shall not apply if filler is cement or lime.

505.2.5 Aggregate

Grading and Binder Content

When tested in accordance with IS.2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and filler for the particular mixture shall fall within the limits given in Table 13-3 for grading 2.

Table 13-3 : Composition of Dense Graded Bituminous Macadam

Grading	2
Nominal aggregate size*	26.5
Layer Thickness	50 - 75 00 mm
IS Sieve1 (mm)	Cumulative % by weight of total aggregate passing
45	-
37.5	100

26.5	90-100
19	71-95
13.2	56-80
9.5	-
4.75	38-54
2.36	28-42
0.3	7-21
0.15	-
0.075	2-8
Bitumen content % by mass of total mix	Min 4.5**

* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is - 10°C or lower, the bitumen content may be increased by 0.5 percent.

Bitumen content indicated in above Table is the minimum quantity. The quantity shall be determined in accordance with Clause of Mix Design.

Mix Design

The bitumen content required shall be determined following the Marshall mix design procedure contained in Asphalt Institute Manual MS-2.

The Fines to Bitumen (F/B) ratio by weight of total mix shall range from 0.6 to 1.2.

Requirements for the Mix

Apart from conformity with the grading and quality requirements for individual ingredients, the mixture shall meet the requirements set out in Table 13-4.

Table 13-4 : Requirements for Dense Graded Bituminous Macadam

Properties	Viscosity Grade Paving Bitumen	Test Method
Compaction level	75 blows on each face of the specimen	
Minimum stability (kN at 600C)	9.0	AASHTO T245
Marshall flow (mm)	2 - 4	AASHTO T245
Marshall Quotient (Stability / flow)	2 - 5	MS-2 and ASTM D2041
% air voids	3-5	
% Voids Filled with Bitumen (VFB)	65-75	
Coating of aggregate particle	95% minimum	IS:6241
Tensile Strength ratio	80% Minimum	AASHTO T 283
% Voids in Mineral Aggregate (VMA)	11.0 – 13.0	

Binder Content

The binder content shall be optimized to achieve the requirements of the mix set out in Table 13-4. The binder content shall be selected to obtain 4 percent air voids in the mix design. The Marshall method for determining the optimum binder content shall be adopted as described in the Asphalt Institute Manual MS-2.

Where maximum size of the aggregate is more than 26.5 mm, the modified Marshall method using 150 mm diameter specimen described in MS-2 and ASTM D 5581 shall be used. This method requires modified equipment and procedures. When the modified Marshall test is used, the specified minimum stability values in shall be multiplied by 2.25, and the minimum flow shall be 3 mm.

Minimum Percent Voids In Mineral Aggregate (VMA)

Nominal Maximum Particle Size ¹ (mm)	Minimum VMA Percent Related to Design Percentage Air voids		
	3.0	4.0	5.0
26.5	11.0	12.0	13.0
37.5	10.0	11.0	12.0

Note : Interpolate minimum voids in the mineral aggregate (VMA) for designed percentage

Job Mix Formula

The Contractor shall submit to the Engineer for approval at least 21 days before the start the work, the job mix formula proposed for use in the works, together with the following details:

- i) Source and location of all materials;

ii) Proportions of all materials expressed as follows:

- a) Binder type, and percentage by weight of total mix;
- b) Coarse aggregate/Fine aggregate/Mineral filler as percentage by weight of total aggregate including mineral filler;
- iii) A single definite percentage passing each sieve for the mixed aggregate;
- iv) The individual gradings of the individual aggregate fraction, and the proportion of each in the combined grading;
- v) The results of mix design such as maximum specific gravity of loose mix (Gmm), compacted specimen densities, Marshall stability, flow, air voids, VMA, VFB and related graphs and test results of AASHTO T 283 Moisture susceptibility test;
- vi) Where the mixer is a batch mixer, the individual weights of each type of aggregate, and binder per batch;
- vii) Test results of physical characteristics of aggregates to be used;
- viii) Mixing temperature and compacting temperature.

While establishing the job mix formula, the Contractor shall ensure that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mix and its different ingredients satisfy the physical and strength requirements of these Specifications.

Approval of the job mix formula shall be based on independent testing by the Engineer for which samples of all ingredients of the mix shall be furnished by the Contractor as required by the Engineer.

The approved job mix formula shall remain effective unless and until a revised Job Mix Formula is approved. Should a change in the source of materials be proposed, a new job mix formula shall be forwarded by the Contractor to the Engineer for approval before the placing of the material.

Permissible variation from job mix formula:

It shall be the responsibility of the Contractor to produce a uniform mix conforming to the approved job mix formula subject to the permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used within the limits as specified in below Table.

Table 13-5 : Permissible Variations in the Actual Mix from the Job Mix Formula

Description	Base/binder Course
Aggregate passing 19 mm sieve or larger	±8%
Aggregate passing 13.2 mm, 9.5 mm	±7%
Aggregate passing 4.75 mm	± 6%
Aggregate passing 2.36 mm, 1.18 mm, 0.6 mm	±5%
Aggregate passing 0.3 mm, 0.15 mm	±4%
Aggregate passing 0.075 mm	±2%
Binder content	± 0.3%
Mixing temperature	± 10°C

Construction Operations

Preparation of Base

The base on which Dense Bituminous Macadam is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross sections as directed by the Engineer. The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used. A priming coat where needed, shall be applied as directed by the Engineer

Prime Coat

Where the material on which the dense bituminous macadam is to be laid is other than a bitumen bound layer, a prime coat shall be applied, as specified in the tender specification or as directed by the Engineer.

Tack Coat

Where the material on which the dense bituminous macadam is to be laid is either bitumen bound layer or primed granular layer, tack coat shall be applied, as specified in the tender specification or as directed by the Engineer.

Mixing and Transportation of the Mix

Pre-mixed bituminous materials shall be prepared in a hot mix plant of adequate capacity and capable of yielding a mix of proper and uniform quality with thoroughly coated aggregates. Appropriate mixing temperatures are given in Table 13-6 of these Specifications, the difference in temperature between the binder and aggregate shall at no time exceed 14°C. In order to ensure uniform quality of the mix and better coating of aggregates, the hot mix plant shall be calibrated from time to time.

Table 13-6 : Mixing, Laying and Rolling Temperatures for Bituminous Mixes (Degree Celsius)

Bitumen Viscosity Grade	Bitumen Temperature	Aggregate Temperature	Mixed Material Temperature
VG-40	150-165	150-170	150-165

Bituminous materials shall be transported in clean insulated and covered vehicles. An asphalt release agent, such as soap or lime water, may be applied to the interior of the vehicle to prevent sticking and to facilitate discharge of the material.

Spreading

The mix transported from the hot mix plant to the site shall be spread by means of a self-propelled paver with suitable screeds capable of spreading, tamping and finishing the mix to specified grade, lines and cross-section. The paver finisher shall have the following essential features:

- (a) Loading hoppers and suitable distributing mechanism.
- (b) All drives having hydrostatic drive/control.

(c) The machine shall have a hydraulically extendable screed for appropriate width requirement.

(d) The screed shall have tamping and vibrating arrangement for initial compaction to the layer as it is spread without rutting or otherwise marring the surface. It shall have adjustable amplitude and variable frequency.

(e) The paver shall be equipped with necessary control mechanism so as to ensure that the finished surface is free from surface blemishes.

(f) The paver shall be fitted with an electronic sensing device for automatic levelling and profile control within the specified tolerances.

(g) The screed shall have the internal heating arrangement.

(h) The paver shall be capable of laying width 7.50 mt. to extended up to 9.5mt.),

(i) The paver shall be so designed as to eliminate skidding/slippage of the tyres during operation.

However, in restricted locations and in narrow widths where the available equipment cannot be operated in the opinion of the Engineer, he may permit manual laying of the mix. Similarly for smaller jobs, mechanical paver may be used with the approval of the Engineer.

The temperature of mix at the time of laying shall be more than 120° C.

Mixes with a temperature of less than 120° C shall not be put into paver spreader. Longitudinal joints and edges shall be constructed true to the delineating lines parallel to the centre line of the road. Longitudinal and transverse joints shall be offset by at least 250 mm from those in the lower courses and the joint on the top most layer shall not be allowed to fall within the wheel path. All transverse joints shall be cut vertically to the full thickness of the previously laid mix with asphalt cutter and the surface painted with hot bitumen before placing fresh material. Longitudinal joints shall be preferably hot joints. Cold longitudinal joints shall be properly heated with joint heater to attain a suitable temperature of about 80° C laying of adjacent material.

Rolling

After spreading the mix by paver, it shall be thoroughly compacted by rolling with a set of rollers moving at a speed not more than 5 km/h, immediately following close to the paver. Generally the initial or breakdown rolling shall be done with 80-100 kN static weight smooth wheeled roller. The intermediate rolling shall be done with 80-100 kN static weight vibratory roller or with a pneumatic tyred roller of 150-250 kN weight having a tyre pressure of at least 0.7 MPa. The finish rolling shall be done with

60-80 kN weight smooth wheeled tandem roller. All the compaction operations, i.e., breakdown rolling and intermediate rolling can be accomplished by using vibratory tandem roller of 80-100 kN static weight. During initial breakdown rolling and finish rolling, no vibratory compaction shall be resorted to. The exact pattern of rolling shall be established after trial compaction as approved by the Engineer. Any displacement occurring as a result of reversing of the direction of a roller or from any other cause shall be corrected at once as specified and/or removed and made good. The rollers shall not be permitted to stand on pavement which has not been fully compacted and where temperature is still more than 70° C. Necessary precautions shall be taken to prevent dropping of oil, grease, petrol or other foreign matter on the pavement either when the rollers are operating or standing.

The wheels of roller shall be kept moist to prevent the mix from adhering to them. But in no case shall fuel/lubricating oil be used for this purpose nor excessive water poured on the wheels. Rolling shall commence longitudinally from edges and proceed towards the centre, except that on superelevated and unidirectional cambered portions, it shall progress from the lower to upper edge parallel to the centre line of the pavement. The roller shall proceed on the fresh material with rear or fixed wheel leading so as to minimise the pushing of the mix and each pass of the roller shall overlap the preceding one by half the width of the rear wheel.

Rolling shall be continued till the proper density is achieved and all roller marks are eliminated. Skin patching of an area that has been rolled will not be permitted. Rolling operations shall be completed in all respects before the temperature of the mix falls below 100° C.

Opening to Traffic

It shall be ensured that the traffic is not allowed on the surface until the dense bituminous layer has cooled to the ambient temperature.

Surface Finish and Quality Control of Work

Quality control:

Control on the quality of materials and works shall be exercised by the Engineer as per

Table 13-7 : Control Tests for Bituminous Works and their Minimum Frequency

Type of Construction	Test	Frequency (Min.)
Dense Bituminous Macadam / Bituminous	Quality of binder	Material Testing Certificate (MTC) is required from IOC as per number of samples per lot.

Concrete		
	Aggregate Impact Value/ Los Angeles Abrasion Value	One test per 100 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
	Flakiness and Elongation Indices	One test per 100 cu.m of aggregate for each source and whenever there is change in the quality of aggregate
	Water absorption of aggregates	One test for each source and whenever there is change in the quality of aggregate
	Mix grading	One test per 200 cmt subject to minimum of two tests per day per plant.
	Marshall stability and voids analysis of mix	Three tests for stability, flow value, density and void contents for each 400 tonne of mix subject to minimum of two tests per day per plant.
	Temperature of binder in boiler, aggregate in dryer and mix at the time of laying and compaction	At regular intervals
	Binder content	One set for each 400 tonnes of mix subject to minimum of two tests per day per plant
	Density of Compacted layer	One test per 300 mt length of road

Arrangement for Traffic

During the period of construction, arrangements for the traffic shall be provided. The Contractor shall take all necessary measures for the safety of traffic during construction and provide, erect and maintain such barricades, including signs, marking, flags, lights and flagmen as per instruction of the Engineer-in-charge.

Measurements for Payment

The rate shall be for a unit of one MT.

In addition to above, the contract unit rate of bituminous work shall also includes:

1. Finding of buried man hole during resurfacing activity if any
2. Cleaning of bitumen from all catch pits.
3. Submission of colored photographs of cleaned catch pits
4. Removal of all debris from site.

Item 112:

Providing & laying 30 mm. thick Compacted Bitumen Concrete(BC) with BT aggregate as per M.O.R.T.&H.gradation & asphalt grade VG-30 for mixing at the rate of 54 Kg./M.T. i.e. 5.40% of total weight of total mix including heating the aggregate & asphalt in continuous batch mix plant & spreading the same by sensor paver finisher & consolidation with vibratory roller & flushing sand @ 0.30 Cum/ 100 Smt. including providing all materials wquipments, tools & plants, fire wood, oil, kerosene, labour charges etc complete using constructors own machinery drum mix plant & paver finisher etc complete.

Materials**Bitumen**

The bitumen shall be viscosity grade (VG-40 / modified Bitumenous) paving bitumen complying with the Indian Standard Specification IS:73.

Coarse Aggregates

Clause of Dense Bituminous Macadam (DBM) shall apply. The aggregates shall satisfy the requirements specified in Table 14 -1 and these property of aggregate should be checked by the Engineer in charge in the Mix Design submitted by the contractor.

Table 14-1 : Physical Requirements for Coarse Aggregate for Dense Bituminous Macadam

Property	Test	Specification	Method of Test
Cleanliness (dust)	Grain size analysis	Max 5% passing 0.075 mm sieve	IS: 2386 Part I
Particle shape	Combined Flakiness and Elongation Indices*	Max 35%	IS: 2386 Part I
Strength	Los Angeles Abrasion Value or Aggregate Impact Value	Max 30% Max 24%	IS: 2386 Part IV
Durability	Soundness either :Sodium Sulphate or	Max 12%	IS: 2386 Part V

	Magnesium Sulphate	Max 18%	
Polishing	Polished Stone Value	Min 55	BS:812-114
Water Absorption	Water Absorption	Max 2%	IS: 2386 Part III
Stripping	Coating and Stripping of Bitumen Aggregate Mix	Minimum retained coating 95%	IS:6241
Water Sensitivity	Retained Tensile Strength**	Min 80%	AASHTO 283

To determine this combined proportion, the flaky stone from a representative sample should first be separated out. Flakiness index is weight of flaky stone metal divided by weight of stone sample. Only the elongated particles be separated out from the remaining (non-flaky) stone metal. Elongation index is weight of elongated particles divided by total non-flaky particles. The values of flakiness index and elongation index so found are added up.

If the minimum retained tensile test strength falls below 80 percent, use of anti stripping agent is recommended to meet the requirement.

Fine Aggregates

Clause of Dense Bituminous Macadam (DBM) shall apply.

Filler

Clause of Dense Bituminous Macadam (DBM) shall apply.

Grading and Binder Content

When tested in accordance with IS.2386 Part 1 (wet sieving method), the combined grading of the coarse and fine aggregates and filler for the particular mixture shall fall within the limits given in Table 14-2 for grading 2.

Table 14-2 : Composition of Bituminous Concrete.

Grading	1	2
Nominal aggregate size*	19 mm	13.2 mm
Layer Thickness	50 mm	30-40 mm
IS Sieve1 (mm)	Cumulative % by weight of total aggregate passing	
26.5	100	-
19	90 - 100	100
13.2	59-79	90-100
9.5	52-72	70-88
4.75	35-55	53-71
2.36	28-44	42-58
1.18	20-34	34-48
0.6	15-27	26-38
0.3	10-20	18-28
0.15	5-13	12-20
0.075	2-8	4-10
Bitumen content % by mass of total mix	Min 5.4**	Min 5.4**

* The nominal maximum particle size is the largest specified sieve size upon which any of the aggregate is retained.

** Corresponds to specific gravity of aggregates being 2.7. In case aggregate have specific gravity more than 2.7, the minimum bitumen content can be reduced

proportionately. Further the region where highest daily mean air temperature is 30°C or lower and lowest daily air temperature is - 10°C or lower, the bitumen content may be increased by 0.5 percent.

Bitumen content indicated in above Table is the minimum quantity. The quantity shall be determined in accordance with Clause of Mix Design.

Mix Design

Requirements for the Mix

Clause of Dense Bituminous Macadam (DBM) shall apply.

Binder Content

The binder content shall be optimized to achieve the requirements of the mix set out in Table 14-2.

Clause of Dense Bituminous Macadam (DBM) shall apply.

Job Mix Formula

Clause of Dense Bituminous Macadam (DBM) shall apply.

Permissible variation from job mix formula:

It shall be the responsibility of the Contractor to produce a uniform mix conforming to the approved job mix formula subject to the permissible variations of the individual percentages of the various ingredients in the actual mix from the job mix formula to be used within the limits as specified in below Table.

Table 14-3 : Permissible Variations in the Actual Mix from the Job Mix Formula

Description	Base/binder Course
Aggregate passing 19 mm sieve or larger	±7%
Aggregate passing 13.2 mm, 9.5 mm	±6%
Aggregate passing 4.75 mm	± 5%
Aggregate passing 2.36 mm, 1.18 mm, 0.6	±4%

mm	
Aggregate passing 0.3 mm, 0.15 mm	±3%
Aggregate passing 0.075 mm	±1.5%
Binder content	± 0.3%
Mixing temperature	± 10°C

Construction Operations

Preparation of Base

The base on which Bituminous Concrete is to be laid shall be prepared, shaped and conditioned to the specified lines, grades and cross sections as directed by the Engineer. The surface shall be thoroughly swept clean free from dust and foreign matter using mechanical broom and dust removed or blown off by compressed air. In portions where mechanical means cannot reach, other approved method shall be used as per instruction of engineer in charge.

Tack Coat

Where the material on which the Bituminous Concrete is to be laid, tack coat shall be applied, as specified in the tender specification or as directed by the Engineer.

Mixing and Transportation of the Mix

Clause of Dense Bituminous Macadam (DBM) shall apply.

Spreading

Clause of Dense Bituminous Macadam (DBM) shall apply.

Rolling

Clause of Dense Bituminous Macadam (DBM) shall apply.

Opening to Traffic

It shall be ensured that the traffic is not allowed on the surface until the bituminous concrete layer has cooled to the ambient temperature.

Surface Finish and Quality Control of Work

Arrangement for Traffic

Clause of Dense Bituminous Macadam (DBM) shall apply.

Measurements for Payment

The rate shall be for a unit of one MT.

In addition to above, the contract unit rate of bituminous work shall also includes:

1. Finding of buried man hole during resurfacing activity if any
2. Cleaning of bitumen from all catch pits.
3. Submission of colored photographs of cleaned catch pits
4. Removal of all debris from site.

Item 113:

Providing and laying in position Control concrete M-300 grade concrete for using cement content as per approved design mix, improve workability without impairing strength and durability as per direction of the engineer-in-charge. (Min cement level as per latest IS 456 shall be maintained) (Cement level 410kg) for Trimix C.C. Road with trimix vacuum dewatering system work with power trowling sheet form with M.S. Channles, surface vibrator finishing with floor hardner necessary all equipments, all labour charges complete.

1. Scope of Work

The work comprises **designing the concrete mix, providing, laying, compacting, vacuum dewatering, finishing, curing, testing and completing 150 mm thick M-30 grade (M-300) cement concrete road using Trimix Vacuum Dewatering System**, including:

- Approved Design Mix Concrete (Minimum cement content: 360 kg/m³)
- Use of admixtures to improve workability without impairing strength and durability
- MS channel side formwork
- Mechanical batching and mixing
- Surface and screed vibration
- Vacuum dewatering system
- Application of floor hardener
- Power trowel finishing
- Joint cutting and sealing
- Curing and protection
- Testing and quality control
- All labour, machinery, tools, consumables, and incidental works complete

The work shall be executed strictly as per latest IS Codes, IRC guidelines, and directions of the Engineer-in-Charge.

2. Applicable Standards

- IS 456 – Plain & Reinforced Concrete
- IS 10262 – Concrete Mix Design
- IS 383 – Aggregates for Concrete
- IS 9103 – Chemical Admixtures
- IS 1199 – Methods of Sampling & Analysis
- IS 516 – Compressive Strength Test
- IRC 15 – Concrete Road Construction

Latest amendments shall apply.

3. Materials

3.1 Cement

- OPC 43/53 Grade or PPC conforming to relevant IS.
- Minimum cement content: **360 kg per cubic meter.**

- Stored in dry condition.

3.2 Aggregates

- Coarse Aggregate: 20 mm down graded, angular, clean.
- Fine Aggregate: Zone II/III sand.
- Free from deleterious materials.

3.3 Water

- Potable quality.
- Free from oils, acids, and salts.

3.4 Admixtures

- Approved plasticizer/superplasticizer.
- Improves workability.
- Shall not reduce strength or durability.
- Dosage as per manufacturer and design mix approval.

3.5 Floor Hardener

- Metallic or non-metallic type.
- Abrasion resistant.
- Application rate: 3–5 kg/m².

4. Concrete Specifications

- Grade: M-30 (Characteristic strength = 30 MPa at 28 days)
- Minimum Cement: 360 kg/m³
- W/C Ratio: As per approved design mix and durability requirements
- Slump: 75–100 mm (suitable for Trimix process)
- Batching: Weigh batching only

5. EXECUTION METHODOLOGY

5.1 Subgrade Preparation

1. Subgrade shall be compacted to minimum 95% Modified Proctor Density.
2. Leveling and dressing shall be completed to required camber and slope.
3. Soft spots shall be removed and replaced.
4. Final level approval shall be obtained before concreting.

5.2 Formwork Installation

1. M.S. channel sections shall be used as side forms.
2. Proper alignment, line and level shall be ensured.
3. Forms shall be rigidly supported to prevent displacement.

4. Internal surfaces shall be oiled before concreting.
5. Forms shall be capable of withstanding vibration loads.

5.3 Batching & Mixing

1. Concrete shall be produced using mechanical batching plant.
2. Weigh batching shall be strictly followed.
3. Mixing time shall ensure uniform consistency.
4. No re-tempering with water shall be permitted.

5.4 Transportation

1. Concrete shall be transported by transit mixer or mechanical means.
2. No segregation or loss of workability shall occur.
3. Concrete shall be placed within initial setting time.

5.5 Placing of Concrete

Concrete shall be laid uniformly to slightly higher than required level.

1. Thickness shall be controlled to ensure **150 mm compacted thickness**.
2. Panels shall be laid in predetermined sequence.
3. Continuous placing shall be ensured to avoid cold joints.

5.6 Compaction

1. Initial compaction using screed vibrator.
2. Surface vibrators shall be used to remove entrapped air.
3. Vibration shall be sufficient to achieve full compaction.
4. Over-vibration causing segregation shall be avoided.

5.7 Trimix Vacuum Dewatering Process

Equipment:

- Vacuum pump
- Suction hoses
- Filter pads
- Vacuum mats

Procedure:

1. After vibration and leveling, filter pads shall be placed over concrete.
2. Vacuum mats shall be positioned and sealed.
3. Vacuum pump shall be started to create suction.
4. Excess water shall be extracted.
5. Duration shall depend on slab thickness (approx. 1–2 minutes per cm thickness).

6. Process shall reduce surface water-cement ratio.
7. Resulting concrete shall achieve:
 - Higher early strength
 - Reduced permeability
 - Increased abrasion resistance
 - Reduced shrinkage cracking

5.8 Application of Floor Hardener

1. Immediately after vacuum dewatering.
2. Spread uniformly in two stages.
3. First broadcast: 2/3 quantity.
4. Second broadcast: Remaining quantity.
5. Ensure uniform distribution.
6. Surface shall be floated before troweling.

5.9 Power Trowel Finishing

1. Mechanical power trowels shall be used.
2. Multiple passes to achieve smooth dense finish.
3. Surface shall be free from undulations.
4. Final finish shall be hard, abrasion-resistant, and level.
5. Tolerance: Max 3 mm variation under 3 m straight edge.

5.10 Joint Formation

Contraction Joints:

- Saw cutting within 24 hours.
- Depth: Minimum 50 mm (1/3 slab thickness).
- Spacing: 3.5 m to 4.5 m.

Expansion Joints:

- As per design interval.
- Pre-moulded filler board.
- Sealed with approved sealant.

Construction Joints:

- Dowels/tie bars as per design.

5.11 Curing

1. Curing shall begin immediately after finishing.
2. Continuous water curing for minimum 14 days.
OR

3. Approved curing compound may be applied.
4. Surface shall be protected from traffic for minimum 14 days.

6. Quality Control

6.1 Field Tests

- Slump test (every batch or 25 m³)
- Cube test (minimum 3 cubes per 30 m³)
- Thickness measurement
- Surface regularity check

6.2 Acceptance Criteria

- 28-day compressive strength ≥ 30 MPa
- Proper surface finish
- Correct thickness
- No visible cracks or honeycombing

7. Tolerances

- Thickness: ± 10 mm
- Level: ± 5 mm
- Alignment: Within specified limits

8. Safety & Protection

- Barricading during execution
- Safety PPE for workers
- Electrical safety for equipment
- Proper handling of vacuum equipment

9. Measurement

Measured in **Square Meter (Sq.m)** of finished surface area.

Thickness considered: 150 mm compacted thickness.

10. Rate Includes

The quoted rate shall include:

- Design mix preparation
- Cement (minimum 360 kg/m³)
- All aggregates and admixtures

- Mechanical batching & mixing
- Trimix vacuum system
- Power troweling
- Floor hardener
- MS channel formwork
- Labour and supervision
- Testing and QC
- Curing
- Joint cutting and sealing
- All tools, plants, machinery
- All leads, lifts, royalties, taxes

No extra payment shall be made for vacuum dewatering, troweling, or equipment usage.

11. Completion Criteria

The work shall be deemed complete only after:

- Achieving required compressive strength
- Joint cutting and sealing completed
- Surface finishing approved
- Engineer-in-Charge certification obtained

ADDITIONAL CONDITIONS

1. The contractor shall have to provide his own level instrument for this work.
2. Lowering, laying and jointing works of all the pipelines shall have to be carried out by using Sight Rails and Boning Staves.
3. Work is required to be carried out in residential area where all the services like water supply, sullage water pipeline, telephone / electric cable are existing. Under the circumstances, prior to starting the work agency shall have to excavate the trenches manually for up to 1 mt. depth. During the course of execution, all the services shall have to be maintained by the agency and any damage to any services or property, the agency shall have to get it repair at their cost.
4. For excavation of trench, use of JCB machine will not be permitted directly on the top surface of the road. After excavation up to minimum 1.00 mt. depth from road surface or existing ground level, same shall have to be carried out manually or by using Breaker and after locating underground services like; water supply pipeline, water connection lines, pipe gutters, telephone cables, electric cables etc., and thereafter upon taking the prior approval of the Engineer-In-Charge, the excavation can be carried out by using JCB machine.
5. Gandhidham Municipal Corporation shall recommend to the competent authority to give Controlled Blasting License to the contractor for carrying out excavation in hard rock. In case of blasting license not permissible from the competent authority in some places then excavation is to be done by using wedges and hammers, chiseling, breakers, pneumatic tools, etc. Also in case where blasting license is permitted but even then if there is no possibility of carrying out the blasting for whatsoever reason, the excavation is to be done by using Wedges and hammers, chiseling, breakers, pneumatic tools etc. No extra payment shall be made for excavation to be carried out in any of the above mentioned both the situations.
6. Excavation in soft rock and hard rock shall have to be carried out only by Chiseling, Breaker (pneumatic tools) etc., as far as possible. If excavation is not possible in terms of above and if excavation is required to be carried out with the help of blasting then the same shall have to be carried out only after taking prior approval and necessary license for blasting from the competent authority.
7. In case of excavation not possible manually or by chiseling in certain place(s) as well as if blasting is also not possible due to various reasons i.e. to avoid damage to nearby water pipeline, pipe gutter, telephone cables / Duct, Raw houses / weak buildings / narrow street etc., then the excavation by blasting will not be permitted. Under these circumstances, excavation shall have to be carried out only by Breaker (pneumatic tools) as per the instructions of the Engineer-In-Charge. No extra payment will be made for such type of excavation done by using Breaker. The rate for excavation shall be paid as per the rate of related item mentioned in Schedule-B.

8. The safety of the trenches is the prime important factor. Along the trenches on both the side, a hump of excavated stuff of minimum height 3 to 5 ft shall have to be provided till the work is got complete. However, where there is no defined road, in such area, the fencing/ lighting etc., requires to be provided as per clause 1.1.15. Sign Board shall have to be provided at required locations, so that there will not be any fatal accident.
9. Regarding the width of excavation, as (a) it is difficult to carry out the vertical trench excavation, (b) possibility of sliding the soil, and (c) uneven excavation trench width in case of blasting. In this connection, for every 1.5 mt lift if there is less width upto 5 cm at the bottom then the top width of excavated trench, it shall be considered as per the specified trench width or actual trench width carried out at the ground level by the contractor whichever is less. If excavation is carried out more than the specified width then the payment will be made only for the specified width of excavation. For mode of measurement for excavation, the width of excavation will be considered as given at the time of line out by engineer-in-charge or actual width done whichever is less.
10. The pipes shall be with ISI mark whereas that of manhole frame and cover shall be confirming to relevant IS.
11. After entering into an agreement, the agency shall have to finalize the agency for supply of the material like pipes, manhole / house connection chamber frame and covers etc., and the name of manufacturer / supplier should immediately be informed to Gandhidham Municipal Corporation so that Gandhidham Municipal Corporation can also expedite the manufacturer / supplier for the material. If necessary, Gandhidham Municipal Corporation will visit and inspect the factory. During the inspection, if Gandhidham Municipal Corporation is not satisfied then the contractor shall have to procure the material from other manufacturer(s).
12. While the work in progress, there is possibility of change in drainage line routes according to the site conditions. Under these circumstances, the contractor shall have to carry out the work accordingly, for which, no extra payment shall be made in such situations. Over and above, the decision of Engineer-in-charge for change in drainage line routes shall be final and binding to the contractor.
13. The quantity of various items mentioned in the schedule-B is liable to increase or decrease up to any extent. Under the circumstances, the contractor shall have to carry out the work accordingly without any rate escalation. Gandhidham Municipal Corporation will not entertain any dispute in this regard.
14. In excavation, the decision regarding classification of strata shall rest with the Engineer-In-Charge and his decision in this regards shall be final and binding to the Contractor.

15. The rates are inclusive of dewatering, if require
16. Regarding water supply for hydro / flow testing, necessary water, power, labour etc. required for the necessary test shall be arranged by the contractor at his own cost.
11. During construction activity, proper care must be taken for labour safety and must follow the provisions of the Labour Laws.
18. Testing of the material like; Brick, Sand, Aggregate etc. should have to be tested periodically as suggested by the engineer- in-charge at Government approved material testing Laboratory and testing charges for the same has to be borne by the contractor.
19. In case of any ambiguity found in specifications / drawings etc. the engineer-in-charge is empowered to take necessary decision for rectification and same shall be final and binding to the contractor.
20. The contractor shall have to get registered under ESI (Employer's State Insurance)
21. Act and obtain ESI Registration number if the number of workers are 10 Nos. or more. Also, the agency shall have to give all the benefits to the workers as available under the ESI Act. The agency should follow all the rules and regulations of ESI Act as per prevailing norms.
22. The contractor will be responsible to avail P F Code as per the prevailing Circular of Government for the employees on work. The required documents regarding deduction of P F shall have to be submitted by the contractor to the competent authority.
23. The restoration work for the excavation done is to be carried out immediately as per the instructions of engineer in charge. The excess material shall have to be disposed with no extra cost at the site specified by engineer-in-charge.

**CITY ENGINEER
Gandhidham Municipal Corporation**

Signature of Contractor

BILL OF QUANTITIES AND PRICE

The Bill of quantities consists of following sections :

CIVIL WORKS:

Civil works requires following:

Excavation of Trenches

- Providing, supplying, lowering, laying, jointing, testing and commissioning of various dia. distribution & street service DI pipeline with DI Specials network as per the detailed specifications shown in Vol- II.
- Bedding for pipes with selected murrum
- Support of piping system, Thrust blocks of RCC in various concrete etc.
- Refilling the pipeline trenches with proper ramming
- All required necessary items as directed by engineer in charge.

The bill of quantities forms the most important part of the e-tender documents. The supply, lowering laying jointing, erection testing and commissioning of pipeline which form a part of total works are indicated in the schedules separated include in the documents. The e-tendering contractors shall price of this document.

Performance testing and commissioning:

The bill of quantities, general conditions of contractor and the specifications which from an integral part of this contractor shall be read in conjugation.

The bill of quantities, general conditions of contractor and the specifications which from an integral part of this contractor shall be read in conjugation.

Payment for different items shall be paid on % (percentage) above or

below quoted by the contractor online in the given price bid.

However for

any extra items to be carried out with permission of engineer in charge rates

will be decided by the Gandhidham Municipal Corporation as per GC-70 wherever not specified in the tender.

Whenever manufacturer is separate and contractor for lowering, laying, joining and testing is separate, the principal contractor shall enter in to an agreement with DI pipes & DI Specials manufacturer for satisfactory manufacturing as per the relevant code of practice, testing, transporting, stacking & testing after laying at site as per MMC requirement.

APPROVED VENDOR LIST

SR. NO.	PARTICULARS	DESCRIPTION
1.0	DI PIPES	ELECTOSTEEL, JINDAL, WELSPUN, ELECTROTHERM
2.0	TAPPING FERRULES	AS PER IS STANDARD BUT LONG BODY
3.0	SLUICE VALVE /BUTTERFLY VALVE	
	A. Up to 600 mm Valve (As per ISI Mark Only)	KIRLOSKAR / IVI/ VAG/ L&T/ FOURESS/GM VALVES
	B. More than 600 mm Valve (As per ISI Mark or As per IS Standard)	KIRLOSKAR / IVI/ VAG/ L&T/ FOURESS/GM VALVES
5.0	DI PIPE SPECIALS	ELECTOSTEEL, JINDAL, WELSPUN, ELECTROTHERM, KM METALS, TRUEFORM, TRUEFLOW