

**BRIHANMUMBAI MUNICIPAL  
CORPORATION**  
**WATER SUPPLY PROJECTS DEPARTMENT**



**VOLUME-II**  
**STANDARD SPECIFICATIONS FOR**  
**WATER SUPPLY PROJECTS DEPARTMENT**  
**2023**

**GENERAL NOTES****A. COMMON GENERAL NOTES**

1. The schedule of rates will be operative from 01-02-2023.
2. The unified schedule of rates includes following department:
  - i. Buildings
  - ii. Water Supply Projects
  - iii. Hydraulic Engineering
  - iv. Sewerage Projects
  - v. Storm Water Drainage
  - vi. Roads
  - vii. Bridges
  - viii. Traffic and Signals
  - ix. Mechanical and Electrical
  - x. Garden Works
3. Volume-I contains USOR, basic rate list and Suggested makes and Volume-II contains specification along with drawings wherever necessary and mandatory tests.
4. The specification of the items shall be as per latest Indian Standard Codes unless otherwise specified.
5. The rates of the items in this schedule of rates are worked out assuming average lead for Greater Mumbai area for all sorts of materials.
6. The rates are inclusive of transportation, duties, taxes and charges of all Government, Municipal or any other statutory body, applicable from time to time but exclusive of GST & Labour Cess levied by Government of Maharashtra.
7. The rates also includes Overheads @ 5% and Contractor's Profit @10% which is inclusive of labour supervision charges, tools and plants. The rates of items in USoR shall be increased to 5% for inaccessible areas, remote sites outside Greater Mumbai and areas subjected to high security restrictions subject to prior approval.
8. Rates of common material and labour is attached in the Annexure-A in Volume-I.

9. As per the Government policy the use fly ash is done for framing the items of work in accordance with the latest provisions of IS Codes. Also green building items have been introduced in new schedule to minimize the consumption of energy during construction and occupancy of building and also maintaining ecological balance.
10. All materials shall be as per approved list of MCGM or equivalent material having quality standards as per relevant IS codes and shall be of first quality unless otherwise specified.
11. Rates given in SOR are for estimation purpose.
12. Rates of items and specification for excavation, concrete, plaster and brickwork shall be referred from common schedule unless and otherwise not mentioned in concerned department's schedule.

## 2.7 Buried Pipelines

### 2.7.1 Scope

This specification covers supply, fabrication, testing, delivery at site, laying, erecting and jointing of buried pipelines.

### 2.7.2 Applicable Codes & Specifications

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

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

1	AWWA	:	M11:1998	-	Steel Pipe - A Guide for Design and Installation
2	BS	:	639	-	Specification for Covered electrodes for manual metal arc welding of mild steel and medium tensile steel.
3	IS	:	62:1950	-	Graphite for Paints
4	IS	:	102:1962	-	Specification for Ready Mixed Paint, Brushing, Red Lead, non setting, Priming.
5	IS	:	269:1989	-	Specification for 33 grade ordinary Portland cement
6	IS	:	383:1970	-	Specification for coarse and fine aggregate from natural Source for concrete.
7	IS	:	432:1982(Part-I)	-	Specification for Mild Steel Medium Tensile bars and hard drawn steel wire for concrete reinforcement : Mild Steel and medium tensile steel bars
8	IS	:	432:1982(Part-II)	-	Specification for mild steel Medium Tensile steel bars and hard drawn steel wires for concrete reinforcement: Hard drawn steel wire.
9	IS	:	456:2000	-	Code for practice for plain and reinforced concrete.
10	IS	:	800:2007	-	Code of practice for general construction in Steel.
11	IS	:	808:1989	-	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections
12	IS	:	814:2004	-	Specification for Covered Electrodes for Manual Metal Arc Welding of Carbon and carbon Manganese Steel
13	IS	:	816:1969	-	Code of practice for use of Metal Arc Welding for General Construction in mild steel
14	IS	:	817:1992 (Part1)	-	Code of practice for Training and Testing of Metal Arc welders.(Manual Metal Arc Welding)
15	IS	:	817:1992 (Part2)	-	Code of practice for Training and Testing of Metal Arc welders.(Oxyfuel Welding)

16	IS	:	823:1964	- Code of procedure for manual metal arc welding of mild steel
17	IS	:	1182:1983	- Recommended practice for Radiographic examination of Fusion-Welded Butt Joints in steel plants.
18	IS	:	1566:1982	- Specification for hard drawn steel wire fabric for concrete reinforcement.
19	IS	:	1786:2008	- Specification for High strength Deformed Steel Bars and wires for concrete reinforcement
20	IS	:	2062:2011	- Specification for Hot Rolled Medium and High Tensile Structural Steel
21	IS	:	2074:1992	- Specification for Ready Mixed Paint, Air Drying, Red Oxide Zinc Chrome and Priming
22	IS	:	2595:2008	- Code of Practice for Industrial Radio-graphic Testing.
23	IS	:	2598:1966	- Safety Code for Industrial Radio-graphic Practice.
24	IS	:	2720:1983	- Method of test for soils
25	IS	:	3589:2001	- Specification for Steel pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter). Note: The provisions of various clauses of the above IS code are deemed to be applicable to diameters above 2540mm as well.
26	IS	:	3600:1985 (Part -1)	- Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel: Cruciform fillet weld tensile test
27	IS	:	3600:1985 (Part-2)	- Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel: Beam Impact (charpy v notch) test
28	IS	:	3600:2009 (Part-3)	- Destructive test on welds in metallic materials :Transverse Tensile Test
29	IS	:	3600:1984 (Part-4)	- Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel. (Longitudinal Tensile stress on cylindrical weld metal test pieces on butt welds)
30	IS	:	3600:1983 (Part-5)	- Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel. Transverse root and face bend test on butt welds
31	IS	:	3600:1983 (Part-6)	- Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel. Transverse side and bend test on butt welds
32	IS	:	3600:1985 (Part-7)	- Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel. Longitudinal root and face bend test on butt welds

33	IS	:	3600:1985 (Part-8)	- Code of Procedure for Testing of Fusion Welded Joints and weld-metal in steel. Nick break test and fillet weld fracture test
34	IS	:	3600:1985 (Part-9)	- Code of Procedure for Testing of Fusion Welded Macro and Micro Examination
35	IS	:	3613:1974	- Acceptance tests for wire flux combinations for submerged arcwelding.
36	IS	:	3658:1999	- Code of Practice for Liquid Penetrant Flaw Detection.
37	IS	:	3664	- Code of Practice for Ultrasonic Pulse echo testing by contact and immersion methods
38	IS	:	4353:1995	- Recommendation for Submerged Arc Welding of Mild Steel & Low Alloy Steels.
39	IS	:	4853:1982	- Recommended Practice for Radiographic Examination of Fusion Welded Butt Joints In Steel Pipes.
40	IS	:	5334:2003	- Code of practice for Magnetic Particle Flaw Detection of Welding.
41	IS	:	5822:1994	- Code of Practice for Laying of Electrically Welded steel pipes for water supply. <i>Note: The provisions of various clauses of the above IS code are deemed to be applicable to diameters above 2540mm as well.</i>
42	IS	:	6419:1996	- Welding Rods and Bare Electrodes for gas shielded arc welding of structural steels
43	IS	:	6631:1972	- Steel pipes for Hydraulic Purposes.
44	IS	:	7280:1974	- Specification for Bare Wire electrodes for submerged arc welding of structural steels.
45	IS	:	7307:1974	- Approval tests for welding procedure
46	IS	:	7310:1974	- Approval Test for welders working to approved welding procedures
47	IS	:	7343:1986	- Code of practice for ultrasonic Testing of Ferrous Welded Pipes and Tubular Products.
48	IS	:	8041:1990	- Specification for Rapid hardening Portland Cement.
49	IS	:	10221 : 1982	- Code of practice for coating and wrapping of underground mild steel pipelines
50	IS	:	10234 : 1982	- Recommendation for General Pipeline Welding
51	IS	:	12089:1987	- Specification for granulated slag for the manufacture of Portland slag cement

52	IS	: 12330:1988	- Specification for Sulphate Resisting Portland Cement.
53	ISO	: 9001:2008	- Quality Management Systems –Requirements
54	ISO	: 14001:2004	- Environmental management systems –Requirements with guidance for use.
55	OHSAS	: 18001	- International Occupational Health and safety standard

### 2.7.3 Materials

a) Steel Plates - The steel plates for pipes, fittings, specials and stiffeners shall be of mild steel conforming to IS 2062:2011. All the materials shall be procured from reputed manufacturers such as JINDAL, SAIL, ESSAR, ISPAT, TISCO.

b) Welding consumables - such as electrodes, filler rods and wires shall conform to IS 814:2001, IS 3613:1974, IS 6419:1996 and IS 7280:1974.

c) Ultrasonic Testing of welded joints : Ultrasonic Testing to be carried out as per IS 3664 and it should satisfy testing criteria specified in IS 7343:1986

d) Cement - The cement used shall be of one of the following :

i) Ordinary Portland Cement conforming to IS 269:1989

ii) Ground granulated blast furnace slag cement conforming to IS 12089:1987

iii) Sulphate Resisting Portland Cement Conforming to IS 12330:1988

e) Aggregate - The aggregates shall conform to IS 383:1970

f) Water - The water used in preparation of concrete mix shall conform to the requirements of mixing water given in IS 456:2000

g) Steel for Reinforcement shall conform to IS 1786:2008

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

When requested by the Engineer, the Contractor shall supply, free of charge to the Employer, for testing in approved laboratory, suitable sample of the materials to be used / used in the works. The cost of such tests shall be borne by the Contractor and shall be included in his item rates.

The contractors shall provide sufficient separate stacking yard for the steel materials, fabricated pipes, and specials scrap in their factory as per the requirements. Size of plates will be measured in millimetres.



The Contractor shall procure plates and other structural steel required for fabricating pipes / specials considering the wastage / scrap etc. and rate quoted shall be inclusive of wastage / scrap etc. The Contractor should note that no claim will be considered on account of scrap wastage / scrap etc.

#### 2.7.4 Inspection

All works and material under specification will be rigidly inspected during all phases of manufacture and testing and such inspection shall not relieve the Contractor of his responsibility to furnish materials and perform work in accordance with this specification.

Contractor shall make arrangements for mill and shop inspection by Employer's Engineers.

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

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

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

The Contractor shall supply free of cost required specimen of materials for testing by the owner at any time during the progress of work and shall bear the cost of all such tests or re- tests to the satisfaction of Engineer.

#### 2.7.5 Manufacture of Pipes

##### General

All pipes and specials shall be manufactured out of steel plates which shall be free from any cracks, surface flaws, laminations, excessive pitting or any other defects. The pipes shall be truly cylindrical and straight in axis. The ends shall be accurately cut and prepared for field welding. The external circumference of the pipe pieces which are to be fixed adjacent to flange adapter/dismantling joint with fixed outer diameter shall not deviate from theoretical one by more than 1mm. To obtain the accuracy the pipe shall be rolled several times, if necessary, as pipe pieces should be truly cylindrical. The external longitudinal welding of this pipe shall be ground smooth flush with surface to the satisfaction of the Engineer. No extra cost shall be charged by the Contractor for this grinding work.

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



### Fabrication of Pipes

The Contractor shall get the fabrication work done in a duly valid licensed factory of his own or that of a nominated sub-contractor. The fabricator shall have all valid licenses for their factory as required by the local authorities/govt bodies. The fabricator shall furnish a list of their staff with qualification and experiences.

Necessary certificate in support of performance mentioned in the tender shall be enclosed in this bid. The factory shall be ISO 9001:2008, ISO 14001:2004 and OHSAS 18001 approved. This factory meant for fabrication pipes, specials etc. shall also be involved with testing etc., machining as well as painting. For completing the work under the present contract within the contract period, the factory shall be equipped with adequate number of following equipment and plant but not restricted to:

- i) Plate bending machines for rolling of pipe drums
- ii) Automatic welding machines suitable (suitable for circumferential as well as longitudinal welding).
- iii) Hydraulic Testing Machines
- iv) Travelling gantry or crane of suitable capacity
- v) Mobile cranes for loading/unloading of plates, pipes etc.
- vi) Lathe for machining of the flanges rings, plates and expansion joints.
- vii) Channel bending machine of adequate capacity for manufacturing ring girders.
- viii) Equipment for sand blasting and applying paint by spray gun.
- ix) Equipment for cold pressing of plates upto 50 mm thick to the required curvature (domes, plug plates, M.H. cover etc.
- x) Fully equipped in-house laboratory to carry testing such as bend test, tensile test, Ultrasonic test, Welded Joint Test etc. The laboratory shall possess a universal testing machine for testing mechanical properties, Ultrasonic testing machine with all supportive infrastructures. All the tests shall be conducted in-house in the presence of Municipal staff.
- xi) Any other, considered necessary for carrying out the work covered in scope.

The factory shall have adequate area, and shall also have stacking yard for the stacking of plates, structurals, fabricated pipes etc. and the scrap.

The Bidder shall furnish with his bid the details of the factory where he intends to get the fabrication done, such as it's location and the equipment, plant and other facilities available in the factory for the manufacture of Pipes and Specials required under this contract.

Specials and other fabricated items shall include the following:

- A- One piece degree cants, composite bends, pipe, pieces with fixed outer diameter.
- B- Tapers-concentric and eccentric i.e. level invert tapers.
- C- Expansion joints with protective cover
- D- Ring girder and stiffener ring channels

- E- Ring girder supports, rollers, bridge box covers or rollers
- F- Saddle pieces
- G- Stiffener Rings
- H- Pressure and non-pressure blank flanges
- I- Ladders
- J- Platforms scour valves, air valves, expansion joints
- K- Protective covers for scour valves, air valves, etc
- L- By-pass assembly
- M- Tee branches
- N- Y branches- symmetrical as well as unsymmetrical
- O- Dish closures such as domes
- P- Dish closures such as flat and dished manhole covers
- Q- Flange rings
- R- Plug Plates
- S- Any odd size or shape specials not covered by above items.

#### Cutting Plates to Size

The plates shall be indented in such length as to have minimum wastage and so as to make the drums with one longitudinal joint. Contractor shall note that pipes up to the size of 3500mm diameter shall have one longitudinal joint and for pipes above 3500mm and up to 5400mm the contractor will be permitted to have more than one longitudinal joint.

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

The plates shall be cut on all four sides to the exact dimensions and shape required, by a suitable plate cutting machine such as oxy-acetylene cutting machine or a guillotine. Plates shall be cut accurately to the required length with a tolerance of not more than plus or minus 3mm in length and width. The plates shall be given a bevel at the edges wherever necessary, depending upon the type of welding machine to be used by the contractors. The ends of the finished pipe in the factory shall necessarily have bevel edge or v edge with or without shoulder cut/root face to facilitate hand welding in the field. As field welding is to be carried out from inside in the case of bigger diameter pipes i.e. 1200mm and above the bevel for them shall be usually from inside. For pipes of smaller diameter, field welding shall be done from outside and the edges as a rule have bevels to suit welding from outside. The Engineer may at his discretion make changes, in this respect and order external bevelling for bigger pipes and internal bevelling for smaller pipes. Where the automatic welding machines in the factory have sufficient penetration, the edges of the plate shall have a square cut. The type of joint to be adopted in the factory shall depend upon the welding machines and the

method of welding to be adopted. Details such as current, voltage, flux, etc shall be decided after carrying out experimental welding and testing the samples cut out of it. The entire costs of all such preliminary experiments shall be borne by the contractors.

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

#### Rolling of Plates

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

#### Tacking the Drums

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

#### Assembly of Drums into Pipes

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

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

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

#### Welding

All components of a standard pipe shall be welded, wherever possible by use of submerged arc welding machine for full welding. The circumferential as well as longitudinal joints shall be welded on this machine. Hand welding shall not be permitted except for sealing runs and such other minor works at the discretion of the Engineer. The strength of the joint shall be at least equal to that of the parent material.

The Contractor shall use electrodes of approved make and size, the size depending on the thickness of plate and the type of joint. It shall also use with standard current and arc voltage required for the machine in use with such modifications as may be found necessary after experimental welding. For this purpose, samples of welded joints shall be prepared and tested in the presence of the Engineer. The values once determined shall be maintained throughout the work and if any modifications are to be made, a written permission of the Engineer shall be obtained. In the case of thin sheets, electric arc welding may not give satisfactory results and gas welding shall be resorted to. Gas welding shall be subject to the same specifications and tests as those for electric welds.

The list of approved vendors for electrodes is as given below:

- a) Advani-Orlikon Ltd.
- b) Anand arc electrodes pvt. Ltd.
- c) D&h secheron electrodes pvt. Ltd.
- d) Esab india ltd.
- e) Honavar electrodes ltd.
- f) Mailam india ltd.
- g) Modi arc electrodes co.
- h) Weldcraft pvt. Ltd.
- i) Gee limited, Thane.

All the shop and field joints shall be welded, all welding shall conform to the requirements of IS 823: 1964 and IS 4353:1995.

All longitudinal and circumferential joints shall be double welded butt joints. Due to non-accessibility of both side welding, field girth joints shall be accomplished using back up plates. All circumferential welds involving plates of unequal thickness shall be so kept that the inside surfaces of plates match to provide stream lined joints without alteration in the internal diameter. As far as practicable, welding of dissimilar thickness of shells shall be carried out in the shops.

The welding shall be of the best workmanship free from, flaws, burns, etc. and the Contractor shall provide for his own, electrodes and equipment, ovens to keep the electrodes at the desired temperatures and dry. In order to maintain a good standard in welding, welders shall be tested by the Contractor before they are entrusted with the job. Qualification standard for welding procedures, welders and welding operation shall conform to the requirements of IS 7307:1974 and IS 7310:1974. Periodical tests as regards their efficiency shall also be taken at an interval of about 6 months and those found inefficient shall be removed from the job; only those who pass the test, shall be posted on the job. If an incompetent welder has already welded some pipes, all welding done by him previously shall be fully, checked by X-ray in addition to the regular X-ray inspections. The defects if any, shall be set right to the satisfaction of the Engineer. All such check tests and rectification of defects shall be entirely at the cost of the Contractor. No pipes or steel sections shall be erected unless the work of the welder concerned has been proved to be satisfactory. Site welds shall be done by specially selected welders.

The welded joint after welding should not become brittle or sensitive to blows and there should be no loss of toughness due to welding or heat treatment. The material after welding and heat treatment is to be tougher than the base metal, and is to retain its original ductility. No allowance will be made for thinning of weld and the weld should in no point be less than the nominal thickness of plate.

Upon receipt of the order and prior to the start of fabrication, the Contractor shall submit to the Engineer for his approval the "welding procedure" he intends to use in the shop work. Similarly, prior to the start of the field welding, procedure for the field welding must be submitted to the Engineer for his approval. Manual welding shall be adopted for specials only.

#### Fabricating of Specials in Fabrication Shop

Specials, such as tees, Y-Pieces, bends, tapers, dished ends shall necessarily be in steel and shall be manufactured as per standards and tested in the same manner as the pipe. Small branches, single piece bends, etc. may be fabricated at site, care being taken to ensure that the fabricated fittings have the same strength as the pipeline to which they are to be joined.

#### Pre-heating of Plates

The metal adjacent to weld shall be preheated where thickness of plate exceeds 32 mm but less than 38 mm so as to reduce the cooling rate of welding, to obtain tough deposit of metal and to prevent development of cracks.

#### Thermal Stress Relieving

All heavy and rigid parts, specials such as shell piece with manholes, when the nominal thickness of the plates is more than 38 mm and when the welded joints connect plates of

different thicknesses they shall be thermally stress relieved. Stress relieving shall be done in a suitable furnace. Where this is not possible then stress relieving may be done by induction coil heating method. No stress relieving for joints in steel pipes is required where thickness of plates is 32 mm or less. For thicknesses between 32 mm and 38 mm, the joints shall be pre-heated before welding as stipulated in IS 5878 part-6.

#### Tolerance

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

Machined parts shall be within the following limits:

- a) For mitred finished surface = + 20 minutes of arc
- b) For elbow angles = + 20 minutes of arc
- c) For length of elbow pieces = + 6 mm

Straight pipes shall have their faces perpendicular to the axis of the section with a maximum deviation of 2 mm on either side of the plane.

There shall be no negative tolerances on specified thicknesses of various types of steel materials used for this work.

#### Shop Testing

After fabrication, but before application of protective coatings all pipes shall be subjected to a shop hydraulic test as per IS3589:2001. All Specials on which shop hydraulic test cannot be conducted shall be tested using NDT methods as per IS3589:2001. Standard lengths of pipes shall be directly subjected to test and non-standard pipe and elbows can be tested as standard pipe before being cut to size.

The test pressure shall ensure that the plate material is stressed to 60% of the minimum yield strength and at least 1.5 times the allowable working pressure as specified by the Engineer. Each pipe shall be filled with water and the pressure slowly and uniformly increased until the required test pressure is reached.

The pipe to be tested shall be given a serial no. which shall be painted on its inside together with details such as pipe No. Shell thickness, diameter, length etc. as directed. The markings shall be done at four locations - two inside the pipe and two outside the pipe. A fifth marking shall be done with hard punch on the pipe surface externally. It shall be entered in the register to be maintained by the Contractor.

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



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

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

The pressures shall be applied gradually by approved means and shall be maintained for at least 10 minutes or till the inspection of all welded joints is done during which time the pipe shall be hammered throughout its length with sharp blows, by means of a 1 kg. hand hammer. The pipe shall withstand the test without showing any sign of weakness, leakage, oozing or sweating. If any leak or sweating is observed in the welded joints, the same shall be repaired by gouging and re-welding after dewatering the pipe. The repaired pipe shall be retested to conform to the specified pressure.

If any leak or sweating is observed in pipe shell the pipe under test shall be rejected temporarily. The Contractor shall stack such rejected pipes separately in his yard. The Engineer, shall inspect the same and after taking cuts if necessary, shall determine the nature of repairs to be carried out thereon and shall then decide as to how and where they shall be used. No payment shall be made for handling or carrying out repairs, but, payment for the fabrication and hydraulic testing of the pipe shall be released only after acceptance of the pipe with necessary repairs and subsequent testing etc. are carried out by the Contractor to the satisfaction of the Engineer. The Engineer shall be supplied with two copies of the results of all the tests carried out. Pipes will not be allowed to be dispatched to laying site without hydro-testing. Any failure to comply with this may cause the contractors payment to be withheld.

#### Submission of Daily Progress Report

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

#### 2.7.6 Transportation of Pipes and Specials

All pipes and specials fabricated in the factory and temporarily stacked in the Contractor's yard shall be transported to the site of laying after cleaning them internally etc. The item of transport covers the cost of loading in the factory, transporting to 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 contrivances to be used for unloading will be different in different situations and in each case the one approved by the Engineer shall be adopted. The material stacked at site shall be jointly inspected by the Engineer and the contractor and defect or damage noticed shall be repaired to the satisfaction of the Engineer before payment is made.

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, shavings of steel plates can be utilised 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 'T' branches and other complicated items, 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 synchronised as far as possible with the laying operations.

Pipe handling equipment shall be maintained in good condition and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded. Under no circumstances shall pipes be dropped, be allowed to strike one another, be rolled freely or dragged along the ground. No defective/damaged pipe shall be used in the works without rectification to the satisfaction of the Engineer.

No separate payment shall be made for transport of pipes and specials and cost of transport shall be included in the relevant items of Bill of Quantities for fabrication work.

#### 2.7.7 Procedure For Receiving Steel Pipes and Specials

##### 2.7.701 General

To ensure that the work of erecting pipes is not held up at any stage and place, the Contractor shall maintain an adequate stock of standard specials, flange rings, plug plates, manhole covers, etc. and short length of smaller diameter pipelines, etc. at site in his field stores, in consultation with the Engineer. Wherever possible, the Contractor shall arrange one full month's requirement of pipes, specials, etc. stacked along the alignment.

#### Stacking of pipes etc. and inspection

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

#### Handling of pipes, specials

It is essential to avoid damage to the pipes, fittings and specials, etc. or their coatings at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their surface treatment. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas or equally non-abrasive materials of suitable width of special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes to prevent damage to the coating. Great care shall be taken in handling the pipe right from the first operation of manufacture until they are laid and jointed. The Contractor will provide temporary props in order to prevent any sagging of the pipes while they are stacked in their yard and while transporting to the site of delivery, i.e. laying. The props shall be retained until the pipes are laid. If at any time these props are found to be dislodged or disturbed, the Contractor shall immediately reinstate them in such a way that the true shape of the pipe shell or specials is maintained to the satisfaction of the Engineer. 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. No separate payment shall be done for the use of props.

#### Dents

Whenever any dent, i.e. a significant alteration of the curvature of the pipe shell is noticed, the depth of the dent shall be measured between the lowest point of the dent and the pipe shell curvature line. All dents exceeding 1 percent of the outer diameter of the pipe shall be removed by cutting out a cylindrical portion of the pipe and replacing the same by an undamaged piece of the pipe. The Engineer may permit insert patching if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

### Marking

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

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

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

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

A register shall be maintained in suitable proforma 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 | f) Maximum test pressure tested                             |
| g) Details of test | h) Details of radiographic performance examination of welds |
|                    | i) Name of Engineers representative witnessing tests        |

A copy of these details shall be furnished to the owner free of cost.

No separate payment will be made for these markings and the rates for the items concerned shall be deemed to include the cost of such markings.

### Extra Cutting and Welding

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 other fabrication items of the Bill of Quantities. Such special jobs shall be paid for separately, under relevant items.

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 to see that the shape of the materials cut, is not deformed in any way at the time of cutting.

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) during the process of welding. Cleaning of pipes shall be as given earlier.

### Gas Cutting

In the course of the work, the Contractor may be called upon to cut steel pipes, specials, etc. on site. Gas cutting shall be adopted for preparing on site, distance pieces, straps, etc. cutting out holes in the pipeline laid for manholes, scour valves, air valves and other appurtenances, holes required for blast cleaning operation, cutting of pipe faces to form kinks or bends, holes required for by-pass arrangement.

The rate for gas cutting shall include chamfering for forming 'V' or square cut, cost of aligning, holding member in position, etc., and shall cover thickness upto 25 mm.

After cutting, the edges shall be made smooth and even, by using electrical or pneumatic grinder so as to remove all inequalities. Care shall be taken to see that the item is not deformed in any way at the time of cutting. The ends of the pipe shall have bevel edges or 'V' edges to facilitate hand welding. As field welding is to be carried out from inside in the case of pipes of diameter 1200 mm and above, the bevel shall be from inside. For pipes of smaller diameter, as field welding has to be done from outside only, the edges of pipes shall have bevels to suit the above.

#### Blank Flanges

Blank Flanges shall be provided at all ends left unattended for the temporary closure of work, and also for commissioning a section of the pipe line 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 shall be suitably designed as per Engineer's requirement shall be provided.

#### Stiffener Rings

The stiffener rings shall have to be provided wherever directed. The contractors shall weld the same to the pipes with one circumferential run on each side. The pieces of the rings shall also be welded to each other as directed.

If the stiffener rings are fixed in position after the pipes are lowered into the trench, the welding of the stiffener rings shall be carried out in the same welding pit excavated for the field joints and therefore no extra payment will be made for the excavation of the pit for welding of the stiffener ring.

Stiffener rings shall be paid on MT basis and welding under relevant item for field welding.

#### 2.7.710 Straps

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 300mm in length. Straps shall also be provided as per the procedure of fixing expansion joints by the method described in clause 2.8.6 under "Above-Ground Pipelines". Such straps shall be fabricated in the fields by cutting pipes, slitting them longitudinally or 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 its outside

diameter of the pipe to be connected. A minimum lap of 80mm on either ends of the pipe shall be kept and fillet welds shall be run both internally as well as externally for circumferential joint. In case of pipes 900mm dia and below internal fillet weld may not be provided if so permitted by the Engineer. The longitudinal joints of the collar shall be butt- welded. All fillet welds shall have a throat thickness of not less than 0.7 times the width of weldings.

#### 2.7.8 Radiography of Welded Joints

##### 2.7.801 General

Shop welds in pipes, specials shall be radiographed as per requirements mentioned below : As soon as practicable, after welding is done minimum 15% (fifteen percent) length of the weld at random for each pipe shall be radiographed, to detect welding defects as per the requirement of IS 2598:1966 and as directed by the Engineer. This 15% sampling will be at random but ensure 100% coverage of junctions of longitudinal and circumferential joints. If the results of such radiography fail to conform to the requirements, the Contractor shall carry out as directed additional or 100 percent radiography test for the pipe at the Contractor's cost to the satisfaction of Engineer.

The provision for conducting radiography shall apply to pipes of diameter 1200mm and above.

For specials like bends, tapers, tees and Wyes radiography test shall be conducted for 100 percent length of welds.

The weld ripples or weld surface irregularities, on both inside and outside shall be removed by any suitable mechanical process to a degree such that resulting radiographic contact due to any remaining irregularities cannot mark or be confused with that of objectionable defect. The radiograph shall be made in strict accordance with the latest requirements and as per the latest and most efficient technique either with X-ray or gamma ray equipment.

The radiographs are to be marked in such a way that the corresponding portion of the welded seam can be readily identified. All radiographs will be reviewed by the Engineer to identify the defect and determine those which must be removed. Defects that are not acceptable shall be removed by chipping; machining or flame gouging to sound metal and the resulting cavities shall be welded. After rectification, the joint is to be radiographed again to prove the quality of the repair. The radiographs will be judged as acceptable or unacceptable by the Engineer based on the latest standards prescribed by Indian Standard specification.

All X-ray shall be made with equipment and by personnel furnished by the Contractor. Films shall be developed within 24 hours of exposure and be readily accessible at all times for inspection by the Engineer. The Contractor shall provide for the use of the Engineer suitable X-ray viewing equipment. X-ray films shall be properly maintained by the contractor and shall



be handed over to the department on completion of the Contract. All films shall be identified by the No. and chart prepared indicating location of the joint each X-ray photo represents, In the event of additional radiographic inspections required of any work associated with the pipe erection, such inspection shall be performed by the Radiographer at the discretion of the Engineer.

#### 2.7.802 Radiographic Inspection of welded joints

All welded joints to be radiographed shall be examined in accordance with IS 2595:2008-Code of Practice for Radiographic Testing

IS 4853:1982-Recommended Practice for Radiographic Examination of Fusion Welded Circumferential joints Steel Pipes.

IS:1182:1983-Recommended Practice for Radiographic Examination of Fusion Welded Butt-joints

IS:2598:1966-Safety Code for Industrial Radiographic Practice.

The reinforcement on each side of all butt welded joints shall not exceed 1.5 mm.

A complete set of radiographs and records as described in IS: 2595:2008 Clause 14, for each job shall be retained by the Contractor and kept on file for a period of at least five years.

Radiographers performing radiograph shall be qualified in accordance with SNT-TC-1A. Supplements and Appendices "Recommended Practice for Non-destructive Testing Personnel Qualification and Certification" published by the American Society for Non-destructive Testing as applicable for the technique and methods used.

Final acceptance of radiographs shall be based on the ability to see the prescribed penetrometer image and the specified hole.

Sections of welds that are shown by radiography to have any of the following types of imperfections shall be judged unacceptable and shall be repaired.

- (a) Any type of crack, or zone of incomplete fusion or penetration,
- (b) Any elongated slag inclusion which has length greater than 6 mm,
- (c) Any group of slag inclusion in line that have an aggregate length greater than thickness in a length of 12 times thickness, except when the distance between the successive imperfections exceeds 6L where L is the length of the longest imperfection in the group,
- (d) Rounded indications in excess of that specified by the acceptance standards given earlier.

#### 2.7.9 Cement Mortar Lining For Internal Surface Of Pipeline

##### 2.7.901 Scope

This Specification covers the requirements of providing materials and application of in-situ cement mortar lining by mechanical and/or hand application to the internal surfaces of pipeline at surface to be installed. Pipes below 900mm diameter shall not be lined but painted as per specifications. After completion of field hydraulic test of the pipeline, the Contractor shall take up

the in-situ cement mortar lining to the internal surface of the pipeline. The work shall be started only after obtaining the written approval of the Engineer in this respect.

#### 2.7.902 Applicable Codes and Specifications

The following specifications, standards and codes in addition to those listed in Clause 2.7.2 of this specification are made a part of this specification. All standards, specifications, codes of practices referred to herein shall be the latest edition including all applicable official amendments and revisions. In case of discrepancy between this specification and those referred to herein, this specification shall govern.

- 1) AWWA C602-76 - American Water Works Association (AWWA) Standard for Cement Mortar Lining of Water Pipelines - 4 in. and larger - In Place.
- 2) IS 3696:1991 - Safety code for scaffolds and ladders (Part 1 & II)
- 3) ASTM - C40 - Test for organic Impurities in Sands for Concrete.

#### 2.7.903 General

Engineer shall have the right to inspect the source/s of material/s, the operation of procurement and storage of material, Cement mortar batching and mixing equipment and the quality control system. Such an inspection shall be arranged and the Engineer's approval obtained prior to starting of lining work.

#### 2.7.904 Method of Application

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 finishing, then the bidder in his bid shall indicate such areas. By prior approval, of Engineer, these areas may be machine sprayed and hand troweled.

#### 2.7.905 Workmanship

All works shall be performed in a thorough and workmanlike manner by trained personnel with previous experience under the supervision of experienced men skilled in the in-situ application of cement-mortar lining to pipelines.

#### 2.7.906 Programme of Lining And Plant And Equipment :

The plant and equipment Proposed by the Contractor for Carrying out the cement mortar lining application shall be furnished along with the Bid. The contractor shall also furnish the methods he proposes to adopt.

#### 2.7.907 Materials of Construction

##### a) Cement

Cement required for mortar lining shall be "Ordinary Portland Cement" conforming to IS-269:1989.

##### b) Admixture



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.

c) Sand

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% 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. Limitations shall apply to specific substances as follows:

Substances	Percentage by weight	Maximum allowable
Shale		1
Clay lumps		1
Mica and deleterious		
Substances other than Shale and clay lumps		2

Organic impurities – Sand shall not show a colour value darker than the reference standard colour solution prepared as required by ASTM 6.40 “Test for organic Impurities in Sands for Concrete”

d) Water

Water for mixing mortar shall be clean and free from injurious amounts of mud, oil, organic material or other deleterious substances.

e) Wire Mesh:

Wire Mesh of 6mm dia to be provided for hand lined vertical pipes.

2.7.908 Design of Lining

a) General

Composition of mortar for the lining shall be composed of cement, sand and water mixed to such consistency as to produce a dense, homogenous lining that will adhere firmly to the pipe surface. Contractor shall take prior approval for the admixtures he proposes to use.

b) Proportion

Proportions of cement and sand shall be 1 part of cement to 1 parts of sand by volume. Slight modifications in composition could be made at site to suit the characteristics of the sand used. Each bag of cement shall be weighed and converted into volume for its use. Admixtures, if permitted, shall be used in strict accordance with the manufacturer's recommendations. The minimum cement content shall be 1026 Kg / m<sup>3</sup> and water cement ratio of between 0.3: 1 and 0.45:1 by mass.

c) Water Content:

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.

d) Mixing :

Mortar shall be well mixed and of proper consistency to obtain a dense, homogenous lining. Where premixed mortar is used, it shall be done so before initial set.

e) Thickness of Lining

The variation in thickness of Cement mortar lining for various diameters of pipe shall be as mentioned in the table below with a maximum plus tolerance of 3 mm.

Diameter of Pipeline	Nominal Thickness of Lining
Above 2250mm dia	12mm
1200mm to 2250 mm	10 mm
Below 1200mm	3 mm

2.7.909 Method of Constructiona) Access Openings

Only such openings as indicated by the Contractor and approved by Engineer shall be provided in the pipe lines. After lining is completed, closure pieces will be welded to the pipe. Mortar lining of closure pieces and adjacent area shall be included in the rates quoted for the mortar lining work.

b) 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 off the steel pipeline. The pipeline shall be cleaned by use of a 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.

Surfaces applied with cement wash shall be cleaned with wire brush manually to the satisfaction of the Engineer.

Blast cleaning shall be followed for pipe surfaces to be treated with Inertol (or approved equivalent paint), coal tar (or bituminous) enamel with or without wrapping or wherever directed or when the pipe surfaces are badly rusted. The procedure followed for blast cleaning is as follows:

All oil, grease on the surface of the pipe shall be first removed by applying a suitable metal cleaning solution and wiping with clean rags. All foreign matter which cannot be removed by this blasting process shall be removed by any other suitable means approved by the Engineer. All metal surfaces shall be thoroughly cleaned by blasting. Blasting operations shall remove all rust, scale and other impurities from the surface exposing the base metal overall, presenting a greyish appearance, however slight shadows, streaks or discolouration caused by rust stain or mill scale oxide need not be removed. The blast cleaned surface shall be primed immediately after blasting is over. Blast cleaned surfaces that rust before a priming coat could be applied shall be cleaned again of all rust by wire brushing or if directed by the Engineer, they shall be re-blasted at contractor's cost. The Contractors shall avoid strictly, keeping the prepared steel surfaces overnight and painting them the next morning. Blasting should be done at a pressure of 5.62 kg/sq.cm(80psi) at the compressor end and at 4.93 kg/sq.cm (70 psi) at nozzle end so as to get a good clean surface after removing the rust. This pressure should be maintained. Improper jointing of hose pipes and resultant reduction in pressure at nozzle end shall be checked and avoided. The sequence and the programme of blast cleaning and application of zinc rich epoxy primer for more than two hours. Greater care shall be taken in blasting particularly at field joints for getting grey surface. After cleaning the blasted surface shall be inspected to see that no rust is left out. Primer coat shall then be allowed to be applied. Torches may be used to inspect the surface, Re- touching shall be done wherever directed.

c) Machine Application of Mortar Lining Clean Up Ahead of Machine

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.

d) Lining Procedure

The lining shall be placed by centrifugal method in one course by a machine travelling through the pipe and discharging the mortar at a high velocity over all pipe sections and long radius bends. The discharge shall be from the rear of the machine so that the freshly applied mortar will not be marked. The rate of travel of the machine and the rate of mortar discharge shall be mechanically regulated so as to produce uniform thickness throughout. The mortar must be densely packed and shall adhere the pipe wherever applied.

2.7.910 Surface Finish

Mortar lining shall be mechanically trowelled except for the places where hand trowelling is expressly permitted by the Employee.

a) Trowelling Lining

The lining machine shall be provided with attachments for mechanically trowelling the mortar. Both the application and trowelling of the mortar shall take place at the rear of the machine so that the freshly placed and trowelled mortar will not be damaged. The trowel attachment shall be such that the pressure applied to the pipe will be uniform and produce a lining of uniform thickness with a smooth and even finished surface free of spiral shoulders. The finished surface of machine placed and trowelled linings in pipe shall be examined according to the procedures in clause 2.7.910.b

b) Examination Procedure

In the stretch of pipe that has been lined and trowelled in each day's run, ten places shall be selected in straight sections of the pipe by the Engineer. In each of the ten places the thickness of the lining shall be measured as directed by the Engineer. Thickness of lining shall be ascertained frequently during placing of mortar and trowelling. Hair cracks or cracks upto 0.25 mm width in saturated linings and not over 300 mm in length are acceptable.

c) Untrowelled Lining

The finished surface shall be smooth and regular except that it may exhibit a slightly dimpled appearance. Edges or uneven build up caused by irregularity in the travel route of the machine will not be allowed.

2.7.911 Hand Application of Mortar Lining

Handplaced mortar shall have a uniform and smooth surface with smooth transitions to adjacent machine placed linings

Cement mortar lining of bends, specials, areas closely adjacent to valves and other such places where machine placing may not be practical shall be performed by hand. The Engineer may order the correction for any defect by hand application.

Cement mortar for hand work shall be of the same materials as the mortar for machine placed lining.

The areas to be lined shall be thoroughly cleaned as specified earlier and, if necessary, shall be moistened with water immediately prior to placing the hand-applied mortar.

Steel finishing trowels shall be used for the hand application of cement mortar, except at bends the outer edges of hand trowelled areas may be brushed in order to reduce the abutting offset.

All hand finishing work in a section of the pipeline shall be completed within 24 hours after completion of the machine application of mortar lining to that section. If necessary, application of mortar lining by machine shall be delayed or stopped to assure compliance with this schedule.

2.7.912 Special requirements at Laterals and Service connections

Laterals and connections to the pipe that is being lined shall not be left obstructed by the lining operations.

Before the lining is placed, the openings in the pipeline leading to air valves, blowoff, manholes and appurtenances, as well as to laterals and connections that transmit pressure or carry water from the pipeline, shall be temporarily covered or plugged with suitable devices. These shall be removed later without damaging the cement-mortar.

#### 2.7.913 Curing

Curing shall commence immediately after completion of the mortar lining and hand finishing of a section of pipeline. This shall, however, not be later than 8-hours after mixing of mortar. The lining shall be kept continuously in moist condition for a period of 14 days. During the operations of lining, finishing and curing, exterior surface of the pipe exposed to sunlight shall be sprinkled with enough water to keep the pipe cool. Open ends of pipes shall be suitably closed so as to maintain a moist atmosphere and prevent draught. Curing of mortar lining and simultaneous cooling of the pipeline externally shall be continued even beyond the period of 14 days as directed by the Engineer.

#### 2.7.914 Tests of Cement Mortar used for Lining

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 not be less than 300 Kg/sqcm after 28 days of curing or 170 Kg/sqcm of 7 days of curing. The density of the test cube shall not be less than 2300 Kg/m<sup>3</sup>

#### 2.7.915 Inspection

##### a) Responsibility of Engineer and Contractor

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 specifications.

##### b) Defective Lining

Defects in lining including but not restricted to sand pockets, voids, oversanded 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, at no extra cost to the Corporation.

##### c) Guarantee

If on examination by the Engineer of the cement-mortar lining work within a period of two years after final completion and acceptance of the Contract Work reveals evidence of

defective materials or workmanship as defined in this specification but not limited to the same, then the Contractor shall perform the remedial work at his own expense in a manner acceptable to the Engineer.

#### 2.7.10 Cleaning And External Painting Of Pipes And Specials

##### 2.7.1001 General

The fabricated pipes and specials shall be painted externally with Primer, one coat of red oxide of iron paint and covering coat of Grey graphite where they will be exposed after erection. But those pipe surfaces which are to be embedded in concrete shall be provided with cement wash in the shop on their exterior surface.

##### 2.7.1002 Material

Zinc rich epoxy primer and Heavy Duty bitumen paint (Inertol 49W or equivalent) conforming to the following specification shall 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. If any sample of the Paint and/or primer 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 / Owner in writing shall be used for this work.

##### 2.7.1003 Primer

The primer shall be of Zinc Rich Epoxy type conforming to the specifications given below:

a)	Specification for Zinc Rich Epoxy Primer	
1)	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 92% Zinc Dust and 8-10% Resin and curing agent.
2)	Shade	Grey
3)	Characteristics	The paint shall provide a complete rust inhibitive barrier coating of high mechanical and abrasion resistance. The film shall be compatible for fusion and spot weld.
4)	Pot Life	4 – 6 Hours
5)	Covering capacity	8-10 sq.m/litre per coat giving a film thickness of one mil.
6)	Mixing Ratio	The proportion of mixing base and hardener should be as specified by the Manufacturer by weight and volume. The mixed primer shall conform to the specifications detailed under Clause 2.7.1003 (1) to (8).
7)	Viscosity of ready Mixed Paint	15-22 in Fort Cup No.4 at: 30° C
8)	Drying Time	Dust Free – 10- 15 minutes Chamber curing – 24-48 hours.



g)	Procedure	Blasted steel surface of the pipes shall be cleaned of dust and grit and shall be primed immediately following cleaning. The surface shall be dry at the time the primer is applied during rain or fog unless protected from weather by suitable housing and subject to the permission of the Engineer. The primer shall be applied by hand spraying and shall be in accordance with the instructions for application as supplied by the manufacturers. The Priming coat shall be uniform 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, sag, floods or drips shall be removed or all such defects shall be remedied by reblasting and repriming at the discretion of the Engineer and at the cost of the Contractor.
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b) Application of Zinc Rich Primer

The primer shall be Prepared as follows:

The primer shall be prepared in the manner and proportion as specified by the manufacturers as mentioned under Clause 2.7.1003 a). However, the mix primer shall conform to the specification as mentioned in Clause 2.7.21 (1) to (8). The mix of Zinc Rich Epoxy primer shall be prepared 15 minutes before applying on the Works site.

One coat of Zinc Rich Epoxy primer shall be applied by spray right up to the edge of the pipe giving a film thickness of approximately 1 mil

No thinner should be added to the ready mix paint without the previous written approval of the Engineer. Though the priming coats become dust free dry in 10-15 minutes, the finishing coats shall on be applied after allowing the film to cure at least for 48 hours.

Shade after application: Grey.

2.7.1004 Specifications for Red Oxide of Iron Paint

1.0 Composition

- (a) Mixed Pigment Dry - 55%±2%
- (b) Volatile - Not more than 5 %
- (c) Drier - These may be added when necessary in order that the paint may conform requirements. Such drier shall not contain volatile matter other than turpentine or white spirit, The drier shall be linoleat or napthenate. Tesinate drier shall not be used.
- (d) - The remainder.

2. Pigment: The red oxide of iron shall contain not less than 70% of Ferric Oxide ( $Fe_2O_3$ ) and shall be free from acid, water soluble salts and all other impurities.

3. Linseed Oil: The linseed oil shall be of genuine quality prepared from linseed, free from turbidity in water. It shall be of such quality so as to become dry within 8 hours and form a film free from being sticky.



4. Thinners: The thinners used shall either be turpentine or white spirit of standard quality as approved by the Engineer.

5. Weight : The minimum. weight in kg/10 litres of paint shall be 15.5 kg within  $\pm 3\%$ .

#### 2.7.1005 Specification for Covering Coat (Graphite paint)

##### 1.0 Composition

(a)	Mixed Pigment Dry	-	Not less than 45%
(b)	Volatile	-	Not less than 10%
(c)	Drier	-	These shall be linoleat or naphonate and shall not contain any volatile matter other than turpentine or white sprit. Resinate drier shall not be used.
(d)	Linseed oil	-	The remainder.

2. Pigment : The pigment shall contain not less than 50% of white lead and 40% of graphite as per IS: 62:1950, the balance being barytes (Pure graphite being 24% min.)

3. Linseed Oil :The linseed oil shall be of genuine quality prepared from linseed, free from turbidity, sediments undissolved in water. It shall have a specific gravity between 0.981 and 0.942 at 30°C. It shall be of such quality so as to become dry within 8 hours and form a film free from being sticky.

4. Thinners: The thinners used shall either be turpentine or white spirit of standard quality as approved by the Engineer.

5. Weight : The weight of one litre of paint shall not be less than 1.5 kg and not more than 2.1 kg.

6. Colour : According to Indian Standard Specifications Shade No. 671.

7. Remaining Clauses shall be as per the General specifications as stated above.

#### 2.7.1006 Inspection and Testing of Zinc Rich Epoxy primer / Red Oxide of Iron Paint and Grey Graphite

##### (a) Primer

i) Each lot of primer and heavy duty paint supplied shall be accompanied by certified copies of the results of the tests carried out by manufacturers.

ii) The entire procedure of applying the paint as specified shall be rigidly inspected right from blast cleaning stage to the application of the final coat. If, at any time, it is found that the procedure of applying the paint is not as per the standard laid down, all such painting work shall be rejected.

iii) Samples of the paint brought by the Contractor shall be sent to the Testing Laboratory, as directed by the Engineer, for testing as specified. If any sample as found to be not conforming to the specifications, the entire consignment to which the sample may pertain shall be rejected. Samples shall be taken at intervals at the option of the Engineer. All the

cost incidental to such testing, such as the cost of the paint, cost of prescribed testing charges and cost of the transport, etc., shall be deemed to be included in the rates quoted by the Contractor for painting.

(b) Red Oxide of iron Paint, Grey Graphite

One sample from each consignment of paint consisting of 50 drums or less shall be taken by the Engineer and got tested in an approved Laboratory. If the test is satisfactory, the consignment shall be passed for use. If it fails, two more samples from two other separate drums shall be taken for test and the consignment shall be accepted for use provided both samples are found satisfactory. In case one or both of the later two samples fail in the test, the whole consignment of the paint shall be rejected and all the rejected tins of paint shall be marked "Rejected" on the lids with paint. The Contractor shall remove the entire consignment of the rejected paint from his works within three days of such intimation from the Engineer. If the rejected consignment is not so removed within the specified time, the Engineer may remove the same to any Municipal Stores in Greater Mumbai at the Contractor's risk and cost, and the Corporation shall not be held responsible for its safe custody thereafter. The entire cost in connection with testing of all the samples of paints, whether satisfactory or otherwise shall be deemed to be included in the rates quoted by the Contractor.

2.7.1007 Painting

a) General

Except with the permission of the engineer, nothing but ready mixed paints of an approved make and brand shall be 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 temperature 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.

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.

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

b) Preparation of Surface for Painting

i) General

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.

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.

ii) Sand Blasting

The surface of the steel pipes and specials 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 cleaning solution and wiping with clean rags. All foreign matter which cannot be removed by blasting process shall be removed as directed by the Engineer/Owner.

Blasting should be done at a 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.

The blast cleaned surface shall be primed immediately after blasting is over. The sequence and the programme of blast cleaning application of Zinc Rich Epoxy primer shall be arranged in such a way that the blast cleaned surface shall not remain uncovered with Zinc Rich Epoxy primer for more than 2 hours.

Any deviation from above shall require approval of the Engineer / Employer.

iii) Manual Cleaning

Wherever manual cleaning is approved by the Engineer the surface of pipes and specials shall be thoroughly cleaned by 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, crapping 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.

c) Application of Primer

No primer shall be applied without Prior approval of the Engineer / Owner. During rain or fog, shells of the pipes and specials shall be protected from weather by suitable housing.

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.

One coat of primer shall be applied by spray giving a film thickness of approximately one mil. No thinner shall be added to the ready mix paint without previous approval of the Engineer/Owner, 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.

The priming coat shall be uniform in thickness and free from floods, runs, rags, 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/Owner.

#### d) Field Painting

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.

After erection of the pipeline on installation all rust spots, damaged areas and site welded portion of the pipeline shall be cleaned to metal and shall be painted with one coat of red oxide of iron paint and covering coat of Grey graphite.

After lapse of 48 hours of application of repairing coats specified above a finish coat of heavy duty bitumen paint shall be applied to exterior surface of the entire pipeline' care being taken to clean the surface with duster prior to application of the said finish coat.

#### 2.7.1008 Inspection

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 directed by the Engineer.

#### 2.7.1009 Application of Cement Wash

Where the pipeline is to be cement mortar lined, it shall be given a coating of cement wash internally. Also where the pipeline is to be encased in concrete anchor blocks or encasement, it shall be given a coating of cement wash externally.

The pipe shall be first be cleaned manually as specified in Clause 2.7.1007 (b) to the Engineer's satisfaction. Immediately after a short stretch of the pipe is blast cleaned, the Contractor shall commence coating of the pipe with cement wash.

Before painting is started, the inner surface of the pipe shall be thoroughly scrapped by using scrapers, wire brushes to get rid of rust, mill scale etc. and washed with water. A suitable metal cleaning solution of approved make shall be applied over it. After it has dried, the surface shall again be washed with water and scrapped with brushes simultaneously and allowed to dry.

No Separate payment shall be made for items covered under this clause.

#### 2.7.1010 Internal Cleaning and Painting of Pipeline

##### 2.7.1010.1 Internal Cleaning of Pipeline

Wherever directed by the Engineer, internal surfaces of pipes, specials etc. of all size shall be thoroughly cleaned by repeated hosing of water and simultaneous rubbing with gunny cloth.

Further, when a section of pipeline has been laid and all the work inside it has been completed to the satisfaction of the Engineer, its internal shall be cleaned of all dirt, debris, dust or other deposits.

Pipelines larger than 900 mm diameter shall be cleaned by repeated hosing of copious quantities of water on the pipe surface and simultaneously rubbing the surface with gunny cloth. Cleaning with metal cleaning solution, acid, wire brushed, scrapers or sand paper will not be permitted.

For 900 mm and smaller diameters cleaning of laid pipelines will be restricted to cleansing and scraping out of debris and dirt only.

Cleaning shall be done to the satisfaction of the Engineer. The section of the pipeline once cleaned shall not be entered into for any purpose later. Sufficient precaution shall be taken to prevent the ingress of any dirt, debris, or dust inside the section. Failing this the section shall be cleaned again at the discretion of the Engineer.

In the case of above ground pipeline, the length of the section to be taken up for cleaning shall be decided in consultation with the Engineer from the point of view of ventilation etc.

In case of buried pipeline a section shall be taken up for cleaning after the work of back filling around and over the pipeline is completed and the spiders have been removed from inside.

During the pipe laying operation in the adjoining section, the Contractor shall take all precautions to prevent ingress of water, muck, debris, dirt, dust etc. in the cleaned section, failing which the section shall be cleaned again at the discretion of the Engineer. Where deemed necessary by the Engineer suitable closures shall be provided at the open end or the ends of the cleaned sections. No separate payment shall be made for this item. The item rates quoted for the laying of pipes, painting, etc shall include cost thereof.

At the end of a season's work, closure shall invariably be provided at all the open ends to protect the Pipeline from ingress of sub-soil water, mud, muck, etc. No separate payment will

be made for the work of cleaning and providing closures. The rates quoted for the laying the pipes, painting etc. shall include the cost thereof.

#### 2.7.1010.2 Internal Painting of Pipes And Specials

The internal surfaces of pipelines shall be coated with 1 coat of a two component solvent- free food grade epoxy coating achieving a minimum dry film thickness of 500 microns. The product shall have certification for use in potable water service as per BS 6920 or ANSI Standard 61. The protective coating must be spray applied to the pipe / liner surface using suitable air spray equipment so as to form a completely impermeable, pinhole free and seamless lining.

Cleaning: The painting can be carried out after fabrication in a yard where blast cleaning will be permitted. The pipe surface shall be blast cleaned to Sa 2.5 standards. If oxidation has occurred between blasting and application, the surface shall be reblasted to the specified standard.

Shop Painting: All application shall be as per manufacturer's specification. The contractor shall take proper care during loading/ unloading and transport of the pipes and specials from shop to the site of erection to preserve the shop paint in the best possible condition.

Field painting: after erection all damaged spots and welded portion of the pipeline shall be cleaned to metal and shall be hand painted.

Quality control: Each lot of paint supplied shall be accompanied by certified copies of results of tests carried out by the manufacturers. Samples of paint brought by the contractor shall also be sent to testing laboratory as directed by Engineer for testing as specified by paint supplier.

#### 2.7.1011 Testing of Pipeline

After the work of laying of pipeline is completed and before putting it into commission, the pipeline shall be tested in the field, if so directed by the Engineer, both for its strength and leakage. The procedure for the test shall be as follows:

For the purpose of Pressure testing, the pipeline shall be divided into sections as defined by the Engineer.

Before pressure testing is started, the Contractor shall recheck pipes and valves for cleanliness and shall ensure the operation of all valves. The "open" ends of the pipeline (or sections thereof) shall normally be stopped off by blank flanges or cap ends additionally secured where necessary by temporary struts and wedges. All anchor and thrust block shall have been completed and all pipes straps and other devices intended to prevent the movement of pipes shall have been securely fastened. The Contractor shall clean out the whole pipeline and flush it with water, so as to remove dirt, dust and any foreign matter lying in the pipeline. No separate payment for the work of cleaning will be made and the rates under the various items of work shall include the cost thereof.



Each valve section of the pipeline be subjected to a hydraulic test in full length or in part as may be necessary. For this test, the pipe shall be slowly filled with clean water by opening cross connections with existing mains or otherwise as directed and all air shall be expelled from the pipeline through hydrants, air valves and blow off fixed on the pipeline. Once the pipe is full, the cross connections shall be closed. The pressure in the line should then be raised and maintained by means of suitable approved pumps, to the specified test pressure based on the elevation of the lowest point on the line or section under test. The test pressure shall be not less than the static head pressure or 1.5 times the working pressure whichever is higher. No section shall be tested unless anchor blocks have been provided at either end, all appurtenances, etc. have been fixed in position, arrangements for cross connections have been made with existing mains. Before starting the pressure test, the expansion joints shall be tightened. The test Pressure shall be maintained for at least 24 hours. The drop in pressure shall not exceed 0.7 kg/sq. cm (10 lbs. per sq. inch) within a period of 2 hours after the full test pressure is built up. Under the pressure, no leak or sweating shall be visible at the welded joints.

During the test, the pipe shall be struck sharp blows with a 4 lb. Hammer. Water shall not spout, ooze, or sweat through any part. In case of leakage anywhere in the factory joints, whether welded or bolted., the same shall be prepared entirely contractor's cost, which shall included repairs to welding, and coating repainting etc. The repaired joint shall be subjected to a retest. No section shall be accepted put in a perfectly water tight conditions and retested satisfactorily. The entire cost of testing, retesting etc. shall be paid under the relevant items of Bill of Quantities. The Contractor shall make all arrangement for all labour, pumps, pressure gauges equipment, etc. No main valve or cross connections either on the new or existing main shall be operated by the Contractor, and only the Hydraulic Engineer's or Project Department staff shall operate the same. The Contractor shall arrange for labour required for operating the air valves, etc., Municipal labour employed for the test shall be charged to the Contractor.

The hydraulic testing of the water main will be carried out fully, or partly as per the site conditions. If any leakages are observed during the defects liability period due to defective workmanship, the same will be rectified through Hydraulic Engineer's Department as the work on live water main is done by Hydraulic Engineer's department only. The charges of repair will be recovered from the amount of retention money. Repairs on live water mains are to be carried out immediately to avoid wastage of water and other problems such as disruption of water supply, traffic etc. In view of this, it will be very difficult to give prior intimation to the Contractor. As such, the cost of repairs as per Hydraulic Engineer's Department's bill will be recovered from the retention money withheld in deposits without

giving any prior intimation. The Contractor shall not challenge or claim any extra for such action on the part of Municipal Corporation.

#### 2.7.11 Underground Pipeline-Laying

##### 2.7.1101 Handling of pipes and Specials

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 20 cm (8 inches) wide and so arranged to prevent damage to the coating.

During handling of the pipes and fittings, coating shall be protected not less than 20 cm wide and placing strips of heavy belting or other approved sheet materials not less than, 20 cm wide under all ropes or fastening.

##### 2.7.1102 Excavation of Pipe Trenches - General

Trench Excavation means excavation of trenches into which pipes are to be laid and the term pipes shall mean pipes of all kinds and for whatever purpose.

The line and level of trenches shall be as shown on the Drawings or as may be required by the Engineer. Before commencing Trench Excavation, the route of the trench shall be pegged out accurately and the ground levels shall be agreed with the Engineer. Strong sight rails shall then be fixed and maintained at each change of gradient and at as many intermediate points as may be necessary. On these rails shall be marked the centre line and the level to which the excavation is to be carried out, such rails being not more than thirty five metres apart.

##### 2.7.1103 Trench Excavation

Trench excavation shall be carried out by such methods and to such lines, dimensions and depths as shall allow for the proper construction of the Works, provided always that, unless the Engineer permits otherwise, no Trench Excavation shall be less than 500 mm in width and no Trench Excavation for pipes larger than 200 mm diameter shall exceed the widths stated :-

Excavation in firm ground or soft rock, no shoring required	D + 1000 mm
Excavation in soft ground or any conditions requiring shoring	D + 1400 mm
Excavation in Rock	D + 1000 mm

Where D is the inside diameter of the pipe in mm.

Notwithstanding the foregoing, any Hard Rock in Trench Excavation shall be so excavated that the clearance between the pipe when laid and the Hard Rock sides and bottom of the trench is kept to the minimum limits necessary to provide for the specified thickness of bedding haunching and surround to the pipe. Any excavation outside these limits whether for working space or due to overbreak shall be held to be Excess Excavation.

The sides of Trench Excavation shall be vertical unless the Engineer permits otherwise.

Any widening or deepening of Trench Excavations necessary to accommodate curves, joints or bends in the pipe as shown on the drawings or when ordered by the Engineer shall be held to be 'general excavation' but that required by the Contractor to provide extra working space for the construction thereof shall be held to be Excess Excavation.

No length of Trench Excavation shall be started until the pipes to be laid in that length are available on the Site.

#### 2.7.1104 Trial Pits or Trenches

The Engineer may require trial pits or trenches be excavated well ahead of the trench excavation to such depths as he shall order to determine the alignment for the trench.

Any further trial pits or trenches required by the Contractor to determine the position of underground services, sub-soils, drains or for any other reason shall be excavated and reinstated at the Contractor's expense.

The Contractor shall arrange for the refilling and reinstatement of trial pits or trenches to be carried out immediately after the required information is obtained. The reinstatement of the surfaces of trial pits or trenches shall be carried out to the approval of the Engineer.

#### 2.7.1105 Trench Excavation in Roads and Footpaths

All Trench excavation and other work carried out within the limits of any road shall be completed as rapidly as possible and not more than half of the width of the carriageway shall be obstructed at a time. Road drains and grips shall be kept free from obstruction. In a event the Contractor shall take special precautions, which shall include the continuous support of the sides of the excavation, from the time when excavation is begun until the refilling of the trench is placed, to ensure that there is no disturbance of the adjacent road or road foundation. Where excavated material has temporarily been deposited on grass margin or road pavement, the margin or road pavement shall on completion of refilling be restored entirely to its original condition and left free from loose stones.

#### 2.7.1106 Trench Excavation in Fields etc.

The term "fields" includes fields, moorlands, grass verges the like and all private lands, and no length of Trench Excavation located in fields shall be commenced until suitable temporary fencing has been erected around that length unless the Engineer permits otherwise. Temporary fencing shall not be removed without the Engineer's permission which will not normally be given until the Trench Excavation has been refilled and reinstated to the original ground condition or as directed by the Engineer.

The Contractor shall have particular regard to the safety of livestock in fields or which may be introduced to the fields, and shall ensure that all open excavations, access routes and steep or loose slopes arising from the Contractor's operations in these fields are adequately fenced and protected.

After the erection of temporary fencing Contractor shall remove Topsoil to such depth and over such areas as may be necessary to provide sufficient material to ensure adequate surface reinstatement of the working areas occupied by the Contractor for construction of the pipeline.

#### 2.7.1107 Soft & Decomposed Rock and Hard Rock in Trench Excavation

Soft and Decomposed Rock means rock, boulders and other materials which in the opinion of the Engineer could normally be removed by picks, hammer, crow bars, wedges and pneumatic breaking equipment. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Excavation in macadam & tarred roads and pavements and dismantling masonry shall also be included under this item.

Hard Rock means means rock occurring in large continuous masses which in the opinion of the Engineer could be loosened by blasting or by other rock quarrying methods. Rock boulders in sizes not classified under Ordinary/Hard Soils and Soft & Decomposed Rock shall be considered as hard rock.

Any material in Trench Excavation which the Contractor considers may be classified as Soft & Decomposed Rock or Hard Rock as defined above shall be notified to the Engineer before excavation of the material is begun. The quantities of this material excavated from within the nominal limits of Trench Excavation shall be recorded and the record signed by the Engineer and Contractor each day or at such shorter intervals as the Engineer may require. Only such proportion of material so notified and recorded as the Engineer classifies as Soft & Decomposed Rock or Hard Rock shall qualify for additional payment under respective items of BOQ. Overbreak shall be kept to a minimum and shall be held to be Excess Excavation.

#### 2.7.1108 Supporting Trench Excavations

The Contractor shall well and effectively support the sides of Trench Excavations to prevent any fall or run from any portion of the ground outside the excavation and to prevent settlement of or damage to structures adjacent to the excavation. The Contractor shall be deemed to have made his own allowance for any extra excavation necessary to provide space for such support and for any other working space. If for any reason any portion of Trench Excavation shall give way, the Contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed and such extra excavation shall be held to be Excess Excavation.

Where the Contractor elects and is permitted by the Engineer to execute Trench Excavations with battered sides instead of providing support as aforesaid they shall be excavated to stable slopes and heights and the resulting extra excavation shall be held to be Excess Excavation.

#### 2.7.1109 Trimming Trench Excavations

When excavating to specified levels for Trench Excavation or to specified limits for the face of any structure therein required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until immediately before commencing constructional work except where the Engineer permits otherwise. Should the Contractor have excavated to within 150 mm above these specified levels or to within 150 mm of these specified limits before he is ready to able to commence the constructional work he shall where required by the Engineer excavate further so as to remove not less than 150 mm of material immediately before commencing the constructional work and any such further excavation shall be held to be Excess Excavation.

Where no bedding material is specified to be laid beneath the pipe the bottom of Trench Excavations shall be carefully boned in and trimmed true to grade with the aid of a straight edge at least six metres long so as to ensure a continuous support for the pipes. The trench bottom shall then be pricked over with a fork and any stones or flints either likely to cause the pipe to bed unevenly or to damage the pipe and its coating or greater than 20 mm in size shall be picked out of the pipe bed and any holes so formed shall be filled in with soft material and trimmed to the correct level.

Where no bedding material is specified, all shattered and loose material shall be removed from the bottom of the Trench Excavation so that the bedding material rests on a solid and clean foundation.

#### 2.7.1110 Inspection by Engineer

When the specified levels of Trench Excavation are reached the Engineer will inspect the ground exposed and if he considers that any part of the ground is by its nature unsuitable he may direct the Contractor to excavate further and to refill the further excavation with such material as he may direct but such further excavations shall not be held to be Excess Excavation.

Should the bottom of any Trench Excavation while acceptable to the Engineer at the time of his inspection subsequently become unacceptable due to exposure to weather conditions or due to flooding or have become puddled, soft or loose during the progress of the Works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. Such further excavation shall be held to be Excess Excavation.

#### 2.7.1111 Disposing Material from Trench Excavations

Subject to any specified requirements of the Contract, the Contractor shall make his own arrangements for the temporary storage of any excavated material which is required for use in refilling Trench Excavations, including any necessary double handling. In this connection the Contractor shall have regard to the working areas available to him for the construction of the pipeline particularly where this is located in roads or in other places to which the public



has free access. Any temporary tips alongside the Trench Excavations shall be to stable slopes and heights.

Where the nature of the excavated material is suitable the Contractor's temporary storage as aforesaid shall include for the separate storage as the Engineer may direct of any of the various grades of material hereinafter specified for the refilling and surface reinstatement of Trench Excavation, namely, soft material, coarse material, hard material and topsoil.

Any excavated material not required for or not suitable for use as refilling as aforesaid or for use elsewhere in the Works shall become property of the Corporation and shall be dealt with as specified below.

Excavated material which is not required for or is unsuitable for re-use in the works shall be disposed off as directed to locations designated by the Engineer (Engineer's tip). Such material shall remain the property of the Corporation and shall be transported and deposited at places designated by the Engineer. Material so deposited shall be shaped up or spread and levelled as directed by the Engineer. Any necessary work to provide access to Engineer's tips or other preliminary work in connection therewith shall be carried out by the Contractor in consultation with the Engineer and the expenses thereof shall be included in the rate quoted for the item. If any dumping charge is paid by contractor for dumping material at designated site, the amount will not be reimbursed.

#### 2.7.1112 Trenches not to be left open

Trench Excavation shall be carried out expeditiously and, subject to any specific requirements of the Contract, the refilling and surface reinstatement of Trench Excavations shall be commenced and completed as soon as reasonable practicable after the pipes have been laid and jointed.

Pipelaying shall follow closely upon the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of Trench Excavation to remain open while awaiting testing of the pipeline. The Contractor shall take precautions to prevent flotation of pipes in locations where open Trench Excavations may become flooded, and these precautions may include the partial refilling of the trench leaving pipe joints exposed while awaiting tests of the joints.

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 Trench Excavations.

#### 2.7.1113 Measurement of Trench Excavation

Items for Trench Excavation shall apply to excavation in any material and shall include not only for all work in connection with excavation including timber shoring but also for refilling of trenches and for disposal of surplus material, for temporary fencing and, in fields, for the



stripping and subsequent reinstatement of the top surface all as specified. Disposal of surplus excavated material shall be as specified.

The depth of Trench Excavation shall be measured vertically from the original ground level or, where appropriate, from the ground level remaining after the completion of any general excavation or filling down to the specified invert level of the pipe plus the thickness of the pipe plus, where appropriate, the specified thickness of bedding for the pipe.

For the purpose of measuring quantities of other items additional to Trench Excavation (such as Incidental Excavation, surface reinstatement, land drains and services) Trench Excavations shall be deemed to be of the nominal dimensions stated below :-

- (a) The nominal depth shall be depth as defined in the preceding paragraphs.
- (b) The nominal width shall be as set out in Clause 2.7.1103

The sides of Trench Excavation shall be deemed to be vertical and the nominal widths shall apply to any depth of trench and whether or not bedding or surround to the pipe is specified. Shoring and dewatering shall be deemed to be included in the unit rates quoted for trench excavation unless separately provided for in the schedule of quantities.

Trench Excavation and all work in connection therewith as specified shall be valued by the measurement only of such items as are set forth in the Bill of Quantities except where expressly provided for otherwise by the inclusion in the Bill of Quantities of any of the following further items:

Incidental Excavation for trial pits and trenches ordered by the Engineer shall be measured as the volume excavated and shall include for supporting the excavation and for refilling the trial pits and trenches and, where in fields, for surface reinstatement.

Incidental Excavation for structures situated in the pipeline shall be measured only to the extent that the net excavation required to accommodate the structure falls outside the nominal dimensions of the Trench Excavation.

Incidental Excavation for removal of unsuitable material shall (unless it is held to be Excess Excavation) be measured as the volume ordered by the Engineer to be excavated beyond the nominal dimensions of Trench Excavation and shall include for the disposal of the excavated material.

Excess Excavation and the backfilling thereof shall not be measured for payment.

Concrete refill (excluding bedding and surround) to such lengths of Trench Excavation as may be ordered by the Engineer shall be measured as the volume of concrete required to fill such lengths to the depth ordered and to the nominal width of the trench, a deduction having been made for the volume occupied by the pipe, and shall include for any shuttering required and for disposal of additional surplus material.

Concrete bedding and surround to pipes shall be measured as indicated under Pipelines.

Imported or sieved bedding to pipes shall be measured as indicated under Pipelines.

Granular bedding and surround to thin walled pipes shall be measured as under Pipelines.

Surface reinstatement of Trench Excavations in roads and in footpaths as specified shall be measured as the area calculated by multiplying the length of the Trench Excavation to be so reinstated by its nominal width. The stripping of the top surface and the surface reinstatement of Trench Excavation in fields shall be included in Trench Excavation and shall not be separately measured.

Crossing land drains shall include for all temporary and permanent measures for dealing with land drains and the like as specified and shall be measured as the length of land drains so dealt with within the nominal width of Trench Excavation.

Crossing services shall include for all temporary measures for dealing with service pipes and cables of any size as specified and shall be measured as the length of such services so dealt with within the nominal width of Trench Excavation. Any permanent measures required by the Engineer shall be ordered by him as additional work.

Crossing hedges, fences and walls shall include for all temporary measures for dealing with such barriers as specified and shall be measured as the length of such barriers so dealt with within the nominal width of Trench Excavation. Any permanent measures required by the Engineer shall be ordered by him as additional work.

Crossing rivers, culverts and other watercourses shall include for all additional measures necessary to make the crossings as specified. Only such crossings as may be itemised in the Bill of Quantities will be measured (E.O. Trench Excavation) for additional payment.

Overhaul of refill material (E.O. Trench Excavation or Excavation in borrow areas) shall apply in cases where the Engineer orders refill material to be transported from locations of excavation which are more than three hundred metres from the length of trench to be refilled, the "overhaul distance" being the distance in excess of three hundred metres.

Sieving of refill material where ordered by the Engineer shall include for transporting the refill material a distance of up to three hundred metres to the length of trench to be backfilled.

#### 2.7.1114 Sand Bedding

Where specified the sand bedding to required thickness, and level shall be provided below pipe, prior to laying the pipe in trenches. It shall be compacted with a light hand rammer. Any reduction in thickness due to compaction shall be made up by adding sand during ramming. For the purpose of the bedding under this item only screened fine sand of grain size not larger than 2 mm shall be used. The sand shall be clean, uncoated and free from clay lumps, injurious amounts of dust, soft particles, organic matter, loam or other deleterious, substances.

If the sand supplied is unclean it shall be washed. In no case shall sand containing more than 3.5 % by dry volume or 5% by wet volume of clay, loam or silt be accepted. Tests specified for determining silt in sand and organic impurities as described in IS:383 shall apply. Sieved and washed sand shall be stored on the works in such a manner as to prevent intrusion of any foreign matter, including coarser particles of sand or any clay or metal or chips. Tests as indicated above shall be performed if called for by the Engineer at the expense of the Contractor.

During the work of providing sand bedding and laying the pipeline over it, loose material from the sides or edges of the trench shall be prevented from falling inside the trench, by providing shoring and taking other measures. Also where necessary, trench shall be kept dry by pumping out seepage water continuously.

#### 2.7.1115 Lowering and Jointing

The pipe shall be lowered into the trenches by removing only one or two struts at a time. It shall be seen that no part of the shoring is disturbed or damaged and, if necessary additional temporary struts may be fixed during the lowering operations. It shall also be necessary to see that the gunite coating of pipe, if any is not damaged in anyway during the lowering and assembling. After the pipe is lowered into the trench, it shall be laid in correct line and level by using the levelling instruments, sight rails, theodolite, etc. care shall be taken to see that the longitudinal joints of two consecutive pipes at each circumferential joints are staggered by 90°. While assembling the pipes, the ends shall have to be brought close enough to leave a uniform gap not exceeding 4 mm. If necessary, a marginal cut may be taken to ensure a close fit of the pipe faces. For this purpose, only experienced cutters who can make uniform and straight cuts, shall be permitted to cut the faces of the pipes. No extra payment shall be made for such marginal cutting. There shall be no lateral displacement between the pipe faces to be joined. If necessary, spiders from inside and tightening rings from outside shall be used to bring the two ends contact and alignment. It may also be necessary to 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. For welding, refer to clause 2.7.1117

On completion of the pipe jointing and external protection, the trench and the welding pits shall be cleaned of guniting rebound.

Backfilling shall be carried out as detailed in clause 2.7.1119.

#### 2.7.1116 Providing Steel Props Inside The Pipeline ( Dia. 1200 mm and above)

In order to effectively provide cement mortar lining to the inside of the pipes and to avoid difficulties during the work, it is necessary that the roundness of the pipes is maintained circular till the lining work is taken up. To achieve the same, steel adjustable screw type props of screw or similar approved make consisting of minimum six legs shall be fixed inside the pipe. The deflection of the Pipe should be limited to 2% of the average diameter. In no case shall the limit be exceeded, even under the full load, in case of pipes laid underground. The design and drawings of the props that the contractor intends to use should be got approved by the Engineer before starting the work. While laying the pipes underground, the Contractor shall provide this propping arrangement from inside to maintain circularity. These props shall be fixed vertically and at intervals of not more than 1.8 metres or as directed by the Engineer. In case the Engineer finds it necessary, they will have to be fixed in any position. The props should be kept in position at least for three days after the encasing of the pipe in that section is completed or till refilling is done to the full height of fill over the pipe in case the pipes are not encased. The props shall be removed only after obtaining permission from the Engineer. The height of earth fill over the pipe top shall normally be such as to avoid floatation under submerged condition and to have a minimum earth cushion of about 1.25 metres over the pipe whichever is greater. It is also necessary that, in case of buried pipe, adequate side supports from the backfilled materials is developed to keep the diametral deflection within the specified limits. Backfilling of the excavated trenches, particularly below the pipe and along the sides shall, therefore, have to be done with proper care and compaction as desired. No separate payment shall be made for the use of props.

#### 2.7.1117 Welding Joints

As regards the welding work, the following points shall be borne in mind by the Contractor :

(a) The Contractor shall use approved make of standard electrodes depending on the thickness of plate and type of joint. He shall also use standard current and arc voltage required for the machine in use as per manufacturer's directions. Welding electrodes shall conform to I.S. 814 - "Specifications for covered electrodes for metal arc welding of mild steel (Latest Revision).

(b) Welded joints (other than for closing lengths) shall be of the butt welded type with an internal circumferential weld. However, pipes 900 mm and below in diameter shall be jointed with external welds and pipes larger in size will be circumferentially welded both internally and externally. All fillet welds shall have a throat thickness not less than 0.7 times the thickness of the pipe to be welded.

All parts to be welded shall have loose scale, slag, rust, paint and other foreign matter removed by means of a wire brush and shall be left clean and dry. All scale and slag shall be removed from each weld when it is completed.

(c) Gauging

Pipes larger in size, i.e. more than 900 mm diameter shall be welded internally and externally. At the time of internal welding, a 'V' cut is made from inside of the pipes and after completing the internal welding with the required number of runs, the external welding (sealing run) is incumbent. Before starting the external welding (sealing run), the internally welded material in the joint will have to be cleaned by Gouging with Gas Flame. Gouging shall be done before starting the external welding (sealing run) and the rate of welding shall include the cost of gouging also. "Gouging will also be carried out before rectifying the defective welding wherever necessary and as directed by the Engineer.

(d) Procedure

The welding of pipes in the field shall comply with I.S. 816 and I.S. 823 (Latest Revisions). No field welding shall be permitted if there is rain or high wind.

Openings in the laid pipeline in the form of manholes made at suitable distances, for access into the pipeline for the work of cleaning, painting and repairs to the welds, etc. shall be closed by welding a new patch on the opening.

Such manholes should, as far as possible, be provided at the sides of pipelines; cutting at the crown of the pipe should be avoided. The following procedure should be strictly adopted while plugging the manholes by patch plating:

- (i) The manholes shall be plugged by providing a patch plate cut from a separate strake of pipe of the same diameter. The old plate cut from the pipeline shall not be used for this purpose.
- (ii) The edges of the new patch plate shall be properly shaped and the plate inserted in the opening by keeping a gap of 1.5 to 2.5 mm and tacked.
- (iii) The welding of the patch should be done in segments with proper sequence conforming to I.S. 823.

(e) Testing of Welding Joints

- (i) The welded joints shall be tested in accordance with the procedure laid down in I.S. 3600 "Code of Procedure for testing of fusion welded joints and weld metals in steel". One test specimen shall be taken from at least one field joint out of any ten and shall be subjected to test.
- (ii) The test pieces shall be taken out from the positions pointed out by the Engineer without any delay. They shall be machined and tested in a week's time.
- (iii) The shape of the test pieces removed from the pipes shall be such that it will give a specimen of the required dimensions and, at the same time, leave a hole in the pipe with rounded corners. This hole shall be patched up by inserting and welding suitable size plates. Great care should be taken in preparing these plates so as to get a good butt weld. Procedure given in Clause 2.7.1117 (d) shall be followed.



(iv) After the jointing is completed, all protruding portions shall be chipped off and ground smooth and the unpainted portion of the pipeline near the field joint shall be thoroughly scraped and cleaned. Internal and external surface treatment shall be done as per the instructions of the Engineer.

(v) The entire cost of the test, including taking out test samples, machining the test pieces, transport to and from the laboratory and testing them in a laboratory, the cost of patching up the test piece hole in the pipe, payment of all testing fees, cleaning and painting the same, shall be borne by the Contractor. The tests shall be carried out in some Government or Semi-Government institute approved by the Engineer. This shall be arranged by the Engineer entirely at the Contractor's cost.

(vi) The following tests shall be made :

1. Tensile Test, : The test specimen taken across the weld shall be shaped in accordance with I.S. 823. The specimen shall be taken from the end of the pipe or at any field joint in the pipe as directed by the Engineer and shall be cut such that the weld lies approximately in the middle of the specimen length. The specimen shall be machined. The protruding welded portion from both inside and outside shall be removed by machining or grinding before the specimen is tested.

2. At least one field joint out of every ten shall be subjected to test by taking out a specimen. If a test specimen shows defective machining or develops flaws not associated with welding, it may be discarded and another specimen substituted. The welding joint shall show a strength not less than the minimum tensile strength specified for the plate.

3. Bend Test, : The bend test specimen shall be prepared in the same way as that for tensile test and tested in the presence of the Engineer. The specimen shall withstand being bent cold through 180° around a pin, the diameter of which is equal to 4 & 1/2 times the thickness of the plate, without developing cracks. In making the bend test, the side of the specimen representing the inside of the pipe shall be placed touching the pin.

4. Re-test, : If the results of the tensile or bend test of any lot do not conform to the requirements specified, retests of two additional specimens from the same section shall be made, each of which shall conform to the required specifications. In case of failure of one or both, extensive gouging (scooping out) and repairing shall be carried out as directed by the Engineer before the lot can be accepted.

(vii) The welder / operator shall be held responsible for any failure of the joint. Since factors such as current, arc voltage, quality of electrodes, etc. are already determined and controlled, the failure is due only to the carelessness and negligence of the welder. For the



first failure, the welder/operator shall be warned and for the second failure, he shall be removed from the work and replaced by another approved welder / operator. The joints or a portion thereof shall be gouged and repaired to the satisfaction of the Engineer. In order to maintain a good standard in welding, all welders shall be tested before they are entrusted with any job. Further, they shall be periodically tested at intervals of six months.

(viii) A complete record shall be maintained by the Contractor showing the names of welders and operators working on each individual joint. The work shall preferably be carried out by a pair of welders so that, by observing proper sequence, distortion can be avoided. A joint entrusted to a particular individual or pair shall be as far as possible completed by them in all respects, including the sealing run. No helper or other unauthorized unqualified person shall be permitted to do any welding work whatsoever. In case of any infringement, the person concerned shall be penalised as directed by the Engineer.

#### 2.7.1118 Precautions against Floatation

When the pipeline laid underground or above ground in a long narrow cutting gets submerged in water collected in the trench of cutting it is subjected to an uplift pressure due to buoyancy and is likely to float if completely or partly empty. In the design of pipelines, provision is made to safeguard against floatation providing sufficient overburden or by providing sufficient dead weight by means of blocks, etc.

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

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

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

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

#### 2.7.1119 Refilling Trenches

Trench Excavations shall normally be refilled using suitable materials selected from excavations carried out from the length to be refilled. Special requirements for bedding and backfilling around thin walled pipes are as follows:

On completion of the pipe laying operations in any section, for a length of about 100m and while further work is still in progress, refilling of trenches shall be started by the Contractor with a view of restricting the length of open trenches. Pipe laying shall closely follow the progress of Trench Excavation and the Contractor shall not permit unreasonably excessive lengths of trench excavation to remain open while awaiting testing of the pipeline (for field testing of pipeline refer Clause 2.7.8.5 of this Specification). 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. Only soft earth and murrum of good quality free from stones larger than 75 mm in size and free from boulders, roots, vegetation etc., shall be utilised after the lumps are broken for filling in around the pipes for atleast 30 cm all around for pipes less than 1200 mm diameter and D/4 for pipes greater than 1200 mm diameter. Filling shall be in layers not exceeding 150 mm and compacted to 25 percent of the maximum dry density as per part VII of IS:2720. The excavated material nearest to the trench shall be used first. 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 shall not be permitted unless the trench has been filled to height of atleast 30cm over the top of the pipe except as may for tamping etc., during backfilling work.

The remaining portion of the trench may be filled in with a mixture of hard and soft material free from boulders and clods of earth larger than 150 mm in size if sufficient quantity of good earth and murrum are not available. Filling in shall be done in layers not exceeding 225 mm in thickness accompanied by adequate watering, ramming etc., so as to be compacted to 95% of the maximum dry density as per part VII of IS:2720. Water contents of the soil shall be as near the optimum moisture content as possible. The trench shall be refilled so as to build up to the original ground level, keeping due allowance for subsequent settlement likely to take place.

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 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 2m.

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

If any material remains as surplus it shall be disposed of as directed by the Engineer. If the Contractor fails to remove the earth from site within the period specified in a written notice, the Engineer may arrange to carry out such work at the Contractor's risk and cost or may impose such fine for such omission as he may deem fit. Particular care shall be taken to keep the trench dry during the entire refilling operation.

If suitable material for refining 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.

Subsidence in Filling in: Should any subsidence take place either in the filling of the trenches or near about it during the maintenance period of 12 months from the completion of the Contract works, the contractor shall make good the same at his own cost or the Engineer may without notice to the Contractor, make good the same in any way and with any material that he may think proper, at the expense of the Contractor. The Engineer may also, if he anticipates occurrence of any subsidence, employ persons to give him timely notice of the necessity of making good the same, and the expenses on this account shall be charged to the Contractor.

#### 2.7.1120 Soft Refill Material - Special Measures

Where in the opinion of the Engineer, sufficient supplies of the aforesaid soft material for trench refilling cannot reasonably be obtained from Trench Excavations of the length of trench to be refilled without resorting to sieving or other special means, then the Engineer may order the Contractor.

- (a) to carry out such work as may be necessary to sieve out stones, or
- (b) to transport suitable soft material from Trench Excavations at distances from the length to be refilled ("overhaul"), or
- (c) to excavate soft material from suitable borrow areas and transport it to the length of trench to be refilled.

The Contractor shall carry out any or all of these above mentioned items as directed by the Engineer.

2.7.1121 Surface Reinstatement in Fields, etc.

After he has refilled Trench Excavations in fields and grass verges in the manner and to the level specified, the Contractor shall replace all Topsoil previously removed and it shall be evenly distributed and levelled over the full extent of the stripped area. Such of the working areas occupied by the Contractor as were originally down to grass shall be sown with grass seed of equivalent quality and maintained until the new grass is properly established.

Other areas not originally down to grass shall be dressed with suitable fertilizers harrowed in so as to restore the original level of fertility.

2.7.1122 Surface Reinstatement in Roads and Footpaths

Surface reinstatement of refilled Trench excavations in roads and footpaths shall consist of approved backfill material which has been well compacted and brought up to the subgrade level of the adjacent road surface. The balance portion shall be made good with similar material as that of the adjacent road, and shall be so maintained (including topping up when necessary) until the end of the Defects Liability Period or until remain over for permanent reinstatement by the appropriate authority, whichever is sooner.

2.7.1123 Other Structures along the Pipeline

The contractors shall be held responsible for adopting every precaution which may be necessary for protecting any structure or mains or appurtenances which are likely to be damaged during the execution of work. If the Engineer requires the adoption of any special measures or precautions, the contractors shall do so forthwith. This however does not absolve the contractors of their responsibility or liability in this regard. No extra payment shall be made for any such measures taken by the contractors.

The Contractor shall carry out further excavation as may be necessary to accommodate structures such as anchor blocks and valve chambers. Such excavation shall include for disposal of surplus material and where appropriate, for backfilling round the structures.

2.7.1124 Land Drains

Where land drains, mole drains or field drains are severed by Trench Excavation they shall be kept in effective temporary operation during construction of the pipeline.

At the appropriate stage of refilling the Trench Excavation, the drains shall be permanently restored as follows:-

The drain on either side of the Trench Excavation shall be cut back for at least 300 mm and a suitable length and diameter of pitch fiber or other approved pipe shall be jointed to the existing drain and laid resting at the ends on solid ground with clay or other stopping to prevent the subsequent run of land drainage water into the pipe trench. During trench

refilling, earth shall be carefully placed and thoroughly compacted under the drainpipes to give them adequate support.

No separate payment shall be made for the items covered under this clause unless otherwise specified in the bill of quantities.

#### 2.7.1125 Existing Service

Where Trench Excavation is carried out close to or across the line of sewers, pipes, cables and other services, the Contractor shall, where necessary, provide temporary supports or slings and where such sewer, pipe, cable or other service is temporarily disturbed it shall be replaced.

Where, in the opinion of the Engineer, construction of the pipeline cannot reasonably be carried out unless the sewer, pipe, cable or other service is permanently severed or permanently diverted or permanently supported by concrete he shall order the Contractor to undertake such work.

Notwithstanding any relevant information furnished by the Engineer, the Contractor shall be responsible for ascertaining from his own inspection of the site and from the respective supply authorities and other public bodies the positions of all mains, pipes and cables whether underground or overhead, within or near the Site.

No separate payment shall be made for the items covered under this clause unless otherwise specified in the bill of quantities.

#### 2.7.1126 Hedges, Fences and Walls

Where the Trench Excavation crosses barriers such as hedges, fences and walls, the Contractor, as a temporary measure during construction of the pipeline, shall provide temporary fencing for any parts of such barriers as have had to be removed.

After Trench Excavation has been reinstated, the Contractor shall carry out such work as the Engineer may order for permanent restoration of such barriers.

#### 2.7.1127 Crossing Watercourses etc.

Where the pipeline crosses rivers, culverts and other watercourses, the Contractor shall be deemed to have allowed for all the additional measures necessary for the proper construction of the pipeline at these crossings including maintaining the full flow of water across the trench.

#### 2.7.12 Cleaning, Disinfecting And Commissioning Of The Pipeline

Upon completion of a newly laid main, the main shall be disinfected as directed by the Engineer.

The main shall be flushed prior to disinfection except when the tablet method is used. After initial flushing, the hypochlorite solution shall be applied to the water main with mechanically or electrically powered chemical feed pump designed for feeding chlorine solutions. For small applications, the solution may be fed with a hand pump.

In the case of main of large diameter, water from the existing distribution system or other approved source of supply shall be made to flow at a constant measured rate into the newly laid pipe line. The water shall receive a dose of chlorine also fed at a constant measured rate. The two rates shall be proportioned so that the concentration in the water entering the pipe line is maintained at no less than 300 mg/l. The chlorine shall be applied continuously and for a sufficient period to develop a solid column of 'slug' of chlorinated water that will asit passes along the line expose all Interior surfaces to a concentration of at least 300 mg/l foratleast 3 hours. As the chlorinated water flows past tees and crosses related valves and hydrants shall be operated so as to disinfect the appurtenances.

In the case of newly laid mains in which scrupulous cleanliness has been exercised the tablet method can be adopted and in this method, the initial flushing is dispensed with. The calcium hypochlorite tablets are placed in each section of pipe and also in hydrants, hydrant branches and other appurtenances. The tablets shall be attached by an adhesive and must be at the top of the main. The main shall then be filled with water and the water shall remain in the pipe for atleast 24 hours.

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the mains is not higher than that generally prevailing in the system or less than 1 mg /l .

After final flushing and before the water main is placed in service, a sample or samples of water shall be collected from the end of the line and tested for bacteriological quality and shall show the absence of coliform organisms. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples are obtained before the main is placed in service.

The Contractor is expected to carry out the disinfection work as a part of laying the pipes and his rates for laying the pipes should include the disinfection and other connected works till the main is placed in service, unless otherwise specified in the schedule.

No separate payment shall be made for the items covered under this clause.

2.7.13 Deleted.

2.7.14 Clearing the site on completion

In case of pipes, specials, etc become surplus in any section the contractor shall forthwith remove the same to the next section for use in the work. On the completion of the whole work, however, if any pipes and specials, etc become surplus and are stacked on the site, they should be removed from site immediately.

Similarly any mild steel scrap which may result during the process of pipe laying shall on completion of the whole work be collected by the contractors and shall be removed from site immediately.



Where any pavements, trees, shrubs, fencing poles or other property and surface structures have been damaged, removed or disturbed during the course of work, the same shall be replaced or repaired after completion of the work and restored to a condition equal to that before the commencement of the work.

On the completion of the whole of the work, the contractors shall clear the site of all rubbish, building materials, debris, excavated stuff, etc and restore the work site to its original condition, neat tidy, clean to the satisfaction of the Engineer, and handover the same to the Engineer. No Extra Payment shall be made to the Contractor for these works and the rates for laying the pipes shall cover the cost of loading, transporting, and unloading the surplus material on the site.

#### 2.7.15 Guniting for Pipelines

##### 2.7.1401 General

Portions of the pipelines to be laid underground shall be out coated with gunite. The guniting is to be carried out at the site of laying by supporting the pipe temporarily above the ground. Care shall be taken to see that the pipes are perfectly circular while the outcoating is to be given.

This shall be done by providing adequate number of spiders. Spiders should not be allowed to be dislodged until the pipeline is laid in position in the trench and jointed.

The gunite shall be done at least 24 hours before the pipe is lowered into the trench. The thickness of gunite shall not be less than 40mm.

##### 2.7.1402 Reinforcement

The reinforcement used shall conform to IS1786:2008. The reinforcement shall be bent to proper shape to conform as neatly as possible to the surface of pipe to be encased and it shall be securely held about 20mm out from the surface of the pipe by means of spacers made from cement mortar (1:1) and binding wire. Spacers should be placed at least 300mm both ways.

##### 2.7.1403 Proportion of Mix

The proportion of cement and sand shall be 1:3.5 by volume.

##### 2.7.1404 Procedure

Before guniting all the steel surfaces shall be thoroughly cleaned of paint, rust, scales, grease, loose or disintegrated concrete or such other material as are likely to impair the bond between the surface to be encased and the gunite.

The pressure in the lower chamber of the cement gun shall be sufficient to produce a nozzle velocity of 115/150 metres per second when a tip with 19mm opening is used. The velocity shall be steady at all times.

The compressor used shall be of adequate capacity to maintain a pressure of at least 2.8kg/sqcm at the gun end.

The nozzle shall be held at such a distance (0.67 to 1.0 metre) and position that the stream of flowing materials shall impinge as nearly as possible at right angles to the surface being gunited. All deposit of loose sand shall be removed prior to placing any layer of gunite. Should any deposit of sand be covered with gunite, this gunite shall be removed and redone. The gunite shall be shot in one coat to the proper thickness. At the edge of any section where the operations are more or less temporarily suspended, the gunite shall be brought to a tapered edge extending back for not less than 300mm. Prior to placing the gunite on the adjacent section the upper surface of this tapered edge shall be cleaned by scraping and cleaning away all rebound and washing down with water and air blast. No right angle joints shall be allowed in gunite.

The contractors shall provide proper arrangements for blowing all rebound from the area being shot. No gunite shall be placed over rebound and in such case of such conditions arising; the contractors shall remove at their own cost any gunite so placed. Rebound material shall be deposited in mounds and removed from the site of work at places directed by the Engineer. Any rebound falling in the trench shall be removed if it interferes with the pipe laying work. To remove the rebound the surface of the gunite shall be carefully cleaned with an air jet and suitable tools at such periods after shooting as the engineer may deem advisable. In no case, however, shall the rebound remain on the completed surface for more than 12 hours. The scraping of rebound must be done in such a manner as not to disturb gunite and to provide a uniform and proper finish to the surface.

The contractor shall employ experienced men for this work. No nozzle man will be deemed experienced unless he has done considerable work previously, where the work was of a similar type or has otherwise proved his qualifications to the satisfaction of the engineer by experience on other equally important work.

The work shall be supervised by properly trained foreman of the contractors. No one shall be considered as capable of acting as foreman on a job if he has not had active charge of placing gunite lining previously.

#### 2.7.1405 Curing:

The gunite shall be kept thoroughly wet for a period of at least ten days after guniting.

#### 2.7.1406 Measurement and rates

The unit of measurement shall be square metres. For the purpose of measurement, area shall be calculated on the assumption that the diameter is 80mm larger than the diameter of steel pipe. The rate includes cost of all work, labour, supply of materials including providing and fixing of reinforcement, providing and fixing of spacers, removing and stacking of rebound, etc and also guniting of joints in trenches.

#### 2.7.1407 Encasement for Pipelines

At locations specified by the Engineer, concrete encasement shall be provided for the pipes with with/without reinforcement. The grade of concrete shall be as specified in Bill of Quantities. Where specified, F1 class formwork shall be used for encasement. For detailed specifications of concrete, reinforcement and formwork refer Common and building construction works specifications.

## **2.8 Above Ground Pipelines**

### **2.8.1 Scope**

This specification covers supply, fabrication, testing, delivery at site, laying, erecting and jointing of above ground pipelines. This will involve the required steel pipes, bends, tapers, wye branches, ring girders, expansion joints, stools, base plates, rollers, grease box covers, appurtenances, distance pieces, flanges, collars, etc.

### **2.8.2 Fabrication of Pipes, Specials, etc**

For Fabrication of Pipes, Specials, etc mentioned in clause 2.8.1 reference may be made to the following clauses 2.7.2 to 2.7.5 under "Buried Pipelines".

#### **Ring Girder and ring Girder Supports**

The ring girder support shall consist of the following:

(a) Ring Girder: A ring girder shall consist of a rolled steel section (channel) reinforced or strengthened by steel flats or plates when necessary as per details shown in the drawing. The MS Channel shall be rolled /bent to the exact curvature, taking due care to see that there is no distortion whatsoever in any direction or in any of the dimensions thereof. In channels, extra pieces of channel may be welded before commencing the rolling. No extra payment shall be made for this purpose. In case the channel sections of the required size are not available, the contractors shall have to fabricate the required section out of the plates, angles, flats, etc as per the detailed drawings and details to be approved by the Engineer. The rates quoted by the contractors shall be same for the ring girder fabricated from the plates, flats etc.

(b) Stools (Ring Girder Supports): Stools shall be fabricated from MS Channels and or flats as shown in the relevant drawing. For fabrication of stool, specials, jigs shall be made to ensure that no deformation take place during welding. Stools shall be stacked properly in the contractor's yard until they are taken to pipe-laying site. If any of the stools are found to have lost shape and /or developed any other fault, while they are stacked or during handling inside the yard, the contractors shall carry out necessary repairs at their cost to rectify the defects before transporting them to site.

(c) Rollers: At all supports except fixity and end supports M.S Rollers shall be used. The pipeline has been designed assuming a coefficient of friction of 0.02 between the plates and rollers. The rollers shall therefore be straight, accurately machined, clean free from any rust, stains or incrustations.

M.S Rounds for the M.S Rollers shall be procured by contractors. The rollers shall generally be as per drawings and sketches provide by the Engineer. The grooves and surfaces of rollers shall be formed by accurate machining. The diameter of rollers procured shall be atleast 3 mm more than the specified finished diameter. The rollers should be assembled to form a set as shown in the drawings. After assembly, the rollers shall be oiled and stacked carefully in their yards, till delivery of the same is taken to the pipe-laying site.

(d) Base Plates: Base Plates shall be cut from M.S. Flats or M. S Plates to the dimensions shown in the drawing. They shall have slotted holes, guide bars for rollers, etc as shown in the drawing. The top surfaces shall be ground and machined to obtain an even surface. They shall be oiled and stacked under cover in the contractor's yard until their delivery to the pipe laying site.

(e) Bolts for ordinary & fixity supports: For fixity supports, the contractor shall provide bolts as per drawing. These are to be fixed in the pedestal columns while casting the pedestals. For roller supports, the contractor shall provide ragged bolts as per drawing. These will be grouted in position in the pedestal columns at the time of casting the same during laying operation.

The contractor shall fabricate both type of bolts from the steel materials such as bars and rounds, procured by the contractors under the present contract. The fabricated bolts shall be stacked separately in the fabrication contractor's yard until transported to the pipe laying site.

(f) Grease box covers: To protect the roller bearings from the effects of weather and to prevent entry of dust, dirt, grit, etc grease box covers shall be provided as per details shown in the drawing. These shall be fabricated in halves by the contractors from M. S. Plates or black sheets procured by the contractors.. If it is necessary to weld the grease boxes, gas welding shall be resorted to. The grease box covers shall be stacked in contractor's yard under the shed until transported to the pipe laying site..M.S sheets or black sheets in coils can be used for fabrication of grease box covers. The contractors shall have to straightenthe same at the time of fabrication. No payment shall be made separately for straightening ofthe coil into sheets.

#### Expansion Joints

Steel plates and flats required for the manufacture of expansion joints shall be procured by the contractor at their cost. The contractors shall also have to make their own arrangements for procurement of materials other than above for manufacture of bolts, nuts washers etc, required at their own cost. All parts shall be manufactured true to shape and sizes as shown in the drawings. All contact surfaces shall be properly machined and finished smooth to ensure smooth working of the joint. The joints shall be assembled without undue hammering or forcing in to avoid damage to any part thereof. The packing material to be supplied by the

contractors to be used in the expansion joint shall be of synthetic rubber ring packing which shall be capable of withstanding atleast twice the test pressure and shall have high compressibility and properties to with stand deterioration by abrasion or water action.

Specifications for self sealing rubber packing for expansion joints are as follows

- i) Self sealing rubber packing shall be of good quality neoprene or polychloroprene type rubber having shore hardness 65mm to 75mm (+5) as per I.S 3400 an shall be resistant to heat, oil, acid and alcoholic material.
- ii) Size of sealing rubber packing shall be shown as shown in the drawing and shall be of required length so as to have only one joint.
- iii) One sample piece of each type of rubber ring shall be submitted for approval before procuring the self sealing rubber pickings.
- iv) The quality and grade of material for self sealing rubber packing shall be confirming to the requirements as shown in table below:

Sr.no.	Property	Outer End Ring	Intermediate Ring	Inner End Ring	Inner O Ring
1	Hardness 1* IRHD	65+or-5	55+or-5	75+or-5	75+or-5
2	Tensile Strength kg/sq.cm.min <sup>2</sup>	100	120	150	150
3	Elongation @break min <sup>2</sup>	350	350	300	300
4	Compression set max (22 Hr @ 70 degrees) 2 *	30	15	30	30
5	Hardness change in original IRHD	+or-7-0	+or-7-0	+or-7-0	+or-7-0
6	Tensile strength % change max	15	25	20	20

1\* -Testing to be performed as per IS:3400 part II

2\*- Testing to be performed as per IS: 3400 part X

- v) The material shall be tested at any Govt. approved laboratory at the cost of the contractors and submit the test certificate for the quality and grade of the material as mentioned above. If the test reports are not satisfactory, the entire lot will be rejected.

Contractors shall not provide self sealing rubber packing to the expansion joints before the test certificate from the approved laboratory are submitted to the Engineer in charge.

- vi) One set of self sealing rubber packing shall consist of 6 different rubber rings and shall be packed in a polythene bag of adequate thickness and shall be treated with suitable preservative powder before packing in polythene bags for storing the packing safely till providing to the expansion joints.

For dispatch to the site, the expansion joint shall be assembled with steel ring without other packing, using four bolts and nuts only in a locked position. The machined surfaced shall be greased before assembly. The remaining bolts, nuts and washers and the packing material including rubber ring shall be delivered separately by the contractors at the site of laying along with expansion joints.

The expansion joints shall be true in all respects of manufacture. If any manufacturing defect is noticed after its transport and /or erection at site, the contractors shall carry out all necessary repairs either at site or at their factory as directed by the Engineer. All expenses in this connection including its removal, transporting to and fro from the site of work and re- fixing shall be borne by the contractors. The responsibility as regards the defects noticed shall be determined by the engineer and his decision shall be final and binding on the contractors.

The expansion joints shall be properly stacked in the contractor's yard on a raised platform until they are delivered at the site of pipe laying.

The contractor shall also fabricate M.S Protective covers as per drawings and as directed. The contractors shall transport the M.s protective covers separately which will have to be fixed after the hydro testing of the pipeline is carried out. Contractor's shall not be allowed to provide M.S protective covers to the expansion joints before hydro testing the pipeline.

#### 2.8.3 Testing of Pipes & Specials

For Testing of Pipes and Specials like bends, tapers and wye branches, mentioned in clause 2.8.1 reference may be made to clause 2.7.512 under "Buried Pipelines".

#### 2.8.4 Transportation, Handling, Stacking and Inspection

For Transportation, Handling, Stacking and Inspection of Pipes, Specials, etc reference may be made to clause 2.7.6 under "Buried Pipelines".

#### 2.8.5 Laying of Pipelines

##### 2.8.501 General

Before commencing the work of pipe laying, the contractors shall study the Longitudinal Section of the pipeline for the section concerned, and shall also study the details of the type of pedestals to be provided before the actual work of casting is taken in hand.

The Engineer shall give the contractors the detailed working drawings showing the positions of the pedestals to be cast in the section, the formation of which is ready for laying the pipeline. Pipe laying shall generally start from the fixity points on either side, the expansion joint being provided last. Fixity points are at all anchor blocks and deflection blocks.

Where such blocks are not required for long lengths, fixity shall be achieved by bolting the pipeline to the special type of R.C.C. or steel pedestals.

Deflection blocks shall be constructed before commencing the pipe laying work in any section.

The construction of the blocks shall be carried out in ' 3 stages, in the first stage,



construct the lower part up to 150mm. below the invert of the pipeline including concrete chairs to support it, in the second stage lay the pipeline on this part of the block and lastly, construct the remaining block around and over the pipeline.

Generally the distance between successive fixity points shall not exceed about 300 metres. Normal fixity points shall be created by providing bolts in the R.C.C. columns of the pedestals. A fixity point shall consist of three successive pedestals constructed at a distance of about 10.8metres centre to centre. Full details of the central fixity points and end fixity points shall be shown in the relevant drawing. These fixity pedestals and ordinary pedestals shall be cast atleast 3 weeks before the pipeline is laid on them. After the pedestals between successive fixity points have been cast, a line plan showing the actual position thereof shall be prepared, after taking levels and measuring distances. The pipe laying work shall then start from the fixity points and shall proceed towards the Expansion Joints. Every alternate pipe shall have a ring girder attached on the central strake. A pair of such pipes when jointed together at site shall provide the full length from pedestal to pedestals. The method of joining these pipes and erecting them on the previously cast R.C.C. pedestals shall be determined by the Contractors in consultation with the Engineer, depending upon the type of plant and equipment, personnel available with them.

The pipe strakes shall be assembled in position on the pedestal either by cranes, portable gantries or shear legs or any other method of equipment approved by the Engineer. Normally not more than two pipes shall be aligned, tacked and kept in position on temporary supports. The contractors shall not proceed with further work, until the circumferential joints of these pipes are fully welded. During assembly, the pipeline shall be supported on wooden sleepers and wedges with the free end of the pipeline held in position by slings to avoid deflection due to temperature variation during the day. In general, the assembly of pipe strakes and one run of welding shall be done during the day time while full welding including the external gouging and sealing runs shall be done after 5 p.m. or so. The contractors 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 contractors shall proceed with the work of providing permanent supports for the pipeline assembled and welded previously. The work shall consist of supporting the pipeline on concrete pedestals by fixing stools and roller bearings, etc. as described below.

The contractors shall fix the base plates and bolts in position for the pipes, the joints of which are fully welded. The rollers shall then be inserted. The stool with rack and pinion arrangement fixed in correct position to its bottom, shall then be fixed to the ring girder after checking the level of the pipe invert. In case the pipeline has a gradient, the base plate shall be adjusted by providing mild steel shims of suitable thickness. Before transferring the load

of the pipe to the pedestals by removing the temporary supports, the base plates shall be secured in their true position. The maximum eccentricity between the centre of the base plate and the centre of the stool shall not exceed + 6 mm. at the ambient temperature of about 26.6° C (80° F).

The contractors shall ascertain the actual eccentricity of the Ring Girder relative to the base plate centre and shall apply correction in further work to ensure that the error is not carried forward. Only after this is done, the bolt and the base plates may be grouted and further work proceeded with.

The rollers of two supports on either side of the expansion joint shall be of cast iron with roller bearing fixed, to the stools. For other normal supports, mild steel rollers with rack and pinion arrangement may be used. Unlike the cast iron roller sets, the latter-type of rollers are not fixed to the stools. They are supplied separately and shall be fixed in position by the contractors during pipe laying. Also, the racks which are supplied separately by the factory, shall be fixed by the contractor to the bottom of the top plate which is attached to the stool.

Before inserting any expansion joint the temperature of the pipe shell shall be recorded with the help of mercury cups and thermometers which shall be provided by the contractor. The contractor shall also record the axial and transverse deflection of the free end as well as the eccentricity of the stool with respect to the base plate, if any, at each pedestal measured at 26.6°C (80°F).

If at 26.6° (80°F), any of these rollers are found to be eccentric beyond the permissible limit, the contractors shall apply correction either by shifting the position of the base plate or by any other method approved by the Engineer on site. Also, before fixing the expansion joint, the contractors shall ascertain that all the load of the pipeline is transferred to the pedestals through rollers, and that there is no gap left in between the bottom of the stools and the top of the rollers. Any correction required to be done should be done before the expansion joint is fixed in position.

#### 2.8.6 Expansion Joints

##### 2.8.601 Procedure for fixing Expansion Joint

The work of laying pipeline as a rule starts from fixing points towards the expansion joint. It should be continued until the gap between the pipe end is less than the lengths of expansion joint plus pipe stake length. At this stage, the exact gap between the pipe ends should be measured at 26.6°C (80°F). Let it be 'X' similarly exact length of the pipe stake and the expansion joint brought on site should be measured at 26.6°C (80°F). Let these be 'Y' and 'Z' respectively. Normally, the length of the expansion joint (equal to 'Z') is standard as per drawing.

Case-1: When 'Y' plus 'Z' is more than 'X' or equal to 'X' (i.e. fixing of expansion joint without strap)

*Pipe (B) should be laid in position. At 26.6°C (80°F) the exact gap between pipes (B) and (C) should be measured.* Free, ends of pipes should be brought in a correct line and level; lateral movement, if any, should be corrected. Then the gap between the free ends should 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 point of view of bringing the expansion joint to a central position.

The expansion joints are normally supplied without packing. The normal length of the expansion joint should be reduced by about 100mm. by cutting the inside locks & inserting the inner strake by means of turn-buckles. At 26.6°C (80°F), this expansion joint should be inserted inside the gap (care being taken to keep the taper portion on the downstream side), *and one end should be tack welded to pipe (C) and the other end should be tack welded to the other pipe (B) after pulling the expansion joint.* (Tacks of these two joints should be of longer length approx.100mm. long).

Welding of these two joints of expansion joints should 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 below.

Case-2 When 'Y' plus 'Z' is less than 'X' (i.e. fixing of expansion joint with Strap)

*The expansion joint should be laid in locked position. Before laying the pipe, the exact gap between pipes (A) & (B) after it is laid should be calculated by taking measurements of the pipe (B) and the gap between the expansion joint and pipe (A) at 26.6°C (80°F).*

If the gap is less than 100mm, the pipe (B) should be cut to make the desired gap of atleast 100mm. If the gap is more than 200mm, suitable distance piece of not less than 0.6 metres should be inserted after cutting necessary length of pipe (A).

Pipe (B) should be then laid in position. Then a strap of length equal to three times the gap length should be welded to pipe, overlapping the pipe (B) by the gap length. The other end of the strap should be kept free.

At 26.6°C (80°F), the other end of the strap should be tacked to pipe (A) after checking the line and level. Simultaneously, remove all the locks of expansion joint and chip them off properly.

Welding of the joints between the strap and pipe (A) should be started only' after the observations are over and it is ascertained that the expansion joint is functioning properly.

Observations

Before fixing the expansion Joint, two mercury cups-one on the left and the other on the right side-should be fixed on the pipe near the upstream side of the expansion joint.

Immediately after the expansion joint in case (1) or the strap in case (2) is tack-welded, observations for total expansion or contraction and lateral movement should be started and

continued for 48 hours round the clock. Similarly the Central and end fixity pedestals should be kept constantly under observation.

The expansion and contraction should be measured by making a temporary marking on the inner strake (on the upstream side) and measuring the distance between this mark and the edge of the gland of the expansion joint.

The lateral movement is measured by measuring the distance between the edge of the C.I. roller set and the edge of the base plate.

The observations should be recorded in the following proforma:

Reading No.	Time	Shell Temp. on East side	Shell Temp. on West side	Atmospheric Temperature
1	2	3	4	5
Distance between edge of gland and marking				
Distance between edge of roller set & edge of base plate on upstream side				
Distance between edge of roller set and edge of base plate on downstream side.				

If any defects are noticed after its erection at site, the Contractor shall carryout necessary repairs either at site or at their works as directed by the Engineer. All expenses in this connection including its removal, transporting and re-fixing shall be borne by the contractor. The responsibility as regards the defects noticed shall be determined by the Engineer and his decision shall be final and binding on the Contractor.

Hydraulic testing of pipelines shall be conducted in accordance with relevant IS codes for the water tightness of expansion joints. The expansion joints shall prove to be sound and water tight at the time of testing. Any leakage shall be stopped by normal tightening of bolts on the gland.

The rates for expansion joints shall be inclusive of steel plates and other materials required for fabrication, installation, painting and testing.

#### 2.8.7 Anchor Blocks

Anchor blocks shall be provided at horizontal bends, vertical bends or/and at intervals on pipelines with gradients in excess of 1 in 6, at other locations as ordered by the Engineer. The anchorages shall be made from concrete and constructed to the dimensions shown on the Drawings. Where faces of anchor blocks are shown to bear against undisturbed ground,

the Contractor shall take all necessary measures to ensure that such bearing is given over the full dimensions shown.

Curves formed by welded bends and pipe lengths will not require anchoring unless specifically shown in the Drawings.

Welded pipelines shown on the Drawings as having tied couplings and flanges shall require anchor blocks only at the positions specifically noted on the Drawings.

#### **2.8.8 Flexible Joints**

Pipelines entering and leaving certain structures shall include two flexible joints, at distances from the face of structure as shown on the Drawings or as identified by Engineer.

#### **2.8.9 Vertical Thrust Blocks**

Vertical thrust blocks shall be located wherever there is a transition between above ground and buried pipelines. The Contractor shall undertake the construction of the thrust blocks as early in the programme of work as is practical and at least six months prior to the installation of the above ground pipeline, in order to reduce the risk of settlement of imposing additional loads on the pipeline supports.

Where possible the base of the thrust block shall be cast against solid rock in order to prevent any settlement. Any material overlying the rock shall be excavated and replaced with class M15 mass concrete. In the event of no rock being encountered the base of the thrust block shall be cast against undisturbed ground. Any ground which in the Engineer's opinion is unsuitable shall be excavated and replaced with class M15 mass concrete.

#### **2.8.10 Saddle Supports**

Where the Pipes are to be laid on continuous saddle supports (continuous over base of pipe) the pipe shall be erected at 26.6°C (80°F). The saddle support shall have a reinforcement plate, for the part circumference of the pipe base that will make contact with the saddle.

Pipes may also be laid on concrete saddles supported on pads at four locations separated by drainage gulleys formed in concrete, spread over an arc subtending an angle of 120°C at the centre of the pipe, if so indicated on the drawings.

### **2.9 Pipeline Civil Works**

#### **2.9.1 Scope**

These specifications cover Civil works for all welded mild steel pipeline underground as well as above ground.

The main works covered under these specifications are:-

1. Site clearance
2. Earthwork includes :
  - a. Excavation in trenches for laying of pipelines, etc
  - b. Excavation for foundation of blocks, pedestals, etc

c. Cutting down and levelling of Hill etc.

### 2.9.2 Site Clearance

#### 2.9.201 General

All areas of the Site falling within the area marked for site grading and excavation or from which material is to be excavated or upon which filling is to be deposited, as directed by the Engineer shall be cleared by the Contractor to the extent required by the Engineer, of all buildings, walls, gates, fences and other structures and obstructions and of all bushes, hedges, trees and stumps (of girth upto 300mm), roots and other vegetation except for trees marked for preservation and trees with girth greater than 300mm. Material so cleared shall so far as suitable be preserved and stacked for further use but shall otherwise be burnt to ash or disposed off the Site as directed by the Engineer.

#### 2.9.202 Trees

Where directed by the Engineer trees shall be uprooted or cut down as near to ground level as possible. Useful timber, branches and foliage shall be heaped separately for measurement/weighing. Branches and foliage shall be disposed off the Site by the contractor. The contractor shall take possession of Useful Timber and shall make arrangement for weighing the same in presence of the Engineer on priority basis. The useful timber shall be disposed off by the contractor as directed by the Engineer.

#### 2.9.203 Transplantation of Trees

Where directed by the Engineer, trees shall be uprooted without damages by excavating trench around the trees and safely transported to the location for re-plantation.

#### 2.9.204 Stumps

Stumps and roots whether existing or remaining after tree felling shall where directed by the Engineer be grubbed out and disposed off the site. The resulting hole shall be filled with approved material deposited in 225 mm layers and compacted to the same dry density as the adjoining soil.

#### 2.9.205 Forestry Regulations

The Contractor shall familiarise himself with all local rules and regulations governing land clearance including the special requirements for forestry areas and shall carry out his work in strict compliance with all such requirements.

#### 2.9.206 Measurement of Site Clearance

Items in the Bill of Quantities for Excavations shall include for clearing the Site, including felling of trees and grubbing up of stumps of trees of girth less than or equal to 300 mm. Work involving breaking of concrete or brickwork during site clearance shall be paid separately as per items in the Bill of Quantities.



Items for felling trees exceeding 300 mm girth shall include for felling, cutting up, and stacking as directed by the Engineer. Trees shall be classified for measurement according to their girth measured at 1.5 metres above mean ground level. Separate measurement will not be made for trees with girth less than 300 mm. Items for felling trees shall also include for grubbing up and disposal off the Site of stumps and roots and for filling up the resulting hole all as directed by the Engineer.

### 2.9.3 Earthwork

#### 2.9.301 Excavation in trenches for laying of pipelines, etc

The specifications under this item shall be read in 2.7.11

#### 2.9.302 Excavation for foundation of blocks, pedestals, etc

Excavation in trenches for foundation of blocks, pedestals, etc shall generally be taken as shown on drawings or as directed by the Engineer. If for any reason the dimensions of trenches are required to be altered either to suit the peculiar site condition or any special work, the same shall be done after obtaining permission of the Engineer.

The excavation shall be carried out only up to the formation level and no payment for excavation below the formation level shall be made.

For purpose of payment of excavation under this clause original ground levels must be taken and if rock is met with subsequently again the rock level shall be taken. The quantity of excavation shall be worked out on the basis of these levels and the sizes of excavation as mentioned in the drawings.

Where rock is met within the depth specified on the drawings the same shall be excavated as per provisions of clause 2.7.1107.

#### 2.9.303 Cutting Down and Levelling the Hill etc,

The top of the high ground shall be cut down and levelled to the required formation. The sides of the edges shall be cut to the required slopes as directed by the Engineer.

The sides of the cutting shall generally have the following slopes for stability:

- a) 1:1 slope for excavation in earth, murrum, boulders, etc
- b) ½:1 slope for excavation in hard murrum and soft rock
- c) ¼:1 slope for excavation in hard rock

If however the strata met with can sustain safely steeper slopes than those mentioned above, such steeper slopes may be permitted with the prior written permission of the Engineer in charge of work.

For measuring the quantities of excavation, cross sections of suitable close intervals shall be taken by levelling instrument both before cutting the hill and again after the hill has been cut to the required formation level and the quantities worked out as per Simpson's Rule.

The quantity for excavation payable under this item shall be for excavation within the payment lines up to the formation level contained within the side slopes of the above

excavation only as described before or as directed by the Engineer. Any excess excavation in formation and along slopes beyond the payment lines shall not be admissible for payment except within marginal overcuts and undercuts specifies herein after. In case of excavation in rock by blasting, occasional over cuts and undercuts up to a depth of 200mm beyond the payment line shall be admissible for payment. For excavation in rock done by chiseling or wedging the permissible margin shall be 80 mm only.

All overcuts in the formation beyond these marginal limits specified above shall be made good by filling the same in concrete simultaneously while carrying out the work.

Normally a hill or high ground when cut yields good amount of filling material for embankment work. The excavated material thus found suitable shall be lead to embankments on either side of the cutting. A hypothetical center chainage shall be fixed by the engineer for fixing the free lead and extra lead for payment. The continuous chainage on either side of the cuttings shall be embanked with the excavated material. Only after the full quantity of usable excavated materials have thus been consumed, the contractors shall be allowed to use the remaining for their work.

The contractors are free to use any method of excavation either mechanical or manual. The rate mentioned under this item in the bill of quantities is same for either or both means. The excavated material shall be suitably classified by the engineer as useful for embankment, rubble for road metal, masonry etc. Any material found unsuitable shall lead to spoil banks. In case it is found that the quantity of over burden is more than the quantity of embankment, then suitable sites for dumping spoils shall be located and original ground level shall be taken after which the surplus material shall be lead.

If on the other hand, it is found that the quantity of embankment is more than the overburden then all the overburden shall be used in embanking. The contractor shall intimate in writing to the Engineer the necessity of outside earth for embanking.