Part – II

Technical specification

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Section - T1

Technical specification for excavation and filling

1. Scope

1.1 This section of the specification covers the technical requirements for excavation and filling for industrial plots in & around structures, buildings, pipes, foundations, trenches, pits, drains, channels, cable ducts, underground facilities & similar works. It also covers filling areas and plinths with selected materials, conveyance and disposal of surplus soils and/or stacking them properly as directed by the Engineer.

1.2 The contractor shall be fully responsible for getting necessary permission from government authorities to excavate soil from the sources mentioned in the tender and should pay necessary seignerage charges to government authorities as per rules.

1.3 The Contractor shall be fully responsible for proper setting out of works, profiling in excavation, stacking, etc., taking adequate safety measures etc. The Contractor shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein. All work shall be executed to the satisfaction of the Engineer.

1.4 Existing trees, shrubs, any other plants, pole lines, fences, signs, monuments, buildings, pipelines, drains, sewers, or other surface or subsurface systems/drains/facilities within or adjacent to the works being carried out which are not to be disturbed, shall be protected from damage by the Contractor shall provide and install suitable safeguards approved by the Engineer for this purpose.

1.5 During excavation, the Contractor shall take all necessary precautions against soil erosion, water & environmental pollution and where required to undertake additional works to achieve this objective. Before start of operations, the Contractor shall submit to the Engineer for approval, his work plan and the procedure he intends to follow for disposal of waste materials etc. and the schedule for carrying out temporary and permanent control works. However, the approval of the Engineer to such plans and procedures shall not absolve the Contractor of his responsibility for safe and sound work.

2. General requirements

2.1 The Contractor shall make his own surveying arrangements for locating the coordinates and positions of all work and establishing the reduced levels (RL's) at these locations based on two reference grid lines and one bench mark which will be furnished by the Owner. The Contractor has to provide at site all the required survey instruments, along with qualified surveyors, to the satisfaction of the Engineer so that the work can be carried out accurately and according to the specification and drawings.

2.2 The Contractor shall furnish all skilled and unskilled labour, plant, tools, tackle, equipment, men, materials required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer.

2.3 The Contractor shall control the grade in the vicinity of all excavations so that the surface of the ground will be properly sloped or dyed to prevent surface water from running into the excavated areas during construction.

2.4 All materials obtained from excavation shall remain owner's property. All salvaged materials of archeological importance or of value (in the opinion of the Engineer) shall be segregated from the other materials and both stacked separately and in regular manner at locations indicated by the Engineer.

2.5 Excavation shall include removal of trees including roots & organic remains, vegetation, grass, bushes, shrubs, plants, poles, fences, etc. that are in the area to be excavated as well as beyond the excavation line so as to ensure safety of the excavated side slopes, and of men and equipment operating in the area. Before start of excavation work, joint measurements of ground level shall be taken after cleaning all grass, vegetation, etc.

2.6 Excavation shall include the removal of all materials required to execute the work properly and shall be made with sufficient clearance as decided by the Engineer to

permit the placing and setting of forms, inspection and completion of all works to the satisfaction of the Engineer for which the excavation was done.

2.7 Wherever reference is made to 'drawings' in this specification it shall mean the latest issue of the approved drawings.

3. Codes and standards

3.1 All standards, specifications, acts, and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions.

3.2 In case of conflict between this specification and those (IS standards, codes etc.) referred to herein (in para 3.3) the former shall prevail.

3.3 Some of the relevant Indian standards, Acts and Codes are referred to here below:

IS:383	Specification for coarse and fine aggregates from natural sources for concrete
IS:2720 (Part-II, IV to VIII, XIV, XXI, XXIII, XXIV, XXVII to XXIX, XL)	Methods of tests for soils - determination of water content etc.
IS:3764:	Safety code for excavation work
IS:4081:	Safety code for blasting and related drilling operations
IS:4701:	Code of Practice for earth work on canals
IS:9759:	Guide lines for Dewatering during construction.
IS:10379:	Code of practice for field control of moisture and compaction of soils for embankment and subgrade.
IS:3812	Pulverized fuel ash – specification part 2 for use as admixture in cement mortar and concrete

4. Excavation

4.1 Excavation in all types of soils, soft and disintegrated rock (ordinary rock), and hard rock shall be done up to the required level. Excavation shall also include breaking of existing concrete RCC, Masonry work, tar and bitumen surfaces, and paving works etc. In case blasting is required the same shall be subject to the approval of Engineer. Sides and bottoms of excavation shall be cut sharp and true to line and level. Undercutting shall not be permitted. When machines are used for excavation, the last 300 mm before reaching the required level shall be excavated manually or by such equipment that soil at the required final level will be left in its natural condition. Suitability of strata (at the bottom of excavations) for laying the foundation thereon shall be determined by the Engineer.

4.2 Excavation for foundations shall be to the bottom of lean concrete and as shown on drawings or as directed by the Engineer. The bottom of all excavations shall be trimmed to required levels and when excavation is carried below such levels, by error, it shall be brought back to specified level by filling with concrete of nominal mix 1:3:6 / 1:4:8 (cement & Fly ash (20% replacement ratio of cement with fly ash):

coarse sand : 20mm down aggregates) as directed by the Engineer.

4.3 The Contractor shall ascertain for himself the nature of materials to be excavated and the difficulties, if any, likely to be encountered in executing this work. Cofferdams, Sheeting, shoring, bracing, maintaining suitable slopes, draining etc. shall be provided and installed by the Contractor, to the satisfaction of the Engineer.

4.4 All excavation for installation of underground facilities, such as piping, sewer lines, drain lines, etc shall be open cuts. For deep and huge excavations and in other excavations, if required by the Engineer, the Contractor shall submit for Engineer's approval (as already mentioned under Clause 1.5) an "Excavation scheme" showing the methodology to be adopted for excavation in order to maintain the stability of side slopes, means for ensuring safety of existing facilities nearby, dewatering as required etc. However, the Contractor shall be fully responsible for the scheme irrespective of any approvals granted. Benching shall be provided for deeper excavation wherever required.

4.5 When excavation requires bracing, sheeting or shoring etc., the Contractor shall submit drawings to the Engineer, showing arrangements and details of proposed installation. The Contractor shall also furnish all supporting calculations as called for and shall not proceed until he has received written approval from the Engineer. However, the responsibility for adequacy of such bracing, sheeting, shoring etc. will

rest with the Contractor, irrespective of any approval of the Engineer. All precautions shall be taken while excavations near existing structures are to be carried out till the backfilling is completed.

4.6 The Contractor shall have to constantly pump out any water collected in excavated pits and other areas due to rain water, ground water, springs etc. and maintain dry working conditions at all times until the excavation, placement of reinforcement, shuttering, concreting, backfilling is completed. The Contractor shall remove all slush/muck from the excavated areas to keep the work area dry. Sludge pumps, if required, shall be employed by the Contractor for this purpose.

4.7 The Contractor shall remove all materials arising from excavations from the vicinity of the work either for direct filling, stacking and subsequent filling or for ultimate disposal as directed by the Engineer. In no case shall the excavated soil be stacked within a distance of 1.5m from the edge of excavation or one third the depth of excavation whichever is more. Material to be used for filling shall be kept separately as directed by the Engineer.

5. Filling

5.1 Materials

a) Materials to be used for filling purposes shall be stone, sand or other inorganic materials and they shall be clean and free from shingle, salts, organic, large roots and excessive amount of sod. Lumps concrete or any other foreign substances which could harm or impair the strength of the substructure in any manner. All clods shall be suitably broken to small pieces. When the material is

mostly rock boulders, these shall be broken into pieces not larger than 150mm size. Sand used for filling shall be clean, medium grained and free from impurities. Fines less than 5 microns shall not be more than 20%. In any case, the materials to be used for filling purposes shall have the prior written approval of the Engineer.

b) If excavated materials are to be used for filling, then the Contractor shall select the materials from the stockpile, load and transport this material and execute the filling. This shall include excavation of earth which may become hard due to laying in stack yard for a long period of time.

c) In case the materials have to be brought from pits/quarries, then it shall be the Contractor's responsibility for identification of such quarry areas, obtaining approval for their use from concerned authorities, excavation/quarrying, loading and carriage of such material, unloading and filling at specified locations. The Contractor shall pay any fees, royalties etc. that may have to be paid for utilization of borrow areas.

5.2 **Filling procedure**

a) After completion of foundation, footings, walls and other construction below the elevation of the final grades, and prior to filling, all temporary shoring, timber, etc. shall be sequentially removed and the excavation cleaned of all trash, debris & perishable materials. Filling shall begin only with the written approval of the Engineer. Also, areas identified for filling shall be cleared of all soft pockets, vegetation, bushes, slush etc. In case of plinth and similar filling the ground shall be dressed and consolidated by ramming and light rolling.

b) Fill materials shall not be dropped directly upon or against any structure or facility where there is danger of displacement or damage. Filling shall be started after the concrete/masonry has fully set and shall be carried out in such manner so as not to cause any undue lateral thrust on any part of the structure.

c) All space between foundation (concrete or masonry) and the sides of excavation shall be filled to the original surface after making allowance for settlement. Fill

shall be placed in horizontal layers not exceeding 200mm loose thickness. Each layer shall be watered and compacted with proper moisture content & with such equipment as may be required to obtain a compaction / density as specified. Trucks or heavy equipment for depositing or compacting fill shall not be used within 1.5 meters of building walls, piers or other facilities which may be damaged by their weight or operations. The methods of compaction shall be subject to the approval of the Engineer. Pushing of earth for filling shall not be adopted under any circumstances.

d) Fill adjacent to pipes shall be free of stones, concrete, etc. and shall be hand placed and compacted uniformly on both sides of the pipe and where practicable up to a minimum depth of 300mm over the top of pipes. While tamping around the pipes, care should be taken to avoid unequal pressure.

e) Filling shall be accurately finished to line, slope, cross section and grade as shown on the drawings. Finished surface shall be free of irregularities and depressions and shall be within 20mm of the specified level.

f) Where filling with stone from excavated materials is required, as per design and functional requirements, it shall be from broken pieces of boulders. At first a 75mm thick cushion of selected earth shall be laid over which the 200mm thick graded stones shall be laid in loose layers of 200mm and then the interstices filled with properly graded fine materials consisting of selected earth brought from borrow areas. Each layer shall be watered and compacted to the required density as per design and functional requirements before the next layer is laid. However, no cushion shall be required where filling is over non-rocky surface.

g) Where clean stone fill is required as per design and functional requirements it shall consist of clean selected stone metal of 40mm nominal size. It shall be laid in layers not exceeding 150mm (loose) and lightly tamped before the next layer is laid. No compaction shall be required for this type of stone filling.

5.3 Compaction

a) Where compaction of 90% Standard Proctor Density is called for, such compaction shall be by mechanical means but the contractor may be permitted to adopt manual means only if the Engineer finds that the desired compaction is achievable in the field.

b) Where compaction to 95% Standard Proctor Density is called for, it shall be by mechanical means only. Where access is possible, compaction shall be 12 tonne rollers smooth wheeled, sheep foot or wobbly wheeled and directed by the Engineer. A smaller weight roller may be permitted by the Engineer in special cases, but in any case not less than 10 passes of the roller will be accepted for each layer. Each layer shall be wetted or the material dried by aeration to a moisture content of 3-5% above the Optimum Moisture Content to be determined by Contractor. Each layer shall be watered, rammed and compacted to the density as specified in the Schedule of Quantities.

c) For compacting each sand layer, water shall be sprayed over it to flood it and it shall be kept flooded for 24 hours to ensure maximum compaction. Vibrocompactors shall also be used if necessary to obtain the required degree of compaction. Any temporary works required to contain sand under flooded condition shall also be undertaken. The surface of the consolidated sand shall be dressed to required levels or slope.

d) After the compacted fill has reached the desired level, the surface shall be flooded with water for 24 hours, allowed to dry and then rammed and consolidated to avoid any settlement, at a later date. The compacted surface shall be properly shaped, trimmed and consolidated to an even gradient or level. All soft spots shall be excavated, filled and consolidated.

e) The degree of compaction of compacted fill in place will be subject to tests in accordance with relevant Indian Standards as desired by the Engineer. As the work progress, the Contractor shall provide the necessary facilities to make such tests. If any test indicates that the compaction achieved is less than the required as per design and functional requirements degree of compaction, the Engineer may require all fill placed subsequent to the last successfully test to be removed

and re-compacted by the Contractor. Compaction procedure shall be amended as necessary to obtain satisfactory results.

f) When semi-compacted fill is required as per design and functional requirements by the Engineer, the Contractor shall fill up such areas with available earth from stock piles or borrow pits or directly from excavation without special compaction except that obtained by moving trucks, etc.

6. Sampling testing and quality control

6.1 General

a) The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Engineer. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer. Tests shall be done in the field and at a laboratory approved by the Engineer and the Contractor shall submit to the Engineer, the test results in triplicate within three days after completion of a test. The Engineer may, at his discretion, waive some of the stipulations given below, for small and unimportant operations.

b) Work found unsuitable for acceptance shall be removed and replaced by the Contractor. The work shall be redone as per specification requirement and to the satisfaction of the Engineer.

c) Only as a very special case and that too in non-critical areas, the Engineer may accept filling work which is marginally unacceptable as per the criteria laid down. For such accepted work, payment shall be made at a reduced rate prorate to the compaction obtained against that stipulated.

6.2 Quality assurance programme

The Contractor shall submit and finalize a detailed field Quality Assurance Programme within 30 days from the date of award of the Contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, Field Quality Plan, etc. On finalized field quality plan, the owner shall identify customer hold prints beyond which work shall not proceed without written approval from the Engineer.

6.3 Frequency of sampling and testing including the methods for conducting the tests are given in Table-1. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out or call for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications.

6.4 Acceptance criteria

Following acceptance criteria shall be followed.

a) All individual samples collected and tested should pass without any deviation when only one set of sample is tested.

b) For re-test of any sample two additional samples shall be collected and tested, and both should pass without any deviation.

c) Where a large number of samples are tested for a particular test than 9 samples out of every 10 consecutive samples tested shall meet the specification requirement.

d) Tolerance on finished levels for important filling areas at approved intervals shall be + 20 mm. However, for an unimportant area, tolerance up to + 57 mm shall be acceptable at the discretion of the Engineer. However, these tolerances shall be applicable for localized areas only.

Table 1: Frequency of sampling and testing

Sl. No.	Nature of test/ characteristics	Methods of test	No. of samples & frequency of test	Remarks
I.	**Suitability of fill materials**			
	(a) Grain size analysis	IS:2720 (Part-IV)	One in every 2000 Cum. for each type and each source of fill material subject to a minimum of	Test for and sand
	(b) Liquid limit and plastic limit	IS:2720 (Part-V)	two samples	Test for soil
	(c) Shrinkage limit	IS:2720 (Part-VI)	One in every 5000 cum. for each type	The frequency of Test shall be
	(d) Free steel index	IS:2720 (Part-XL)	And each source of fill materials.	increased depending on type of soil
	(e) Chemical Analysis	IS:2720		
	i. Organic matter	Part XXII	One in every 5000 Cum for each type and each source of	Test for sand and soil.
	ii. Calcium carbonate	Part XXIII	Fill materials.	
	iii. pH	Part XXVI		
	iv. Total soluble sulphate	Part XXVII		
II.	**Standard proctor test**	IS:2720 (Part VII)	One in every 2000 cum. for each type and each source of fill materials	Test for soil for determining optimum moisture content, Dry Density etc.
III.	**Moisture content of Fill before compaction.**	IS:2720 (Part II)	-do-	Test for soil
IV.	**Degree of compaction of fill**		(i) For foundation filling, one for every ten foundations for each	Test for soil

	(a) Dry density by core cutter method	IS:2720 (Part XXIX)	Compacted layer. However, each layer for location of important and heavily loaded	
	or			
	Dry density in place by	IS:2720 (Part	Foundations resting on fill	
Sl. No.	**Nature of test/ characteristics**	**Methods of test**	**No. of samples & frequency of test**	**Remarks**
	sand displacement method	XXVIII)	shall be tested.	
			(ii) For area filling one for every 1000 Sqm. Area for each compacted layer.	
	(b) Relative density index	IS:2720 (Part XIV)	-do- (i) & (ii)	Test for sand
	(c) Dry density by proctor needle penetration	Standard Practice	Random checks to be carried out for each compacted layer in addition to tests mentioned under IV (a) above.	Test for soil

Sub-Section - T2

Technical specification for properties, storage and handling of common building materials

Section - T2

Technical specification for properties, storage and handling of common building materials

1. Scope

1.1 The scope of this section of the specification is to specify the properties, storage and handling of common building materials namely, coarse aggregates, cement, water, sand masonry units, reinforcement and structural steel.

1.2 Properties of the materials in general have been discussed. Specific requirements of the materials have been stipulated separately under specification for relevant items of work.

2. General requirements

2.1 The work shall include, providing of all necessary plants and equipment, providing adequate engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out the entire work as directed by the Engineer to his complete satisfaction.

2.2 All materials proposed for use in the work shall conform to the requirements laid down in this section, and also subject to the approval of the Engineer. After specific materials have been accepted, the source of supply of such materials shall not be changed without prior approval of the Engineer.

Approval of any material by the Engineer shall not relieve the Contractor of his responsibility, for the requisite quality and performance of the material used.

2.3 Any material considered to be sub-standard, or not up to satisfaction of the Engineer, shall not be used by the Contractor and shall be removed from the site immediately.

2.4 Representative samples shall be procured by the Contractor and submitted to the Engineer, for approval before bulk procurement. The representative samples shall be retained by the Engineer for future comparison and reference.

3. Codes and standards

3.1 In the event that state, city or other local governmental bodies have requirements more stringent than those set forth in this specification, the former shall govern.

3.2 All applicable standards, acts, specifications, codes of practice, hand books, referred to herein shall be the latest editions, including all official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

Any special materials used, but not covered here, shall conform to relevant Indian Standards, if any, or as specified by the Engineer for any special purpose.

3.3 Some of the applicable Indian standards, codes are referred to here below :

IS:226 Specification for structural steel (standard quality).

IS: 269 Specification for ordinary Portland cement, 33 grades.

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 (Parts 1&2) hard-drawn steel wires for concrete reinforcement.

IS: 455 Specification for Portland slag cement.

IS: 712 Specification for building limes.

IS: 1077 Specification for common burnt clay building bricks.

IS: 1077 Specification for Burnt clay bricks/Fly ash bricks.
IS: 1127 Recommendations for dimensions and workmanship of natural

	building stones for masonry work.
IS: 1129	Recommendation for dressing of natural building stones.
IS:1489	Specification for Portland pozzolana cement (Part-I) Fly ash based (Part-II) Calcined clay based
IS:1542	Specification of sand for plaster.
IS:1566	Specification hard-drawn steel wire fabric for concrete reinforcement.
IS:1597	Code of Practice for construction of Stone masonry, rubble stone masonry.
IS:1786	Specification for high strength deformed bars for concrete reinforcement.
IS:2062	Specification for hot rolled medium and high tensile structural steel.
IS:2116	Specification for sand for masonry mortars.
IS:2386	Testing of aggregates for concrete.(Part I to VIII)
IS:3495	Methods of test of Burnt clay bricks/Fly ash bricks (Part-I to IV)
IS:4031	Methods of physical tests for hydraulic cement.
IS:4032	Methods of chemical analysis of hydraulic cement.
IS:4082	Recommendations on stacking and storage of construction materials at site.
IS:7969	Safety code for handling and storage of building materials.
IS:8112	High strength ordinary Portland cement.

IS:8500 Medium and high strength structural steel.

IS:12269 43/53 grade ordinary Portland cement.

IS:12330 Sulphate resisting Portland cement.

IS:12600 Portland cement, low heat.

IS:12894 Fly Ash Lime Bricks - specification.

IS: 3812-2 Specification for pulverized fuel ash for use as admixture in cement mortar and concrete

4. Burnt clay Bricks

4.1 Burnt clay bricks, for general masonry work, shall conform to IS: 1077 and for face brick work, shall conform to IS: 2691. Fly ash lime bricks shall conform to IS:12894

4.2 Bricks for general masonry work shall be table moulded/machine made, well burnt without being vitrified, of uniform size, shape, having sharp edges and cherry red colour. These shall be free from cracks, flaws or nodules of free lime and shall emit clear ringing sound (metallic sound) when struck. These shall not show any signs of efflorescence either when dry or subsequent to soaking in water. Fractured surface shall show uniform texture free from grits, lumps, holes etc.

4.3 Unless otherwise specified, minimum compressive strength shall correspond to class designation 75 as per IS: 107 with a minimum crushing strength of 75 kg/sq.cm. for general masonry work. However, for non-load bearing walls, bricks pavements, etc. bricks of class designation 50 shall only be used, wherever specified or shown on the drawings. Water absorption after 24 hours immersion shall not exceed 20% by weight for common bricks and 15% for face bricks.

4.4 On the basis of finish and dimensional tolerance, the bricks shall be classified as sub class A and B. Dimensional tolerance shall not exceed 3% and 8% of the size, of common bricks for sub-class A & B respectively and 3% for face bricks. All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chip page for

the face bricks shall be 6mm at the edges and 10mm for corners. The face bricks shall show no efflorescence after soaking in water and drying in the shade.

4.5 The size of the bricks used shall be either modular size as per IS:1077 or locally available conventional size as approved by the Engineer.

4.6 Each brick shall have the manufacturer's identification mark clearly marked on the frog. The colour and texture of face bricks shall be limited to the range of samples submitted. Any brick not found up to the satisfaction of the Engineer shall be removed immediately from site by the Contractor.

5. Fly ash bricks

5.1 Fly ash bricks (cement bonded) shall be locally made. Bricks shall have smooth rectangular faces with sharp and square corners. Bricks shall be hand or machine moulded and shall be made from the admixture of suitable good quality of fly ash, sand and cement as per the composition mentioned below :

FLY ASH : 50-60%
SAND : 32-40%
CEMENT : 8-12%

5.2 The fly ash bricks will be as per latest relevant IS code. The bricks will be of dimension as per standard clay brick, suitable for making 230mm thick full brick wall, 115mm thick half brick wall and 75mm thick minor partition walls, as applicable, as per drawing/specification/BOQ. A maximum tolerance of (+/-) 2mm shall be allowed as the manufacturing tolerance. The bricks shall have frog of 100 mm in length 40 mm in width and 10 to 20 mm deep of one of its flat sides.

The bricks when tested in accordance with the procedure laid down in IS 3495 (part 2) 1992 after immersion in cold water for 24 hrs. Water absorption shall be within 13-15% by weight. Similarly, the porosity of the fly ash bricks shall be within 12-20%. The bricks shall have a minimum crushing strength of 80 Kg/Sqcm.

5.3 Fly ash bricks, for general masonry work, shall conform to IS:2212-1991

5.4 Unless otherwise specified, minimum compressive strength shall correspond to class designation 80 as per IS: 107 with a minimum crushing strength of 80 kg/sq.cm. For general masonry work. However, for non-load bearing walls, bricks pavements, etc. bricks of class designation 50 shall only be used, wherever specified or shown on the drawings. Water absorption after 24 hours immersion shall not exceed 20% by weight for common bricks and 15% for face bricks.

5.5 On the basis of finish and dimensional tolerance, the bricks shall be classified as sub class A and B. Dimensional tolerance shall not exceed 3% and 8% of the size, of common bricks for sub-class A & B respectively. All bricks shall have rectangular faces and sharp straight edges. Maximum permissible chip page for the face bricks shall be 6mm at the edges and 10mm for corners. The face bricks shall show no efflorescence after soaking in water and drying in the shade.

5.6 The size of the bricks used shall be either modular size as per IS:1077 or locally available conventional size as approved by the Engineer.

5.7 Each brick shall have the manufacturer's identification mark clearly marked on the frog. The colour and texture of face bricks shall be limited to the range of samples submitted. Any brick not found up to the satisfaction of the Engineer shall be removed immediately from site by the Contractor.

6. Stones

6.1 All stones shall be from approved quarries. These shall be hard, tough, and durable, compact grained, uniform the texture and colour and free from decay, flaws, veins, cracks and sand holes. The surface of a freshly broken stone shall be bright, clean and sharp and hall show uniformity of texture, without loose grains and free from any dull, chalky or earthy appearance. Stone with round surface shall not be used.

6.2 Stones showing mottled colours shall not be used for face work. A stone shall not absorb more than 5% of its weight of water after 24 hours immersion. The type of stone shall be as specified or shown on drawings and/or as instructed by the Engineer. Stones used for masonry work shall conform to IS:1597 (Part – I) No soft stone shall be used for masonry or for filling purpose.

6.3 Any stone not found up to the satisfaction of Engineer shall be removed immediately from site by the Contractor.

7. Lime

7.1 Lime shall be stone lime and it shall conform to IS: 712. Hydrated lime shall be mixed with water to form a putty. This shall be stored with reasonable care to prevent evaporation of water for at least 24 hours before use. Quick lime shall be slaked with enough water to make a cream and then stored with reasonable care to prevent evaporation of water for at least seven days before use. Type of lime to be used for different purposes such as concreting, plastering, white washing etc. shall be according to the satisfaction made hereunder :

Class – A Eminently hydraulic lime used for structural purposes.

Class – B Semi-hydraulic lime used for masonry mortars, lime concrete and plaster undercoat

Class – C Fat lime used for finishing coat in plastering, white washing, composite mortars, etc. and with addition of pozzolanic materials for masonry mortar.

Class – D Magnesium/dolomite lime used for finishing coat in plastering, whitewashing, etc.

Class – E Kankar lime used for masonry mortar.

Class – F Siliceous dolomite lime used for undercoat and finishing coat of plaster

8. Cement and Fly ash

8.1 Cement shall be ordinary Portland cement, 43/53 grade conforming to IS 8112/12269. The Engineer may permit the use of Portland pozzolana cement conforming to IS: 1489 or Portland slag cement conforming to IS: 455 or sulphate resistant cement confirming to IS 12330 as per the specific site condition. However, any lower grade of OPC, PPC and PSC should never be mixed with higher grade cement.

8.2 Fly ash is generated by burning of coal in coal fired power plants. It has the characteristic of pozzolonic additive to cement. Continuous research studies by various engineering research laboratories revealed its varied usefulness as an additive for enhancing the various qualities of concrete including its workability, strength and durability if handled and cared properly. Partial replacement of cement with fly ash in concrete save much of the energy required for production of OPC and also facilitates the economical disposal of millions of tons of fly ash.

At present most of the fly ash blended cements commercially produced in India has 18 to 25% fly ash by weight and addition of fly ash to this extent has a beneficial effect on the workability and economy of concrete. It has been found that in order to improve the other qualities of concrete like resistance of sulfate attack and thermal cracking, larger percentage of fly ash is to be used in concrete.

Indian standard specification No. 3812-2003, Specification for Pulverized Fuel Ash, Part 2: For Use as Admixture in Cement Mortar and Concrete [CED 2: Cement and Concrete] covers the extraction and the physical and chemical requirements of pulverized fuel ash for use as admixture in cement mortar and concrete. Fly ash confirming to this standard shall be used in place of cement.

The chemical, physical requirements and testing of fly ash shall be in accordance with the IS 3812-2003

9. Water

9.1 Water used for cement concrete, mortar, plaster, grout, curing, washing of coarse aggregate, soaking of bricks, etc. shall be clean and free from injurious amount of oil, acids, alkalis, organic matters or other harmful substances in such amounts that may impair the strength or durability of the structure. Potable water shall generally be considered satisfactory for all masonry and concrete works, including curing. The Contractor shall carry out necessary tests in advance to prove the suitability of the water proposed to be used. As a guide, the following concentrations represent the maximum permissible values :

a. To neutralize 200 ml sample of water, it should not require more than 2ml of 0.1 normal NaOH.

b. To neutralize 200 ml sample of water, it should not require more than 10ml of 0.1 normal HCL.

c. Percentage of solids shall not exceed the following :

i)	Organic	0.02
ii)	Inorganic	0.30
iii)	Sulphate	0.05
iv)	Chlorides	0.10
v)	Suspended matter	0.20

10. Aggregates

10.1 Aggregates mean both coarse and fine inert materials used in the preparation of concrete. Aggregates shall consist of natural sands, crushed stone and gravel from a source known to produce satisfactory aggregate for concrete and shall be chemically inert, hard, strong, durable against weathering, of limited porosity and free from such quantities of deleterious materials as may cause corrosion of reinforcement or may impair the strength and / or durability of the concrete. Total percentage of all deleterious materials, including coal, lignite, clay lumps, and materials finer than 75 microns, soft fragments and shale but excluding mica shall not exceed 5%. However, for crushed fine aggregate, total percentage of coal and lignite and clay lumps, shall be limited to 2%. Both coarse and fine aggregates shall conform to IS:383 for concrete, shuttering etc. unless otherwise mentioned.

10.2 Sample of aggregates for mix design and determination of their suitability shall be sent to the laboratory well in advance in scheduled placing of concrete. Sampling, testing, and interpretation of test results shall be subject to the approval of the Engineer. Aggregates shall be properly graded.

11. Sand

11.1 Sand shall be hard, durable, clean and free from adherent coatings of organic matter and shall not contain clay balls or pellets. The sand shall be free from impurities such as iron pyrites, alkalis, salts, coal, mica, shale, or other laminated materials, in such forms or quantities as to affect adversely the hardening, strength, durability or appearance on mortar, plaster, etc. or to cause corrosion of any metal in contact with such mortar, plaster etc. In no case, the cumulative percentage of Impurities in sand shall be more than 5% by weight. All sand shall be properly graded. Unless otherwise directed by the Engineer, sand for masonry mortars shall conform to IS: 2116 and sand for plaster shall conform to IS: 1542. Sand, when used as fine aggregate, in concrete, shall conform to IS:383. For filling, medium grained sand (having fines less than 75 microns not exceeding 20%) shall be used.

12. Reinforcement steel, structural steel (including embedded steel) and wire mesh

12.1 Billet:- (Primary steel)

A semi-finished product obtained by forging or rolling, usually square and not exceeding 125 x 125 mm in cross section with rounded corners and is intended for further processing into suitable finished product by forging or re-rolling.

Steel shall be manufactured by open hearth, electric, duplex, basic oxygen or a combination of these processes. In case any other process is employed by the manufacturer, prior approval of the purchaser should be obtained.

The ladle analysis of the material when analyzed in accordance with the various parts of IS: 228, shall be confirmed with IS: 8056-1976- Table 1(Chemical composition).

TABLE 1 CHEMICAL COMPOSITION (As per IS: 8056-1976 clauses 3.1 & 6.1)	
CONSTITUENT	**PERCENT**
Carbon	0-45 to 0.80
Silicon	0.15 to 0.35
Manganese	0.40 to 1.00
Sulphur, Max	0.050
Phosphorus, Max	0.050

In case of continuous cast billets, the billet analysis shall be taken as ladle analysis.

Permissible variation in case of product analysis from the limits specified in IS: 80561976 clause-6.1 shall be as follows:

CONSTITUENT	Variation Over the Specified Maximum or Under the Minimum Limits in %
Carbon	0.03
Silicon	0.03
Manganese	0.04
Sulphur, Max	0.005
Phosphorus, Max	0.005

Note - Variations shall not be applicable both over and under the specified limits in several determinations in a heat.

Sampling

At least one ladle sample analysis shall be taken per cast.

If required, the samples for product analysis shall be prepared by forging or rolling down to 30-mm round section.

In case of wire rods the test piece size shall be the size of wire rods.

Drilling shall be taken from the sample representing two-thirds, half and one-third of height from bottom of the billet separately.
In case of continuous cast billets and billets produced from ingots of masses 3 tonnes and more, the sample may be taken from anywhere from the billets.

Freedom from defects

The billets and continuous cast billets shall be free from harmful defects, such as pipe, laminations, segregation, inclusions and cracks.

Subject to agreement between the purchaser and the manufacturer, the billets and continuous cast billets may be supplied with suitable surface dressing.

billets shall either be supplied free from harmful segregation, piping, cracks, inclusions, and blow-hole by appropriate top and bottom discard and dressing or supplied with suitable surface dressing only, without top and bottom discard if agreed to between the purchaser and the manufacturer, to ensure the requirements of freedom from defects specified in the relevant product specifications.

If agreed to between the purchaser and the manufacturer the following tests may be carried out from the samples prepared under IS: 8056-1976

Dimensions

The size and tolerance of billets shall be subject to agreement between the purchaser and the manufacturer. However, the nominal sizes of billets generally supplied as per guidance given in IS: 8056-1976

The preferred sizes of billets shall be 50, 63, 7!, 80, 90, 100 and 125 mm.

The sizes other than those specified may be supplied by agreement between the purchaser and the manufacturer.

A tolerance of the billets shall be confirmed with IS: 8056-1976

The ends of ingots and billets shall be painted with a suitable colour code conforming to IS: 2049-1963.

Each ingot and billet shall be legibly stamped or painted with the cast number, grade and the name or trade-mark of the manufacturer.

The material may also be marked with the IS1 Certification Mark.

12.2 All steel for reinforcement shall be clean and free from loose mill scales, dust, loose rust, oil, grease, paint or other harmful matters which may affect its bond with concrete. Mild steel and medium tensile steel bars and hard drawn steel wire for concrete reinforcement shall conform

to grade-1 of IS:432 (Part-1). High strength deformed steel bars shall conform to grade Fe 415 of IS: 1786. All steel bars shall be of tested quality. Actual grade and type steel, to be used, shall be as specified or shown on drawings.

12.3 Structural steel (including embedded steel) shall be straight, sound, and free from twists, cracks, flaws, laminations and all other defects. Structural steel shall be of tested quality conforming to IS: 226, IS: 2062 or IS: 8500. These shall be free from lamination defects. Grade and type of steel to be used shall be as specified.

12.4 Hard drawn steel wire fabric shall conform to IS: 1566. Wire fabric shall be electrically cross welded.

13. Storage and handling of materials

13.1 Generally, all materials shall be stacked and stored by the Contractor as described in IS: 4082 unless otherwise mentioned and in a manner affording convenient access for identification and inspection at all times. The storage area and arrangements shall be subject to the approval of the Engineer. Any material rendered unserviceable during the Contractor's custody, shall be replaced or repaired by the Contractor as determined by the Engineer.

13.2 All materials shall be as stored as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work. Any material which has deteriorated or has been damaged or is otherwise considered defective by the Engineer, shall not be used and shall be removed and the cost thereof, shall be realized from the Contractor's dues. The Contractor shall maintain up-to-date accounts of receipts, issue and balance (stock wise) of all materials.

13.3 Bricks shall not be dumped at site. These shall be stacked on dry firm ground in regular tiers even as they are unloaded to minimize breakage and defacement of bricks. Bricks of different class, selected for various categories of use in the work, shall be stacked separately. Each stack shall contain equal number of bricks, preferably not more than 3000.

13.4 Dressed stone for all facing, paving etc. shall be stored with special care to avoid defacement of faces and edges or damp and rust stains.

13.5 Lime shall be stored in weather-proof sheds. Lime which has been damaged by rain, moisture or air slaking, shall not be used. If the lime is supplied as hydrated lime, it shall be stored in the same manner as cement.

13.6 Cement and fly ash

a. Consignments of cement shall be stored as received and shall be consumed in the order of their delivery. Cement held in storage for more than ninety days shall invariably be tested, and only if test results are satisfactory, the Engineer may consider permitting its use.

b. Different consignments of different types of cement, i.e. OPC, PPC, PSC shall be stacked separately with clear identifiable stack number.

c. The cement shall be stored in dry, leak proof and weather proof are closed sheds. Storage under tarpaulins shall not be permitted. The cement bags shall be stored well away from the walls and insulated from the floor, using

d. Planks etc. to avoid contact with moisture. The cement shall be stacked in easily countable stacks and in a place of easy access so as to facilitate proper inspection and removal on a first in first out basis. Not more than 15 bags shall be stacked in any tier to prevent lumping up under pressure. However, in stacks more than 8 bags high, the cement bags shall be arranged alternately lengthwise and crosswise so as to tie the stacks together and minimize the danger of toppling over. The cement bags shall be gently kept to avoid leakage of cement from the bags. Substandard or partially set cement shall be immediately removed from the site as soon as it is detected.

e. The contractor shall make his own arrangements for the storage of adequate quantity of cement. Cement in bulk may be stored in bins or silos which will provide adequate protection against dampness, contamination, etc. The bins or silos shall be cleaned periodically.

f. Pulverized fuel ash (Fly ash) shall be stored in accordance with the recommendation given in IS 4082. Additionally, during bulk storage, the fly ash should be suitably covered to avoid getting airborne.

g. Supplies of pulverized fuel ash (Fly ash) may be made in bulk in suitable quantities or in bags (jute, jute-laminated, multiple paper or polyethylene lined) bearing the net mass (may be 15 kg, 30 kg, 300 kg, 600 kg as agreed by the Contractor)

h. Pulverized fuel ash in bulk storage for more than 6 months or in bags for more than-3 months after completion of tests, may be re-tested before use and standard. May be rejected, if it fails to conform to any requirements of this standard.

i. Pulverized fuel ash may be rejected if it does not comply with any of the requirements stipulated in IS 3812 Part 2 of 2003

13.7 Coarse and fine aggregates/sand

a. Coarse and fine aggregates shall be stacked separately. Contamination with foreign materials and earth during storage and while heaping the materials shall be avoided. Coarse aggregates shall be stacked in layers not exceeding 120 cm in height such that corning and segregation do not occur. Each layer shall cover the entire area of the stock pile before succeeding layers are placed.
Segregated aggregates from stock-pile shall be rejected.

b. Aggregates shall be stored on brick soling or an equivalent platform so that they do not come in contact with dirt, clay, grass or any other injurious substance, at any stage. For lifting aggregates from stock piles, rackes shall be used. Aggregates of different sizes shall be kept in separate and easily measurable stacks. If so desired by the Engineer, aggregates from different source shall be stacked separately with proper care to prevent intermixing.

13.8 Reinforcement and Structural Steel (including steel required for embedment)

a. Reinforcement and structural steel (including steel required for embedment) shall be stored consignment wise and size wise, off the ground by at least 150mm and protected by the suitable cover, or as desired by the Engineer. The steel shall be protected from rusting, oil grease and distortions. The reinforcing steel shall be coated with cement wash before stacking to prevent scale and rust, in areas having accelerating corrosion effect like marine atmosphere. The stacks shall be easily measurable. Steel needed for

immediate use only shall be removed from storage. Fabricated steel shall be carefully stored to prevent damage, distortion, corrosion and deterioration.

b. Reinforcement shall be stored according to the diameter, grade and length in such a place as to permit easy approach for inspection and identification.

c. The area shall be such that water does not accumulate and reinforcement does not get distorted or corroded. It shall not be stacked directly over ground or near any harmful materials. It shall be cleaned of excessive rust before use.

d. Steel plates of different specifications shall be stacked separately. Steel of IS: 2062 and IS: 8500 quality shall be given a grade wise, distinctive identification mark. Passage and space between the stacks shall be sufficient for rigging operations.

14. Testing

14.1 All materials provided by the Contractor shall be tested for conformity of the specification and the test results shall be submitted to the Engineer for acceptance. In addition to above, the Contractor shall carry out the relevant tests at site as specified under different items of work.

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Sub-Section – T3

Technical specification for masonry and allied works

Section – T3

Technical specifications for masonry and allied works

1 Scope

This section of the specification covers furnishing, installation including handling, transportation, batching, mixing, laying, scaffolding, centering, shuttering, finishing, curing, protection and repairing till handing over of brick masonry and allied works including DPC, plinth protection and dismantling.

2 General requirements

2.1 The Contractor shall furnish all skilled and unskilled labour, plant, equipment, scaffolding, materials, etc. required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer.

2.2 All workmanship shall be in accordance with the latest standards and best possible practice. Masonry work shall be true to line & level as shown on drawings. All such masonry shall be tightly built against structural members and bonded with dowels, anchors, inserts, etc, as shown on the drawings.

2.3 The Contractor shall carry out all works for settling out the building lines, locating the co-ordinates and establishing the reduced levels (RL's) on the basis of reference grid lines and bench mark, which shall be furnished by the Owner, at one or more locations.

2.4 Any approval, instructions, permission, checking, review, etc. whatsoever by the Engineer shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, safety, strength, quality, workmanship, etc.

3 Codes and standards

3.1 All applicable standards, acts and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the Contractor.

3.2 In case of conflict between this specification and those (IS Standards, Codes etc.) referred to in clause 3.3, the former shall prevail.

3.3 Some of the applicable Indian Standards, Codes, etc. are referred to here below:

IS:1127 Recommendations for Dimensions and Workmanship of Natural Building Stones for Masonry Work.

IS:1597 Code of practice for construction of Stone Masonry.

IS:1905 Code of Practice for Structural Safety of Buildings - Masonry walls.

IS:2116 Specification for sand for masonry mortars.

IS:2185 Specification for Hollow cement concrete blocks

IS:2212 Code of Practice for Brickwork.

IS:2250 Code of Practice for preparation and use of masonry mortar.

IS:2572 Code of Practice for construction of Hollow concrete block masonry

IS:3414 Design and installation of joints in buildings.

IS:3696 Safety code for scaffolds and ladders.

IS:4130 Safety code during demolition of buildings.

IS:4326 Code of practice for earthquake resistant design and construction of buildings

IS:12894 Fly ash lime bricks specifications.

SP:20 Explanatory hand book on masonry code.

4 Brick masonry

4.1 Materials

Properties of common building materials for the construction of brick masonry, viz. burnt clay bricks, sand lime and cement shall be in accordance with the technical specification for 'Properties, Storage and Handling of Common Building Materials' (vide Mode C2). Besides clay bricks, other type of bricks like, fly ash-lime bricks cured by autoclave process shall also be used, whenever specified, or shown on the drawing.

5 Fly ash brick masonry

5.1 Materials

Properties of common building materials for the construction of brick masonry, viz. fly ash bricks, sand lime and cement shall be in accordance with the technical specification for 'Properties, Storage and Handling of Common Building Materials' (vide Mode C2). Besides fly ash bricks, other type of bricks like, fly ash-lime bricks cured by autoclave process shall also be used, whenever specified, or shown on the drawing.

5.2 Mortar

IS: 2250 shall be followed as general guidance for preparation and use of mortar. Only cement &Fly ash-sand mortar shall be used. Lime shall be added for composite mortar with specific approval of the Engineer.

Unless otherwise specified, mortar for brickwork having one or more brick thickness shall be 1 part cement & fly ash (20% replacement ratio of cement with fly ash): and 6 parts sand by volume. Mortar for half-brick thick walls shall be 1 part cement & fly ash (20% replacement ratio of cement with fly ash): and 4 parts sand by volume. Richer mix proportion shall be used, whenever specified or as per design requirement. Mortar shall meet the compressive strength requirement as per IS:
2250 and IS: 1905.

Sand shall conform to IS: 2116. Grading of sand when tested as per IS: 2386 shall be as specified in Table -1.

Table 1: Grading of sand for use in masonry mortars

IS sieve designation IS:460 (Part – I)	Percentage passing by mass	Method of test
4.75mm	100	IS:2386
2.36mm	90 to 100	(Part-I)
1.18mm	70 to 100	
600 micron	40 to 100	
300 micron	5 to 70	
150 micron	0 to 15	

Sand, whose grading falls outside the specified limits due to excess or deficiency of coarse or fine particles, may be processed to comply with the standard by screening through a suitably sized sieve and/or blending with required quantities of suitable sizes of sand particles. Based on test results and in the light of practical experience with the use of local materials, deviation in grading of sand given in Table-1 may be considered by the Engineer. The various sizes of particles of which the sand is composed, shall be uniformly distributed throughout the mass. The required grading may often be obtained by screening and/or by blending together either natural sands or crushed stone screenings, which are by themselves of unsuitable grading.

Cement, fly ash (20% replacement ratio of cement with fly ash): and sand shall be thoroughly mixed dry in a mechanical mixer and water shall then be added to obtain a mortar of the consistency of a stiff paste, care being taken to add just sufficient
water for the purpose. Water shall be clean and free from injurious amount of deleterious matter such as oil, acid alkali, salt and vegetable growth. Hand mixing may be allowed by the Engineer on clean approved platform in special cases only. Mortar shall be used as soon as possible after mixing, before it begins to set and preferably within 30 minutes after water is added to the dry mixture. Mortar unused for more than 30 minutes shall generally be rejected and removed from site of work.
However, the Engineer may allow the use of mortar up to 2 hours.

Surplus mortar droppings while laying masonry, if received on a surface from dirt, may be mixed with fresh mortar if permitted by the Engineer, where direct for addition of extra cement and this shall be implemented.

5.3 Laying

IS: 2212 shall be followed as general guidance for construction of brick masonry Vat/tank of suitable size shall be provided by the Contractor for soaking of bricks. Bricks shall be soaked in water before use for a period generally not less than 6 hours so that the water just penetrates the whole depth of the bricks. Bricks shall be laid in by hand and not thrown inside the tank. Bricks shall be taken out sufficiently in advance so that these are skin dray at the time of laying.

Bricks shall be laid in English Bond unless otherwise specified. Half or cut bricks shall not be used except where necessary to complete the bond. Closers in such cases shall be cut to the required size and used near the ends of the walls, next to quoin headers.

Bricks shall be laid generally with frogs upwards. A layer of mortar shall be spread on the full width and over a suitable length of the lower course. Each brick shall be properly bedded and set home (in position) by gently tapping with the trowel handle or with a wooden mallet. It's inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of a course, all vertical joints shall be fully filled from the top with mortar. The thickness of joints shall be kept uniform and shall not exceed 10 mm. Bricks shall be so laid that all joints are full of mortar.

All face joints shall be raked to a minimum depth of 15 mm by raking tools during the progress of brickwork, when the mortar is still green, so as to provide proper key for the plaster or pointing to be done. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying.

Brickwork in walls shall be taken up truly plumb. All courses shall normally be laid truly horizontal unless indicated to be laid on slope and all vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. Brick wall shall be construed with at least one plain face with proper alignment.

All connected brickwork shall be carried up simultaneously and no portion of work shall be left more than one meter below the rest of the work. Where this is not possible, in the opinion of

the Engineer, the work shall be raked back according to bond (and not toothed) at an angle not steeper than 45 deg. The work done per day should not be more than one meter height

All iron fixtures, pipes, water outlets, holdfasts for doors and windows, etc. which are required to be built into the brickwork shall be embedded in their correct position in mortar or cement concrete as the work proceeds as per directions of the Engineer.

All brickwork shall be built tightly against columns, floor slabs or other structural parts and around door and window frames with proper distance to permit caulked joint. Where drawings indicate that structural steel columns and spandrel beams are to be partly or wholly covered with brickwork, the bricks shall be laid closely against all flanges and webs with all spaces between the steel and brickwork filled solid with mortar not less than 10mm in thickness.

The top courses of all plinth, parapet, steps and top wall below CRC shall be laid with brick on edge (other than modular size bricks) unless otherwise specified. Care shall be taken that the bricks forming the top courses and ends of walls are properly radiated and keyed into position as shown on the drawings.

Scaffolding shall be strong enough to withstand all the dead, live and impact loads which are likely to come upon it. It shall also be so designed as to ensure the safety of the workmen using them.

For all brick masonry except for exposed brickwork, single scaffolding shall be permitted. In such cases, the inner end of the horizontal scaffolding pole shall rest in a hole provided only in header course for the purpose. Only one header for each pose shall be left out. Such holes for scaffolding shall, however, not be allowed in pillars/columns less than one meter in width. The holes left in masonry works for scaffolding purposes shall be filled and made good before plastering.

In case of joining old brickwork with new brick work, the old work shall be toothed to the full width of the new wall and to the depth of quarter of a brick in alternate courses. It shall be cleaned of all dust, loose mortar, etc., and thoroughly wetted before starting new brick work. Thickness of each course of new work shall be made equal to the thickness of the corresponding course of the old work by adjusting thickness of horizontal mortar joints.

The face of the brickwork shall be cleaned on the same day on which brickwork is laid and all mortar dropping removed promptly.

Template (bed-block) of plain or reinforced cement concrete shall generally be provided to support ends of RCC beams. Top surface of the wall shall be suitably treated as per direction of the Engineer so as to minimise the friction to movement of the concrete slab over the bearing.

Brickwork shall be protected from rain by suitable covering when the mortar is green. Masonry work shall be cured by keeping it constantly moist on all faces for a minimum period of seven days. Brickwork carried out during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

5.4 Half brick masonry

The work shall be done in the same manner, as mentioned in 4.03 except that all course shall be laid with stretchers. In cases where reinforcement is considered necessary from structural consideration, 2 nos. 8 mm dia bars shall be provided generally at every 4th layer of bricks or as specified on the drawings. Before laying reinforcement, it shall be cleaned of rust and loose flakes with a wire brush. They shall be securely anchored at their ends where the partitions bond. Half the mortar thickness for the bedding joint shall be laid first and then 8mm dia bars laid straight out near each face of the brickwork maintaining a side cover of 12mm mortar. Subsequently the other half of the mortar thickness shall be laid covering the reinforcement fully.

5.5 Exposed brickwork

Exposed brickwork i.e. brickwork is superstructure which is not covered by plaster shall be as shown on the drawings and shall be done by specially skilled masons. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in alternate courses shall come directly one over the other. Thickness of brick courses shall be kept uniform and for this purpose wooden straight edge with graduations indicating thickness of each course including joint shall be used. The height of window sills, bottom of lintels and other such important points in the height of the wall shall be marked on the graduated straight edge. Masons must check workmanship frequently with plumb, spirit level, rule and string.

For all exposed brick work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

If face bricks are specified on the drawings, the brickwork shall be in composite work with face bricks on the exposed face and balance in standard bricks, but maintaining the bond fully. Where face bricks are not specified, bricks for the exposed face shall be specially selected from available stack of bricks. All exposed brickwork on completion of work shall be rubbed down, washed clean and pointed as specified.
Where face bricks are used, carborundum stone shall be used for rubbing down.

5.6 Reinforcing anchorage

For external walls, the anchorage in the form of flats or rods from spandrel beams and columns and any other anchoring and reinforcement as shown on the drawing shall be adequately embedded in the masonry.

6 Stone masonry

Rubble stone masonry which is commonly used in stone work has been covered under this specification. Details of construction for Random Stone Masonry (uncoursed) and Coursed Rubble Masonry (first and second sorts) are given in the following clauses. IS: 1597 shall be followed as general guidance for construction of stone masonry

6.1 Stone masonry

The stone shall be of the type specified, such as granite, sand stone, quartzite and /or best locally available stone which shall be subject to approval of the Engineer. It shall be obtained only from an approved quarry. Colour of the stone shall be as shown on the drawings or approved by the Engineer. It shall be hard, sound, durable and free from decay, weathering. It shall also be free from defects like cavities, cracks, sand holes, flaws, veins, patches of soft and loose materials, etc. Stones with round surface shall not be more than 5 percent when tested in accordance with IS: 1124. The minimum crushing strength of stone shall be 200 kg/sq cm unless otherwise specified.

6.2 Size of stone

Normally, stones used should be small enough to be lifted and placed by hand. The length of stone, shall not exceed three times the height and the breadth on base shall not be greater than three fourth of the thickness of wall not more than 15 cm.
The height of stone may be up to 30 cm.

6.3 Mortar

Unless otherwise specified, mortar for stone masonry shall be 1 part of cement & fly ash (20% replacement ratio of cement with fly ash): and 6 parts sand by volume. Properties, preparation and use of mortar shall be same as specified for brick masonry work vide, clause no. 4.3)

6.4 Dressing of stone

The dressing of stone shall be as specified below for individual types of masonry work and it shall also conform to the general requirements for stone covered in IS:1129.

a) For Random Rubble Stone Masonry, stone shall be hammered ---- the face, the sides and the beds to enable it to come into close with the neighboring stone. the bushing on the face shall be than 4 cm on an exposed face, and 1 cm on a face, to

b) For coursed Rubble Masonry (First sort) Face stones, shall dressed on all beds, and joints, so as to give them approx. angular shape.

6.5 Laying

a) **Random rubble masonry**

All stones shall be wetted before use. The wall shall be carried up truly plumb or to the specified batter. Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. Stones may be brought to level courses at plinth, window sills and roof level. Leveling up shall be done with concrete comprising of one part of mortar (used for the masonry) and two parts of graded stone aggregate of 20 mm nominal size. The bond shall be obtained by fitting in closely, the adjacent stones and by using bond stones.

Face stones shall extend and bond well into the backing. These shall be arranged to break joints as much as possible, and to avoid long vertical lines of joints, the hearting or interior filling of the wall shall consist of rubble stones which may be of any shape but shall not pass through a circular ring of 15 cm inner diameter. Thickness of these stones in any direction shall not be less than 10 cm. These shall be carefully laid, hammered down with a wooden mallet into the position and solidly bedded in mortar. Clips and spells of stone shall be used where necessary to avoid thick mortar beds or joints and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The hearting shall be laid nearly level with facing and backing except that at about one meter intervals, vertical 'plumb' projecting about 15 cm to 20 cm shall be firmly embedded to form a bond between successive courses. The chips shall not be used below the hearting stone to bring these up to the level of face-stones. The use of chips shall be restricted to the fillings of interstices between the adjacent stones in hearting and these shall not exceed 20% of the quantity of stone masonry. The masonry in a structure shall be carried regularly. Where the masonry of one part has to be delayed, the work shall be raked back at an angle not steeper than 45 deg. Toothing in masonry shall not be permitted.

Bond or through stones running right through the thickness of walls shall be provided in walls up to 60 cm thick and in case of walls above 60 cm thickness, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided in a line from back to back.

In case of highly absorbent type of stones (porous lime stone and sand stone etc.) the bond stone shall extend about two third into the wall. Through stones in such cases may give rise to damp penetration and therefore, for all thickness of such walls, a set of two or more bond stones overlapping each other by at least 15 cm shall be provided.

Where bond stones of suitable length are not available, cement concrete block of mix 1:3:6 (with 20mm nominal size graded stone aggregate) shall be used. At least one bond stone or a set of bond stones shall be provided for every 0.5 sq m of the wall surface. All bond stones in stone masonry shall be marked suitably as directed by the Engineer.

The quoins shall be selected stones, neatly dressed with the hammer or chisel to form the required angle, and laid header and stretcher in the alternate layers. Volume of these stones shall not be less than 0.03 cu m.

Stones shall be so laid that all joints are fully packed with mortar and chips. Face joints shall not be more that 20mm think. When plastering or pointing is not required to be done, the joints shall be struck flush and finished at the time of laying. Otherwise the joints shall be raked to a minimum depth of 20 mm by raking tool during the progress of work, when the mortar is still green.

Single scaffolding having one set of vertical support shall be allowed. Masonry work shall be kept constantly moist on all faces for a minimum period of seven days. Green work shall be protected from damage, mortar dropping and rain during construction.

b) Coursed rubble masonry (First Sort)

All stones shall be wetted before use. The walls shall be built up truly plumb or to specified batter. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. The height of each course shall not be less than 150 mm nor more than 300 mm. Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints. Face stones shall be laid in alternate header and stretcher fashion. No face stone shall be less in breadth than its height and at least one third of the stones shall tail into the work for length not less than twice their height. These shall be so arranged as to break joints by 7 at least 75 mm. Each face stone shall be of the same height in any given course. The bond shall be obtained by fitting in closely the adjacent stones and by using bond stones.

Stones shall be laid with grains horizontal so that the load is transmitted along the direction of the maximum crushing strength.

The hearting or the interior filling of the wall shall consist of stones carefully laid on their proper beds in mortar; chips and spalls of stone being used where necessary to avoid thick beds or joints of mortar and at the same time ensuring that no hollow spaces are left anywhere in the masonry. The chips shall not be used below the hearting stone to bring these up to the level of face stones. The use of chips shall be restricted to the filling of interstices between the adjacent stones in hearting and these shall not exceed 10% of the total volume of stone masonry. All bed joints shall be horizontal and all side joints vertical. All joints shall be fully packed with mortar. Face joints shall not be more than 10 mm thick. When plastering or pointing is not required to be done, the joints shall

be struck flush and finished at the time of laying. Otherwise, the joints shall be raked to a minimum depth of 20mm by raking took during the progress of work, when the mortar is still green.

Stone may be brought to level courses at plinth, window sills and roof level. Leveling up at plinth level, window sills and roof level shall be done with concrete comprising of one part of the mortar (use for the masonry) and two parts of graded stone aggregate of 20mm nominal size.

The masonry in a structure shall be raised up uniformly and regularly but where breaks are unavoidable, the work shall be raked back at angle not steeper than 45 deg. Too things shall not be allowed. Masonry on any day should not be raised by more than 1 meter in height.

Bond or through stones running right through the thickness of walls shall be provided in walls up to 600 mm thick and in case of walls above 600 mm thickness, a set of two or more bond stones overlapping each other by at least 150mm shall be provided in a line from face to back.

In case of highly absorbent types of stones (porous limestone and sand stone etc.) the bond stone shall extend about two-third into the wall. Through stones in such cases may give rise to damp penetration. Therefore, for all the thickness of such walls, a set of two or more bond stones overlapping each other by at least 150mm shall be provided.

Where bond stones of suitable lengths are not available, cement concrete blocks of 1; 3:6 mix (1cement: 3 sand: 6 graded stone aggregate 20mm nominal size) shall be used.

A bond stone or a set of bond stones shall be inserted 1.5 to 1.8 meters apart, in every course. All bond stones shall be suitably marked during construction for subsequent verification and shall be staggered in subsequent layers. The quoins shall be of selected stones, neatly dressed with the hammer or chisel to form the required angle. These shall be of the same height in which these occur. These shall be at least 450 mm long and shall be laid stretchers and headers alternately. These shall be laid square on the beds, which shall be rough chisel dressed to a depth of at least 100 mm. In case of exposed work, these stones shall have a minimum 25mm wide chisel drafts at four edges, all the edges being in the same plane. Single scaffolding having one set of vertical support

shall be allowed. The supports shall be sound and strong, tied together by horizontal scaffolding member may rest in a hole provided in the masonry. Such holes, however, shall not be allowed in pillars less than one meter in width. The holes left in masonry work for supporting scaffolding shall be filled and made good with cement concrete 1:3:6 (1 cement : 3 sand : 6 stone aggregate 20 mm nominal size)
Masonry work shall be kept constantly moist on all faces for a minimum period of seven days. Green work shall be protected from rain by suitable covering. The work shall also be suitably protected from damage, mortar dropping and rain during construction.

c) Coursed rubble masonry (second sort)

Laying of this type of masonry shall be in the same manner as First Sort masonry described above except for the following:

The use of chips for filling of interstices of adjacent stones in hearting shall not exceed 15% of the total volume of stone masonry, and stone in each course need not be of the same height, but more than two stones shall not be used in the height of a course. Face joints shall not be more than 20mm thick.

7 Mouldings and cornices

The relevant clauses of the specifications described under 4.0 & 6.0 shall also apply. The bricks or stones shall be cut and dressed to the required shape as shown on architectural drawings. If no subsequent finish is envisaged, these shall be rubbed to correct profile with carborundum stone.

8 Plinth protection

Plinth of buildings shall be protected with brick on edge paving of minimum 750mm width unless otherwise shown on the drawings. the treatment shall consist of laying bricks conforming to class 50 (min.) of IS:1077 in cement mortar 1:6 (1 cement & fly ash (20% replacement ratio of cement with fly ash): : 6 sand) over a 75 mm thick bed of dry graded brick aggregate, 40mm nominal size, grouted with sand. the top shall be finished with 1:3 cement mortar pointing (1 cement & fly ash (20% replacement ratio of cement with fly ash):: 3 sand). Plinth protection shall be laid with

a minimum outward slope of 1 in 50. The brick aggregate shall be well graded, broken from well burnt or slightly over burnt and dense brick bats. It shall be homogeneous in texture, roughly cubical in shape, clean and free from dirt or any other foreign matter.

The ground shall first be prepared to the required, slope around and building. The high portions of the ground should be cut down, hollows and depressions filled up to the required level from the excavated earth and rammed so as to give uniform outward slope. The bed shall be watered and rammed and heavy iron square rammers. Surplus earth, if any, shall be disposed off beyond a lead of 50 m or as directed by the Engineer.

Over this, 75mm thick bed of dry brick aggregate of 40mm nominal size shall be laid with a minimum outward slope of 1 in 50. Aggregates shall be carefully laid and packed, bigger sized being placed at the bottom. The brick aggregates shall be consolidated dry with heavy iron rammers.

The aggregates shall then be grouted evenly with sand at the rate of 0.06 cubic meter per square meter area, adequately watered to ensure filling of voids by sand and again rammed with heavy iron rammers. The finished surface shall give uniform appearance. After the sub grade has been compacted thoroughly, brick flooring with bricks of specified strength in cement mortar 1:6 (1 cement & fly ash (20% replacement ratio of cement with fly ash): 6 sand) shall be laid. The soaking of bricks shall be done as mentioned under clause 4.4 above. The bricks shall be laid on edge in Diagonal / herring Bone Bond or other pattern as specified or as directed by the Engineer. Bricks shall be laid on 12mm thick mortar bed and each brick shall be properly bedded and set home by gentle tapping with handle of trowel or wooden mallet. It's inside face shall be buttered with mortar before the next brick is laid and pressed against it. On completion of the portion of flooring, the vertical joints shall be fully filled from the top with mortar. The surface shall present a true plain surface with the required slope.

The point shall be done in cement mortar 1:3 (1cement & fly ash (20% replacement ratio of cement with fly ash): 3 sand). The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and a straight edge the mortar shall not spread over surface of the masonry.

Brick flooring and pointing shall be kept wet for a minimum period of seven days. These shall be protected from rain by suitable covering when the mortar is green.

9 Damp Proof Course (DPC)

All walls in a building shall be provided with a damp proof course generally immediately below the underside of the ground floor or as shown on the drawings. This shall run without break throughout the length of the wall, even under door or other openings.

Damp proof course shall be 50 mm thick (unless, otherwise specified) consisting of cement concrete in proportion 1:1.5:3 (1 cement: 1.5 sand: 3 graded stone aggregate 10mm nominal size) mixed with water proofing cement additive as approved by the Engineer. The additive shall be used in proportion recommended by the manufacturer.

The surface of masonry work shall be leveled and prepared before laying the cement concrete. Edges of DPC shall be straight and even. The side shuttering shall consist of wooden forms and shall be strong and properly fixed so that it does not get disturbed during compaction and mortar does not leak through. The concrete mix shall be of workable consistency and shall be tamped thoroughly to make a dense mass. When the side shuttering are removed the surface should be smooth without any honeycombing. The top surface shall be double chequered and cured by pounding for at least 7 days. The cement concrete shall be allowed to dry for at least 24 hours after curing and hot bitumen of grade 85/25 conforming to IS:702 at the rate of 1.7 kg/sq meter shall be applied over the dried up surface of cement concrete after being properly cleaned with brushes and finally with a cloth soaked in kerosene oil. The bitumen shall be applied uniformly so that no blank spaces are left anywhere.

10 Dismantling and demolition

10.1 The term ‘Dismantling’ implies carefully removing without damage (up or down). This shall consist of dismantling one or more part of the building as specified or shown on the drawings.

10.2 The term ‘Demolition’ implies breaking up. This shall consist of demolishing whole or part of work including all relevant items as specified or shown on the drawings.

10.3 General requirements

(a) All materials obtained from dismantling or demolition shall be the property of the Owner, unless otherwise specified and shall be kept in safe custody until handed over at owner's stores or to the Engineer. Demolition shall be carried out in the shape and profile shown on the drawings or as directed by the Engineer.

(b) The dismantling or demolition shall always be planned before hand and shall be done in reverse order of the one in which the structure was constructed. The scheme shall be got approved from the Engineer before starting the work.

10.4 **Precautions**

(a) Necessary propping, shoring and under pinning shall be provided for the safety of the adjoining work or property before dismantling or demolition is taken up and the work shall be carried out in such a way that no damage is caused to the adjoining work or property. Wherever specified, temporary enclosures or partitions shall also be provided.

(b) All demolition work shall be carried out in conformance with the local safety regulations, ensuring the safety of men and materials.

(c) Necessary precautions shall be taken to keep down the dust nuisance.

(d) All materials which are likely to be damaged during the operation shall be carefully removed first.

(e) Dismantling shall be done in a systematic manner. The dismantled articles shall be passed by hand, where necessary, lowered to the ground (and not thrown) and then properly stacked as directed by the Engineer.

(f) Where fixing is done by nails, screws, bolts, rivets, etc. dismantling shall be done by taking out the fixing with proper tools and not be tearing or ripping off.

(g) All serviceable materials obtained shall be separated out and stacked properly as directed by the Engineer, up to a lead of 500m or handed over at Owner's stores. All unserviceable materials, rubbish etc. shall be disposed off, as directed by the Engineer up to a lead of 2 kms.

11 Sampling testing and quality control

11.1 General

(a) The Contractor shall carry out all sampling and testing in accordance with the relevant Indian Standards and/or International Standards and shall conduct such tests as are called for by the Engineer. Where no specific testing procedure is mentioned, the tests shall be carried out as per the prevalent accepted engineering practice to the directions of the Engineer. Tests shall be done in the field and at a laboratory approved by the Engineer and the Contractor shall submit to the Engineer, the test results in triplicate within three days after completion of a test. The Engineer may at his discretion, waive off some of the stipulations given below, for small and unimportant operations.

(b) Material / work found unsuitable for acceptance shall be removed and replaced by the Contractor. The works shall be redone as per specification requirements and to the satisfaction of the Engineer.

11.2 Quality assurance programme

The Contractor shall submit and finalise a detailed field Quality Assurance Programme within 30 days from the date of award of the Contract according to the requirements of the specification. This shall include setting up of a testing laboratory, arrangement of testing apparatus/equipment, deployment of qualified/experienced manpower, preparation of format for record, field quality plan etc. On finalised field quality plan, the Owner shall identify, customer hold points beyond which work shall not proceed without written approval from the Engineer.

11.3 Frequency of sampling and testing including the methods for conducting the tests are given in Table-2. The testing shall be done at site. The testing frequencies set forth are the desirable minimum and the Engineer shall have the full authority to carry out or all for tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the appropriate specifications. Some of the type tests and performance tests which are not included in the table shall be carried out at the manufacturer’s premises or at an independent Government approved laboratory.

11.4 All masonry shall be built true and plumb within the tolerances prescribed as below. Care shall be taken to keep the pretends properly aligned.

a) Deviation in vertically in total height of any wall of a building more than one storey in height shall not exceed +/- 12.5 mm.

b) Deviation from vertical within a storey shall not exceed +/- 6mm per 3 m height.

c) Deviation from the position shown on the plan of any brickwork more than one storey in height shall not exceed 12.5 mm.

d) Relative displacement between load bearing walls in adjacent storeys intended to be in a vertical alignment shall not exceed 6 mm.

e) Deviation of bed joint from horizontal in any length up to 12 m shall not exceed 6 mm, and in any length over 12 m it shall not exceed 12.5 mm total.

f) Deviation from the specified thickness of bed-joints, cross joints or pretends shall not exceed +/- 3 mm.

Table 2: Frequency of sampling and testing

Sl. No.	Type of material/ work	Nature of test /characteristics of test	Method of test	No. of samples and frequency	Remarks/ acceptance norms
1	2	3	4	5	6
1.	Burnt clay bricks/Fly ash bricks	(a) Dimensions	Clause No.5.2.1 of IS:1077		Max. 8% deviation for non-modular bricks. For modular bricks as per Clause no.5.2 of IS: 1077. For face bricks as per IS: 2691.

		(b) Compressive strength	IS:3495 (Part-1)		As specified
		(c) Water absorption	IS:3495 (Part-2)	A set of 20 bricks (min.) for each lot of 50,000 or part thereof for all tests (a to c)	Max. 20%. However, 15% for face bricks only.
		(d) Efflorescence	IS:3495 (Part-3)		Moderate. However for face brick nil.
		(e) War page	IS:3495		For face brick 2.5 mm (max.)

Sl. No.	Type of material/ work	Nature of test /characteristics of test	Method of test	No. of samples and frequency	Remarks/ acceptance norms
1	2	3	4	5	6
II.	Stone	a) Type of stone by petro graphic examination	IS:1123	One set of stones of each type and from each source.	As specified.
		b) Shape & size	Physical measurement	Random	As specified

		c) Crushing strength	IS:1121 (Part-I)	One set of stones of each type and from each source.	As specified
		d) Water absorption	IS:1124	One set of stones of each type and from each source.	As specified
		e) Durability	IS:1126	One set of stones of each type and from each source.	As specified
III.	Sand	a) General quality	Visual	One set of samples from each source of material per 100 Cum. or part thereof.	As specified

Sl. No.	Type of material/ work	Nature of test /characteristics of test	Method of test	No. of samples and frequency	Remarks/ acceptance norms
1	2	3	4	5	6
		b) Deleterious material	IS:2386 (Parts-I & 2)	One set of samples from each source of material per 100 cum. or part thereof.	Clause 3.3 of IS:2116

		c) Grading	Sieve analysis as per IS:2386 (Part-I)	One set of samples from each source of material per 100 cum. or part thereof.	Table-1 of IS:2116
IV.	Cement	a) Setting time	IS:4031	One set of sample for each lot of material received	No separate testing is required in case cement is tested for preparation of concrete mix
		b) Compressive strength	IS:4031	One set of sample for each lot of material received	No separate testing is required in case cement is tested for preparation of concrete mix
V.	Water	a) Harmful	IS:3025	Once a month for	No separate

Sl. No.	Type of material/ work	Nature of test /characteristics of test	Method of test	No. of samples and frequency	Remarks/ acceptance norms
1	2	3	4	5	6
		substances, pH value		each source	testing is required in case water is tested for concrete mix

		b) Initial setting time	IS:4031	Once a month for each source	No separate testing is required in case water is tested for concrete mix
		c) Compressive strength	IS:516	Once a month for each source	No separate testing is required in case water is tested for concrete mix
VI.	Mortar	a) Compressive strength	Appendix-A of IS:2250	One sample (consisting of min 3 specimens)	Table-1 of IS:2250
		b) Consistency	Appendix-B of IS:2250	One sample for each type of mix	Clause 7.2 of IS:2250
		c) Water retentively	Appendix-C of IS:2250	One sample for each type of mix	Clause 7.3 of IS:2250
VII.	Masonry	a) Workmanship	Visual &	All work	As per
Sl. No.	**Type of material/ work**	**Nature of test /characteristics of test**	**Method of test**	**No. of samples and frequency**	**Remarks/ acceptance norms**
1	**2**	**3**	**4**	**5**	**6**

	construction		Physical measurement		specification and Cl. No.11.0 of IS:2212 for brickwork
		b) Verticality and alignment	Physical measurement	All work	As per specification and Cl.No.6.3.4 of IS:1905

Section – T4

Technical specification for plastering and allied works

Section – T4

Technical specification for plastering and allied works

1. Scope

This part of the specification covers the requirements for plastering and allied works for all types of masonry and concrete surfaces.

2. General requirements

2.1 The Contractor shall furnish all skilled and unskilled labour, plant, equipment, scaffolding, materials, etc. required for complete execution of the work in accordance with the drawings and as described herein and/or as directed by the Engineer.

2.2 The Contractor shall follow all safety requirements/rules during execution of the work.

2.3 I.S:1661 shall be followed as a general guidance for plastering work.

3. Codes and standards

3.1 All applicable standards, acts and codes of practice referred to shall be the latest editions including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at Site with the Contractor.

3.2 In case of any conflict between this specification and those (IS Standards, Codes etc.) referred to in clause 3.3, the former shall prevail.

3.3 Some of the applicable Indian Standards, Codes, etc. are referred to here below:

IS:383 Coarse and fine aggregates from natural sources for concrete.

IS:712 Building limes.

IS:1542 Specification for sand for plaster

IS:1635 Code of practice for field slaking of Building lime and preparation of putty

IS:2250 Code of practice for preparation and use of masonry mortar.

IS:2333 Plaster-of-paris

IS:2402 Code of practice for external rendered finishes

IS:2547 Gypsum building plaster

IS:3150 Hexagonal wire netting for general purpose

4. Materials

4.1 Materials namely, cement, sand, water, Coarse aggregate, shall be in accordance with Technical Specifications for properties, storage and handling of common building materials.

4.2 Lime for preparation of putty or neeru for punning work shall be according to class B& C of IS: 712.

4.3 For rough cast plaster, coarse aggregate of size 6 to 12 mm shall be used in the finishing coat. Coarse aggregate shall be as per IS: 383.

4.4 Gypsum, for use in plaster-of-paris punning work shall be according to IS:2333.

4.5 For lath plastering, galvanised hexagonal wire netting with wire 0.9mm dia and 12.5 mm mesh conforming to IS:3150 shall be used.

5. Mortar

5.1 Unless otherwise specified cement & Fly ash (20% replacement ratio of cement with fly ash): - sand mortar shall be used. Cement mortar shall be prepared by mixing cement & fly ash (20% replacement ratio of cement with fly ash): and sand in specified proportions by

volume. Sand shall be measured on the basis of its dry volume using gauge boxes. Suitable allowance in quantity shall be made to cater for the bulkage. Cement and fly ash shall preferably be measured by weight. For the purpose of determining the corresponding volume, one cubic meter of cement shall be taken to weigh 1440 Kg and one cubic meter of fly ash shall be taken to weigh 641 Kg (i.e. coal ash)

5.2 The mixing of mortars shall be done in mechanical mixer. However, depending on nature, magnitude and location of the work, the Engineer may relax the condition of use of mechanical mixer and allow hand mixing.

Cement, fly ash and sand in the specified proportions shall be fed into the mixer and mixed dry thoroughly in the mixer. Water shall then be added gradually and the wet mixing continued for at least 3 minutes. Hand mixing shall be carried out on a clean, water tight platform. Only that quantity of mortar, which can be used within 30 minutes of its mixing, shall generally be prepared at a time. Care shall be taken, not to add more water than that which shall bring the mortar to the consistency of a stiff paste. IS: 2250 and IS: 1661 shall be referred for ascertaining the quantity of water.

In case of cement mortar, the mortar that has stiffened because of evaporation of water from the mortar may be retempered under special circumstances, with the approval of the Engineer, by adding water as frequently as needed to restore the requirements of consistency but this retempering shall be permitted only up to one hour from the time of addition of cement.

Cement mortar shall be used as soon as possible after mixing and before it begins to set, preferably within half an hour from the time water is added to cement during mixing and in any case within one hour thereof.

Sweep mortar shall not be used.

6. Plastering

6.1 Mix proportion and plaster thickness

The mix proportion and thickness of plaster for various surfaces shall be as specified or shown in the drawings. Unless otherwise specified the following shall be adopted.

i.	Ceiling plaster	minimum 6mm thick cement mortar (1:4)
ii.	Plaster on external/ rough face of masonry work or concrete surface	18mm thick, cement mortar* (1:6)
iii.	Plaster on plain face of masonry work or concrete surface.	12mm thick, cement mortar*(1:6)

*In case of special application like water proofing surface, base course of decorative finish etc., richer mix proportion not leaner than 1:4 shall be used.

6.2 Preparation of surface

The surface shall be cleaned of all dust, loose mortar droppings, traces of algae, efflorescence and other foreign matter by water or by brushing. Smooth surfaces shall be roughened by wire brushing, if it is not hard and by hecking when it is hard. In case of concrete surface, if a chemical retarder has been applied to the framework, the surface shall be roughened by wire brushing and all the resulting dust and loose particles cleaned off and care shall be taken that none of the retarders is left on the surface.

Trimming of projections, wherever necessary shall be done to achieve an even surface. Ranking of joints in case of brickwork where necessary shall be done. The masonry shall be allowed to dry out for sufficient period before plastering.

For ceiling plaster, the concrete surface shall be pock marked with a pointed tool to ensure a proper key for the plaster.

The wall shall be dampened evenly and not soaked before application of plaster. If the surface becomes dry in spots, such areas shall be moistened again.

6.3 Sequence of plastering operations

For external plaster, the plastering operations shall be started from the top and carried downwards. To ensure even thickness and a true surface, plaster about 15 x 15 cm shall be first applied horizontally and vertically, at not more than 2m intervals over the entire surface to serve as gauges. The surfaces of those gauged areas shall be truly in the plane of the finished plastered surface. For internal plaster, the plastering operations may be started wherever the

building frame and cladding work are ready; the temporary supports of the ceiling resting on the wall have been removed.

The first undercoat shall then be applied to ceilings. After the ceiling plaster is completed and scaffolding for the same removed, the first undercoat on walls shall then be applied.

After a suitable time interval as detailed under application of plaster, the second coat (finishing coat) shall be applied, first to the ceiling and then to the walls.

Where corners and edges have to be rounded off, such rounding off shall be completed along with the finishing coat to prevent any joint marks.

6.4 Application of plaster

6.4.1 Wall/vertical surface plaster

Unless otherwise stated, the plastering above 12mm thick shall be carried out in two coats only.

i) The backing or first coat

The backing coat shall be 10 to 12 mm thick and carried to the full length of the all or to natural breaking points like doors and windows. Before the rendering coat hardens, it shall be roughened to provide mechanical key for the second coat.

Masonry walls on which plaster is to be applied directly, shall be properly set and cured with the joints raked to a depth of at least 10 mm. The rendering coat shall be troweled hard and tight, forcing it into surface depressions to obtain a permanent bond.

On smooth concrete walls, the surface shall be roughened and the rendering coat shall be dashed on to ensure adequate bond. The dashing of the rendering 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 or cement gun.

ii) Finishing coat

Before starting to apply the finishing coat, the surface of the backing coat shall be dampened evenly. The final plastered surface shall be cured and kept continuously damp for minimum 7 days.

6.4.2 Ceiling plaster

Stage scaffolding shall be provided for ceiling plaster. This shall be independent of the walls.

Projecting burrs of mortar formed due to gaps at the joints is shuttering shall be removed. The surface shall be scrubbed clean with wire brushes. In addition, the concrete surfaces shall be pock marked with a pointed tool at a spacing of not more than 50 mm centres, the pocks being made not less than 3 mm deep, to ensure a proper key for the plaster. The mortar shall be washed off and all surface cleaned of all oil, grease, etc. and well wetted before the plaster is applied.

Ceiling plaster shall not be commenced until the slab above has been furnished and centering has been removed. The average thickness of plaster shall not be less than 6 mm. The minimum thickness over any portion of the surface shall not be less than 5 mm.

The Surface shall be cured at least twice a day for a minimum period of seven days.

6.4.3 Grooves in plaster

Where specified in drawings, rectangular grooves 12 to 20 mm wide and 8 to 10 mm deep shall be provided in external plaster by means of timber battens or metal strips, fixed on plaster when plaster is still green. Battens or strips shall be carefully removed after initial set of plaster and broken edges and corners made good. All grooves shall be uniform in width and depth and shall be truly plumb and correctly aligned.

6.4.4 Drip course

Drip course wherever indicated in the drawings shall be provided at the time of plastering to prevent travelling of water drops from the projections. Unless otherwise, specified, projected strip form drip course shall be provided.

6.4.5 Metal lathing

The lathing shall be tightly stretched with the long way of the mesh across the supports before nailing. This shall be secured with 25 mm galvanised steel staples or nails at 200 mm centres, if the studding is of wood and with 0.90 mm iron tying wire, if the studding is of steel. Edges of lathing shall be lapped not less than 25 mm at the sides and ends and wired together with galvanised wire of diameter not less than 1.25 mm, every 100 mm between supports.

Before plastering, the surface of metal lathing shall be brushed over with thin cement slurry or given a protective coat of bitumen oil paint.

6.4.5.1 Plastering to lathing

It shall be carried out in two coats. Mortars for the first coat shall be of stiff consistency and applied as evenly as possible to give a uniform good cover to the lathing. It shall be allowed to dry until all shrinkage movement has ceased before the second coat is applied. Too much pressure shall not be used in applying plaster to lathing to guard against its deflection.

6.4.6 Rough cast finish

The plaster base over which the rough cast finish is to be applied shall be done in general as per clause no. 6.4 under sub head "Application of Plaster".

It shall be ensured that the base surface which is to receive rough cast mixture is in plastic state. Coarse aggregate of size 6 to 12 mm shall be used in the finishing coat. The grading and size shall vary according to the texture required.

The rough cast mix shall be wetted and shall be dashed on the plaster base in plastic state by hand scoop so that the mix gets well pitched into the plaster base. The mix shall again be dashed over the vacant spaces, if any, so that the finished surface represents a homogeneous surface of sand mixed with grovel. The surface shall be cured for a minimum period of 7 days.

6.5 Punning work

6.5.1 Lime punning or Neeru finish

6.5.1.1 Materials

Lime putty: It shall be obtained by slaking lime with fresh water and sifting it. The slaking shall be done in accordance with IS: 1635.

Neeru: It shall be obtained by mixing lime putty and sand in equal proportion and chopped jute @ 4 Kg. per cu.m. of mortar. The mixture shall be properly ground to a fine paste between two stones.

6.5.1.2 Application of punning

Lime punning consists in finishing the interior with a thin coat (3 mm) of fat lime putty mixed with an equal amount of sand. Before actual use, putty shall be matured for 2 to 3 days.

The mortar for punning shall be applied in 3 mm thick layer just after the undercoat has hardened. It shall be finished to a smooth surface by means of a plaster's trowel.

The curing shall be started as soon as the punning has hardened but in any case not earlier than 24 hours after the punning has been completed. The punning shall be kept wet for a period of seven days.

6.5.2 Plaster of paris punning

The plaster of paris (gypsum Anhydrous) conforming to IS: 2547 shall be used for plaster of paris punning. The plaster of paris shall be mixed with water to a workable consistency and shall be applied on the plastered surface and finished to a smooth surface by steel float. The finished surface shall be smooth and true to plane, slopes or curves as required. The nominal thickness of the punning shall be 2 mm.

6.5.3 Neat cement punning

The plastered surface over which neat cement punning is to be done, shall be uniformly treated over its entire area with a paste of neat cement and rubbed smooth, so that the whole surface is covered with neat cement coating. The quantity of cement applied shall be 1 kg. per sq. meter. Smooth finishing shall be completed with a float immediately and in no case later than half an hour of adding water to the cement.

6.6 Trueness of plastering system

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

6.7 Thickness of plaster

The thickness of the plaster shall be measured exclusive of the thickness of key i.e. grooves or open joints in brickwork. The average thickness of plaster shall not be less than the specified thickness. The minimum thickness over any portion of the surface shall not be less than the specified thickness by more than 3 mm for plaster thickness above 12 mm and 1 mm for ceiling plaster. Extra thickness required in dubbing behind rounding of the corners at junctions of wall or in plastering of masonry cornices etc. shall be ignored.

6.8 Inspection and testing

a) The plastered surface shall be checked for following defects and the remedial measures for the same shall be adopted as per IS: 1661.
i) Blistering ii) Bound failure or loss of adhesion
iii) Cracking iv) Crazing
v) Efflorescence vi) Grinning
vii) Irregularity of surface texture viii) Popping or blowing ix) Recurrent surface dampness x) Softness or chalkiness

b) Trueness of the plaster shall be checked as per Clause no. 6.6

c) Thickness of the plaster shall be checked as per Clause no. 6.7

7. Pointing

7.1 The materials, preparation of mortar etc. shall be same as specified for cement plaster works. The mix proportion shall not be leaner than 1:3, unless otherwise specified. For all exposed brickwork or stone masonry work, self supporting double scaffolding, having two sets of vertical supports shall be provided so as to avoid openings in the wall.

7.2 Preparation of surface

The joints shall be raked out properly to such a depth that the minimum depth of the new mortar measured from either the sunken surfaces of the finished pointing or from the edge of the brick shall not be less than 10 mm. Dust and loose mortar shall be brushed out. Efflorescence, if any shall be removed by brushing and scraping. The surface shall then be thoroughly washed with water, cleaned and kept wet before commencement of pointing.

7.3 Application of mortar and finishing

The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raked, according to the type of pointing required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall then be finished with the proper tool according to the type of pointing required.

7.4 Type of pointing

7.4.1 Ruled pointing

Unless otherwise specified ruled pointing shall be adopted for all exposed brick/block masonry work However, for rubble masonry works, recessed pointing shall be adopted.

The mortar shall be pressed into the raked out joints and shall be finished off flush and then while the mortar is still green, a groove of shape and size as shown in drawings shall be formed by running a forming tool straight along the centre line of joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical joints shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same. For recessed pointing in rubble masonry recess shall be provided along the centre line of the joint profile.

7.4.2 Flush pointing

The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the brick, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a trowel and straight edge. Unless otherwise specified, flush pointing shall be adopted for drains and brick on edge paving.

7.4.3 Raised and cut pointing

Raised and cut pointing shall project from the wall facing with its edges cut parallel so as to have a uniformly raised band about 6 mm raised and width 10 mm or more as directed. The superfluous mortar shall be cut off from the edges of the lines and the surface of the masonry shall also be cleaned off all mortar. Unless otherwise specified, raised and cut pointing shall be adopted for stone masonry pointing, and shall be provided along the Centre line of the joint profile.

7.5 Curing

The pointing shall be kept wet for 7 days.

Sub-Section – T5

Technical specifications for laying of pipes and fittings / specials

Sub-Section – T5

Technical specifications for laying of pipes and fittings / specials

1. Scope

The work shall include providing of materials (Pipes alone will be supplied free of cost at site by the Employer), all necessary plant and equipment, providing adequate engineering supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire work as indicated on the drawings and/or described herein subsequently and/or as directed by the Engineer. The Contractor shall carry out all works meant within the intent of this specification even if not explicitly mentioned herein.

All works shall be executed to the satisfaction of the Engineer.

This specification is divided into 5 sections, sections C-l,C-2, C-3, C-4 & C-5 deal with specifications for 5 different items / activities for civil construction items which will be met with during laying of the pipe lines. All these five sections are as follows:-

Section C – l Technical specification for Excavation and Filling.
Section C – 2 Technical specification for properties, storage and handling of common building materials
Section C – 3 Technical specification for cast in situ concrete and allied works

Sub section:

1. Common requirement
2. Cast in situ concrete and Allied works.
3. Reinforcement
4. Form work and staging

Section C – 4 Technical specification for masonry and allied works.
Section C – 5 Technical specification for plastering and allied works

The two parts (i.e. Specifications from C-l to C-5 as mentioned above are complementary and are to be read together for a correct interpretation of the provisions of this specification.

2. Applicable codes

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

Any approval, instructions, permissions, checking, review, etc. whatsoever by the Engineer, shall not relieve the Contractor of his responsibility and obligation regarding adequacy, correctness, completeness, timely completion, safety, strength, quality & workmanship etc.

The Contractor shall make his own surveying arrangements for locating the coordinates and positions of all work and establish the reduced levels (RLs) at these locations, based on two reference grid lines and one bench mark which will be furnished by the Employer. If need be the Employer reserves the right to have the Contractor re-verify the coordinates at no cost to the Employer. The Contractor has to provide at site, all the required survey instruments, along with qualified surveyors, to the satisfaction of the Engineer so that the work can be carried out accurately and according to the specifications and drawings.

2.1 Codes of practice

All applicable standards, specifications, etc. and codes of practice shall be the latest editions, including all applicable official amendments and revisions. A complete set of all these documents shall generally be available at site, with the Contractor.

All work shall be carried out as per the stipulations contained in various sections of these specifications and the latest Indian Standards, Act, Codes and best practices.

In case of conflict between the stipulations contained in various sections of these specifications and stipulations of Indian Standard Codes, etc. the requirements of stipulations contained in various sections of these specifications shall prevail over that of Indian Standards, Codes, etc. Contractor is responsible to notify the Employer in writing well in advance of such conflicts prior to execution of the work.

Some of the applicable Indian Standards, Codes are referred to herein below:

a) IS.783 Code of practice for laying of concrete pipes

b) I.S. 3764 Excavation work - code of safety
c) I.S. 5822 Code of practice for laying of electrically welded steel pipes for water supply
d) I.S. 1726 Specifications for Cast Iron Manhole covers & frames
e) I.S. 5455 Specifications for C.I. steps for manholes.
f) I.S.4111 Code of practice for ancillary structures in sewerage system(Part -1) (manholes)
g) I.S.12288 Code of practice for use and laying of D.I. Pipes
h) IS 1200 part16 Method of measurement of building and civil engineering works: Laying of water and sewer lines including appurtenant items
i) IS 7634 Code of practice for plastics pipe work for potable water supplies:
Part 1 - Choice of materials and general
Part 2 - Laying and jointing of polyethylene (PE) pipes
j) IS 12235 Thermoplastics pipes and fitting – methods of test (Parts 1 to 19)

The above codes are only indicative. Any other codes relevant to the works concerned shall be applicable for specifications

3. Carting & handling

Pipes and fittings/specials shall be transported to all the work sites at places along the alignment of pipe line as directed by the Employer/Engineer. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading storage etc. Every care shall be exercised in handling pipes and fittings/specials to avoid possible damage. While unloading, the pipes and fittings/specials shall not be dropped down from the truck on to any hard surfaces. They should be unloaded on timber skids with steadying ropes or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes/stacks of pipe should be left at intervals in order to permit free access from one side to the other. In case of spigot & socket pipes care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only the pipes shall be checked for any visible damage (such as broken edges, cracking & spalling of pipe etc.) while unloading and shall be sorted out for replacement. Any pipe which shows any damage to preclude it from being used shall be discarded. Dragging of pipes and fittings/specials along concrete and similar pavement with hard surfaces shall be prohibited.

4. Storage

4.1 Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5 m. Also necessary security arrangements should be provided to avoid these till the pipes are finally used.

4.2 Fittings/specials shall be stacked under cover and separated from pipes and with suitable security measures.

4.3 Rubber rings shall be stored in a clean & cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they do not be left out on the ground in the sun or overnight under heavy frost or snow conditions.

5. Laying

5.1 General

The Contractor shall visit the site before tendering and get himself acquainted with site conditions and the regulations regarding the laying of pipes in congested areas, heavy traffic areas etc. The successful bidder shall obtain necessary permissions and clearances from all the local authorities, department of roads, traffic, water supply and drainage, electricity board, telephone company etc. wherever necessary.

Road reinstatement shall not be included in backfilling unless specified.

General lighting for worksite, warning lights, sign boards, fencing & barricading etc. shall be provided by Contractor at his own cost.

5.2 Excavation

5.2.1 Before excavating the trench the alignment of pipeline shall be approved by the Employer/Engineer. The excavation of trenches and pits for manholes/chambers shall be carried out in accordance with the specifications contained herein below and shall be done in such a manner that IT DOES NOT GET FAR AHEAD OF THE LAYING OPERATION as approved by the Employer/Engineer.

After excavation of trenches, pipes shall not be lowered in position unless the dimensions of trenches and bedding work at the bottom of the trenches areapproved and measured by Engineer / the Employer. Pipes and fittings shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block etc. for lowering the pipes and fittings shall be made by Contractor at his own cost. In no case pipes shall be dropped. Slings of canvas or equally **NON ABRASIVE MATERIAL** of suitable width and strength or special attachment to fit the ends of pipes and fittings shall be used to lift and lower the coated pipes and fittings. The pipes and fittings shall be inspected for defects and, be struck with light hammer preferably while in suspended position to detect presence of any cracks. If doubt persists, further confirmation shall be done by pouring a little Paraffin on the inside of the pipe at the suspected spot and after doing vigilant investigation whether the Paraffin is leaking on to the external side of the pipe or not then only the non leaking pipe should be considered fit for use. Pipes and fittings damaged during lowering or aligning shall be replaced by contractor at no extra cost.

5.2.2 To protect the persons from injury and to avoid any damage to property, adequate barricades, construction signs, red lanterns and guards, as required for smooth functioning of work and to avoid any minor or major accidents, shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regard to safety provisions shall be observed.

5.2.3 Suitable fencing/barricades shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3m. Apart and they shall not be less than 75 mm. in diameter or less than 1.2 m. above the surface of the ground. There shall be two rails, one near the top of the posts and the other about 450 mm. above the ground and each shall be from 50 mm. to 70 mm. in diameter and sufficiently long to run from

post to post to which they shall be bound with strong rope. The method of projecting rails beyond the posts and tying them together where they meet will not be allowed on any account. All along the edges of the excavated trenches a bund of earth about 1.2 m. high shall be formed where required by the Employer/Engineer (but due care shall be taken while stacking the excavated stuff to cause least inconvenience for day to day site activities) for further protection. The above work shall not be paid for separately and the Contractor shaft takes into account the costs of such works and quote accordingly.

Total quantity of water required for entire work including for testing- pipes and fittings at work site shall be arranged by Contractor at his own cost. Dragging of pipes and fittings along concrete and similar pavements with hard surfaces shall be prohibited.

5.2.4 The road metal and also the rubble packing obtained out of road surface excavations etc shall first be stripped off for the whole width and entire length of the trench/pit and separately deposited in such place or places as may be determined by the Employer/Engineer. In case of the metal packing or "Khandkies" not being so deposited or being mixed up with excavated materials and not available for backfilling and making good the excavation, the cost of the new metal, packing or "Khandkies" required shall be charged to the Contractor.

5.2.5 The portions of trenches in stony or rocky ground are to be excavated all along to the entire length and for the full depth such that the bottom of the excavation shall not be higher at any point than the bottom of the concrete' bedding layer below the sewer pipe.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit or as may be necessary to prevent the sides of the trench/pit to "cave-in" or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manhole covers etc., and so as to avoid abutting the wall or structure or causing inconvenience to the public and other service, organization or otherwise as the Employer/ Engineer may direct.

5.2.6 Contractor also shall take into account while quoting his rates for possible additional excavations for trial pits of such sizes and depths that may be required to be undertaken by him as per the instructions of the

Employer/Engineer for determining the locations of various existing underground service line such as water pipes, drains, sewers, gas pipe lines, electric and telephone cable etc. which may be met with. Contractor should also as per the instructions of the Employer/Engineer backfill and thoroughly compact all such additional excavations and make the area as original after the purpose of locating is served. No additional payment will be considered by the Employer on this account.

During the pendency of the contract the Contractor should take all due precautions for proper maintenance and protection against damage of all such service lines if met with during excavation, by means of shoring, strutting, planking over, padding- or otherwise as the Employer / Engineer may direct. Also all precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structures. In case if any such damages have occurred then those shall be made good either by Contractor or by other agency, as Engineer/the Employer may decide and wholly in either case at the expense of Contractor.

5.2.7 If the work for which the excavation has been made is not completed by the expected date of the setting of monsoon or the setting in of rain whichever is earlier, or before the day fixed by the Employer/Engineer for filling in any excavation on account of any festival or special occasion, contractor shall backfill such excavation and consolidate the filling at his own expenses as directed by Engineer/the Employer and shall re-excavate when required at his own cost.

Engineer/the Employer may order portions of shoring to be left in the trenches at such places, where it is found absolutely necessary to do so as to avoid any damage which may be caused (because of pulling out shoring from the- excavated trench/pit) to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation. Contractor shall be paid at the negotiated rate for the shoring left in the trenches / pit if directed by Engineer / the Employer. Contractor shall not claim, for any reasons whatsoever for the shoring which may have been left in position by him at his own discretion. Contractor shall not be paid for shoring left in the portions of the rackers, struts, or other timber cut off and not permanently left in the work.

5.2.8 Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than that as specified. In case additional width is required it shall be provided only in the top portion from the ground level up to 300 mm. above the crown of pipe. If any extra width is provided in the area below this portion because of mistake on part of the Contractor, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry or otherwise at the discussion and to the satisfaction of the Employer / Engineer. Contractor shall not be paid any additional for extra excavation as well as for the resulting remedial measures adopted to make up for the additionally done excavation. If rock is met with, it shall be removed to 15 cm. below the bottom of pipes and fittings / specials and the space resulting shall be refilled with granular materials and properly consolidated. No compensation will be paid to the Contractor on this account and financial implications for the same should be included by the Contractor in his rates. Bottom of trenches / pits shall be saturated with water and well rammed wherever the Employer / Engineer may consider it necessary to do so.

5.2.9 Wherever a socket or collar of pipe or fitting / special is to be accommodated a strip sufficient enough for this purpose is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm. below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such strip shall be of sufficient size in every respect to admit the free movements of hand holding necessary tools of the skilled worker, all around the socket in order to make the joint completely water tight and the strip shall be maintained clear until the joint has been approved by the Employer / Engineer.

All the pipes are to be laid perfectly true both in alignment and to the gradient specified.

5.2.10 When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60 cm. in depth and 90 cm. in length shall be made at joints in order to facilitate welding. The excess volume of this excavation should be brought to the acceptable level by making good with necessary fill material as directed by the Employer / Engineer. The charges on this account should be included in his rates by the Contractor.

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

5.3 Dewatering

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

5.4 Special foundation in poor quality soil

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

5.4.2 When the work of constructing the pipe lines has to be carried out in soft underground strata, such as puddle etc. or in a reclaimed land, a good foundation shall be provided for the pipes and manholes. For the former,

excavation in the trench shall be taken 75 mm. deeper than what is ordinarily required and for this depth the whole of the trench shall be covered over with M-150 bed concrete of the required width, reinforced with B.R.C. fabric No.9 or any other fabric- approved-by the Engineer.

5.4.3 The fabric shall be suitably cut to the requirement and securely joined together with adequate laps which should not be less than 200 mm. The fabric in the pipe line must also be securely jointed together. The rates in both the cases shall be held to include all lapping, jointing and also any probable wastage.

5.5 Wooden shoring

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

5.5.2 The Employer/Engineer may order portions of shoring to be left in the trenches/pits at such places, where it is found absolutely necessary to do so as to avoid any damage which may be caused to the adjacent buildings, cables, gas-mains, water
mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. Contractor shall not claim, on any reason, whatsoever for the shoring which may have been left in by him at his own discretion.

5.6 Steel plate shoring

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

5.7 Boning staves and side rails

5.7.1 In laying the pipes and fittings/specials the centre for each pipe line shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 mm. x 100 mm. x 1800 mm.) at each junction of pipe lines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation, so arranged that a side rail when fixed at a certain level against the post shall cross the centre line of the manhole / chamber or pipe lines. The side rail shall not in any case be more than 30 m. Apart intermediate rails shall be put up if directed by the Employer / Engineer.

5.7.2 Boning staves of 75 mm. x 50 mm. size shall be prepared by Contractor in various lengths, each length being of a certain whole number of meters and with a fixed teehead and fixed intermediate cross pieces, each about 300 mm. long. The top-edge of the cross piece must be fixed below the top-edge of this tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of pipe etc. as the case may be.

5.7.3 The side rail of size 250 mm. x 40mm. shall be screwed with the top edge resting against the level marks. The centre line of the pipe shall be marked on the rail and

this mark shall denote also the meeting point of the centre lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe and the depth of the bed of pipe at any intermediate point may be

determined by letting down the selected boning staff until the tee head comes in the line of the sight from rail to rail.

5.7.4 The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee heads and cross piece of the boning staves shall be painted black.

5.7.5 For the pipes converging to a manhole / chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M. of the surface of the ground, a higher sight rail shall be fixed for use with the rail over the next point.

5.7.6 The posts and rails shall be in no case be removed until the trench is excavated, the pipes are laid and the Employer / Engineer gives permission to proceed with the backfilling.

5.8 Encasing / being / hunching etc.

5.8.1 The pipes shall be provided with encasement / bedding / hunching etc. as specified in drawings.

5.9 Laying of pipes and fittings / specials

5.9.1 All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipe line of water, gas, sewage etc. and excavation to proceed in accordance with the stipulations of Clause No. 5.2.1 of this specifications

5.9.2 All the pipes are to be laid perfectly true both in alignment and to gradient specified In case of spigot and socket pipe the socket end of the pipe shall face upstream

EXCEPT WHEN THE PIPE LINE RUNS UPHILL IN WHICH CASE THE SOCKET ENDS SHOULD FACE THE UPGRADE. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings / specials which do not allow a sufficient and uniform space for joints shall be removed and replaced with

pipes and fittings / specials of proper dimensions to ensure such uniform space: Precaution shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Employer / Engineer. During the period that the plug is on, the contractor shall take proper precautions against flotation of the pipe owing to entry of water into the trench: Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted, the deflection allowed at joints shall not exceed 2^1 /2°. In the case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

5.9.3 The cutting of pipe for inserting valves, fittings or closure pieces /specials shall be done in a neat and workmanlike manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used and skilled labourers only should be allowed to achieve this task.

5.10 Thrust blocks

5.10.1 Thrust blocks shall be provided as directed by the Employer / Engineer to counteract hydraulic thrust, at places wherever directed and as per relevant drawing.

5.10.2 Where the hydraulic thrust is in an upward direction, anchor blocks as per the relevant drawing shall be provided to which the pipes shall be secured with steel straps.

5.11 Jointing of pipes

5.11.1 Jointing for pipes and fittings / specials shall be done in accordance with: the relevant specifications depending on type of pipes being used. (Please refer Clause No.2.1 of these specifications)

5.12 Testing and commissioning

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

5.13 **Backfilling**

5.13.1 Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipe line. The tamping around the pipe shall be done by hand or other hand operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that the level of filling rises gradually and unequal pressure does not occur on the pipe. Back filling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care being taken not to damage to the pipe line. In case of mild steel pipes / specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipe line to aid alignment, these timbers shall be removed before backfilling.

5.14 **Reinstatement of road / footpath**

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

5.15 **Clearing of site**

5.15.1 All surplus materials, and all tools and temporary structures shall be removed from the site as directed by the Employer / Engineer and the construction site left clean to the satisfaction of the Employer/Engineer.

6. Measurement

6.1 The measurements for excavation in trenches shall be done in following manner and will be paid accordingly.

(i) Length (L) As per the actual length of pipe and fittings / specials laid at work site.

Width (B) Average width as per the standards specified in the Central Public Works Department, Government of India for water supply works.

(ii) Depth (D) Average depth of trench from natural ground level to bottom of pipe or fittings.

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

The rate for this item should be inclusive of all excess excavated material to be transported from site of work to a place up to a maximum distance of 5 km. as directed by Engineer / the Employer immediately after his instructions so as not to cause any inconvenience to the public or traffic.

6.3 In case the excavation is done in wet condition either by bailing out water or by resorting to pumping, the respective items shall be paid according to the items in schedule of quantities and rates. The measurement for these items shall be made as per the units for relevant item(s) in schedule of quantities and rates. However, Engineer will decide on site the mode of dewatering and his decision shall be final and binding on Contractor.

6.4 Shoring (open / close) if to be paid separately shall be measured on the square meter basis of the actual area of trenches shored.

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

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

7. Notes

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

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

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

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

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

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

Sub-Section – T6

Technical specifications for laying of jointing of cast iron fittings

Sub-Section – T6

Technical specifications for laying of jointing of cast iron fittings

1. Scope

This specification covers the requirements for collection, transporting to work sites, laying, jointing and field testing of cast iron fittings for the water distribution and transmission Network.

2. Applicable codes

Various operations such as transporting to work sites, lowering in trenches, laying, jointing and field testing of cast iron pipes and fittings shall comply with all currently applicable standards. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards shall be referred to. If requirements of this specification conflict with the requirements of the standards, this specification shall govern.

a) Specials (Tees, crosses, bends etc.) - IS : 1538
b) Sluice Valves - IS : 14846/2000
c) Butterfly Valves (Double flanged long body) - BS : 5155 / IS: 13095
d) Kinetic Double Air Valves with
isolating sluice valve - IS:14845/2000 e) Fire Hydrants - IS : 908
f) Rubber Gasket for Flanged Connection - IS : 638
g) Ferrules - IS : 2692
h) Specification for rubber sealing rings
for gas mains, water mains and sewers. - IS:5382
i) Scour/Sluice valve including C.I. L.A class drain pipe of dia. equivalent to that of Scour valve
and 6 m. length - IS:780 & IS:2906
j) Steel pipes flanges - IS 6392

These are only indicative. Any other codes relevant for the works shall be applicable
.

3. Laying

For Clauses No.3.0 i.e. Carting and Handling, 4.0 i.e. Storage and 5.0 i.e. Laying – please refer Sub-Section WS-1 for "Technical Specifications for Laying of Pipes and Fittings / Specials" which are common for this item also.

4. Valves

4.1. General

a) Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges and conform to ISO 7005, IS 6392 or BS 4504.

b) Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

c) Valve buried or installed in underground chamber, where access to a hand wheel would be impractical shall be operated by means of extension spindle and / or keys.

d) Valve of diameter 450 mm. and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning and servicing.

e) Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

f) 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.

g) Valves shall be free from sharp projections.

4.2. Butterfly valves

a) Butterfly valve shall be as per IS 13095 / BS 5155. Valve shall suitable for mounting in any position.

b) The valve seat shall be secured to the valve body. When the valve is fully closed, a seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

c) The valve seal shall be replaceable and securely clamped to the edge of the disc by stainless steel seal retention members, or equivalent so as to prevent leakage and to hold the seal securely during operation. The seal retention member shall be securely clamped with stainless steel fasteners. All fasteners shall be set flush so as to offer the least resistance possible to the flow-through the valve.

d) Valve shall be suitable for throttling purpose.

e) All valve spindles and hand wheels shall be positioned to give good access for operational personnel.

f) Valve of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

g) 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

4.3. Sluice valves

a) Sluice valve shall conform to IS 14846/2000 or relevant internationally recognized standards.

b) They shall be of rising or non-rising spindle type depending on application. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.

c) The gate face rings shall be screwed into the gate or alternatively securely pegged over the full circumference.

d) Valves of 450 mm. and above shall be provided with thrust bearing arrangement for ease of operation.

e) Valves of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

f) Valves, spindles and hand wheels shall be positioned to give good access for operational personnel.

g) All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

4.4. Non-return valve

a) The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.

b) The valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.

c) In case of multi door swing type check valve, the non-slam characteristic shall be achieved by providing suitable combination of door and hydraulic passages without any external damping arrangements or passages. The
angle of sealing and door weight shall be designed to provide the most efficient working with least restriction to flow.

d) Valve of diameter greater than 450 mm. shall be provided, in addition to others, feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

4.5. Air valves

a) The valve shall be capable of exhausting air form pipe work automatically when being filled. The air being released at a sufficiently high rate to prevent the restriction of the inflow rate. Similarly the valve shall be capable of ventilating pipe work automatically when being emptied, the air inflow rate being sufficiently high to prevent the development of a vacuum in the pipelines. The valve shall also automatically release air accumulating in pipe work during normal working conditions.

b) Air valve shall be of the double orifice type with a large orifice for ventilation or exhaust of the pipeline and smaller orifice for automatic release of air under normal working pressure.

c) Air valve shall be designed to prevent premature closure prior to all air having been discharged from the line. The orifice shall be positively sealed in the closed position but the float (ball) shall only be raised by the liquid and not by a mixture of air and liquid spray. The seating shall be designed to prevent the floats sticking after long periods in the closed position.

4.6. Pressure relief valves

a) Pressure relief valves shall be capable of relieving pressure in the system to prevent the system being pressurized in excess of a preset maximum allowable pressure. The valves shall be drop tight under normal operating conditions.

b) The valve operation shall be achieved by the interaction of the inlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valves.

c) The pilot valve or relay system shall be actuated by a diaphragm connected to the inlet pressure on its underside and a constant pressure on its upper side derived either from weight or from a spring.

5. Jointing

5.1. Tyton Joints

The rubber rings shall be stored in a cool dark, dry and dust free environment. The storage location shall not be exposed to direct sunlight or any heat radiating appliances. The rings shall not be allowed to come in contact with any fuels and shall be stored free of tension.

Rubber rings shall be clearly labeled in bundles to indicate the type of ring, the size of pipe which they are to be used, the manufacturer's name or trademark and the month and the year of the manufacture.

The rings shall comply with IS:5382 regarding their material finish, tolerance in dimensions and physical requirements. Rubber ring bundles from every lot shall carry with them manufacturer's test certificate showing the results of following tests:

a) Hardness
b) Tensile Strength
c) Compression test
d) Oil immersion test
e) Water absorption test
f) Stretch test and visual examination

The test procedures, the scale of sampling and the criteria for acceptance shall be as per IS: 5382 and IS: 3400.

The rubber rings shall be such that they shall not show any signs of deterioration for any reasons during the contract period plus the defects liability period. Entire expenses associated with correcting defects in this regard including replacement of rubber rings shall be fully borne by the Contractor.

In jointing cast iron spigot and socket pipes and fittings with tyton flexible joints, the Contractor shall take into account the manufacturer's recommendations as to the methods and equipment 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, that the rubber ring as per IS::5382 is correctly positioned in the socket and that the two pipes are accurately in line, before the joint is made. The rubber rings and any recommended lubricant shall be procured only through the reputed pipe supplier or as directed by the Engineer.

5.2. Flanged Joints

In case of flanged joints, the jointing material used between flanges of pipes and fittings shall be compressed fibre board or rubber insertion sheets conforming to IS: 638 of thickness between 1.5 mm. to 3 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per Sqm shall be not less than 112 g/mm. thickness. Each bolt shall be tightened a little at a time taking care not to tighten the bolt which is located immediately adjacent to the tightened bolt and the bolt which is located diametrically opposite each other should alternatively be tightened.

The practice of fully tightening the bolts one after another shall not be allowed. The bolts shall be of mild steel unless otherwise specified.

5.3. Lead caulking Joint

The jointing shall be done with molten lead and spun yarn. Pig lead shall be of uniform quality, clean and free from any impurities and any foreign materials. It shall be of uniform softness capable of being easily caulked or driven. It shall conform to IS: 782. Spun hemp yarn shall be of clean hemp and of good quality. It shall conform to IS: 6587. The quantity of lead and spun yarn to be used for jointing of different diameters of C.I. pipes and fittings shall be as per Table 1 of IS::3114.

Lead shall be heated in a melting pot kept in easy reach of the joint to be poured so that the molten metal will not be chilled in being carried from the melting pot to the joint and shall be brought to a proper temperature so that when stirred it will show a rapid change of colour. Before pouring, all scum shall be removed. Each joint shall be made with one continuous pour filling in the entire joint space with solid lead. Spongy or imperfectly filled joints shall thoroughly cleaned by heating/burning till all the contents of the imperfectly tilled lead in the joint are cleared. After clearing the joint it should be re-poured as per the original procedure.

The joint runner shall fit snugly against the face of the socket and a bund of clay should be made on outside of the pipe to form a pouring lip to provide for filling the joint flush with the face and to the top of the socket.

The jointing is done by first caulking in spun yarn, then filling the remainder of the joint space by running in molten lead, taking care that no dross enters the joint, and then thoroughly

caulking the lead. The spun yarn shall be used to centre the spigot in the socket and to prevent the flow of molten lead into the bore of the pipe.

After the lead has been run into the joint the lead shall be thoroughly caulked. Caulking of joints shall be done after a convenient length of the pipes shall been laid and leaded. The leading ring shall first be removed and any lead outside the socket shall be removed with a flat chisel and then the joint caulked around three times with caulking tools of increasing thickness and hammer of 2 kg. Weight. Lead run joints shall be preferably finished 3 mm. behind the socket face. The joints shall not be covered till the pipe line has been tested under specified hydrostatic test pressure, though the rest of the pipe line should be covered up to prevent expansion and contraction due to variation in temperature.

5.3.1. Proposed jointing of C.T. pipes

It is proposed to use spigot and socket pipes with rubber ring tyton joints and flanged joints for valves and other appurtenances.

The pipeline shall be laid such that the socket ends should face the upstream on level ground. When the line runs uphill the socket end should face the upgrade.

Whenever valve or hydrant connection is to be made socket and flanged specials or T specials as shown in the drawings shall be used.

In case of rubber ring joints, the groove and the socket shall be thoroughly cleaned before inserting the rubber gasket. While inserting the gasket, it shall be made sure that it takes the proper direction and that it is correctly seated in the groove. After cleaning dirt or foreign materials from the plain end, lubricant shall be applied in accordance with the pipe manufacturer's recommendations. The plain end of the pipe shall be pushed into the socket of the pipe and while pushing, the pipe shall be kept straight. If any deflections are to be made in the alignment, it may be made after the joint is assembled.

For joints between pipe and valve, socket and flanged specials shall be used. The gasket used between flanges of valves and pipe shall be compressed fiber board or natural / synthetic rubber (IS::638) of thickness between 1.5 to 3.0 mm. The fiber board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square meter shall be not less than 112 g/mm thickness. Each bolt should be tightened a little at a

time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable.

5.3.2. Property connections

A property connection should consist of following parts

(i) Brass ferrule
(ii) Communication pipes with couplings, bends, elbows, union etc. (Length as per drawings)
(iii) Cap at the end of the communication pipe near the plot boundary.

The plot owner is expected to construct and connect the remaining portion of property connections at plot boundary. The desired arrangement of property connection is shown in Drawing.

5.3.3. Connection at main

Boring on water main should be done on top of main to reduce possible entry of silt into pipe and subsequently damaging of meters. A manual drilling and tapping machine should be used for this purpose. A bore shall be drilled and tapped on CI main and a ferrule shall be screwed directly into the bore. Up to 38 mm size of property connections, ferrules shall be used where as for higher size property connections, T connection shall be given. Ferrule shall be of gunmetal or brass as per IS:: 2692. The ferrule should be so set in the main that the communication pipe leads off in line with the main before curving round right handed into its proper course as show in the Drawing. G I. Pipes to be used as property connections shall confirm to IS: 1239. Class C. the pipe should be provided, external protection of bitumen coating with hession cloth wrapped over it. It should be provided with PVC sheathing wherever they are exposed such as in case of drain crossings.

The specials to be used at crossing of pipelines, T joints, 90 deg. bends and valve joints are shown in the Drawing.

5.4. Testing

After the pipes and specials are laid, jointed and the trench partially back filled except at the joints the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test. Where any section of the rising main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the test shall not be made until at least two days have elapsed after concreting.

Each section of pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the test have been completed. Specified pressure as per relevant standards, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe as directed by Engineer. The duration of test shall not be less than 5 minutes. Where the field test pressure is less than twothird the work test pressure, the period of test should be increased to at least 24 hours. If a drop in pressure occurs, the quantity of water added in order to reestablish the test pressure should be carefully measured. This should not exceed 0.1 litre/mm, dia. per km. of pipe line length per day for each 30 m head of pressure applied The exposed joints shall be carefully examined and all such joints showing visible leaks shall be rectified until it becomes fully water tight. Any cracked or defective pipes and fittings as a consequence of this pressure test shall be removed from site and replaced by acceptable quality of pipes by Contractor and the test shall be repeated to the satisfaction of Engineer/the Employer

After the satisfactory completion of pressure test, the section of pipeline shall be subjected to leakage test at a pressure as specified in the relevant code. The duration of test shall be 2 hrs. No pipe installation shall be accepted until the leakage is less than the number of CUM./hr. as determined by the formula;

$$qL = \frac{ND\sqrt{p}}{3.3}$$

where,

q L = the allowable leakage in CUM./hr.

N = number of joints in the length of the pipeline

D = diameter in mm. and

p = the average test pressure during the leakage test in kg./sq.cm.

Should any test of pipe laid disclose leakage greater than that specified above the defective joints shall be repaired by Contractor at no extra cost to the Engineer until the leakage is within the specified allowance

Necessary equipment and water used for testing shall be arranged by Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by him at no extra cost to the Engineer/the Employer. Water used for testing shall be drained out from the pipe to safe location and should not be released in the excavated trenches.

After the tests mentioned above are completed to the satisfaction of Engineer/the Employer the backfilling of trenches shall be done as per specification.

5.5. Disinfection of water mains

The mains intended for potable water supplies should be disinfected before commissioning them for use.

After pressure testing the main, it should be flushed with water with sufficient velocity to remove all dirt and other foreign materials. When this process has been completed the process of disinfection (using liquid chlorine, sodium or calcium hydrochloride) can proceed by one of the following methods.

5.6. Continuous feed

In this method, water from the distribution system or other approved source and the chlorine are fed at a concentration of at least 20 to 50 mg./litre. A properly adjusted hydrochloride solution injected into the main with a hydro chlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump shall be used. The residual chlorine should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. The water should remain in the main for a minimum of 24 hours, during which time all valves, hydrants, etc. along the main should be operated to ensure their proper disinfection. Following the 24 hours period not less than 10 mg./l. residual chlorine should remain in the main.

5.7. Slug method

In this method a continuous flow of water is fed with .a constant dose of chlorine but with rates proportioned to give a chlorine concentration of at least 300 mg./l. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that will contact all interior surface of the main for a period of at least three hours. As the slug passes tees, crosses etc., valves must be properly operated to ensure their disinfection. This method shall be used principally for large diameter mains.

Regardless of the method used, it is necessary to make certain that back flow of the strong chlorine solution into the supplying line does not occur. The' chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating to 0.2 tng./l. that throughout the rest of the system bacteriological tests should be taken and if the result fails to meet minimum standards, the disinfecting procedure must be repeated and the results again tested before placing the main in service.

6. Measurement

The measurement for pipe laying shall be on running meters of net length along the centre line of pipe as laid including specials. The length of pipes shall not include the portion of spigots within the sockets of fittings and pipes.

6.1. Procedure of measurements

i. Length (L): As per the actual length of pipe and fittings / specials laid at work site.
ii. Trench Width (B): For payment of excavation, the width of trench shall be considered as O. D. + 600 mm. only where O.D. is the outside diameter of the pipe in mm. iii. Depth (D): Average depth of trench from ground level to invert of pipe and fittings.

7. Notes

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

7.2. In case of the road metal packing or dressed stones not being deposited as specified or being mixed up with excavated materials and not available for the reinstatement of road

/ pavement, the cost of the new metal packing or dressed stones required shall be charged to Contractor by the Employer/ Engineer.

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

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

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

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

Sub-Section – T7

Technical specifications for laying and jointing of ductile iron fittings

Sub-Section – T7

Technical specifications for laying and jointing of ductile iron pipes and fittings

1. Scope

This specification covers the requirements for collecting, transporting to work sites, laying, jointing and field testing of ductile iron pipes (Pipes will be supplied free of cost at site by the Employer) and fittings for the water distribution and transmission Network.

2. Applicable codes

Various operations such as transporting to work sites, lowering in trenches, laying, jointing and field testing of ductile iron pipes and fittings shall comply with all currently applicable standards. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards shall be referred to. If requirements of this specification conflict with the requirements of the standards, this specification shall govern.

a) Ductile Iron Pipes – K7/K9 Class-IS : 8329
b) Specials (Tees, crosses, bends etc. - IS: 9523
c) Property connections & Fittings – IS : 1239 (Part I & II)
d) Laying of D.I. pipes -IS: 12288
e) Sluice Valves - IS : 14846/2000
f) Butterfly Valves (Double flanged long body) - BS : 5155 / IS: 13095
g) Kinetic Double Air Valves with isolating sluice valve – IS: 14845/2000
h) Fire Hydrants-IS : 908
i) Rubber Gasket for Flanged Connection - IS : 638
j) Ferrules - IS : 2692
k) Specification for rubber sealing rings for gas mains, water mains and sewers. IS::5382
l) Scour valve including D.I. K7/K9 class drain pipe of dia. equivalent to that of Scour valve and 6 m. length IS:780 & IS:2906

3. Laying

For Clauses No.3.0 i.e. Carting and Handling, 4.0 i.e. Storage and 5.0 i.e. Laying – please refer Sub-Section WS-1 for "Technical Specifications for Laying of Pipes and Fittings / Specials" which are common for this item also.

4. Valves

4.1. General

a) Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges and conform to ISO 7005, IS 6392 or BS 4504.

b) Valves shall be double flanged type and the face shall be parallel to each other and flange face should be at right angles to the valve centerline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

c) Valve buried or installed in underground chamber, where access to a hand wheel would be impractical shall be operated by means of extension spindle and / or keys.

d) Valve of diameter 450 mm. and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning and servicing.

e) Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

f) 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.

g) Valves shall be free from sharp projections.

4.2. Butterfly valves

a) Butterfly valve shall be as per IS 13095 / BS 5155. Valve shall suitable for mounting in any position.

b) The valve seat shall be secured to the valve body. When the valve is fully closed, a seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

c) The valve seal shall be replaceable and securely clamped to the edge of the disc by stainless steel seal retention members, or equivalent so as to prevent leakage and to hold the seal securely during operation. The seal retention member shall be securely clamped with stainless steel fasteners. All fasteners shall be set flush so as to offer the least resistance possible to the flowthrough the valve.

d) Valve shall be suitable for throttling purpose.

e) All valve spindles and hand wheels shall be positioned to give good access for operational personnel.

f) Valve of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

g) 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

4.3. Sluice valves

(a) Sluice valve shall conform to IS 14846/2000 or relevant internationally recognized standards.

(b) They shall be of rising or non-rising spindle type depending on application. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.

(c) The gate face rings shall be screwed into the gate or alternatively securely pegged over the full circumference.

(d) Valves of 450 mm. and above shall be provided with thrust bearing arrangement for ease of operation.

(e) Valves of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

(f) Valves, spindles and hand wheels shall be positioned to give good access for operational personnel.

(g) All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

4.4. Non-return valve

a) The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.

b) The valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.

c) In case of multi door swing type check valve, the non-slam characteristic shall be achieved by providing suitable combination of door and hydraulic passages without any external damping arrangements or passages. The angle of sealing and door weight shall be designed to provide the most efficient working with least restriction to flow.

d) Valve of diameter greater than 450 mm. and above shall be provided, with feet and jacking screws in addition to others. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

4.5. Air valves

a) The valve shall be capable of exhausting air form pipe work automatically when being filled. The air being released at a sufficiently high rate to prevent the restriction of the inflow rate. Similarly the valve shall be capable of ventilating pipe work automatically when being

emptied, the air inflow rate being sufficiently high to prevent the development of a vacuum in the pipelines. The valve shall also automatically release air accumulating in pipe work during normal working conditions.

b) Air valve shall be of the double orifice type with a large orifice for ventilation or exhaust of the pipeline and smaller orifice for automatic release of air under normal working pressure.

c) Air valve shall be designed to prevent premature closure prior to all air having been discharged from the line. The orifice shall be positively sealed in the closed position but the float (ball) shall only be raised by the liquid and not by a mixture of air and liquid spray. The seating shall be designed to prevent the floats sticking after long periods in the closed position.

4.6. Pressure relief valves

(a) Pressure relief valves shall be capable of relieving pressure in the system to prevent the system being pressurized in excess of a preset maximum allowable pressure. The valves shall be drop tight under normal operating conditions.

(b) The valve operation shall be achieved by the interaction of the inlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valves.

(c) The pilot valve or relay system shall be actuated by a diaphragm connected to the inlet pressure on its underside and a constant pressure on its upper side derived either from weight or from a spring.

5. Jointing

5.1. Flexible joint

The spigot and socket flexible joint should be designed to permit angular deflection in direction and axial movement to compensate for ground movement and thermal expansion and contraction. They incorporate gasket of elastomeric materials and the joints may be of the simple push-on-type or the type where the seal is effected by the compression of a rubber gasket between a seating on the inside of the socket and the external surface of spigot. Joints

of the latter type are referred to as mechanical joints. Both push-in and mechanical joints are flexible joints. Flexible joints require to be externally anchored at all changes in direction such as at bends, etc. and at blank end to resist the thrust created by internal pressure and to prevent the withdrawal of spigots.

5.2. Flanged joint

Flanged joints are made on pipes having a machined flange at each end of the pipe. The seal is usually effected by means of a flat rubber gasket compressed between two flanges by means of bolts which also served to connect the pipe rigidly. Gaskets of other materials, both metallic and non-metallic are used for special applications.

5.3. Joints

5.3.1. Proposed jointing of D.I. pipes

It is proposed to use spigot and socket pipes with flexible joints and flanged joints for valves and other appurtenances.

The pipeline shall be laid such that the socket ends should face the upstream on level ground. When the line runs uphill the socket end should face the upgrade.

Whenever valve or hydrant connection is to be made socket and flanged specials or T specials as shown in the drawings shall be used.

In case of rubber ring joints, the groove and the socket shall be thoroughly cleaned before inserting the rubber gasket. While inserting the gasket, it shall be made sure that it takes the proper direction and that it is correctly seated in the groove. After cleaning dirt or foreign materials from the plain end, lubricant shall be applied in accordance with the pipe manufacturer's recommendations. The plain end of the pipe shall be pushed into the socket of the pipe and while pushing, the pipe shall be kept straight. If any deflections are to be made in the alignment, it may be made after the joint is assembled.

For joints between pipe and valve, socket and flanged specials shall be used. The gasket used between flanges of valves and pipe shall be compressed fiber board or natural / synthetic rubber (IS::63S) of thickness between 1.5 to 3.0 mm. The fiber board shall be impregnated with

chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square meter shall be not less than 112 g/mm thickness. Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable.

5.3.2. Property connections

A property connection should consist of following parts

a) Brass ferrule
b) Communication pipes with couplings, bends, elbows, union etc. (Length as per drawings)
c) Cap at the end of the communication pipe near the plot boundary.

The plot owner is expected to construct and connect the remaining portion of property connections at plot boundary. The desired arrangement of property connection is shown in Drawing.

5.3.3. Connection at main

Boring on water main should be done on top of main to reduce possible entry of silt into pipe and subsequently damaging of meters. A manual drilling and tapping machine should be used for this purpose. A bore shall be drilled and tapped on CI main and a ferrule shall be screwed directly into the bore. Up to 38 mm size of property connections, ferrules shall be used where as for higher size property connections, T connection shall be given. Ferrule shall be of gunmetal or brass as per IS: 2692. The ferrule should be so set in the main that the communication pipe leads off in line with the main before curving round right handed into its proper course as show in Drawing No. 15-A-I01. G I. Pipes to be used as property connections shall confirm to IS: 1239. Class C. the pipe should be provided, external protection of bitumen coating with hession cloth wrapped over it. It should be provided with PVC sheathing wherever they are exposed such as in case of drain crossings.

The specials to be used at crossing of pipelines, T joints, 90 deg. bends and valve joints are shown in the Drawing.

5.4. Testing

After the pipes and specials are laid, jointed and the trench partially back filled except at the joints the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test. Where any section of the rising main is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the test shall not be made until at least two days have elapsed after concreting.

Each section of pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the test have been completed. Specified pressure as per relevant code based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe as directed by Engineer. The duration of test shall not be less than 5 minutes. Where the field test pressure is less than two-third the work test pressure, the period of test should be increased to at least 24 hours. If a drop in pressure occurs, the quantity of water added in order to reestablish the test pressure should be carefully measured. This should not exceed 0.1 litre/mm, dia per km of pipe line length per day for each 30 m head of pressure applied The exposed joints shall be carefully examined and all such joints showing visible leaks shall be rectified until it becomes fully water tight. Any cracked or defective pipes and fittings as a consequence of this pressure test shall be removed from site and replaced by acceptable quality of pipes by Contractor and the test shall be repeated to the satisfaction of Engineer/Owner.

After the satisfactory completion of pressure test, the section of pipeline shall be subjected to leakage test at a pressure as specified in relevant code. The duration of test shall be 2 hrs. No pipe installation shall be accepted until the leakage is less than the number of Cum/hr. as determined by the formula;

$$qL = \frac{ND\sqrt{p}}{3.3}$$

where,

q L = The allowable leakage in CUM./hr. N = Number of joints in the length of the pipeline D = Diameter in mm. and

p = The average test pressure during the leakage test in kg./sq.cm.

Should any test of pipe laid disclose leakage greater than that specified above the defective joints shall be repaired by Contractor at no extra cost to the Engineer until the leakage is within the specified allowance

Necessary equipment and water used for testing shall be arranged by Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by him at no extra cost to the Engineer/Owner. Water used for testing shall be drained out from the pipe to safe location and should not be released in the excavated trenches.
After the tests mentioned above are completed to the satisfaction of
Engineer/Owner, the backfilling of trenches shall be done as per specification.

5.5. Disinfection of water mains

The mains intended for potable water supplies should be disinfected before commissioning them for use.

After pressure testing the main, it should be flushed with water with sufficient velocity to remove all dirt and other foreign materials. When this process has been completed the process of disinfection (using liquid chlorine, sodium or calcium hydrochloride) can proceed by one of the following methods.

5.6. Continuous feed

In this method, water from the distribution system or other approved source and the chlorine are fed at a concentration of at least 20 to 50 mg/litre. A properly adjusted hydrochloride solution injected into the main with a hydro chlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump shall be used. The residual chlorine should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. The water should remain in the main for a minimum of 24 hours, during which time all valves, hydrants, etc. along the main should be operated to ensure their proper disinfection. Following the 24 hours period not less than 10 mg./l. residual chlorine should remain in the main.

5.7. Slug method

In this method a continuous flow of water is fed with .a constant dose of chlorine but with rates proportioned to give a chlorine concentration of at least 300 mg/l. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that will contact all interior surface of the main for a period of at least three hours. As the slug passes tees, crosses

etc., valves must be properly operated to ensure their disinfection. This method shall be used principally for large diameter mains.

Regardless of the method used, it is necessary to make certain that back flow of the strong chlorine solution into the supplying line does not occur. The' chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating to 0.2 tng./l. that throughout the rest of the system bacteriological tests should be taken and if the result fails to meet minimum standards, the disinfecting procedure must be repeated and the results again tested before placing the main in service.

6. Measurement

The measurement for pipe laying shall be on running meters of net length along the centre line of pipe as laid including specials. The length of pipes shall not include the portion of spigots within the sockets of fittings and pipes.

The rate for providing and laying of D.I. pipes shall be deemed to include the extra excavation required for ordinary bedding of pipes as per IS: 783 and also for sockets or flanges if any and cost of jointing material.

6.1. Procedure of measurements

a) Length (L): As per the actual length of pipe and fittings / specials laid at work site.

b) Trench Width (B): For payment of excavation, the width of trench shall be considered as O. D. + 600 mm. only where O.D. is the outside diameter of the pipe in mm.

c) Depth (D): Average depth of trench from ground level to invert of pipe and fittings.

7. Notes

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

7.2. In case of the road metal packing or dressed stones not being deposited as specified or being mixed up with excavated materials and not available for the reinstatement of

road / pavement, the cost of the new metal packing or dressed stones required shall be charged to Contractor by the Employer / Engineer.

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

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

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

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

Sub-Section – T8

Technical specifications for HDPE pipes

Sub-Section – T8 Technical specifications for HDPE pipes

1. Scope

This specification covers the requirements for successfully designing, manufacturing, supplying, laying, jointing and testing at works and site of High Density Polyethylene Pipes used for water supply system.

2. Applicable codes

The manufacturing, testing, supplying, laying, jointing and testing at work sites of HDPE pipes shall comply with all currently applicable statutes, regulations, standards and Codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the standards / Codes, this Specification shall govern.

Code no.	Title / Specification
IS 4984	High Density Polyethylene Pipes for potable Water Supply
IS 2530	Methods of test for polyethylene molding materials and polyethylene compounds
IS 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS 4905	Methods for random sampling
IS 7328	High density polyethylene materials for molding and extrusion
IS 7634 Part-2	Laying & Jointing of Polyethylene (PE) Pipes
IS 9845	Method of analysis for the determination of specific and/or overall migration of constituents of plastics material and articles intended to come into contact with foodstuffs
IS 10141	Positive list of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water.
IS 10146	Polyethylene for its safe use in contact with foodstuff, Pharmaceuticals and drinking water.
IS 8008 Part I to X	Injection molded high density polyethylene(HDPE) fittings for potable water supplies

IS 10124	Fabricated PVC-U fittings for potable water supplies

The above are only indicative. Other Codes not specifically mentioned here but pertaining to the use of HDPE pipes form part of these Specifications.

3. Designation

Pipes shall be designated as per IS 4984 and IS 15328 for HDPE pipes.

3.1. HDPE Pipes:

The pipes shall be designated according to the grade of material, followed by pressure rating and nominal diameter, for example, PE 100 PN 6 DN 200 indicates a pipe pertaining to material grade 100 having a pressure rating 0.6 MPa and outside nominal diameter 200 mm.

4. Colour

The colour of the pipe shall be as specified in the relevant Indian standards.

5. Materials

5.1. HDPE pipe:

The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant taste or odor, cloudiness or discoloration of water. Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any internationally reputed organization as per the satisfaction of the engineer in charge.

The pipe shall contain no recycled compounds All pipes shall be suitable for use as pressure conduits, and shall have nominal burst values of three times the Working Pressure Rating (WPR) of the pipe for the pipes 2inches and smaller and shall have nominal burst values of three and half times the Working Pressure Rating (WPR) of the pipe for the pipes 3inches and larger.

5.1.1 Raw material

Raw material used to manufacture the HDPE pipes shall be 100% virgin PE compound or Natural black PE resin confirming to IS: 4984, IS: 7328 and ISO: 4427 for this a certification has to be given by the resin manufacturer as per clause 3.2.3 of IS: 4984.

Certificate for having passed the full scale rapid crack propagation test as per ISO 13478 has to be given. High density Polyethylene (HDPE) used for the manufacture of pipes shall conform to designation PEEWA-45-T-006 of IS 7328. HDPE conforming to designation PEEWA-45- T-012 of IS 7328 may also be used with the exception that melt flow rate (MFR) shall not exceed 1.10 g/10 min. In addition the material shall also conform to clause 5.6.2 of IS 7328.

The specified base density shall be between 941.0kg/ m^3 and 946.0kg/ m^3 (both inclusive) when determined at 27°C according to procedure prescribed in IS 7328 The value of the density shall also not differ from the nominal value by more than 3 kg/ m^3 as per 5.2.1.1 of IS 7328. The MFR of the material shall be between 0.41 and 1.10 (both inclusive) when tested at 190°C with nominal load of 5 kgf as determined by method prescribed in IS 2530. The MFR of the material shall also be within ± 20 percent of the value declared by the manufacturer.

The resin shall be compounded with carbon black. The carbon black content in the material shall be within 2.5 ±0.5% and the dispersion of carbon black shall be satisfactory when tested as per IS 2530.

5.1.2 Anti-oxidant

The percentage of anti-oxidant used shall not be more than 0.3 percent by mass of finished resin. The anti-oxidant used shall be physiologically harm less and shall be selected from the list given in IS 10141

5.1.3 Reworked material

No addition of Reworked/ Recycled Material from the manufacturer's own rework material resulting from the manufacture of pipes is permissible and the vendor is required to use only 100% virgin resin compound.

5.1.4 Maximum ovality of pipe

The outside diameter of pipes, tolerance on the same and ovality of pipe shall be as given in table 2 of IS 4984. Ovality shall be measured as the difference between maximum outside

diameter and minimum outside diameter measured at the same cross section of the pipe, at 300 mm away from the cut end. For pipes to be coiled the ovality shall be measured prior to coiling. For coiled pipes, however, re-rounding of pipes shall be carried out prior to the measurement of ovality.

5.1.5 Wall thickness

The minimum & maximum wall thickness of pipe for the PE100 grade shall be as given in table 5 in IS: 4984

5.1.6 Length of straight pipe

The length of straight pipe used shall be more than 6 m or as agreed by engineer in charge. Short lengths of 3 meter (minimum) up to a maximum of 10% of the total supply may be permitted.

5.1.7 Coiling

The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented.
Pipe beyond 110mm dia shall be supplied in straight length not less than 6m.

5.1.8 Workmanship / Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS Code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

5.1.9 Fittings & specials

All HDPE fittings/ specials shall be fabricated in accordance with IS: 8360 (Part I & III). PE Injection molded fittings shall be as per IS: 8008 (Part I to IX). All fittings/specials shall be

fabricated or injection molded at factory only. No fabrication or molding will be allowed at site, unless specifically permitted by the Engineer.
Fittings will be butt welded on to the pipes.

For industrial connections and smaller diameter (<90mm OD) polyethylene pipes where the working pressures do not exceed 1.0Mpa, jointing by mechanical compression fittings is recommended. The Compression Fittings shall be as per the Specification given in PE Fittings Specifications

Certification from international recognized organization should be submitted for compression fittings. Molded PE Fittings shall be homogeneous throughout, and free of visible cracks, holes, foreign inclusions, blisters, dents, or other injurious defects. The molded PE fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties, as the pipe.

The size and length of jointing threads, where applicable shall be suited to fit the threads of Galvanized Iron (GI) Pipes manufactured as per IS 1239:1990. A tight fit test with a BIS marked GI Pipe shall be demonstrated.

Butt Fusion Fittings - Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits and shall have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.

Electro fusion Fittings - Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans. All electro fusion fittings shall be suitable for use as pressure conduits and shall have nominal burst values of three and one-half times the Working Pressure Rating (WPR) of the fitting.

Flanged and Mechanical Joint Adapters - Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans

5.1.10 Bends

HDPE bends shall be plain square ended conforming to IS: 8360 Part I & III Specifications. Bends may be fabricated by jointing several small sections of pipes to reach the required angle.

5.1.11 Tees

HDPE Tees shall be plain square ended conforming to IS: 8360 Part I & II Specifications. Tees may be equal tees or reduced take off tees. Tees may be molded or fabricated from pipes elements.

5.1.12 Reducers

HDPE Reducers shall be plain square ended conforming to IS: 8008 Part I & VII Specifications. Reducer must be molded.

5.1.13 Flanged HDPE pipe ends

HDPE Stub ends shall be square ended conforming to IS: 8008 Part I & VII Specifications. Stub ends will be welded on the pipe. Flange will be of slip on flange type as described below.

5.1.14 Slip-on flanges

Slip-on flanges shall be metallic flanges covered by epoxy coating or plastic powder coating. Slip-on-flanges shall be conforming to standard mating relevant flange of valves, pipes etc. Nominal pressure rating of flanges will be PN10.

5.1.15 Tapping saddles

Tapping saddles shall be of PP with suitable female threaded tapping or Electro fusion saddle as per site requirements.

6. Handling, transportation storage and lowering of pipes

During handling, transportation, storage and lowering, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole.

The following procedures should be followed so as to eliminate potential damage to pipes and fittings and to maintain maximum safety during unloading, lifting and lowering.

- Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60oC.

- Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials.

- Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.

- PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.

- Only polyester webbing slings should be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks be used on PE pipes.

- Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.
- During coiling care should be taken to maintain the coil diameter at or above the specified minimum to prevent kinks. Coiling shall be done when the pipe attains the ambient temperature from the extruder. In uncoiling or recoiling care should be taken that sharp objects do not scour the pipe.

- When releasing coils, it must be remembered that the coil is under tension and must be released in a controlled manner. The end of the coil should be retained at all times, then the straps released steadily, one at a time. If the coil has bands at different layers of the coil, then they should be released sequentially starting from the outer layers. The amount of the energy locked up in the coil will depend on the size of the pipe, the SDR of the pipe, and the size of the coil.

- Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set

- Bare coils shall be wrapped with hesian cloth for long distance (> 300Kms) transportation. The truck used for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded – especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the Pipe.

- Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment/road side/elsewhere near by the work site or as directed by the Engineer.

- Damages during transit, handling, storage will be to the Contractor's account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Engineer.

- Handle pipe and fittings to insure delivery in a sound undamaged condition

7. Lowering, laying of pipes

Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer shall be laid.

While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. In most cases, the bedding is not required, as long as the sharp and protruding stones are removed, by sieving the dug earth, before using the same a backfill material. While laying in rocky areas suitable bed of sand or gravel should be provided. The fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, bed concrete M15, 15 cm or 20cm thick sand bed as approved by the engineer may be provided

As PE pipes are flexible, long lengths of fusion-jointed pipes having joints made above ground can be rolled or snaked into narrow trenches. Such trenches can be excavated by narrow buckets.

During the pipe laying of continuous fusion jointed systems, due care and allowance should be made for the movements likely to occur due to the thermal expansion/contraction of the material. This effect is most pronounced at end connections to fixed positions (such as valves etc) and at branch connections. Care should be taken in fixing by finishing the connections at a time the length of the pipe is minimal (lower temperature times of the day.)

For summer time installations with two fixed connection points, a slightly longer length of PE pipe may be required to compensate for contraction of the pipe in the cooler trench bottom.

The final tie-in connections should be deferred until the thermal stability of the pipeline is achieved.

The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain Pipe. Thus the total system enables directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 25 times the OD of the pipe.

The Installation of flanged fittings such as connections to sluice/air/gate valves and hydrant tees etc., requires the use of stub ends (collars/flange adaptors complete with backing rings and gaskets. Care should be taken when tightening these flanges to provide even and balance torque.

Provision should be made at all heavy fittings installation points for supports (such as anchoring of the flange in the soil) for the flange joint to avoid the transfer of valve wheel turning torque on to the PE flange joint.

PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done

When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.

However, weights by way of concrete blocks (anchors) are to be provided so that the PE pipe does not float when suddenly the trench is flooded and the soil surrounding the pipe is washed away. Thus site conditions study is necessary to ensure the avoidance of flotation.

Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum dry density.

8. Jointing of pipes

The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for HDPE pipe as per IS 4984 shall be selected considering site and working condition, pressure and flow of liquids

Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures should be capable of meeting all conditions as per ISO 12176. The butt fusion joining will produce joint weld strength equal to or greater than the tensile strength of the pipe itself. All welds will be made using a Data Logger to record temperature, fusion pressure, with a graphic representation of the fusion cycle shall be part of the Quality Control records Mechanical joining will be used where the butt fusion method cannot be used. Mechanical joining will be accomplished by either using a HDPE flange adapter with a Ductile Iron back-up ring or HDPE Mechanical Joint adapter with a Ductile Iron back-up ring

Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe

Only trained and technically qualified for the welding methods are to be employed for the welding operation. Welding to be carried out only through the manufacturer authorized person. Manufacturer should submit valid and authentic certificate for each person those who are performing welding at site before starting of the work to the client.

8.1. Welding procedure

Jointing between HDPE pipes and specials shall be done as per the latest IS: 7634 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with butt fusion welding using automatic or semi automatic, hydraulically operated, superior quality butt fusion machines which will ensure good quality butt fusion welding of HDPE pipes. If approved by the concerned Engineer, jointing with PP compression fittings may be carried out for smaller diameters of PE pipes (up to 110mm).

9. Bedding, Backfilling and Compaction

9.1. Bedding

In case of sandy strata no separate bedding is required. However the bottom face / trench bed where pipe shall be placed shall be compacted to provide a minimum compaction corresponding to 95% of maximum dry density. The pipe bedding should be placed so as to give complete contact between the bottom of the trench and the pipe.

9.2. Back filling

Backfilling should be placed in layers not exceeding 15cm thickness per layer, and should be compacted to a minimum of 95% maximum dry density. The refilling should be done on both sides of pipe together & height difference in earth fill on each side should not be more to cause lateral movement of pipe.

Most coarse grained soil are acceptable. This may comprise of gravel or sand. However silty sand, clayey sand, silty and clayey gravel shall not be used unless proposed to be used in conjunction with gravel or clean sand.

It is very important that the pipe zone backfill material does not wash away or migrate in to the native soil. Likewise, potential migration of the native soil in to the pipe zone backfill must also be prevented.

Heavy earth moving equipment used for backfilling should not be brought until the minimum cover over the pipe is 90 cm in the case of wide tracked bulldozers or 120 cm in the case of wheeled roaders or roller compactors.

9.3. Compaction

Vibratory methods should be used for compaction. Compaction within distances of 15 cm to 45 cm from the pipe should be usually done with hand tempers. The backfill material should be compacted not less than 95% of maximum dry density.

10. Thrust block

RCC thrust block should be suitably designed & provided at bends and at places of reduction in cross section to take care of trust

11. Inspection & testing

Pipes, fittings & specials shall be inspected for defects before installation and fusion by the client. Defective, damaged or unsound pipe will be rejected.

12. Tests to establish portability of work

Pipe specimen shall be subjected to tests specified below in order to establish the suitability of these pipes for use in carrying potable water:

I) Smell of the extract
II) Clarity of the colour of the extract
III) Acidity and alkality
IV) Global migration UV absorbing material Heavy metals
V) Un-reacted monomers (styrene) and Biological tests

13. Testing of pipes

Pipes shall be given different Performance Tests as per IS: 4984 (clause 8) and Notch Test as per ISO: 4427 for ensuring quality of pipes.

13.1. Hydraulic test

- Pipes shall be given hydraulic tests for ensuring quality of manufacture as per specification.

- The pressure-testing medium shall be clean water only. The HDPE pipe shall be filled with water, raised to test pressure and allowed to stabilize Any trapped air is to be bleeded off by suitable air release mechanism at the end of the pipe section. While the test section is being filled, venting at high points may be necessary to purge air pockets. Failure to do this will give false notion of pipe having been filled and while testing the pipe the air pockets may get compressed and hazards may occur.

- Field Leak Testing of Polyethylene Pressure Piping Systems shall be in accordance with Hydrostatic Pressure. For pressure piping system the maximum allowable test pressure is

1 ½ times the system design operating pressure or Pipe rating whichever is higher at the lowest point in the system.

- For any test pressure, the total test pressure time including initial pressurization, initial expansion, and time at test pressure must not exceed three (3) hours, ideal being one to 1 ½ hour. If the test is not complete due to leakage, equipment failure etc; the system shall be depressurized the same shall be allowed to 'relax' for at least eight hours, before bringing the section to test pressure again.

- The pipe tested shall be signed with glass marking pencil (white) by the company engineer and customer site engineer, before the pipe is buried. Location, length and the date of testing shall be duly signed by company and site engineers are to be kept as a record.

13.2. Hydraulic characteristics of pipes

When subjected to internal creep rupture test in accordance with procedure given in BIS standards and or ISO 1167, the pipes under test shall show no signs of localized swelling, leakage or weeping and shall not burst during the prescribed test period. The temperatures, duration of test and induced stress for the test shall conform to those specified in Table below:

Hydraulic characteristic requirements of pipes			
Sl. No.	**Test temp 0C**	**Test duration (h)**	**Induced stress in MPA**
1	80 □ 1	1000	5
2	80 □ 1	165	5.5

13.3. Reversion test

The pipe shall be tested according to the procedure specified in IS 4984. The value of the longitudinal reversion shall not be greater than 3 percent.

13.4. Overall migration test

When tested from a composite sample of minimum 3 pipes as per IS 9845 the overall migration of constituents shall be within the limits stipulated in IS10146.

13.5. Resistance to slow crack growth

The pipes shall be tested for their slow crack growth resistance in-house or at an independent organization as per ISO 13479 shall have the following test results when tested as per annexure A of IS 4984:1995. The manufacturer shall submit such a certification for the material (tested on any pipe > 110mm) as a part of their Vendor Accreditation evaluations. Where necessary the user may insist on the test in their presence.

Slow crack growth – ISO 13479			
Sl. No.	**Test temp 0C**	**Test duration**	**Pressure**
1	80 □ 1	>165	9.2

13.6. Fusion qualification

The manufacturer of pipe and fittings supplied under this specification shall establish and qualify heat fusion procedures for the joining of the materials supplied, with a documented proof of availability of welding equipment as per ISO 12176. Qualified fusion procedures, with appropriate supporting data, shall be furnished to the purchaser along with tender.

14. Marking

Each straight length of pipe shall be clearly marked in indelible ink / paint on either end and for coil at both ends or hot embossed on white base with every meter throughout the length of pipe / coil with the following information

1. Manufacturers name / trade mark
2. Designation of pipe (as per clause 3.1)
3. Lot number / batch number

15. Measurement

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item. The portion of the pipe at the joints (inside the joints) shall not be included in the length of pipe work.

Excavation, refilling, masonry and concrete work wherever required shall be measured and paid for separately under relevant items of work.

Sub-Section – T9

Technical specifications for valves

Sub-Section – T9

Technical specifications for valves

1. Scope

This specification covers the design requirements, features of construction, inspection and testing of all valves.

2. Codes and standards

The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the latest editions of applicable codes and standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

3. General

Valves shall be as per internationally recognised standards. Flanges shall be machined on faces and edges and conform to ISO 7005, IS 6392 or BS 4504.

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. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Valve buried or installed in underground chamber, where access to a hand wheel would be impractical shall be operated by means of extension spindle and / or keys.

Valve of diameter 450 mm. and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning and servicing.

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

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.

Valves shall be free from sharp projections.

All valves shall be so designed that the hand wheel moves in a clockwise direction to close the valve. The face of the hand wheel shall be clearly marked with the words ‘open’ and close and an arrow to indicate the direction for opening. All hand wheels shall be fitted with the name plate.

The design of valves shall ensure a streamlined passage and low pressure drop. The seats and discs shall be easily renewable. Valve discs shall be of such design as to keep the seats tight when the valve body is subjected to pressure, temperature variations and pipeline stresses

Valves that are to be kept locked in full ‘open’ / ‘close’ position shall be provided with a non detachable locking arrangement.Gland packing’s should be of material free from asbestos

Motor operators shall be designed to close the valves within the time specified from the full open position.Flow directions shall be clearly embossed on the valve body for valves whose function and service ability is affected by fluid flow direction.

4. Butterfly valve

Butterfly valve shall be as per IS 13095 / BS 5155. Valve shall suitable for mounting in any position

Valves shall be double flanged short body type and Cone-sphere eccentric design The valve seat shall be secured to the valve body. When the valve is fully closed, a seal shall seat firmly so as to prevent leakage. The seat surfaces shall be machined smooth to provide a long life for the seal.

Valves should have two stub shafts, extending at least 2 times their dia, within a robust housing on either side fitted with PTFE lined stainless steel.

The valve seat on the body should be integral with it to preclude any leakage from beneath the ring/`O’ ring when the disc is closed.

The valve seal shall be replaceable and securely clamped to the edge of the disc by stainless steel seal retention members, or equivalent so as to prevent leakage and to hold the seal securely during operation. The seal retention member shall be securely clamped with stainless steel

fasteners. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

Seal ring arrangement should be made to prevent the seal ring becoming loose in service

Valve disc, shaft and cotter pins, actual working stress at designed pressure should not exceed 40% of the yield stress of material.

Valve shall be suitable for throttling purpose.

All valve spindles and hand wheels shall be positioned to give good access for operational personnel.

Valves should be drop tight and designed for flow in either directions

Valve of diameter 450 mm. and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head 25% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

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.

In addition to providing end of travel stops in the gear box, an integral stopper in the body to be provided to prevent over travel of disc during closure.

Gear box must be self locking type, with a continuous indicator. Travelling nut and screw type of gear boxes are not acceptable.

All valve operators shall be equipped with adjustable mechanical stop-limiting devices to prevent over-travel of the valve disc in the open and closed positions. Either end of the worm shaft must be provided with needle roller bearing to take on the lateral thrust. The design must ensure thrust is arrested within the worm housing.

The housing for the gearing must be enclosed and sealed in such a way that there is no leakage of oil / grease even after long period of inuse and there is no ingress of rain water. Operator for

valves which are likely to be submerged in water for long period during the rainy season, must be water tight.

The hand wheels may be provided with extension and plastic cover for easy grip. Alternatively the hand wheels must have a provision for locking with a chain and pad lock. All operators when fitted to the valve shaft must ensure clock wise closing and this must be indicated on the housing. A mechanical indicator is to be provided to show disc travel and end of travel.

Data sheet for butterfly valves

Sl. No	Description		Particulars
1.	Size	:	300 & 600 NB
2.	Rating (Kg/sq.cm)	:	As specified in the scope of work
3.	Drilling	:	IS 1538 Table 4 & 6
4.	**Material of construction**	:	
	Body	:	CI IS 210 Gr. FG 260
	Disc		SG IS 1865 Gr. 500 / 7
	Shaft, Cotter	:	Stainless steel AISI 431
Sl. No	**Description**		**Particulars**
	Bearing	:	PTFE lined stainless steel, self lubricated
	Seat	:	Monel 60 integral
	Seal Ring	:	Nitrile / EPDM
	Seal Retaining Ring	:	S.G.Iron
	Internal fasteners	:	Stainless steel AISI 304
5.	**Gear Box**		
	Housing and Cover		CI Gr 25/SG Gr 500-7/CS Gr WCB
	Quadrant		SG Gr 500-7
	Spur Gears		EN-8 with hardened (by nitriding)
	pinions		EN-19
	Worm		EN-19, hardened (by nitriding)
	Bearings		FAG/SKF/Equivalent
	“O” rings		Nitrile rubber

	Hand wheel		Steel / SG Iron
	Make		Bidder to confirm
6.	**Shop Testing**		
	Seat leakage (Minimum for 5 minutes)	:	1 time of maximum working pressure
	Body (Minimum for 5 minutes)	:	1.5 times of maximum working pressure
	Material Test Certificate	:	Required for all material

5. Sluice valves

Sluice valve shall conform to IS 780 and IS 2906 / IS 14846 or relevant internationally recognised standards.

They shall be of rising or non-rising spindle type depending on application. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage. They shall also have renewable channel and shoe linings. The gap between the shoe and channel shall be limited to 1.5 mm.

The gate face rings shall be screwed into the gate or alternatively securely pegged over the full circumference.

Valves of 450 mm and above shall be provided with thrust bearing arrangement for ease of operation.

Valves of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

Valves 450 mm and above shall be provided with a drain and air plug.

All valves, 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 to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Valves 300 mm ø & above shall be provided with an antifriction device / ball thrust bearing arrangement to minimize friction between spindle collars and casting. These should be housed away from wet chamber and should have facility for periodic greasing.

Valves 300 mm and above shall be fitted with gunmetal channel and shoe arrangement, the clearance being controlled between 2 to 3 mm throughout the door travel. The channels should be fixed from inside. Puncturing the body for fixing of channels is not permitted.

All valve doors when fully closed, would ensure door faces are riding on body seat ring by at least 50% of the width of seat ring and there is sufficient room for wear travel.

All face and seat rings will be force/press fitted and additionally riveted (300 NB & above) to the recess in the CI casting

Manufacturer to justify with calculation that the valve proposed is operable within the effort parameters specified and no. of turns to ensure the time required to operate the valve from full open to full close is within reasonable limits.

The rated torque capability of each operator shall be sufficient to seat, unseat and rigidly hold in only intermediate position the sluice valve door it controls under the operating conditions specified. Operator base is to be drilled as per ISO 5210 keeping in mind the rated torque of selected operator.

The operator could be of worm/ spur type to ensure that the effort on hand wheel (did not exceeding 750 mm) is limited to 80N pull and push, unless stated otherwise in the valve specification. Either end of the worm shaft, if used, must be provided with needle roller bearings to take on the lateral thrust.

The housing for the gearing must be enclosed and sealed in such a way that there is no leakage of oil/grease even after long period of in use and there is no ingress of rain water. Operator for valves which are likely to be submerged in water for long period during the rainy season must be water tight

The hand wheels may be provided with extension and a plastic cover for easy grip. Alternatively they may be powder coated with a mat finish. The hand wheels must have a provision for locking with chain and pad lock. All operators when fitted to the valve shaft must ensure clockwise closing and this must be indicated on the housing / hand wheel.

A mechanical indicator is to be provided to show door travel and end of travel. Valve manufacturer to ensure that a protective thrust plate is provided between the valve and the gear operator so that no lateral thrust comes on the gear box.

Data sheet for sluice valves

Sl. No	Description		Particulars	
1.	Size	:	25 mm to 300 mm NB	
2.	Rating (Kg/sq.cm)	:	As specified in the scope of work	
3.	Drilling	:	IS 1538 Table 4 & 6	
4.	**Material of construction**	:		
	Body	:	CI IS 210 Gr. FG 200 / CI IS 210 Gr. FG 260	Cast Steel IS 1030 Gr. 230 – 450 W / ASTM A 216 Gr. WCB
	Wedge	:	CI IS 210 Gr. FG 200 / CI IS 210 Gr. FG 260	Cast Steel IS 1030 Gr. 230 – 450 W / ASTM A 216 Gr. WCB
	Spindle	:	Stainless steel AISI 410 / 431	
	Seat & face rings	:	Bronze IS 318 LTB II	
	Channel & shoe	:	Bronze IS 318 LTB II	
	Drain & air plug	:	Bronze IS 318 LTB II	
	Ball thrust bearing	:	SKF or equivalent	
	Bushing arrangement	:	Halprene on bronze	
	Rivets	:	Soft annealed brass	

	Gland packing	:	Teflon coated / graphite asbestos / hemp
	Fasteners	:	Carbon Steel
5.	**Gear Box**		
	Housing and Cover		CI Gr 25/SG Gr 500-7/CS Gr WCB
	Spur Gears		EN-8 with hardened (by nitriding)
	pinions		EN-19
	Worm		EN-19, hardened (by nitriding)
	Bearings		FAG/SKF/Equivalent
	"O" rings		Nitrile rubber
	Hand wheel		Steel / SG Iron
	Make		Bidder to confirm
6.	**Shop Testing**		
	Seat leakage (Minimum for 5 minutes)	:	1 time of maximum working pressure
Sl. No	**Description**		**Particulars**
	Back Seat leakage (Minimum for 2 minutes)		0.5 times of maximum working pressure
	Body (Minimum for 5 minutes)	:	1.5 times of maximum working pressure
	Material Test Certificate	:	Required for all material

6. Non-return valve

The valves shall generally conform to IS 5312 Part I & II (Single Door Type and Multi door type)

The valve shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body.

The valves shall possess high speed closing characteristics and be designed for minimum slam condition when closing.

Valves shall have in built quick closing non-slam characteristics achieved by suitable disposition of weight on door and the hydraulic passage.

Spring loaded/ spring return action or external dampening arrangement is not acceptable. If the manufacturer prefers to provide, the same to be informed to us before quoting

In case of multi-door swing type check valve, the non-slam characteristic shall be achieved by providing suitable combination of door and hydraulic passages without any external damping arrangements or passages. The angle of sealing and door weight shall be designed to provide the most efficient working with least restriction to flow.

Valves of multi door type shall be additionally provided with a supporting foot

All faces and seat rings shall be force/press fitted and additionally riveted (300 NB & above) to the recess in the CI casting

Valve of diameter greater than 450 mm. shall be provided, in addition to others, feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

Data sheet for non-return valves

Sl. No	Description		Particulars	
1.	Size	:	300 NB	
2.	Rating (Kg/sq.cm)	:	As specified in the scope of work	
3.	Drilling	:	IS 1538 Table 4 & 6	
4.	Material of construction	:		
			Cast iron valve	**Cast steel valve**
	Body	:	CI IS 210 Gr. FG 200 / CI IS 210 Gr. FG 260	Cast Steel IS 1030 Gr. 230 – 450 W / ASTM A 216 Gr. WCB / Cast Steel IS 1030 Gr. 230 – 450 W / ASTM A 216 Gr. WCB

	Hinge pin / Stub pin	:	Stainless Steel AISI 304 (IS 6603 Gr 04 Cr 19 Ni 9)	Stainless Steel AISI 410 / 431
	Seat & Face rings	:	IS 318 Gr. LTB II	
	Rivets	:	Soft annealed brass	
	Fasteners	:	Carbon Steel	
5.	**Shop testing**			
	Seat leakage (Minimum for 5 minutes)	:	1 time of maximum working pressure	
	Body (Minimum for 5 minutes)	:	1.5 times of maximum working pressure	
	Material Test Certificate	:	Required for all material	

7. Air valve

Automatic air valves generally conforming to IS 14845 are to be used for evacuation of accumulated air in water mains under pressure, for the exhaust of air when such mains are being charged with water and for ventilating the mains when they are being emptied of water

The valve shall be capable of exhausting air form pipe work automatically when being filled. The air being released at a sufficiently high rate to prevent the restriction of the inflow rate. Similarly the valve shall be capable of ventilating pipe work automatically when being emptied, the air inflow rate being sufficiently high to prevent the development of a vacuum in the pipelines. The valve shall also automatically release air accumulating in pipe work during normal working conditions.

Air valve shall have two orifices in a valve for air discharge or intake together with an isolating valve to isolate the air valve proper from the main to facilitate maintenance, repair or replacement work. One of the two orifices to be used for bulk evacuation or intake, the large one, sealed by a hard vulcanite covered timber cored float (or ball). The other for evacuation of accumulated air in the pipeline under normal working condition

For ease of operation the isolating valve is to be complete with a pair of mitre wheels, i.e., a set of bevels having a pitch cone angle of 45°.

Air valve shall be designed to prevent premature closure prior to all air having been discharged from the line. The orifice shall be positively sealed in the closed position but the float (ball) shall only be raised by the liquid and not by a mixture of air and liquid spray. The seating shall be designed to prevent the floats sticking after long periods in the closed position.

Valves must have proven kinetic design features to eliminate premature blowing shut of large orifice by the vulcanite covered timber ball due to the high velocity of emergent stream of air even a**t** critical level of 344 mtr/sec

The design shall be such that the higher the rate of flow (and therefore the greater the differential pressure) the greater the resultant down thrust keeping the ball glued to its seat until the last drop of air is expelled from the pipe system.

The specific gravity of the rubber / vulcanite covered timber cored ball floats in the high and low pressure chambers must be within 0.6 to 0.8 to ensure stipulated free board with the ball freely floating.

The isolating sluice valve should be of standard class I design except the modification in its operating arrangement. The valve shall have a pair of mitre wheel gearing for ease of operation. These are to be machine cut

Function and performance test of air valves

When tested as below, the air passage and the function of ball floats in a valve shall be satisfactory, and the valve shall work smoothly.

The valve shall be fitted on a test bench. The pressure of the water in pipe shall be developed to working pressure, and the main valve shall be gradually opened to check the air release and float function. Compressed air shall then be slowly put into the valve through underside of the valve, and check the function of floats.

Hydrostatic test of valve body, when tested as mentioned below there shall be no leakage through pressure sustaining components and joints. There shall be no permanent deformation of any part.

The valve body (without cover and ball floats) shall be covered by a blank flange, keeping isolating valve open. Hydrostatic pressure of 1.5 times the pressure class of the valve shall be applied for duration of 5 minutes to check the water tightness of the body.

Valve seat and cock, when tested as mentioned below, shall not show any leakage.

7.1 High pressure orifice seat test

Orifice Seat is to be tested for one time of the working pressure to check leakage of orifice seat for duration of three minutes.

7.2 Low pressure orifice seat test

Subsequent to high pressure orifice performance test, hydraulic pressure shall be reduced up to half of the working pressure to check leakage of orifice seat for duration of three minutes.

Data sheet for air valves

Sl. No	Description		Particulars
1.	Size	:	50 mm NB
2.	Rating (Kg/sq.cm)	:	As specified in the scope of work
3.	Material of construction	:	
	Body	:	CI IS 210 Gr. FG 200
	High Pressure Cover	:	CI IS 210 GR FG 200
	Low Pressure Cover	:	CI IS 210 GR FG 200
	Cowl	:	CI IS 210 GR FG 200
	High Pressure Orifice Plug	:	IS 318 Gr. LTB 2 / St. St. AISI 410
	Low pressure Seat Ring	:	Nitrile rubber (Dexine)
	Isolating sluice valve	:	Conforms to IS 14846
	Spindle for sluice valve	:	Stainless steel AISI 410
	Fasteners	:	Carbon Steel

	Minimum float size - Low / High pressure ball		200 / 150 mm
4.	Shop Testing		As specified in clause 7
	Material Test Certificate	:	Required for all material

8. Electric actuator

All local controls shall be protected by a lockable cover.

Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

The 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 shall be suitable for continuous remote indication of door travel besides having a local mechanical indicator

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. Heaters shall be suitable for single phase operation. The heaters shall be switched “ON” when the starters are “OFF” and shall be switched “OFF” when the starters are “ON”.

Each valve will be tested with corresponding electric actuator and must be supplied by the valve manufacturer only.

8.1 Each starter shall be equipped as follows

i. 2 Nos. Three phase magnetically operated line contactors with no-volt release and electrical and mechanical interlock.

ii. 1 No. Three phase terminal cut-out device.

iii. 1 No. Control circuit transformer fully protected by fuses on primary and secondary circuit.

iv. 1 No. Set of “Open”, “Close” and “Stop” buttons.

v. 1 No. Local - Off-remote switch with padlocking facilities.

vi. 1 No. Set of torque and limit switches for “Open” and “Close” positions.

vii. Valve position indicator and hand wheel for manual operation.

viii. Reduction gear unit.

8.2 Testing of actuator

Following test to be carried out at factory

Crack open : Against full differential / working pressure to demonstrate efficacy of system

Smooth travel : From full open to full close under no flow (dry) condition and to check soundness of limit switches

Gearbox shall have a life of 1,00,000 hours, and be selected in accordance with AGMA recommendation.

9. Cleaning

Prior to factory inspection, all manufacturing waste, such as metal chips and fillings, rags, debris and all other foreign matter shall be removed from the interior of the each valve. All scale, rust, oil, grease, chalk, crayon, paint marks and other deleterious material shall be

removed from the interior and exterior surfaces. At the time of shipment, valve shall be clean inside and outside.

10. Inspection and tests

All valves shall be checked for correctness in respect of flange details and face - to - face dimensions. Material test certificates to be provided

All valves shall be tested hydrostatically for strength, tightness of seats and tightness of back seating at pressures for the full rating of the valve. There shall be no signs of leakage. Water used for hydrostatic testing of valves with stainless steel components shall not have chloride content exceeding 20ppm. Tap water may be used for testing all other valves.

11. Painting and corrosion protection

Unless otherwise specified one coat of primer and two coats of enamel shall be applied to all cast iron exposed surfaces as required to prevent corrosion, after release has been given for painting and before dispatch. All parts shall be adequately protected for rust prevention. The use of grease or oil, other than light grade mineral oil, for corrosion protection is prohibited.

12. Drawings

The Bidder shall furnish, along with his Bid, drawings giving outline dimensions, clearance dimensions for disassembly and weight of valve with actuator if actuator is warranted by size or specification.

13. Name plates

All valves shall have a permanent name plates indicating details as per “Standard marking systems for valves, fittings, flanges and Unions. “In addition they shall have a permanent stainless steel tag fixed on the valve body indicating the Purchaser’s valve specification tag number or as may be stipulated by Inspecting Engineer.

14. Information to be furnished after the award of contract

The Vendor shall furnish six copies of functional and dimensional drawings for approval

Sub-Section - T10

Technical specifications for mild steel pipes

Sub-Section - T10

Technical specifications for mild steel pipes

1. General

1.1 Scope of work

1.1.1 This specification covers the technical requirements and essential particulars for the supply, fabrication, inspection, erection, testing and cleaning of piping systems as covered in the specification documents and drawings. The CONTRACTOR shall demonstrate that the piping satisfies the requirements of the specification and applicable codes

1.1.2 This specification covers all details regarding the Mild Steel Pipe.

1.1.3 This part of the specification covers the requirements of supply, fabrication, transport, laying, jointing, testing and commissioning of all welded Mild Steel pipe lines, above/below ground excluding civil works for the same.

2. Mild steel pipes

2.1 Applicable codes and standards

2.1.1 All piping shall comply with all currently applicable statutes, regulations and safety codes in the locality where the project coming up. The piping shall also conform to the latest editions of the codes and standards listed under clause 2.1.2 below and other applicable standards. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

2.1.2 The applicable Indian Standards and codes shall be followed wherever applicable for the pre-stressed concrete pipes. In all cases, the latest revision of the standards shall be referred to. If requirements of this specification conflict with the requirements of the standards, this specification shall govern. The following standards, unless otherwise specified herein, shall be referred to.

a) IS: 3589 Specification for seamless or electrically welded steel pipes
b) IS: 228 Methods of chemical analysis of steels
c) IS: 1608 Methods for tensile testing of steel products
d) IS: 2328 Methods for flattening test on metallic tubes
e) IS: 3803 Part I Methods for elongation conversions for steel : Part I carbon and low alloy steels
f) IS: 4711 Methods for sampling of steel pipes, tubes and fittings

g) IS: 4736 Hot-dip zinc coatings on mild steel tubes

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

i) IS: 814 Covered electrodes for manual metal arc welding of carbon and carbon manganese steel

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

k) IS: 1200 Methods of measurement of building and civil engineering works:
Part I Earth work

l) IS: 2062 Steel for general structural purposes

m) IS: 2720 Part 7 Methods of test for soils: Part 7 Determination of water content dry density relation using light compaction

n) IS: 780 Specification for sluice valves for water works purposes (50 to 300 mm size)

o) IS: 2906 Specification for sluice valves for water works purposes (350 to 1200 mm size)

p) IS: 3600 methods of testing fusion welded joints and weld metal in steel: Part
I Cruciform fillet weld tensile test

q) IS: 4081 Safety code for blasting and related drilling operations

r) IS: 4853 Recommended practice for radiographic inspection of fusion welded
butt joints in steel pipes

s) IS: 4260 Recommended practice for ultrasonic testing of butt welds in ferritic steel

t) IS: 5330 Criteria for design of anchor blocks for penstocks with expansion
joints

u) IS: 5555 Code of procedure of conducting field studies on atmospheric corrosion metals

v) IS: 7808 Code of procedure for conducting studies on underground corrosion of metals

w) IS: 10221 Code of practice for coating and wrapping of underground and steel pipelines

x) IS: 432 Specification for mild steel and medium tensile bars and hard drawn steel wire for concrete reinforcement -Part I Mild steel and medium tensile steel bar

y) IS: 432 Specifications for mild steel and medium tensile bars and hard. Drawn steel wire for concrete reinforcement - Part II: Hard drawn steel wire

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

aa) IS: 269 Specification for ordinary and low heat Portland cement bb) IS: 8041 Specification for Rapid Hardening Portland Cement cc) IS: 1489 (Part 1) Portland – Pozzolana cement (part 1) Fly ash based dd) IS: 1489 (Part 1) Portland – Pozzolana cement (part 1) calcined clay based. ee) IS: 2116 Sand for masonry mortars. ff) IS: 3114 Code of practice for laying of cat iron pipes.

gg) IS: 12330 Sulphate resisting Portland cement hh) IS: 456 Code of practice for plain and reinforced concrete ii) IS: 516 Methods of tests of strength of concrete

2.2 Fittings, specials and appurtenances

2.2.1 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.

2.2.2 Bends shall be fabricated taking into account the vertical and horizontal angles for each case Bends shall have welded Joints and the upstream and downstream ends of each bend shall have straight piece of variable lengths as required. 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

2.2.3 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.

2.2.4 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 tile head and preparation of the plate edges for the final weld after testing. No separate payment will be made for such test heads.

2.2.5 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

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

2.2.7 The Contractor shall provide stiffener rings wherever directed by the Engineer. 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 the width of welding.

2.2.8 Wherever pipe laying work is done from two faces and/or has to be done in .broken stretches due to any difficulty met with at site, the final connection has to be made by introducing straps to cover gaps up to 30 cm length. Such straps shall be fabricated in the field by cutting pipes, slitting them longitudinally and slipping them over the ends to be connected in the form of a collar. The collar shall be in two halves and shall have its inside diameter equal to the outside diameter of the pipe to be connected. A minimum lap of 8 cm on either ends of the pipe shall be kept and fillet welds shall be run both internally and externally for circumferential joint. The longitudinal joints of the collar shall be butt-welded.

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

2.3 Protective cement mortar coatings

2.3.1 Mortar lining on internal surface of steel pipe

2.3.1.1 This clause covers the requirement of providing materials and application of cement mortar lining application to the internal surfaces of steel pipes, fittings, specials, etc by centrifugal spinning or by other methods to provide equivalent results.

2.3.1.2 The in-situ cement mortar lining shall be applied to the internal surface of the pipeline after completion of shop hydraulic tests and on receipt of the written approval of the Engineer thereof.

2.3.1.3 In case of any discrepancy between this Specification and the standards and codes of practice referred to herein, this Specification shall govern. All standards and codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions. The following standards and codes are of particular relevance to this work:

AWWA C602-76	Standard for cement mortar lining of water pipelines (4 inches and larger) in Place
IS: 3696	Safety code for scaffolds and ladders (Parts I & II)
ASTM C40	Test for organic impurities in sands for concrete

2.3.1.4 The Engineer shall have the right to inspect the source(s) of materials, the operation of procurement and storage of materials, cement mortar batching and mixing equipment and the quality control system. Such inspection shall be arranged and the Engineer's approval obtained prior to starting of any lining work.

2.3.2 Materials

2.3.2.1 The cement required for mortar lining shall be Portland Cement conforming to IS: 269

2.3.2.2 To improve workability, density and strength of the mortar, admixtures as approved by the Engineer may be used by the Contractor at his own cost. No admixtures shall be used that would have a deleterious effect on water flowing in the pipe, which is required for drinking purposes.

2.3.2.3 Sand shall consist of inert granular material. The grains shall be strong, durable, and uncoated. The sand shall be well graded and shall pass a 1.18 mm mesh screen (ASTM No.16) with not more than 5 percent passing 150 micron sieve (ASTM No.100). Sand shall be free from injurious amounts of dust, clay, lumps, shale, soft or flaky particles mica, loam, oil, alkali, and other deleterious substances. The total weight of such substances shall not exceed 3 percent of the combined weight of the substances and the sand that contained them.

2.3.2.4 Sand shall not show a colour value (darker than the reference standard colour solution prepared as required by ASTM 640 - Test for Organic Impurities in Sands for Concrete.

2.3.2.5 Water for mixing mortar shall be clean and free from injurious amounts of mud, oil, organic material or other deleterious substances.

2.4 Design of lining

2.4.1 The composition of the mortar for the lining shall be cement, sand and water and shall be well mixed to obtain such consistency as to produce a dense, homogenous lining that will adhere firmly to the pipe surface.

2.4.2 The mix proportions of cement and sand shall be 1 part cement to 2 parts sand by volume. Slight modifications in composition may be made on Site to suit the characteristics of the sand used. Each bag of cement shall be weighed and converted into a volume for use. Admixtures, if approved by the Engineer, shall be used in strict accordance with the manufacturer's recommendations. The minimum cement content shall be 330 kg/m3. The soluble chloride ion (Cl) content of the cement of the cement mortar mix shall not exceed 0.15 percent, expressed as a percentage of cement weight.

2.4.3 The water content shall be the minimum that is required to produce a workable mix, with full allowance made for water collecting on the interior of pipe surface.

2.4.4 Cement mortar lining shall have a minimum final thickness as specified below

Outside dia of steel pipe mm	Minimum thickness of lining mm	Tolerance
168.3 to 323.9	6	+ 2 - 0
355.6 to 610	7	+ 2 - 0
660 to 1219	9	+ 2 - 0
1321 to 2540	12	+ 3 - 0

2.5 Workmanship

2.5.1 All lining work shall be done by machine/hand application. If there are areas where the lining can be done by machine but cannot perform trowel finishing, then the Contractor shall indicate such areas in the method statement submitted as part of his bid. By prior approval of Engineer, these areas may be machine sprayed and hand trowelled.

2.5.2 The plant and equipment proposed by the Contractor for carrying out the cement mortar lining application shall be approved by the Engineer.

2.6 Preparation of pipe surface

2.6.1 The interior surface of pipe to be lined shall be cleaned to remove all rust, chemical or other deposits, loose and deteriorated remains of old coating materials, oil, grease, and all accumulations of water, dirt, and debris. The cleaning of the surface shall be carried out by the use of suitable chemical or mechanical means with the approval of Engineer. The extent of cleaning shall be to the satisfaction of the Engineer.

2.6.2 All loose mill scale, dirt, rust, and accumulation of construction debris shall be removed from the interior surface of the steel pipeline. The pipeline shall be cleaned by use of power-driven cleaner incorporating revolving brushes on rotating arms. After this cleaning the pipe shall be flushed with potable water and all standing water removed.

2.6.3 Immediately prior to the travel of the lining machine through the pipeline, all foreign material shall be removed. This includes sand and loose mortar that might have accumulated since the work of preparation of surfaces was completed.

2.7 Lining procedure

2.7.1 Straight sections of pipe shall be lined by use of a spinning machine specifically designed and built for the purpose of rotating the pipe section and centrifugally applying cement mortar lining to the interior of steel pipe or by a method known to provide equivalent result.

2.7.2 Mortar lining shall be mechanically troweled except for the places where hand trowelling is permitted by the Engineer.

2.7.3 The mortar shall be mixed in batches. The amount of cement and sand entering into each batch shall be measured by weight. The quantity of water entering the mixer shall be measured automatically by an adjustable device, or it shall be otherwise measured to ensure that the correct quantity of water is being added.

2.7.4 When required to prevent distortion or vibration during the spinning, each section of pipe shall be suitably braced with external or internal supports appropriate to the equipment.

2.7.5 After the mortar has been distributed to uniform thickness the rotation speed shall be increased to produce a dense mortar with smooth surface.

2.7.6 Provision shall be made for removal of surplus water by air blowing, tilting of the pipe or other methods approved by the Engineer.

2.8 Curing and testing

2.8.1 Pipe sections may be moved to a curing area immediately after completion of the mortar lining and hand finishing of a section of pipeline. Care shall be exercised at all time to prevent damage to the lining. At the option of the manufacturer, linings shall be either accelerated cured or moist cured.

2.8.2 On arrival at the curing area, but not later than 30 min after completion of the lining operation, pipe ends shall be covered with plastic or wet burlap for a minimum period of 24 hour before applying the exterior coating. The lining shall be cured for a total period of four days before shipment. The ends of the pipe sections shall be kept closed during the curing period, with plastic end caps except when sprinkling hands are used. The reinforcement and outside coatings are being applied or accelerated curing is being substituted. Care must be taken by the manufacturer to avoid drying to or cracking of the lining

2.8.3 Accelerated curing may begin immediately on arrival of the pipe at the curing area but the temperature of pipe shall not exceed for 3 hour until the mortar has taken its initial set, whichever occurs first. The ambient vapour shall then be maintained at a temperature between 45deg c and 65 deg c at a relative humidity of not less than 85 percent for a curing period of 6 hour after which the exterior coating may be applied.
The lining shall be cured for a total period of 18 hour before shipment.

2.8.4 Test blocks of the same material as used for the lining shall be made in 150 mm cube moulds and subjected to Works cube crushing tests. Each block shall be removed from its mould as soon as practicable and cured under the conditions of temperature and humidity identical with those in which the lining of the pipe is cured. The number of tests shall be at least 4 cubes for each age and each water cement ratio. The works cube strength of the test cube shall no' be less than 300 kg/cm2 after 28 days of curing or 170 kg/cm2 after 7 days of curing. The density of the test cube shall not be less than 2300 kg/m3

2.8.5 A set of minimum two test cylinders, 50 mm in diameter by 300 mm in length shall be made each day. The test cylinders shall be cured with the pipe at the same temperature and for the same total length of time. Other sizes cylinders, such as 50 mm x 100 mm may be used to test compressive strength.

2.8.6 Centrifugally spun test cylinders may be used by the manufacturer. Test cylinders shall be spun about their longitudinal axes in 150 mm diameter by 300 mm long steel molds at a speed that will simulate the compaction of mortar in the lining to produce a spun cylinder wall thickness of at least 35 mm. The net cross sectional area of the hollow cylinder shall be used to determine its compressive strength.
Damaged cylinders shall not be tested.

2.8.7 Minimum compressive strength should be of 7 MPa in 7 days and 31 MPa in 28 days. Pipe made with mortar lining does not meet the strength requirements set forth above shall be subject to rejection.

2.8.8 The average of 10 consecutive strength tests of cylinder representing each mortar mix shall be equal to or greater than specified strength and not more than 20 percent of the strength tests shall have values less than the specified strength. No cylinder test result shall be less than 80 percent of the specified strength.

2.9 Inspection and remedial work

2.9.1 The entire procedure of applying cement mortar lining shall be subject to continuous inspection by the Engineer but such inspection shall not relieve the Contractor of his responsibility to, furnish material and perform work in accordance with this specification. All cement mortar lining not applied in accordance with this specification, shall be subject to rejection by the

Engineer. Lining so rejected shall be removed and replaced by the Contractor at his own expense.

2.9.2 Defects in lining including but not restricted to sand pockets, voids, over sanded areas, blisters, cracked and dummy areas, and thin spots shall be removed, and the area shall be repaired by hand application to the full required thickness of the mortar lining. Defective areas encompassing the full diameter of the pipe shall be replaced by machine wherever practical. Defective lining rejected at the time of lining shall be removed before initial set of the mortar. Defective lining rejected after initial set shall be replaced or repaired by the must practical method as determined by the Engineer.

2.10 Gunite coating to external surfaces -underground pipes

2.10.1 In case of steel pipeline to be laid underground, before lowering into the trenches, the external surfaces of all pipes specials and fittings shall be provided with a cement mortar coating applied by guniting. A length of 150 mm at each end of the pipe strake shall be left ungunited to facilitate site welding. This portion shall be lined after laying, welding and field testing of the pipeline is completed satisfactorily. If the Contractor desires so, guniting the pipe externally, after lowering them in the trenches will be allowed if the Contractor evolves a suitable method and the same is approved by the Engineer. Any widening or deepening of the pipe trench or any other measure required for this purpose shall be at the Contractor's expense.

2.10.2 The minimum thickness of the mortar coating shall be 25 mm with a maximum positive thickness tolerance of 1- 3 mm

2.10.3 Where the pipes/ specials are to be gunited externally or encased in concrete, the external surface of the pipe shall be given a coat of cement wash. The pipe surface shall be blast cleaned to the Engineer's satisfaction. Immediately after the pipe/ special is blast clean the Contractor shall commence coating of the surface with cement wash.

2.11 Materials

2.11.1 Cement mortar applied by mechanical placement or by the steam pneumatic process shall consists of 1 part cement and 3 parts sand by volume. The water in the mixture shall be carefully controlled so that the mortar will not run, sag or segregate. Slight modifications in

composition may be made on Site to suit the characteristics of the sand used. Each bag of cement shall be weighed and converted into a volume for use. Admixtures, if approved by the Engineer, shall be used in strict accordance with the manufacturer's recommendations. The minimum cement content shall be 330 kg/m3. The soluble chloride ion (Cl) content of the cement of the cement mortar mix shall not exceed 0.15 percent, expressed as a percentage of cement weight.

2.11.2 Welded fabric reinforcement shall conform to IS: 1566 or equivalent mild steel reinforcement, as directed by the Engineer The welded fabric used shall be bent to proper shape to conform to the surface of the fitting /special/pipe to be coated and shall be securely Held 20 mm away from the surface of the pipe / special/fitting by means of spacer blocks made from 1:1 cement mortar and binding wire. Spacers shall be placed at spacing not exceeding 300 mm in both directions Adjacent sheets of fabric shall lap at least 80 mm and shall be securely fastened together by binding wire at intervals not exceeding 300 mm.

2.12 Preparation of steel surface

2.12.1 The exterior surfaces of all pipes to be lined with Portland cement mortar shall be thoroughly cleaned by sand or steel grit blasting.

2.12.2 Hand cleaning

Before blasting, all oil and greases on the surface of the metal shall be removed thoroughly by flushing and wiping using suitable solvents and clean rags. The use of dirty or oily rags will not be permitted All other foreign materials shall be moved by buffing or by scrapping and wire brushing. After cleaning, the special shall be protected and maintained free of all oil, grease and dirt that might fall upon the plate from whatever source until the plate has received its cement .mortar coating

2.12.3 Mechanical cleaning

All metal surface shall be thoroughly blasted to bright metal. Blasted surfaces which acquire a coat of rust by buffing or wire-brushing or at the discretion of the Engineer, shall be reblasted. Adequate air separators shall be used to remove all oil and free moisture effectively from the air supply to the blaster. Any plate showing pits or structural defects shall be aside pending examination.

2.12.4 Rust preventive coating

Immediately upon completion of blasting, surfaces at the end of fittings which are \to be left bare shall be given a brush coat of a suitable rust preventive material. Rust preventing coating shall be applied and shielded and maintained during the subsequent application and curing of mortar lining and application of the exterior coating to protect from other corrosion. Rust preventive material used shall be of such character that the quality of the weld and other functions of the steel plate will not be impaired by its presence.

2.13 Application of mortar lining by guniting

2.13.1 The pressure in the lower chamber of 'Cement Gun' shall be sufficient to produce a nozzle velocity of 115 to 150 m/s when a tip with 19 mm opening is used. The compressor used shall be of an adequate capacity to maintain a pressure of at least 2.8 kg/cm2 at the gun end. The nozzle shall be held at such a distance (650 to 1000 mm) and position that the stream of flowing materials shall impinge as nearly as possible at right angles to the surface being gunited. All deposits of loose sand shall be removed prior to placing any layer of gunite. Gunite shall be shot in one coat to the specified thickness. Every precaution shall be taken to prevent the formation of sand pockets and if any develop, they shall be cut out and replaced with satisfactory machine placed material. No hand patching will be allowed. The Contractor shall apply the coating in such a manner that no sloughing shall occur at any time during or following its application.

2.13.2 Gunite shall be placed in the top and sides of the pipe, then screeded to a uniform thickness and the ground lines or blocks removed. All rebound and waste materials shall then be removed by air blowing and gunite placed in the bottom of the fittings and screeded. When completed, the lining shall be concentric with the barrel of an even thickness. The entire surface shall then receive a final flash coat of gunite and shall be steel trowelled to a true surface equal in smoothness to the spun lining in such a manner not to impair, the bond between mortar and steel plate. The guniting and surface finishing shall complete in set and sha11 be applied continuously without the fuse of construction joints. In case, for any reason whatsoever, the cement does not adhere to the walls of pipes and sloughs off, swabbing the pipe with cement slurry shall not be permitted.

2.13.3 If for any reason it is necessary to interrupt the placing of the gunite for a length of time that will result in the material t2king a permanent set, a square shoulder shall be formed at the ends of the sections and or elsewhere by shooting against a backing up strip or by cutting back with a trowel or other suitable tools the irregular edges of the material last placed to a clean unbroken surface perpendicular to the face that will provide a suitable connection or construction joint between such material and the material to be placed subsequently. When performing this work care shall be taken not to shatter or disturb the material remaining in place or disturb the embedded wire mesh. Before placing fresh material against the surface of such joints it shall be carefully cleaned and wetted to ensure a good bond between the fresh material and that previously placed. When gunite has hardened sufficiently to permit sprinkling, it shall be thoroughly wetted by sprinkling and maintained in a moist condition.

2.14 Curing

2.14.1 Immediately upon the completion of lining of special fittings, the fittings shall be closed tightly at each end by bulk heads. After the mortar has set but not later than 12 hours after application of the lining, curing shall be commenced by the water spray method and continued thereafter for 14 days. The water spray method shall consist of sprinkling the mortar lining with water by means of sprinkled heads placed within the barrel of fittings, of such capacity to keep the entire surface of mortar lining continuously wet throughout the entire period of curing and storing.

2.14.2 The application of exterior coating shall begin not less than 72 hours after the completion of interior' lining but in any event, such water spray curing shall be continued inside without interruption during the application of exterior coatings and thereafter until the fitting is 1cadeli for transportation to the trench regardless of the lapse of time after loading Each fitting shall be closed at both ends during transportation and storage along the trench and the Contractor shall continue the interior water spraying and it shall be scheduled that all the fittings will be laid within 24 hours after such water salary has been discontinued.

2.14.3 The Contractor shall protect all cement mortar from damage during handling and transportation after the internal mortar has been cured, internal bracings shall be placed at the ends of the fitting and elsewhere, if necessary without damaging the mortar lining to preserve the roundness of the barrel of the pipe. All such bearings except those that may interfere with the joining operation shall remain in position until the fitting has been installed and back filled.

2.15 Marking of pipe work

2.15.1 The component parts of the pipes shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending. The marking operation shall be conducted with full size rulers and templates. Only blunt nose punches should be used.

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

2.15.3 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 or flow shall be stamped in a prominent manner on each piece.

2.15.4 A register shall be maintained in suitable pro-forma giving the following information for each shell tested

(a) Serial No.
(b) Shell No.
(c) Date of test
(d) Thickness and specification of steel
(e) Weight of shell tested
(f) Maximum test pressure
(g) Details of test performance
(h) Details of radiographic examination of welds

2.16 Transport and storage

2.16.1 All pipes and specials fabricated in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally. The item of transport covers the cost of loading in the factory, transporting to the site of laying or to stacking yard selected by the Engineer in its vicinity and unloading and stacking them carefully in such a manner that the material so kept is not easily disturbed or rolled away from the place of stacking. 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 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.

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

2.16.3 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 similar parts 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.

2.16.4 Fabricated materials such as manhole covers, appurtenances, bolts, nuts, distance pipes, flanges, saddles, collars bypass arrangements etc. shall be transported to the site of laying from the fabrication shop according to the needs of the laying operations only.

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

2.16.6 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.

2.17 Handling

2.17.1 It is essential to avoid damage to the pipes, fittings and specials 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.

2.17.2 Great care shall be taken in handling the pipe right from the first operation of manl1facture until they are laid and jointed. The Contractor shall provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer. 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.

2.17.3 Coated pipes and specials that are to be stored on supports shall bear on the uncoated ends only. If bearing on coating is employed the supports shall be not less than 200 mm wide and so arranged to prevent damage to the coating.

2.17.4 During handling of the pipes and fittings, coating shall be protected not less than 200 mm wide and placing strips of heavy belting or other approved sheet materials not less than 200 mm wide under all ropes or fastening.

2.18 Dents and damage

2.18.1 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.

2.18.2 Any damage to the coating shall also be carefully examined and rectified.

2.19 Extra cutting and welding

2.19.1 In course of work, the Contractor may be called upon to either cut steel plates, pipes and specials etc. or carry out certain welding jobs which are not covered by any other items of the Bill of Quantities.

2.19.2 After cutting, the edges shall be made smooth and even by the use of electrical or pneumatic grinders so as to remove all inequalities. Care shall be taken that the shape of the materials cut is not deformed in any way at the time of cutting.

2.19.3 Welding may be done either by electric arc welding or by gas welding and payment shall be per meter of pipe length welded. The Engineer shall specify the leg length in case of lap joints required for each job as well as the gauge of the electrodes to be used. The rate for welding shall also include the cost of assembling the steel pieces to be welded and holding them in correct position (without distortion) the
process of welding. Cleaning of pipes shall be as mentioned elsewhere in this document

2.20 Pipe laying

2.20.1 Unless specified otherwise, the pipeline shall be erected on saddles or laid on granular bedding. Only material approved by the Engineer shall be used. The Contractor shall equip himself with all necessary tools, machinery, labour etc. required for the purpose.

2.20.2 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.

2.20.3 Chipping shall not be kept in arrears for more than 15 joints.

2.20.4 The components of the pipe work have been so designed that the corresponding joints, holes, edges etc shall coincide at the mean temperature. All works such as fixing flanges, base plate

etc. in true alignment and in correct position and tack welding pipes shall therefore be done at the mean temperature. The temperature shall be ascertained by means of mercury cups fixed to the pipe shell from outside and thermometers of the required type and range.

2.20.5 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.

2.20.6 Pipe laying for river/canal crossings shall generally start from the fixing points on either side, the expansion joints being provided last. Fixing points shall be at all anchor blocks.

2.20.7 Anchor blocks shall be constructed before commencing the pipe laying work in any section by the owner. The construction of the blocks shall be carried out in 3 stages:

(a) The lower part up to 150 mm below the invert of the pipeline, including concrete support chairs, shall be constructed;
(b) The pipeline on this part of the block shall be laid;
(c) The remaining block around and over the pipeline shall be constructed.

2.20.8 The saddles along with the embedded stainless steel plate 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 reinforced concrete saddles shall be determined by the Contractor.

2.20.9 The pipe strakes shall be assembled in position on the saddles by the 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 pipe1jne 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 5.00 PM. 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.

2.20.10 Where specified, a granular bedding of the required thickness and level shall be provided below the pipe prior to laying the pipe in the trench. The bedding shall be compacted with a light hand rammer, and any reduction in thickness due to compaction shall be made up by adding sand during ramming.

2.20.11 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 gunite coating of pipe is not damaged in any way during the lowering and assembling, After the pipe is lowered
into the trench, it shall be laid in correct line and level by using the leveling instruments, sight rails, theodolite, etc, 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. Necessary measures 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.

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

2.20.13 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 made

to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc.

2.20.14 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.

2.20.15 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.

2.20.16 The progress of pipe laying shall follow the detailed programme submitted by the Contractor with his bid and confirmed and updated at the start of construction. The Contractor shall programme his activities such that the laying of pipes follows closely the manufacturing schedule and no pipes remain stacked in the factory or at Site for a period of more than two months.

2.21 Fixing expansion joint

2.21.1 The work of laying pipeline as a rule 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.

2.21.2 Case when ‘y’ plus ‘Z’ is more than ‘X' or equal to ‘X’ (i.e. fixing of expansion joint without strip)

a) 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.

b) The expansion joints are normally supplied without packing. The normal length of the expansion joint shall be reduced by about 100 mm by cutting the inside locks, and inserting the inner strake by means of turnbuckles. At mean temperature this expansion joint shall be inserted inside the gap (care being taken to keep the tapered portion on the down-stream side), and both ends shall be tack welded to the pipe ends, after pulling the expansion joint. (Tacks
of these two joints shall be of longer length. approximately 100 mm long).

c) Welding of these two joints of the expansion joints shall be started only after it is ascertained by taking observations that the expansion joint is functioning properly. The procedure to be followed for taking observations is given in item (2.21.4) of this clause.

2.21.3 Case when ‘Y' plus 'Z' is less than. Xi (i. e. fixing of expansion joints with strap):

a) 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.

b) 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.

c) 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.

d) 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.

e) 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.

2.21.4 Observations:

a) 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.

b) 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.

c) 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.

2.22 Backfilling trenches

2.22.1 The trench shall be filled with selected material up to 300 mm above the pipes. This backfill shall be provided in layers not more than 150 mm, with a density more than 95% of Standard Proctor Density. Samples shall be tested as directed by the Engineer. The remaining depth of trenches shall be filled with ground backfill material.

2.22.2 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. 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, 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 will not be permitted unless the trench has been filled to height of at least 300 mm over the top of the pipe except as may be necessary for tamping etc. , during backfilling work. The backfilling shall be done in accordance with Specifications given elsewhere in this report.

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

2.22.4 For pipelines of diameters below 1200 mm strutting shall be done from inside at either end of the stretch of the pipeline under refilling, by means of strong spiders

which shall be sufficiently stiff to resist all deformation for which no extra payment will be made

2.22.5 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 2 m.

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

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

2.22.8 Regular measurement of the field dry density shall be taken by the Contractor at various levels in the backfilling as required by the Engineer.

2.22.9 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.

2.23 Field hydraulic test

2.23.1 After erection at site and after the Concrete anchor blocks have been constructed but prior to internal painting, the entire pipeline shall be subjected to a hydraulic test as follows:

a) The test pressure shall be minimum of 1.5 times the working pressure, but not to exceed a pressure that would result in a stress greater than 80% of the yield point of the steel plates used.

b) The pressure test shall be conducted in dry weather with pressure held constant for 24 hours to observe whether any pressure drop takes place. The test pressure shall be gradually raised at the rate of 0.1 N/Sq.mm per minute. A leakage of 0.1 litre per mm diameter of pipe per kilometer length per 30 m head test pressure per 24 hours is allowed if the test pressure is maintained
by pumping. Any leakage beyond that specified herein above shall be rectified to the satisfaction of the Engineer.

c) 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 plates and other raw materials shall be carried out by the Contractor at his own cost.

2.24 Cleaning and painting of steel pipes and specials

2.24.1 General

a) The inner and outer surfaces of the fabricated pipes and specials shall be painted with 2 shop coats and one field coat of Heavy Duty Bitumen Paint over a coat of Zinc Rich Epoxy Primer as specified hereunder.

b) Zinc rich epoxy primer and heavy duty bitumen paint (Inertol 49 W or equivalent) conforming to the following requirements sha11 be used for painting. Each lot of the paint supplied shall be accompanied by the certified copies of the results of the tests carried out by the manufacturer.

c) If any sample of the paint and/or prin1er is not conforming to the specification, the entire consignment to which the sample may pertain shall be rejected. Only those primers and painting materials. That have been approved by the Engineer in writing shall be used for this work.

2.24.2 Materials

Zinc rich epoxy primer

(a) Description. two pack zinc rich consisting of:

i. Base -fine zinc dust ground in epoxy resin solution, supplied in, paste form;
ii. Catalyst (Abduct type) -the non-volatile portion of the material --(mixed) should consist of 90% -92% zinc dust and 8% -10% epoxy, resin and curing agent.

(b) Shade

Grey.

(c) Characteristics

The paint shall provide ~ complete rust inhibitive barrier coating of high mechanical and abrasion resistance. The film shall be compatible for fusion and spot weld.

(d) Pot life

Between 4 and 6 hours

(e) Mixing ratio

The proportion of mixing of base and hardener should be as specified by the manufacturer by weight and volume. The mixed primer shall conform to the specifications detailed.

(f) Viscosity of ready-mixed paint

Between 15 and 22 in Fort Cup No.4 at 30° C

(g) Drying time:

i. Dust Free - Between 10 and 15 minutes,
ii. Chamber curing – Between 24 and 48 hours.

2.24.3 Heavy duty bitumen paint ('Inertol 49W' or equivalent)

(a) Description

A heavy duty coating having matt with slight sheen and black finish, which after long exposure to the sun and weather attains a pleasant slate stone appearance.

(b) Shade

Black -the second coat is slightly red tinted.

(c) Finish

Rough and matt with slight sheen.

(d) Characteristics

The paint shall not impart any taste or odour to the water it carries, and shall be non-toxic. It shall afford a highly durable protective airtight coating to prevent corrosion or rust of iron and steel against air moisture or sea water, and shall be sufficiently elastic to prevent its cracking. Blistering or peeling. It shall retain its consistency at the ordinary atmospheric temperature when packed in suitable containers. After application or drying, the paint shall not show any surface cracks due to weathering action or expansion and contraction. Its resistance to water must be perfect. Also, it shall be resistant to weak acids and alkalies, neutral salts and to dry heat up to 150° C.

(e) Shelf life

Paint which has been under storage for more than 6 months shall not be used. In order to ensure non-settlement of the heavier constituents, the paint drums should be turned upside down every 14 days or such period as the manufacturer recommends. For this purpose, dates when the overturning is to be done should be painted on the drum ends.

(f) Drying time

- Surface dry -not more than 4 hours
- Hard dry -not more than 18 hours (on application a non-absorbent surface should give a film thickness of between 3 and 4 mils per coat)

(g) Consistency

Thixotrophic liquid

(h) Stripping test

Check that the test surface is scratch free. Apply one coat of the material by brushing on a mild steel panel 150 mm x 50 mm. Allow to dry for 48 hours. Scratch the film with a sharp penknife so that the bare metal is visible. The scratch so produced shall be free from jagged edges.

(i) Flexibility and adhesion test

Check that there is no visible damage or detachment of the film. Prepare a panel as for (h) above. Allow it to dry for 96 hours and bend the panel double 75 mm from the upper edge over a 6 mm

diameter rod with the paint film on the outside. The time of bending shall not exceed one second and the film shall not become visibly damaged or detached.

(j) Corrosion protection test

Check that there is no sign of corrosion. Prepare a panel 150 mm x 100 mm of cold rolled iron, properly derusted, with one coat of zinc rich primer and three coats of bitumen paint as indicated in the detailed Specification. Allow the panel to stand in air for 7 days with complete curing Keep the panel in a corrosion chamber in which the temperature is maintained at between 420° C and 480° C in such away that continuous condensation of water takes place on the panel. After exposure to these conditions for 7 days take out the panel and examine for signs of corrosion after removing a portion of the film at the centre of the panel. There should be no indication of any corrosion.

(k) Impact test

To pass Test II as described in Clause 2.24.4.8 Resistance to Heat To pass Test I as described in Clause 2.24.4.8

(l) Flash point test

When tested in Abel's closed apparatus, the flash point is to be not below 350° C.

(m) Stability in storage

No evidence of change in characteristics after being stored for at least 6 months.

(n) Lead content

The result of chemical analysis should show a lead content of not more, than 0.03% calculated as PbO.

(o) Phenol or phenolic content

The result of chemical analysis should show no indications of the presence - of any phenol or phenolic compounds

(p) Packing

The paint shall be packed in metal containers.

(q) Minimum bulk unit weight

The minimum weight of 10 litres of the material should not be less than 11.5 kg.

2.24.4 Painting

2.24.4.1 General

a) Except with the permission of the Engineer only ready mixed paints of an approved make and brand shall he used. Thinning or heating of paints will not be permitted except with specific approval and in accordance with instructions. Any warming of paint shall be performed by means of a hot water bath and paint shall not be heated to temperatures higher than 40°C. All paint shall be in thoroughly mixed condition at the time of application. On completion of the work, the Contractor shall remove any oil stains or paint spots, leaving the structures and equipment in a clean and acceptable condition.

b) Paint shall be applied only to dry, freshly cleaned surfaces, free from dust, rust, scale, grease or other substances which might affect the adhesion or the durability of the coating. In no case shall paint be applied to surfaces that are not to be applied during rainy or misty weather, unless unavoidable, in which case the work shall have suitable and satisfactory protection and such protection shall be maintained until the paint has dried.

c) All paint shall be applied by skilled workmen in workmanship manner and the average coverage shall be equal to that recommended for first class work with the type of paint and on the kind of surface being painted.

2.24.4.2 Preparation of surface for painting

a) All oil and grease shall be removed from surface to be painted by washing with a suitable solvent and by wiping with rags until completely clean. After removal of all oil and greases surfaces of metal work required to be painted shall be cleaned by removing all rust, loose scale and dirt by sandblasting, grit blasting or other effective means. Surface which will be permanently or intermittently submerged or subjected to moisture from spray or excessive condensation shall be cleaned to clean metals by sand or grid blasting. After cleaning, all surfaces shall be maintained free from oil, greases, rust, dirt and other contaminations until they have received the final coat of paint

b) Surface of stainless steel and bronze and machined surfaces which are attached or adjacent to metal work that is being cleaned or painted shall be protected by adhesive tape or other suitable means during the cleaning and painting operations.

c) The surface of the steel pipes arid specials to be painted shall be thoroughly cleaned by sand or shot blast cleaning process to SA 2.5 finish, to remove all rust mill scale etc. Oil and grease shall be removed by applying a suitable metal cleaning solution and wiping with clean rays All foreign matter which cannot be removed by blasting process shall be removed as directed by the Engineer.

d) Blasting should be done at pressure of 5.62 kg/sq.cm (80 p.s.i) at the compressor end and at 4.93 kg/sq.cm. (70 p.s.i) at nozzle end. This pressure should be maintained during the entire blasting operations. Improper jointing of hose pipes and resultant reduction in pressure at nozzle end shall be checked and avoided

e) The blast cleaned surface shall be primed immediately after blasting is over. The sequence and the programme of blast cleaning and application of zinc rich epoxy primer shall be arrange in such a way that the blast cleaned surface shall not remain uncovered with zinc rich epoxy' primer for more than 2 hours.

f) Any deviation from above shall require the approval of the engineer.

g) Wherever manual cleaning is approved by the Engineer the internal surface of specials shall be thoroughly cleaned using scrapers and wire brushes to remove all rust, mill scale etc. to give a shining metallic (SA 2.5) surface. The surface so cleaned shall be washed with water and allowed to dry. A metal cleaning solution of approved make

shall then be applied over it. After it is dry, the surface shall be again washed with water, scrapping wire brushes simultaneously. A copious use of water is necessary at this state to ensure that the metal cleaning solution is completely removed. The primer coat shall be applied immediately after the surface has become dry.

2.24.4.3 Shop painting

a) Immediately after cleaning and inspection and before removal from the shop, all metal work except machine finished surfaces, and surfaces of metals to be embedded in concrete, shall be give one coat of zinc rich epoxy primer followed by two coats of Heavy duty Bitumen paint as specified hereafter. Surface not accessible after assembly or erection shall be given a second shop coat of primer. Machine finished surfaces sha11 be effectively coated with white lead to prevent rust.

b) No coating shall be applied closer than 100nim from ends of pipes and specials and this coating shall be done after field yielding. The exposed steel surfaces shall be protected by rust preventive applications which shall not interfere with the field welding.

2.24.4.4 Application of primer

a) No primer shall be applied without prior approval of the Engineer. During rain or fog shells of the pipes and specials shall be protected from weather by suitable housing.

b) The proportion of mixing of base and hardener shall be as specified by the manufacturer by weight and volume. The mix of Zinc rich epoxy primer shall be prepared at the work site/yard not earlier than 15 minutes before applying the same on pipe and specials surfaces.

c) One coat of zinc rich primer shall be applied by spray giving a film thickness of approximately one mil.

d) No thinner shall be added to the read mix paint without previous approval of the Engineer, and the finishing coats on top of the primer coat, shall only be applied after allowing the film to cure for at least 48 hours.

e) The priming coat shall be uniform in thickness and free from floods, runs, sags, drips, or bare spots. Any bare spots shall be recoated with an additional application of the

primer. All runs, sags, floods or drips shall be removed or all such defects shall be remedied by repriming as per the instruction of .the Engineer

2.24.4.5 Application of two shop coats of bitumen paint

a) Application of the paint under very strong sun or in the early morning in winter shall be avoided. After application of zinc rich epoxy primer, the surface should be cleaned by duster and inspected, if during inspection any portion is found rusting the same shall be removed by emery paper and coated with zinc rich epoxy primer. When complete section is checked as above, two coats of heavy duty bitumen paint shall be applied. When one coat is applied, the date of application of this coat should be written on either end of section. Before application the paint shall be properly stirred so as to get a good mix.

b) The painting shall be done by cross brushing i.e coat shall be given vertically and another coat shall be given horizontally so as to get required thickness, a good looking surface and also to avoid sagging of paint. To distinguish the second coat from first coat, the tint of the second coat shall be changed slightly. Every successive coat of paint shall be given only after the lapse of 48 hours of painting the previous coat. Before applying the next coat, the surface shall be properly cleaned by duster. The paint shall be stirred every time before applying with brush. Each coat of bitumen paint shall give a film thickness of between 3 and 4 mils.

2.24.4.6 Field painting

a) The contractor shall take proper care during loading unloading and transport of the pipes and specials from the shop to the site of erection to preserve the shop paint in the best practicable condition.

b) After erection of the pipeline on installation all rust spots, damaged areas and site welded portion of the pipeline shall be clea11ed to metal and shall be painted with one coat of zinc rich epoxy primer and two coats of heavy duty bitumen paint.

c) After lapse of 48 hours of application of repairing coats specified above a finish coat of heavy duty bitumen paint shall the applied to interior surface of the entire pipeline,

care being taken to clean the surface with duster prior to application of, the said finish coat.

2.24.4.7 Inspection and acceptance

a) The entire procedure of applying the paint as specified will be rigidly inspected right from the cleaning stage to the application of final coat by the Engineer. If, at any time, it is found that the procedure of applying the paint is not as per the standards laid down, all such painting work done shall be rejected and shall be rectified by the Contractor at his own cost, as directly by the Engineer.

b) After completing 3 coats of heavy duty bitumen paint inspection of paint thickness will be done by the Engineer using Elcometer or other standard measuring devices. If the thickness is found to be less than specified the pipe, shall be resurfaced to bring the 5alne to the specified thickness as directed by toe Engineer. All instruments and facilities for testing shall be provided by the Contractor

c) Two parallel knife cuts about 100 mm long and 20 mm apart shall be made through the coating. If necessary, the test knife may be heated to make the cut. The painted surface between tile two cuts shall be lifted off the pipe with a stiff blade. If the paint film does not peel off more than the width of the cut, the bond shall be deemed to be satisfactory should the width of peel exceed the width of the cut two additional tests shall be made on the same pipe at two different locations. The painted surface shall be accepted if both the tests are satisfactory. If the results of either of these tests are unsatisfactory, the painting work shall be rejected.

d) Covering capacity of paint shall be checked ay taking into account the actual consumption of paint on site by dividing the area covered by paint by the quantity of paint actually consumed. The covering capacity shall be between 8 and 10 m^2/1litre per coat of zinc rich epoxy primer giving a film thickness of 1 mil, and between 5 and 6 m^2/1litre per coat of bitumen paint giving a film thickness of between 3 and 4 mils.

2.24.4.8 Specific tests on painted surfaces

a) Test I - Determination of resistance to heat

Apply a coat of the material by brush to a 150 x 100 mm clean mild steel panel to give a dry film thickness of between 3 and 4 mills.

Allow the panel to air – dry in a horizontal position for 24 hours. Heat the panel in vertical position in the electric furnace, thermostatically controlled at temperature of 150°C for one hour. Take out the panel and examine it after air-drying for one hour.

Material shall be deemed to have passed the test if the film remains firmly adherent and shows no sign of cracking, blistering of flaking.

b) Test II – Impact test

Two plates size 300 mm x 300 mm x 3 mm thick shall be painted as specified. They shall be held in water bath at a uniform temperature of 25°C for a period of at least one hour before testing. The plates shall be removed from the water bath, wiped dry and shall immediately be subjected to the following tests:

- ✓ **Direct Impact**

  Each plate shall be supported on the true plane surface of a block of wood. A 650 g steel ball with a well polished spherical surface shall be dropped from a height of 2400 mm above the surface of the plate. The ball shall be dropped so as to strike the plate at least 100 mm from any edge of the plate. After one such impact, the painted surface shall be examined for evidence of shattering and loosening from the plate. The area of disbanded paint surface shall not exceed 100 cm^2.

- ✓ **Indirect Impact**

  After being subjected to direct impact, each plate shall be placed with the coated face downwards on a wooden block which has a 90 mm diameter hole drilled out at the centre. The 650 g steel ball, used for the direct impact test, shall be dropped onto the plate from a height of 2400 mm over the centre of the hole in the wooden block. The point of impact shall be at least 100 mm from any edge of the plate and shall be at least 75 mm from the point of impact during the direct impact test. After one such impact, the painted surface shall be examined for evidence of shattering and loosening of coating. The area of disbanded paint surface shall not exceed 40 cm^2,

so as to strike the plate at least 100 mm from any edge of the plate. After one such impact, the pointed surface shall be examined for evidence of shattering and loosening from the plate. The area of disbanded paint surface shall not exceed 40 cm^2.

Sub-Section – T11

Technical specifications for ductile iron pipes

Sub-Section - T11

Technical specifications for ductile iron pipes

1. General

1.2 Scope of work

1.2.1 This specification covers the technical requirements and essential particulars for the supply, manufacture, inspection, erection, testing and cleaning of piping systems as covered in the specification documents and drawings. The CONTRACTOR shall demonstrate that the piping satisfies the requirements of the specification and applicable codes

1.2.2 This specification covers all details regarding the Ductile Iron Pipe & fittings.

1.2.3 This part of the specification covers the requirements of supply, manufacture, transport, laying, jointing, testing and commissioning of all Ductile Iron pipe lines, above/below ground including civil works for the same.

2. Ductile iron pipes

2.1 Applicable codes and standards

All piping shall comply with all currently applicable statutes, regulations and safety codes in the locality where the project coming up. The piping shall also conform to the latest editions of the codes and standards listed under below and other applicable standards. Nothing in this specification shall be construed to relieve the contractor of this responsibility.

The applicable Indian Standards and codes shall be followed wherever applicable for the Ductile Iron pipes & fittings. In all cases, the latest revision of the standards shall be referred to. If requirements of this specification conflict with the requirements of the standards, this specification shall govern. The following standards, unless otherwise specified herein, shall be referred to.

aa) IS: 8329 Specification for Centrifugally Cast (Spun) Ductile Iron Pressure

Pipes for Water, Gas and Sewage bb) IS: 9523 Specification for Centrifugally Cast (Spun) Ductile Iron fittings for

Pressure Pipes for Water, Gas and Sewage cc) IS: 12288 Code of practice for Use and Laying of ductile Iron pipes dd) IS: 455 Portland Slag Cement ee) IS: 638 Sheet rubber jointing and rubber insertion jointing ff) IS: 1387 General requirements for supply of metallurgical materials gg) IS: 1500 Methods for Brinell hardness test for metallic materials hh) IS: 1608 Mechanical testing of metals – Tensile testing ii) IS: 5382 Rubber sealing rings for gas mains, water mains & sewers jj) IS: 6452 Specification for high alumina cement for structural use kk) IS: 6909 Specification for super sulphate cement ll) IS: 8112 43 grade ordinary portable cement mm) IS: 11606 Methods of sampling of Cast Iron pipes and fittings nn) IS: 12330 Sulphate resisting portable cement oo) IS: 13382 Cast Iron specials for mechanical and push on flexible joints for pressure pipe lines for water, gas & sewage

2.2 Fittings, specials and appurtenances

a) General

1. All fittings and special pieces required for curves, tees, branches, air valves, Scour valves, sluice valves etc. shall be suitable for the DI pipes for specified internal diameter and to withstand the specified test pressures.

2. The metal used for the manufacture of casting shall confirm to the appropriate grade as per IS 1865. It shall be prepared at the discretion of the manufacturer in a cupola, or an active mixer or other suitable furnace.

3. The castings shall be stripped with all precautions necessary to avoid warping or shrinkage defects, detrimental to the good quality. The castings shall be sound and free from surface or other defects.

4. Casting showing small imperfections which result from the method of manufacture and which do not affect its final use shall not be rejected on that account alone.

5. Minor defects may be rectified with the approval of the purchaser. Repairing of defects by welding, plugging off leaks by caulking or by application of epoxy putty may not be done without previously securing the approval of the purchaser. Any dressing to remove imperfections shall not reduce the thickness of the casting below the specified thickness.

6. The castings shall be such that they could be cut, drilled or machined. In case of dispute the castings may be accepted provided that the hardness measured on the external un-machined surface does not exceed 250 HBS.

b) Thickness

The thickness 'E' of fittings is calculated as a function of the nominal diameter 'DN' by using the formula given below with the following values for K:

$$E = K\,(0.5 + 0.001\,DN)$$

Where K = 14

$$E = 7 + 0.014\,DN$$

Where K = 12

$$E = 6 + 0.012\,DN$$

For 'DN 80' the thickness of the fitting has been limited to minimum of 7 mm, so that taking the tolerances into account the thickness of the fittings is always at least equal to that of the pipes of the same nominal diameter.

c) Joints

1. In the case of push-on-joints for sizes 'DN 600' and above the sockets may be with or without centering rings.

2. In case of push-on-joints the spigot end of fitting, if any, shall be suitably chamfered to facilitate smooth entry of spigot in the socket of the pipes or fittings fitted with rubber gasket.
3. In case of flange and mechanical joint casting, the flange shall be at right angle to the axis of the joint. The bolt holes shall be either cored or drilled.

4. The center bolt holes circle shall be concentric with the bore circle and shall be located off the centerline, unless otherwise specified by the purchaser. Where there are two or more flanges, the bolt holes shall be correctly aligned between them.

5. The spigot and socket flexible joint should be designed to permit angular deflection in direction and axial movement to compensate for ground movement and thermal expansion

and contraction. They incorporate gasket of elastomeric materials and the joints may be of the simple push-on-type or the type where the seal is effected by the compression of a rubber gasket between a seating on the outside of the socket and the external surface of the spigot. Joints of latter types are referred as mechanical joints.

6. Flanged joints are made on pipes having a machined flange at each end of the pipe. The seal is usually effected by means of a flat rubber gasket compressed between two flanges by means of bolts which also serves to connect the pipe rigidly. Gaskets of other materials, both metallic and non-metallic, are used for special applications.

7. The flanges can be of adjustable type where the flange comprises of a ring, in one or several parts assembled together, which bears on an end joint hub and can be freely rotated around the pipe axis before jointing.

8. Flanges shall be provided at the end of pipes or special where sluice valves, blank flanges, tapers, etc. have to be introduced. The flanged spigot / socket received from the manufacturers will have necessary bolt holes drilled. The Contractor shall assemble the flanged spigot / socket in the exact position so as to get the desired position of the sluice valves, etc. either vertical or horizontal. The drilling pattern shall be matching with the drilling pattern of flanges of valves.

9. Blank flanges shall be provided at ail 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 may be used. For pipes subjected to pressures, the blank flanges or domes suitably designed as per Engineer's requirements shall be provided.

d) Jointing procedure

Procedure for jointing will vary according to the type of joint being used. Basic requirements for all types are:

a. Cleanliness of all parts,
b. Correct location of components,
c. Centralization of spigot within socket, and
d. Strict compliance with manufacturer’s jointing instructions.

The inside of sockets and the outside of spigots should be cleaned and wire brushed for a distance of 150 to 225 mm. Glands and gaskets should be wiped clean and inspection for damage. When lifting gear is used to place the pipe in the trench, it should also be used to assist in centralizing the spigot in the socket.

Where the pipeline is likely to be subjected to movement due to subsidence or temperature variations, the use of flexible joints is recommended. A gap should be left between the end of the spigot and the back of the spigot and the back of the socket to accommodate such movement.

e) Rubber gaskets

The material of rubber gaskets for use with mechanical joints and push-on-joints shall confirm to IS 5382.

f) Sampling

Sampling criteria for checking the conformity of the casts shall be as per the IS 9523 & IS 11606.

g) Mechanical test

Mechanical test shall be carried out during manufacture by batch sampling system.
Samples shall be taken, at the manufacturer's option, from an integrally cast sample, either form a sample attached to the casting or from a sample cast separately. In the latter case, it shall be sent from the same metal as that used for casting. If the casting is subjected to heat treatment as that of castings the samples, being representative of finished product, are tested for tensile strength, elongation and hardness to verify mechanical requirements. One test for castings produced during 24 hours shall be adequate. The results obtained shall be taken as to represent all the fittings of all sizes made during that period.

h) Tensile test

One tensile test shall be made on bar cast from the same metal in accordance with the methods specified in IS 1608.

i) Hardness test

For checking Brielle hardness specified in 4.5 test may be carried out on the test bar used for the test in 9.1. Test shall be carried out in accordance with the procedures laid down in IS 1500.

j) Heat treatment

Fittings shall be supplied in either `as cast' condition or `heat treated' condition. In either case, the fittings shall comply with the mechanical properties specified in 9.1 and 9.2. in the case of heat treated fittings the test samples shall be subjected to the same heat treatment process as that of fittings to which they are representative.

k) Hydrostatic test

For hydrostatic test, the fittings shall be kept under pressure for 10 seconds. They shall withstand the pressure test without showing any sign of leakage, sweating or other defect of any kind. The test shall be conducted before the application of surface coating. **l) Tolerances**

The tolerance on dimensions of barrel and socket for push on joints fittings shall be as per IS 9523

2.3 Cement mortar linings

This clause covers the requirement of providing materials and application of cement mortar lining application of Ductile Iron pipes, fittings, specials, etc by centrifugal spinning or by other methods to provide equivalent results.

In case of any discrepancy between this Specification and the standards and codes of practice referred to herein, this Specification shall govern. All standards and codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions. The following standards and codes are of particular relevance to this work:

AWWA C602-76	Standard for Cement Mortar Lining of Water Pipelines (4 inches and larger) in Place

IS: 3696	Safety Code for Scaffolds and Ladders (Parts I & II)
ASTM C40	Test for Organic Impurities in Sands for Concrete

The Engineer shall have the right to inspect the source(s) of materials, the operation of procurement and storage of materials, cement mortar batching and mixing equipment and the quality control system. Such inspection shall be arranged and the Engineer's approval obtained prior to starting of any lining work.

m) Materials

The cement required for mortar lining shall be Portland Cement conforming to IS: 455 / IS 269 / IS 8112 or any other type of cement best suited for lining.

To improve workability, density and strength of the mortar, admixtures as approved by the Engineer may be used by the Contractor at his own cost. No admixtures shall be used that would have a deleterious effect on water flowing in the pipe, which is required for drinking purposes. Sand shall consist of inert granular material. The grains shall be strong, durable, and uncoated.
Sand shall not show a colour value (darker than the reference standard colour solution prepared as required by ASTM 640 - Test for Organic Impurities in Sands for Concrete.

Water for mixing mortar shall be clean and free from injurious amounts of mud, oil, organic material or other deleterious substances.

2.4 Design of lining

The composition of the mortar for the lining shall be cement, sand and water and shall be well mixed to obtain such consistency as to produce a dense, homogenous lining that will adhere firmly to the pipe surface.

The mix proportions of cement and sand shall be 1 part cement to 3.5 parts sand by weight. Slight modifications in composition may be made on Site to suit the characteristics of the sand used. Admixtures, if approved by the Engineer, shall be used in strict accordance with the manufacturer's recommendations. The minimum cement content shall be 330 kg/m3. The

soluble chloride ion (Cl) content of the cement of the cement mortar mix shall not exceed 0.15 percent, expressed as a percentage of cement weight.

The water content shall be the minimum that is required to produce a workable mix, with full allowance made for water collecting on the interior of pipe surface.

Cement mortar lining shall have a minimum final thickness of lining shall be as per IS 8329 & IS 9523.

2.5 Workmanship

All lining work shall be done by machine/hand application. If there are areas where the lining can be done by machine but cannot perform trowel finishing, then the Contractor shall indicate such areas in the method statement submitted as part of his bid. By prior approval of Engineer, these areas may be machine sprayed and hand trowelled.

The plant and equipment proposed by the Contractor for carrying out the cement mortar lining application shall be approved by the Engineer.

2.6 Preparation of pipe surface

The interior surface of pipe to be lined shall be cleaned to remove all rust, chemical or other deposits, loose and deteriorated remains of old coating materials, oil, grease, and all accumulations of water, dirt, and debris. The cleaning of the surface shall be carried out by the use of suitable chemical or mechanical means with the approval of Engineer. The extent of cleaning shall be to the satisfaction of the Engineer.

All loose mill scale, dirt, rust, and accumulation of construction debris shall be removed from the interior surface of the pipeline. The pipeline shall be cleaned by use of power-driven cleaner incorporating revolving brushes on rotating arms. After this cleaning the pipe shall be flushed with potable water and all standing water removed.

Immediately prior to the travel of the lining machine through the pipeline, all foreign material shall be removed. This includes sand and loose mortar that might have accumulated since the work of preparation of surfaces was completed.

2.7 Curing and testing

Pipe sections may be moved to a curing area immediately after completion of the mortar lining and hand finishing of a section of pipeline. Care shall be exercised at all time to prevent damage to the lining. At the option of the manufacturer, linings shall be either accelerated cured or moist cured.

On arrival at the curing area, but not later than 30 min after completion of the lining operation, pipe ends shall be covered with plastic or wet burlap for a minimum period of 24 hour before applying the exterior coating. The lining shall be cured for a total period of four days before shipment. The ends of the pipe sections shall be kept closed during the curing period, with plastic end caps except when sprinkling hands are used. The reinforcement and outside coatings are being applied or accelerated curing is being substituted. Care must be taken by the manufacturer to avoid drying to or cracking of the lining

The pipes shall be cured at temperatures greater than 4º C. Any loss of water from the mortar by evaporation shall be sufficiently slow so that hardening is not impeded.

Test blocks of the same material as used for the lining shall be made in 150 mm cube moulds and subjected to Works cube crushing tests. Each block shall be removed from its mould as soon as practicable and cured under the conditions of temperature and humidity identical with those in which the lining of the pipe is cured. The number of tests shall be at least 4 cubes for each age and each water cement ratio. The works cube strength of the test cube shall no' be less than 300 kg/cm2 after 28 days of curing or 170 kg/cm2 after 7 days of curing. The density of the test cube shall not be less than 2300 kg/m3

A set of minimum two test cylinders, 50 mm in diameter by 300 mm in length shall be made each day. The test cylinders shall be cured with the pipe at the same temperature and for the same total length of time. Other sizes cylinders, such as 50 mm x 100 mm may be used to test compressive strength.

The manufacturer may use centrifugally spun test cylinders. Test cylinders shall be spun about their longitudinal axes in 150 mm diameter by 300 mm long steel molds at a speed that will simulate the compaction of mortar in the lining to produce a spun cylinder wall thickness of at least 35 mm. The net cross sectional area of the hollow cylinder shall be used to determine its compressive strength. Damaged cylinders shall not be tested.

Minimum compressive strength should be of 7 MPa in 7 days and 31 MPa in 28 days. Pipe made with mortar lining does not meet the strength requirements set forth above shall be subject to rejection.

The average of 10 consecutive strength tests of cylinder representing each mortar mix shall be equal to or grater than specified strength and not more than 20 percent of the strength tests shall have values less than the specified strength. No cylinder test result shall be less than 80 percent of the specified strength.

2.8 Inspection and remedial work

The entire procedure of applying cement mortar lining shall be subject to continuous inspection by the Engineer but such inspection shall not relieve the Contractor of his responsibility to, furnish material and perform work in accordance with this specification. All cement mortar lining not applied in accordance with this specification, shall be subject to rejection by the Engineer. Lining so rejected shall be removed and replaced by the Contractor at his own expense.

Defects in lining including but not restricted to sand pockets, voids, over sanded areas, blisters, cracked and dummy areas, and thin spots shall be removed, and the area shall be repaired by hand application to the full required thickness of the mortar lining. Defective areas encompassing the full diameter of the pipe shall be replaced by machine wherever practical. Defective lining rejected at the time of lining shall be removed before initial set of the mortar. Defective lining rejected after initial set shall be replaced or repaired by the most practical method as determined by the Engineer.

2.9 Marking of pipe work

The component parts of the pipes shall be carefully marked for identification in the field. The marking shall be on the side which will be the inside of the pipe after bending. The marking operation shall be conducted with full size rulers and templates. Only blunt nose punches should be used.

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 or flow shall be stamped in a prominent manner on each piece.

A register shall be maintained in suitable pro-forma giving the following information for each shell tested

i. Serial No. ii. Shell No. iii. Date of test iv. Thickness and specification of pipe
v. Weight of shell tested vi. Maximum test pressure
vii. Details of test performance viii. Details of radiographic examination of welds

2.10 Transport and storage

All pipes and specials manufactured in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally. The item of transport covers the cost of loading in the factory, transporting to the site of laying or to stacking yard selected by the Engineer in its vicinity and unloading and stacking them carefully in such a manner that the material so kept is not easily disturbed or rolled away from the place of stacking. 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 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 shall be fixed to the pipes during transit to avoid undue sagging and consequent distortion. After the pipes are carefully stacked, props may be removed and re-used for subsequent operations. The stacking ground, both in the Contractor's yard and at the site of laying shall be selected in such a way as not to get waterlogged during monsoon. If this cannot be done, the pipes shall be supported on sleepers to avoid contact with wet earth and subsequent rusting. In order to prevent sagging during transit, savings of steel plates can be utilized by cutting to the required length and tacking the same to the pipe ends, in place of props, if approved by the Engineer.

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 similar parts shall be stacked in the

Contractor's yard until they are required for laying in the field, In view of this, the work of fabrication of such materials shall be properly synchronized as far as possible with the laying operations.

Fabricated materials such as manhole covers, appurtenances, bolts, nuts, distance pipes, flanges, saddles, collars bypass arrangements etc. shall be transported to the site of laying from the fabrication shop according to the needs of the laying operations only.

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

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.

2.11 Handling

It is essential to avoid damage to the pipes, fittings and specials 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 manl1facture until they are laid and jointed. The Contractor shall provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction

of the Engineer. 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.

Coated pipes and specials that are to be stored on supports shall bear on the uncoated ends only. If bearing on coating is employed the supports shall be not less than 200 mm wide and so arranged to prevent damage to the coating.

During handling of the pipes and fittings, coating shall be protected not less than 200 mm wide and placing strips of heavy belting or other approved sheet materials not less than 200 mm wide under all ropes or fastening.

2.12 Dents and damage

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. Cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe shall remove all dents exceeding 2 percent of the outer diameter 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.

2.13 Cutting of pipes

The cutting of pipe for inserting valves, fittings, etc, shall be done in a neat and workman like manner without damage to the pipe or lining so as to leave a smooth end at right angles to the axis of the pipe. **Methods of cutting**

By hacksaw

Hand or Power operated hacksaw should be used with blades having teeth at a pitch of 1 mm.

By manually operated wheel cutter

The type of cutting wheel used for cast iron pipes is not suitable for ductile iron pipes. Special Wheels, as used for cutting steel pipes shall be used and cut ends are trimmed with a file.

By pipe cutting machine

Machines with cutter heads or abrasive wheels shall be used. Cutter head should have a front rake angle of 7º as used for steel pipes.

2.14 Pipe laying

Unless specified otherwise, the pipeline shall be erected on saddles or laid on granular bedding. Only material approved by the Engineer shall be used. The Contractor shall equip himself with all necessary tools, machinery, labour etc. required for the purpose.

No work shall be done in the absence of Contractor's Engineer, either during the daytime or at night.

The components of the pipe work have been so designed that the corresponding joints, holes, edges etc shall coincide at the mean temperature. All works such as fixing flanges, base plate etc. in true alignment and in correct position and tack welding pipes shall therefore be done at the mean temperature. The temperature shall be ascertained by means of mercury cups fixed to the pipe shell from outside and thermometers of the required type and range.

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.

Pipe laying for river/canal crossings shall generally start from the fixing points on either side, the expansion joints being provided last. Fixing points shall be at all anchor blocks.

The owner shall construct anchor blocks before commencing the pipe laying work in any section. The construction of the blocks shall be carried out in 3 stages:

(a) The lower part up to 150 mm below the invert of the pipeline, including concrete support chairs, shall be constructed;
(b) The pipeline on this part of the block shall be laid;
(c) The remaining block around and over the pipeline shall be constructed.

The saddles along with the embedded stainless steel plate 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 Contractor shall determine the method of jointing the pipes and erecting them on previously cast reinforced concrete saddles.

The pipe strakes shall be assembled in position on the saddles by the 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 pipe1jne 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 5.00 PM. 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.

Where specified, a granular bedding of the required thickness and level shall be provided below the pipe prior to laying the pipe in the trench. The bedding shall be compacted with a light hand rammer, and any reduction in thickness due to compaction shall be made up by adding sand during ramming.

Pipes should be lowered into the trench with tackle suitable for weight of pipes. For smaller sizes, up to 250 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes, either a well designed set of shear legs or mobile crane should be used. When lifting gear is used, the positioning of the sling to ensure a proper balance should be checked when the pipe is just clear of the ground. If sheathed pipes are being laid, suitable wide slings or scissor dogs should be used.

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 made

to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc.

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 blankflanging in the open ends of the pipeline and filling the pipeline with water etc. shall be taken up as directed by the Engineer.

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.

The progress of pipe laying shall follow the detailed programme submitted by the Contractor with his bid and confirmed and updated at the start of construction. The Contractor shall programme his activities such that the laying of pipes follows closely the manufacturing schedule and no pipes remain stacked in the factory or at Site for a period of more than two months.

2.15 Fixing expansion joint

The work of laying pipeline as a rule 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)

a) 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.

b) The expansion joints are normally supplied without packing. The normal length of the expansion joint shall be reduced by about 100 mm by cutting the inside locks, and inserting the inner strake

by means of turnbuckles. At mean temperature this expansion joint shall be inserted inside the gap (care being taken to keep the tapered portion on the down-stream side), and both ends shall be tack welded to the pipe ends, after pulling the expansion joint. (Tacks of these two joints shall be of longer length. approximately 100 mm long).

c) Welding of these two joints of the expansion joints shall be started only after it is ascertained by taking observations that the expansion joint is functioning properly. The procedure to be followed for taking observations is given in item (2.21.4) of this clause.

d) Case when ‘Y' plus 'Z' is less than. Xi (i. e. fixing of expansion joints with strap):

   i. 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.

   ii. 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.

   iii. 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.

   iv. 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.

   v. 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.

e) Observations

   i. 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.

ii. 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.

iii. 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.

2.16 Backfilling trenches

The trench shall be filled with selected material up to 300 mm above the pipes. This backfill shall be provided in layers not more than 150 mm, with a density more than 95% of standard proctor density. Samples shall be tested as directed by the Engineer. The remaining depth of trenches shall be filled with ground backfill material.

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. 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, 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 will not be permitted unless the trench has been filled to height of at least 300 mm over the top of the pipe except as may be necessary for tamping etc. during backfilling work. The backfilling shall be done in accordance with Specifications given elsewhere in this report.

To prevent buckling of pipe shell of diameters 1200 mm and above, pipes shall be strutted from inside while the work of refilling is in progress, for which no separate payment shall be made. For pipelines of diameters below 1200 mm strutting shall be done from inside at either end of the stretch of the pipeline under refilling, by means of strong spiders which shall be sufficiently stiff to resist all deformation for which no extra payment will 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 2 m.

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

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

Regular measurement of the field dry density shall be taken by the Contractor at various levels in the backfilling as required 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.

2.17 Field hydraulic test

After erection at site and after the Concrete anchor blocks have been constructed but prior to internal painting, the entire pipeline shall be subjected to a hydraulic test as follows:

a) The test pressure shall be minimum of 1.5 times the working pressure, but not to exceed a pressure that would result in a stress greater than 80% of the yield point.

b) The pressure test shall be conducted in dry weather with pressure held constant for 24 hours to observe whether any pressure drop takes place. The test pressure shall be gradually raised at the rate of 0.1 N/Sq.mm per minute. A leakage of 0.1 litre per mm diameter of pipe per kilometer length per 30 m head test pressure per 24 hours is allowed if the test pressure is maintained by pumping. Any leakage beyond that specified herein above shall be rectified to the satisfaction of the Engineer.

c) 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. The Contractor at his own cost shall carry out repairs and replacements and further testing including the cost of the plates and other raw materials.

2.18 External coating

a) Zinc coating

Pipe surface condition

The pipe surface shall be dry and free from rust or any non-adhering particles or foreign matter such as oil or grease. Metallic zinc shall be applied on to the oxide external surface of the pipe.

Materials

The coating materials are metallic zinc with content of at least 99 percent by mass.

Method of application

The metallic zinc coating shall be applied by a spraying process in which metallic zinc material is heated to a molten state and projected in small droplets by spray guns onto surface. The zinc rich paint coating shall be applied by a spraying or a brush process onto the pipe surface in case of repair only.

Coating characteristics

The metallic zinc coating shall cover the outside diameter of the pipe and shall be free from such defects as bare patches or lack of adhesion, Damaged areas or zinc coating caused by handling arc acceptable provided that the damage is less than 5 cm^2/m^2 of coated Surface and provided that the minor dimensions of the damaged area do not exceed 5 mm.

Zinc coating mass

The average mass of zinc coating shall be not less than 130 g/m^2 with a local minimum of 110 g/m^2. **Determination of zinc coating**

Manufacturing process control system shall specify the frequency of this test. A rectangular token is attached along the pipe axis before passing it through the zinc coating equipment, after coating and trimming the minimum token sizes shall be either:

a) 250 mm x 100 mm, or
b) 500 mm x 50 mm.

Repairs of the zinc coating

Areas left uncoated, for example under the test token and coating damaged in excess of 5 cm^2/m^2 or coating shall be repaired by either:

a) A metallic zinc spray.
b) By application of zinc rich paint containing more than 90 percent zinc by mass in the dried film: mean mass of the applied paint shall not be less than 150 g/m^2.
c) Flanges of welded flanged pipes and welded parts of the flanges shall be coated with zinc rich paints (90 percent).

Finishing layer

After metallic zinc coating or zinc rich paint coating the pipe shall be given a finishing layer of bituminous paint or synthetic resin compatible with the zinc coating. Application of this finishing layer may be done by any proven process such as spraying or brush coating at the manufacturers choice. It shall uniformly cover the zinc coating and be free from bare patches or lack of adhesion. The mean dry film thickness of the finishing layer shall not be less than 70~m with nowhere less than 50 µm

b) Bituminous coating

General

Unless otherwise agreed between the purchaser and Manufacturer, all pipes shall be coated externally and internally with the same material, (Bituminous coatings are either hot applied or cold applied,)

General characteristics

Coating shall not be applied to any pipe unless its surfaces arc clean, dry and free from rust.

Unless otherwise agreed between the purchaser and the manufacturer all pipes shall be coated externally and internally with the same material. The method of coating shall be as per usual practice of the manufacturer. The coating material shall set rapidly with good adherence and shall not scale off. The mean thickness of the coating shall be not less than 70 µm and the local. Minimum thickness shall be not less than 50 µm.

Where the coating material has a bitumen base, it shall be, smooth and tenacious and hard enough not to flow when exposed to a temperature of 65°C but not so brittle at a temperature or 0°c as to chip off when scribed with a penknife.

When the pipes arc to be used for conveying portable water the inside coating shall not contain any constituent soluble in such water or any ingredient which could impart any taste or whatsoever to the portable water after sterilization and suitable washing of the mains.

Pipes with or without sockets and flanges, which are imperfectly coated, or where the coating does not set or conform to the required quality, the coating shall be removed and the pipes/flanges recoated.

c) Polyethylene sleeving

Material

Characteristics

The material used for making the film is polyethylene or a mixture of polyethylene or a mixture of polyethylene and /or ethylene and olefin copolymers.

Its density shall be between 910 and 930 kg / m^3

Additives and impurities

If protection against ultra – violet rays is required, the material shall be stabilized by the addition of an appropriate product: if carbon black is used for this purpose the addition shall be in the range of 2 to 3 percent by mass.

Dimension

Width

The normal flat width of the tube or flat or flat sheet is specified in Table 34.

Thickness

The normal thickness of the sleeving shall be not less than 200 µm and not more than 250 µm unless otherwise agreed.

The negative tolerance on the nominal thickness shall not exceed 10 percent.

If necessary, it is permitted to use thicker sleeving or double sleeving.

Mechanical properties

Tensile strength of the film in the longitudinal and transverse direction shall not be less than 8.3 MPa.

Elongation

The elongation at fracture of the film in the longitudinal and transverse directions shall not be less than 300 percent.

Dielectric strength

The dielectric strength of the film should be 31.5V/µm minimum.

Documental Transmittal	
Project No : Contract No : Project Title :	Transmittal No : Transmittal date :
Forwarded To	**Action Codes**
Attn : CC :	1: For Review & Comment 2: For Review & Approval 3: Approved for Construction 4: For Information Only 5: As Built 6: Final Document (Project Dossiers) 7: Signature 8: Others

Sl. No.	Drawing/ Document Number	Rev.	Issue Date	Set	Drawing/ Document Description	Document Code

Remarks:

Name	Designation	Signature	Date

Please acknowledge Receipt of the above document by returning a copy of this form duly signed

Received by (Name)	Position / Title	Signature	Date

Appendix -4: Quality Management System Feedback Form

Mahindra WORLD CITY Jaipur

Quality Feedback No.
Feedback to procedure Custodian:-
Date:
Issued by:
Please acknowledge receipt of this document by return. Name: Date:
Reply:-
Issue date:
Issued by:
Issue approved by:
Actions arising:

Annexure B

List of approved makes

(The following makes for the products mentioned or equivalent to the products shall be strictly considered for quoting the prices. If the contractor wishes to suggest equivalent product then the contractor should get prior approval from the Employer after submitting the details of the product, manufacturer details, and advantages for proposing the particular make. The Employer may accept or reject the same and the contractor should adhere to the Employer's decision)

Sl. No	Equipment	Approved makes	
1	Ductile Iron Pipes & Fittings	Lanco	Kiswok
		Electrosteel	Jindal Saw
2	HDPE Pipe & Fittings – PE 100	Jain	Dura-Line
		Kisan.	Supreme
		RADIANCE	Godavari
3	MS ERW Black Pipe & Fittings	Jindal.	Swastik Pipe
		PSL	
6	RCC hume pipe Local make	Bharath Spun Pipe	Sri Rashi Spun Pipes
7	Ball Valve/Gun metal valve	VAG-Valves	Kirloskar
		Amco	Sant Valves
		Audco.	Leader

Sl. No	Equipment	Approved makes	
8	C.I Sluice Valve / Butterfly Valve/ Scour valve	VAG-Valves	Kirloskar
		Amco	Sant Valves
		Leader	Bikaner Engineering or Equivalent

9	AIR Valve	VAG-Valves	Kirloskar
		Sant Valves	Amco
		AM Flow Technologies.	C.R.I.
10	Water Meter/Flow meter	Itron India	Sant Valves
		Teleflo	Kamstrup
11	Check Valve (NRV)	VAG-Valves	Kirloskar
		Sant Valves	Amco
		Audco	Leader
		Advance	Zoloto
12	Level Indicator - Tank	Teleflo	
13	Leak Detection – D System	Detector India	
14	Strainer	Sant Valves Pvt. Ltd.	Leader
		Zoloto	D. S. Engineers
		Trishul Valves	
15	Saddle	Leader	VK Valves
		Jain	
16	Ferrules	Leader	Jain
		Dura-Line	
17	Dismantling joints	Anant Engineering & Fabricators	Bikaner Engineering
		Bharat	