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TERMINOLOGY

Air Gap:

The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or fitting supplying water to a tank or other device and the flood level rim of the receptacle in a water supply system.

Air Valve:

A valve that releases air from a pipe line automatically without loss of water, or introduces air into a pipe line automatically if the internal pressure becomes less than that of the atmosphere.

Available Head:

The head of water available at the point of consideration due to main's pressure or overhead tank or any other source of pressure.

Back Flow:

The flow of water into the distributing pipes of water system from any source or sources other than its intended source.

Back Siphonage:

The flowing back of used, contaminated or polluted water from a plumbing fitting or vessel into a water supply system due to a lowering of pressure in such system.

Ball cock

A faucet opened or closed by the fall or rise of a ball floating on the surface of water.

Ball Valve:

A simple non return valve consisting of a ball resting on a cylindrical seat within a fluid passageway.

Bell Mouth:

An expanded rounded entrance to a pipe or orifice.

Bend:

Length of pipe bend or cast into an angle shape.

Benching

The sloped floor of a manhole or an inspection chamber on both sides and above the top of the channel.

Bib Tap:

A tap with a horizontal inlet and nozzle bent to discharge in a downward direction.

Blister:

A raised portion of the surface protruding not more than one millimeter above the surface and not greater than 3mm in its greatest dimension.

Box Union:

A device for joining two threaded pipes.

Branch

(i) A special form of cast iron pipe used for making connections to water mains. The various types are called T,Y,T-Y, double Y, and V branches, according to their respective shapes.
(ii) Any part of a piping system other than a main.

Caulking:

(a) The process of driving, pouring or forcing lead, oakum, plastic or other material into a joint to make it leak proof.
(b) The material used in the caulking process.

Caulked Joint:

A spigot and socket joint in which the jointing material is compacted by means of caulking tool and hammer.

Channel:

The open waterway through which sewage, storm water or other liquid waste flow at the invert of a manhole or an inspection chamber.

Chase:

A continuous recess in wall, floor or ceiling for the purpose of holding pipes and conduits.

Cleaning Eye:

An access opening having a removable cover to enable obstructions to be cleared by means of a drain rod.

Connections:

The junction of a foul water drain, surface water drains with public sewer, cesspool soak-way or other water courses.

Collar

A pipe fitting in the form of a sleeve for jointing the spigot ends of two pipes in the same alignment.

Coupling:

A pipe fitting with inside threads only, used for connecting two pieces of pipe.

Craze or Crazing:

Fine cracks in the glaze.

Cross:

A pipe fitting used for connecting four pipes at right angles:

Curb, kerb:

The stone margin of a side walk.

Depth of Manhole:

The vertical distance from the top of the manhole to the outgoing invert of the main drain channel.

Deviation of Length:

Amount by which the design length may differ from the standardized length of a pipe.

Diameter: Diameter of pipes, specials, valves etc. shall be the nominal internal diameter of the pipes except for PVC/HDPE pipe for which the diameter of pipe will denote the outer nominal diameter.

Drain:

A line of pipes including all fittings and equipment, such as manholes traps, gullies and floor traps used for the drainage of a building, or a number of buildings or yards appurtenant to the buildings, within the same cartilage. Drain shall also include open channels used for conveying surface water.

Drainage:

The removal of any liquid by a system constructed for the purpose.

Drop Connection:

A branch drain of which the last length of piping of the incoming drain, before connection to the sewer, is vertical.

Drop Manhole:

A manhole incorporating a vertical drop for the purpose of connecting a sewer or drain at high level to one at lowers level.

Effluents:

(a) Tank Effluent: The supernatant liquid discharge from a septic tank.
(b) Filter Effluent: The liquid discharged from a biological filter.

Elbow:

A pipe fitting for providing a sharp change of direction in a pipe line.

Ferrule:

A pipe fitting for connection with the supply, measurement, control, distribution, utilization or disposal of water.

Fire Hydrant:

A device connected to a water main and provided with necessary valve and outlets, to which a fire hose may be attached for discharging water at a high rate for the purpose of extinguishing fires, washing down streets, or flushing out the water main.

Flange:

A projecting flat rim on the end of a valve, pipe etc.

Flanged Pipe:

A pipe provided with flanges so that the ends can be joined together by means of bolts.

Float Valve:

A valve in which the closure to an opening such as a plug or gate is actuated by a float to control the flow into a tank.

Fittings:

Coupling, flange, branch, bend, tee, elbow, union, waste with plug, P or S trap with vent, ferrule, stop tap, bib tap, pillar tap, globe tap, ball valve, cistern, storage tank, baths, water closets, boiler geyser, pumping set with motor and accessories, meter, hydrant valve and any other article used in connection with water supply, drainage and sanitation.

Gasket:

A piece of compressible material used to make a joint between two flat surfaces.

Gully Chamber:

The chamber built of masonry around a gully trap, for housing the same.

Gully Trap:

A trap water seal provided in a drainage system in a suitable position to collect waste water from the scullery, kitchen sink, wash basins, baths and rain water pipes.

Haunching:

Concrete bedding with additional concrete at the sides of the pipe.

Invert:

The lowest point of the interior or a sewer or drain at any cross action.

Inspection Chamber:

A water tight chamber constructed in any house drainage system which takes wastes from gully traps and disposes off to manhole with access for inspection and maintenance.

Interceptor Manhole:

A manhole incorporating an intercepting trap, and providing means of access thereto and equipped with a fresh air inlet on the upstream side of the trap.

Junction Pipe:

A pipe incorporating one or more branches.

Manhole (Manhole Chamber):

Any chamber constructed on a drain or sewer so as to provide access thereto for inspection testing or the clearance of obstruction.

Nipple

A tubular pipe fitting usually threaded on both ends and less than 300mm long used for connecting pipes or fittings.

Non Return Valve:

A device provided with a disc hinged on one edges so that it opens in the direction of normal flow and closes with reversal of flow.

Nominal Pressure PN:

A numerical designation expressed by a number which is used for reference purposes. All components of the same nominal size DN designated by the same PN number have compatible mating dimensions.

Nominal Size DN:

Numerical designation of size which is common to all components in a piping system. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.

Oakum:

Hemp or old hemp rope soaked in oil to make it water proof.

Offset:

A combination of elbows or bends which brings one section of the pipe out of line but into a line parallel with the other section in a piping system.

Ovality :

Out of roundness of a pipe section : it is equal to 100 (A_1 - A_2/A_1+A_2) where A_1, is the maximum axis and A_2 the minimum axis of the pipe cross-section.

Reducer:

A pipe-fitting with inside threads larger at one end than at the other. All such fittings having more than one size are reducers because of the custom of stating the larger size first.

Reflux Valve:

A non return valve used in a pipe line at a rising gradient to prevent water that is ascending the gradient from flowing back in the event of a burst lower down.

Rest Bend (Duck Foot Bend):

A bend supported in a vertical position by a foot formed at its base.

Scum:

The greasy and other substances floating on the surface of sewage.

Service or Supply Pipe:

Pipe through which supply is drawn from water mains.

Sewer :

A closed drain carrying night soil and other water borne waste.

Sluice Valve (Gate Valve):

A valve in which the flow of water is cut off by means of a circular disc, fitting against machine-smoothed faces, at right angles to the direction of flow. The disc is raised or lowered by means of a threaded stem connected to the handle of the valve; the opening in the valve is usually as large as the full bore of the pipe.

Sullage waste Water:

Spent water from baths, wash basins, kitchen sinks, and similar appliances which does not contain human or animal excreta.

Sludge:

The settled solid matter in semi solid condition.

Socket:

The female part of the spigot and socket joint.

Soak Pit (Seepage Pit Soak Way):

A pit through which effluent is allowed to seep or leach into the surrounding soil.

Spigot:

The male part of a spigot and socket joint.

Stop Cock:

A control valve fixed at the end of a communication pipe which controls the supply from the water main.

Storage Tank:

A tank or a cistern for storage of water which is connected to the water main by means of a supply pipe.

Surface Water Drain:

A drain conveying surface water including storm water.

Surface Water:

The run off from precipitation, other water that flows over surface of the ground.

Sub Soil Water:

Water occurring naturally below the surface of the ground.

Trap:

A fitting/device so designed and constructed as to provide, when properly vented, a liquid seal which will prevent the back passage of air without materially affecting the flow of sewage or waste water through it.

Union:

A pipe fitting used for joining the ends of two pipes neither of which can be turned.

Valve:

A device used for controlling the flow of water in a pipe line.

Ventilating Pipe (Vent Pipe):

The pipe which provides a safe outlet into the atmosphere for the foul gases in the drain or sewer.

Warpage:

Distortion of original shape during manufacturing process.

Water Seal:

The depth of water which should be removed from a fully charged trap before air can pass through the trap.

Definitions:

(i) Engineer in Charge:- Engineer in Charge would refer to the concerned Engineer of the urban local body.

(ii) Providing & Fixing means the provision of all materials and labour and the performance of all workmanship together with the use of all materials and labour, transport, tools, plants, appliances and all other provisions necessary for the proper execution of work as described in the concerned item of schedule of rates and the provision and uses of all coverings or casing etc. necessary to protect the work from inclement weather etc. and from damages from falling materials or other causes and all required safety arrangements.

(iii) Laying and fixing only means as above for 'providing and fixing' except that materials will be supplied free of cost by the local body for execution of the work, but including taking supply of the material from the local body's Stores and the provisions of materials necessary for the proper execution of the work as described in the item of schedule of rates which are subsidiary to, but are not supplied as part of the main material viz bolts, nuts, packing, jointing materials etc, unless other-wise specifically excluded and mentioned in the tender documents.

It also includes loading and returning empty cases, containers, bags & baggage of the articles provided by the local body if any, to the place of issue, for which no extra charges shall be aid.

(iv) Complete: The provision of all such materials and labour and the performance of all such workmanship which may be necessary for the proper execution of the work in best workmanship manner but not particularly described in the items of schedule of rates.

(v) Best: With reference to quality of material and workmanship the word "BEST" shall mean that in the opinion of the Engineer-in-Charge, there is no superior material or article or class of workmanship obtainable from the market.

Alternative:

No alternative materials other than specified will generally be allowed to be used in the works except when their use becomes absolutely necessary in the interest of work on such grounds as non-availability in the market due to reasons beyond control.

In all such cases, Engineer-in-charge will permit in writing the use of such alternatives and will recommend suitable alternation in rates for such works to the competent authority.

Laying:

The approximate positions of all fittings should generally be shown on the plans but it will be the sole responsibility of the contractor to ascertain the work on the spot and the exact position where each fitting is to be fixed should be got approved from the concerned official before carrying out the work.

Testing of materials:

The contractor, on completion, or during the execution of the work shall prove that all materials, pipes, fittings, joints etc. are clean, perfect in working conditions and strong enough to withstand the test as specified here-in-under/in the relevant IS codes of different items. For this purpose the contractor at his own expense, shall provide all instruments and suitable appliances and carry out the necessary test before the Engineer-in-Charge or his representative to his entire satisfaction. The contractor shall rectify any defects as to the materials or workmanship, so noticed, and the defective portions re-tested at his expense. Until such time 10% of the bill amount shall be withheld from the contractor's running bill and same will be released only after testing, up to the entire satisfaction of the Engineer-in-Charge.

Specifications:

Work shall be executed in accordance with the specifications given in this schedule and the specifications attached with the 'Notice Inviting Tenders' and the 'Contract Agreement'. In case of any discrepancy, the provision in the 'Contract Agreement' will take precedence and the decision of the authority, sanctioning the tender, shall be binding and final.

The materials such as pipes specials, valves etc either supply by local body or by the contractor should conform to the specification mentioned in the schedule of rates given in following chapter and should in variably should conform to the relevant I.S. Standards, B.S. standards/ material of best quality available in the market shall only to be used.

In all cases the latest revision of the IS Codes shall be referred to. If requirements of these specifications conflict with the requirements of the standards/codes, standards/codes shall govern.

Civil works:

It shall be done as per specification given in chapter 15 and standard IS code in practice.

Excise Duty: As per prevailing excise duty norms there is excise duty exemption on certain diameter of Water Supply Pipes of different material class. All though in the computation of item rates for pipes, the rates are inclusive of excise duty but excise duty exemption shall be obtained as per prevailing rules for such pipes. This benefit shall be availed by the local bodies. All the concerned officers shall be responsible to get all the exemptions of such taxes and duties.

Cleat:

A short member of shoring and timbering which directly resists the downward movement of strut or wale.

Sheathing:

The vertical members of shoring and timbering which directly resists pressure from the side of a trench.

Strut:

A transverse member of shoring and timbering which directly resists pressure from sheathing or wale's.

Trench:

Any excavation in the ground where the depth of the excavation exceeds the width of excavation.

Wale:

A longitudinal member of shoring and timbering which directly resists pressure from sheathing.

Sheet Pilling:

A line of piles driven in the soil to create a barrier or retaining wall.

Abbreviations:

The following abbreviations wherever they appear in the specifications, shall have the meaning or implication hereby assigned to them:

mm	Millimeter
cm	Centimeter
M	Meter
Km	Kilometer
Mm^2/sqmm	Square Millimeter
Cm^2/sqcm	Square centimeter
M^2/sqm	Square meter
M^3/cum	Cubic meter
MI	Milliliter
Kg	Kilogram
Fig	Figure
Re/Rs	Rupee/Rupee
No.	Number
Dia	Diameter
CI	Cast iron
GI	Galvanized corrugated
PVC	Polyvinyl chloride
RCC	Reinforced cement concrete
SW	Stone ware
SWG	Standard wire Gauge
ISS	Indian Standard Specifications
BSS	British Standard Specifications
DN	Nominal Diameter
DI	Ductile Iron
DE	External Diameter

CHAPTER NO.1
CAST IRON SOCKET AND SPIGOT PIPES AND SPECIAL WITH LEAD JOINTS

1.1 Scope

This Specification covers the requirements of supplying, laying, jointing and testing centrifugally cast (spun) iron pipe for pressure main line of water supply and sewerage

1.2 Applicable Codes

The laying of CI pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of CI pipes shall be part of this Specification.

Table No.1.1

IS : 1536:2001 with amendment No. 3 July 2008	Specification for Centrifugally Cast (Spun) iron Pressure Pipes for Water, Gas and Sewage
IS : 1538:1993 reaffirmed 1999	Specification for Cast iron Fittings.
IS: 11606 : 1986	Methods for Sampling of Cast Iron Pipes and Fittings.
IS : 3114:1994	Code of Practice for Laying of CI Pipes
IS: 782: 1978	Caulking lead (3rd revision)

1.3 Pipes – Centrifugally Cast (Spun) Iron Pipes

The spun iron pipes shall conform to IS 1536. The spun iron pipes shall be of cast iron cast centrifugally and vary in diameters from 80mm to 1050mm. These shall be of class LA, class A and class B, as specified. Each pipe shall have the following marks either cast, stamped or indelibly painted on it. Marking may be done on the socket faces of pipe centrifugally cast in metal mould or on the outside of the socket or on the barrel of pipe centrifugally cast in sand mould.

(i) Manufacturer's name, initials or identification mark;
(ii) The nominal diameter;
(iii) Class reference;
(iv) The last two digits of the year of manufacture.

1.4 Dimensions of uncoated socket and barrel of lead joint pipes are given in table 1.2 (Refer table 6 : IS 1536:2001) for class LA table 1.3 (Refer table 7 : IS 1536:2001) for class A and table 1.4 (Refer table 8 : IS 1536:2001) for class B.

Socket and spigot pipes- Class LA

Table 1.2

Nominal Diameter	Barrel	
DN Mm	DE Lead joint mm	e mm
(1)	(2)	(3)
80	98	7.2
100	118	7.5
125	144	7.9
150	170	8.3
200	222	9.2
250	274	10.0
300	326	10.8
350	378	11.7
400	429	12.5
450	480	13.3
500	532	14.2
600	635	15.8
700	738	17.5
750	790	18.3
800	842	19.2
900	945	20.8
1000	1048	22.5
1050	1124	23.6

Socket and spigot pipes –**Class A**
Weight of pipe for Different length is given in Table No. 1.3

Nominal Diameter	**Barrel**	
DN Mm	DE Lead joint mm	e mm
(1)	(2)	(3)
80	98	7.9
125	144	8.7
150	170	9.2
200	222	10.1
250	274	11.0
300	326	11.9
350	378	12.8
400	429	13.8
450	480	14.7
500	532	15.6
600	635	17.4
700	738	19.3
750	790	20.2
800	842	21.1
900	945	22.9
1000	1048	24.8
1050	1124	26.00

Socket and spigot pipes – **Class B**
Table. 1.4

Nominal Diameter	**Barrel**	
DN **Mm**	**DE Lead joint** **mm**	**e** **mm**
(1)	(2)	(3)
80	98	8.6
100	118	9.0
125	144	9.5
150	170	10.0
200	222	11.0
250	274	12.0
300	326	13.0
350	378	14.0
400	429	15.0
450	480	16.0
500	532	17.0
600	635	19.0
700	738	21.0
750	790	22.0
800	842	23.0
900	945	25.0
1000	1048	27.00
1050	1124	29.00

1.4.1 Mass for sockets, pipe barrels and flanges are calculated on the basis of the density of cast iron as 7.15 kg/dm^3.

1.5 Testing of Pipes:

1.5.1 Pipes shall be subjected to the mechanical test during manufacture after every four hour of production.

1.5.2 The Pipes may be subjected to reheat treatment to ensure that Brinell hardness does not exceed the specified value and the specified mechanical properties are satisfied.

1.5.3 The ring test shall be conducted for pipes for sizes up to and including 300 mm. For above 300 mm sizes bar test are to be conducted.

1.5 .4 Pipe shall be tested hydrostatically at the pressure specified in table 1.5

TABLE 1.5

Hydrostatic Test pressure for centrifugally cast socket & spigot pipes in MPa		
Hydrostatic Test pressure for work in MPa		
Class	Up to DN 600 (including)	DN 700 & above
LA	3.5	1.5
A	3.5	2.0
B	3.5	2.5

Dn - Nominal diameter

1.6 Tolerance on Barrel diameter and socket dimensions suitable for (Lead Joints) are given in table 1.6 below

Table No. 1.6
Tolerance for "caulking space"

Dimensions	**Nominal diameter (DN)**	**Tolerances in mm**
(a) External diameter of barrel (DE)	All diameters	±1/2 f = ± (4.5+0.0015DN)
(b) Internal diameter of socket (DI)	All diameters	±1/3 f= ± (3±0.001 DN)
(c) Depth of socket (P)	(1) Up to and including 600mm	±5
	(2) Over DN 600mm and up to and including 1000mm	±10

Note: "f" is the caulking space of the joint in millimeters and is equal to (9 + 0.003DN).

1.7 Length of pipes:
(See Drawing No.-1)

1.7.1 Length of pipes does not include the length of the socket of the pipe.

1.7.2 Length - Effective length of pipe, as shown on the drawings.
Note - For flanged pipes the effective length is equal to the overall length and is noted L. For socketed pipes the effective length is equal to the overall length minus the spigot insertion depth.

1.7.3 Tolerance on length:
The tolerance on length of pipes shall be as under:

Type of casting	Tolerance in mm
(a) Socket and spigot pipes	± 100
(b) Flange pipes	± 10

1.7.3 On the total number of socket and spigot pipes to be supplied in each diameter, the Manufacturer may supply up to l0 percent in lengths shorter than the specified length as mentioned under:-

Table No.1.7

	Specified Length	Decrease in Length
	Up to 4 m	0.5, 1 m
	Over 4 m	0.5, 1, 1.5, 2m

1.8 Tolerance on pipe wall thickness "e" and flange thickness "b" in mm shall be as follows:

Wall thickness	- (1+0.05 e)
Flange thickness	± (2+0.05 b)

1.9 Specials (Fittings):
(See Drawing No.-2)

1.9.1 The specials shall conform to IS 1538:1993. Tolerances on external diameter of the barrel, internal diameter and the depth of the socket (for lead joints) shall be as prescribed below:-

Table No.1.8

Dimensions	Nature of Joint	Nominal diameter (DN)	Tolerances in mm
External diameter of spigot (DE)	Lead Joints	All diameters	± ½f or ±(4.5+0.0015DN)
Internal diameter of socket (DI)	Lead Joints	All diameters	± 1/3f or ± (3 + 0.001 DN)
Depth of socket (P)	Lead Joints	Upto and including 600mm	± 5
		Over 600mm upto and including 1000mm	±10
		Over 1000mm upto and including 1500mm	±15

- Where DN is the nominal diameter of the fittings in millimeters and f is the caulking space of the joint in millimeters and is equal to (9.00 + 0.003 DN).

1.9.2 Testing of fittings :

1.9.2.1 Fittings are subjected to mechanical test viz tensile test & Brinell Hardness tests at the time manufacture.

1.9.2.2 Fittings are subjected to Hydrostatic test by keeping under pressure for 15 seconds, they are struck with a 700g hammer. Fitting shall withstand the test pressure without showing any leakage, sweating or other defect of any kind.

1.9.2.3 Hydrostatic test pressure for the fittings shall be as under:-

TABLE 1.9

Hydrostatic Test pressure for fittings in MPa (kgf/mm^2)		
Nominal – Diameter	**Fitting without branches or with branches not greater than half the principal diameter**	**Fitting with branches greater than half the principal Diameter**
Up to and including 300mm	2.5 (25)	2.5 (25)
Over 300mm and up to and including 600mm	2.0 (20)	2.0 (20)
Over 600mm and up to and including 1500mm	1.5 (15)	1.0 (10)

1.9.3 Mass (weight) of the various types of fittings as under:-

1.9.3.1 Double socket cast iron 90º bend:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	18	-
100	24	23
125	33	31
150	43	41
200	67	63
250	98	91
300	135	125
350	181	167
400	234	215
450	290	265
500	370	338
600	546	496
700	770	697
750	899	812
800	1047	944
900	1389	1247
1000	1780	1597

1.9.3.2 Double socket cast iron 45º bend:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	18	-
100	24	23
125	32	30
150	41	39
200	62	58
250	89	83
300	121	113
350	159	148
400	202	188
450	248	229
500	310	287
600	448	412
700	619	568
750	716	655
800	827	756
900	1077	980
1000	1368	1243

1.9.3.3 Double socket cast iron 22.5º bend:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	16	-
100	21	20
125	27	26
150	35	34
200	53	51
250	75	72
300	100	95
350	130	123
400	164	155
450	197	186
500	246	232
600	351	329
700	478	446
750	551	517
800	632	588
900	813	754
1000	1024	948

1.9.3.4 Double socket cast iron 11.25º bend

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	15	14
100	19	18
125	25	24
150	32	31
200	48	46
250	67	65
300	89	86
350	115	110
400	144	138
450	172	164
500	215	205
600	302	287
700	408	386
750	469	443
800	534	501
900	682	641
1000	852	800

1.9.3.5 All socketed tees:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80x80	23	22
100x80	28	27
100x100	30	29
125x80	36	34

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
125x100	38	36
125x125	41	39
150x80	45	43
150x100	47	45
150x125	50	47
150x150	53	50
200x80	67	63
200x100	69	65
200x125	71	67
200x150	74	70
200x200	81	77
250x80	94	88
250x100	96	90
250x125	99	93
250x150	102	96
250x200	108	102
250x250	116	109
300x80	128	119
300x100	129	120
300x125	132	123
300x150	134	125
300x200	142	133
300x250	150	140
300x300	159	149
350x200	182	169
350x250	190	177
350x300	199	186
350x350	209	195
400x200	229	212
400x250	237	220
400x300	246	228
400x350	256	238
400x400	268	250
450x250	295	274
450x300	304	283
450x350	314	293
450x400	324	303
450x450	337	315
500x250	356	327
500x300	365	336
500x350	375	346
500x400	386	356
500x450	398	368
500x500	413	382
600x300	521	476
600x350	531	486
600x400	543	498
600x450	556	510
600x500	569	523
600x600	602	554
700x350	729	668

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
700x400	742	680
700x450	756	693
700x500	769	706
700x600	795	733
700x700	832	768
750x400	855	781
750x450	869	795
750x500	884	809
750x600	911	836
750x700	942	867
750x750	965	889
800x400	982	896
800x450	996	909
800x500	1010	923
800x600	1040	953
800x700	1072	984
800x750	1089	1000
800x800	1114	1024
900x450	1288	1170
900x500	1302	1184
900x600	1337	1217
900x700	1371	1251
900x750	1388	1267
900x800	1405	1285
900x900	1453	1331
1000x500	1648	1493
1000x600	1681	1525
1000x700	1723	1565
1000x750	1741	1582
1000x800	1759	1601
1000x900	1797	1639
1000x1000	1852	1693

1.9.3.6 All socketed cast iron crosses:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	30	29
100	39	37
125	52	50
150	67	64
200	102	97
250	145	137
300	197	186

1.9.3.7 Socket and spigot cast iron tapers (Reducer):-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
100x80	16	15
125x80	21	20

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
125x100	23	21
150x80	27	25
150x100	28	26
150x125	31	29
200x100	40	37
200x125	42	39
200x150	45	42
250x125	56	53
250x150	59	55
250x200	66	61
300x150	80	74
300x200	88	81
300x250	97	88
350x200	104	96
350x250	113	104
350x300	123	112
400x250	143	131
400x300	154	141
400x350	166	151
450x350	185	169
450x400	199	181
500x350	211	194
500x400	225	206
500x450	240	219
600x400	300	275
600x450	316	289
600x500	333	304
700x500	398	365
700x600	437	399
750x600	492	449
750x700	539	490

1.9.3.8 Double socket cast iron tapers (Reducer):-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
100x80	18	15
125x80	27	20
125x100	30	21
150x80	31	25
150x100	34	26
150x125	38	28
200x100	43	37
200x125	47	39
200x150	51	42
250x125	58	53
250x150	62	55
250x200	72	61
300x150	75	74
300x200	84	81

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
300x250	95	88
350x200	117	96
350x250	131	104
350x300	146	112
400x250	149	131
400x300	164	141
400x350	181	151
450x350	195	169
450x400	213	181
500x350	222	194
500x400	241	206
500x450	256	219
600x400	310	275
600x450	310	289
600x500	332	304
700x500	388	365
700x600	437	399
750x600	470	449
750x700	522	490

1.9.3.9 Cast iron collars:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	14	13
100	17	16
125	22	21
150	28	27
200	40	38
250	55	52
300	71	68
350	90	86
400	110	103
450	133	127
500	159	151
600	216	205
700	283	269
750	320	304
800	360	341
900	448	424
1000	547	518

1.9.3.10 Cast iron socket caps:-

Diameter (mm)	Weight (approx) kg Heavy
80	7
100	9
125	12
150	15

Diameter (mm)	Weight (approx) kg Heavy
200	24
250	34
300	46
350	61
400	77
450	97
500	118
600	171
700	235
750	272
800	314
900	405
1000	514

1.9.3.11 Cast iron plugs:-

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	3	2
100	4	3
125	6	5
150	9	8
200	14	13
250	22	20
300	30	28
350	41	38
400	54	51
450	69	65
500	86	81
600	127	120
700	180	171
750	211	201
800	246	235
900	321	307
1000	411	394

1.10 Inspections of pipes:

The pipe and fittings shall be inspected for defects and be rung with a light hammer, preferably while suspended, to detect cracks. Smearing the outside with chalk dust helps the location of cracks.

1.10.1 If doubt persists further confirmation may be obtained by purring a little kerosene of the inside of the pipe at the suspected spot. If a crack is present the kerosene seeps through and shows on the outer surface any pipe found unsuitable after inspection before laying shall be rejected.

1.11 Laying and jointing of CI pipes and fittings

The laying of CI pipe lines shall, in general be in accordance with of specifications given in IS: 3114 shall also be followed as applicable.

1.12 Lead Joints

1.12.1 Pig Lead-Pig lead should be of uniform quality, clean and free from foreign materials. It shall be of uniform softness and capable of being easily caulked or driven. It shall conform to IS: 782 for caulking lead in all respects.

1.12.2 The quantity of lead and spun yarn required for different sizes of C.I. pipes are as below:

TABLE 1.20

Diameter	Lead per joint	Depth of Lead Joint	Yarn per joint
Mm	Kg	mm	Kg
80	1.8	45	0.10
100	2.2	45	0.18
125	2.6	45	0.2
150	3.4	50	0.22
200	5.0	50	0.3
250	6.1	50	0.35
300	7.2	55	0.48
350	8.4	55	0.60
400	9.5	55	0.75
450	14	55	0.95
500	15	60	1
600	19	60	1.2
700	22	60	1.35
750	25	60	1.45
800	31.5	65	1.53
900	35	65	1.88
1000	41	65	2.05

1.12.3. Lead shall be heated in a melting pot kept in easy reach of the joint to be poured so that the molten metal will not be chilled in being carried from the melting pot to the joint and shall be brought to a proper temperature so that when stirred it will show a rapid change of colour.

1.12.3.1 Before pouring, all scum shall be removed. Each joint shall be made with one continuous pour filling of the entire joint space with solid lead. Spongy or imperfectly filled joints shall be burnt out and repoured.

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

1.12.5 The common form of joint is made by first caulking in spun yarn, then filling the remainder of the joint space by running in molten lead, taking care that no dross enters the joint, and then thoroughly caulking the lead. The lead need not extend into the joint further than the back of the groove formed in the socket.

1.12.6 The spun yarn is used to centre the spigot in the socket, to prevent the flow of molten lead into the bore of the pipe, to reduce the amount of lead required to complete the joint to make the joint watertight, Spun yarn may become infected with bacteria, which may contaminate the water and, therefore, shall be effectively disinfected before use.

1.12.7 Caulking may be done with pneumatic tools or with a hand hammer weighing not less than 2 kg. When working with lead wool, it is very important to use caulking tools of appropriate thickness to fill the joint space, and to thoroughly consolidate the material from the pack to the front of the socket. Lead run joints shall be preferably finished 3 mm behind the socket face.

1.13. Detection of Cracks in Pipes :

1.13.1 The pipe and fittings shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. Smearing the outside with chalk dust helps the location of cracks. If doubt persists further confirmation may be obtained by pouring a little kerosene on the inside of the pipe at the suspected spot; if a crack is present the kerosene seeps through and shows on the outer surface.

1.13.2 If a pipe is mishandled either accidentally or due to carelessness during unloading or lowering it should be thoroughly inspected before laying and should be rejected if found unsuitable.

1.14 Measurement

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. specials should be excluded and enumerated and paid for separately. The portion of the pipe within the collar at the joints shall not be included in the length of pipe work.

1.15 Rates:

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER NO.2
CAST IRON TYTON PIPES WITH TYTON JOINTS

2.1 Applicable code

The laying of CI pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of CI pipes shall be part of this Specification.

Table No. 2.1

I.S. Number	Title
IS: 1536 : 2001 with amendment 3 July 2008	Centrifugally cast (spun) iron pressure pipe for water, gas and sewerage (second revision)
IS: 5382: 1985	Rubber sealing rings for gas mains, water mains and sewers (first Revision)
IS: 7181: 1986	Horizontally cast iron double-flanged pipes for water, gas and sewage (first revision)
IS: 1538 : 1993 Reaffirmed 1999	Specification for cast iron fittings.
IS: 11606 : 1986	Methods for sampling of cast iron pipes and fittings.
IS: 3114 : 1994	Code of practice for laying of CI pipes.

2.2 Pipe and fittings shall be as per IS: 1536 and 1538 as described in details in chapter no. 1.chapter no.1 should be referred for all technical details.

2.2.1 Outer diameter (DE) of the tyton pipes of class LA, A and B is 3 mm less than the outer diameter (DE) of lead joint pipes for all 3 classes. For example for 80 mm nominal diameter pipes outer diameter for lead joints pipes of all 3 classes is 98 mm while for tyton pipes it is 95 mm.

2.3 Inspection of Pipes

2.3.1 The pipe and fitting shall be inspected for defects and be rung with a light hammer, preferably while suspended, to detect cracks. Smearing the outside with chalk dust helps the location of cracks. If doubt persists further confirmation may be obtained by pouring a little kerosene on the inside of the pipe at the suspected spot. If a crack is present the kerosene seeps through and shows on the outer surface.

2.3.2 Any pipe found unsuitable after inspection before laying shall be rejected.

2.4. Laying and Jointing of CI pipes and fittings.

2.4.1 The laying of CI pipe lines shall, be as given in IS:3114.

2.4.2 Rubber ring Tyton joints shall be used for jointing of CI pipes lines outside the buildings and other external water supply installations. They shall be used strictly in accordance with the manufacturer's instructions. Wherever required, for internal water supply piping arrangements with CI pipes, pipes shall be connected by flanged joints.

2.5 Thrust Blocks

2.5.1 In case of bigger diameter pipes where the pressure is very high, thrust blocks of cement concrete (1 cement: 2 coarse sand: 4 graded stone aggregate of 20mm nominal size) of adequate size and shape shall be provided on all bends/tees etc., to transmit the hydraulic thrust to the ground, spreading over a sufficient areas, depending upon the type of soil met with, as per the relevant Drawings or as directed by Engineer.

2.5.2 Mass for sockets, pipe barrels and flanges are calculated on the basis of the density of cast iron as 7.15 kg/dm^3.

2.6 Testing

2.6.1 Mechanical Tests

Mechanical tests shall be carried out during the manufacture of the pipes as specified in IS:1536.

2.6.2 Hydrostatic tests at works.

1. For hydrostatic tests, the pipes shall be kept under pressure for 15 seconds, they may be struck moderately with a 700 g hammer. They shall withstand pressure test without showing any leakage or any other defect of any kind. As far as possible the hydrostatic test shall be conducted before given any coating to the pipes. These pipes shall be used upto half the hydraulic test pressure as given in the following table. The hydraulic test pressure for Centrifugally Cast Iron pipes as per IS: 1536, shall be as given below.

Table 2.2
Refer Table 1 of IS 1536:2001

Class	Hydrostatic Test Pressure for Works, MPa	
	Up to DN 600[1] (Including)	DN 700 and Above
1	2	3
LA	3.5	1.5
A	3.5	2.0
B	3.5	2.5

2. The specials shall conform to IS : 1538. The hydraulic test pressure of each class of specials shall be as follows:

Table 2.3
Refer Table 1 IS 1538:1993

Nominal diameter	Test pressure	
	Fittings without Branches or With Branches not Greater than Half the principal Diameter MPa (kgf/mm^2)	Fittings with Branches greater than Half the Principal Diameter
Upto 300 mm (including)	2.5 (25)	2.5 (25)
Over 300 mm up to 600 mm (including)	2.0 (20)	2.0 (20)
Over 600 mm up to 1500 mm (including)	1.5 (15)	1.0 (10)

3. Water of approved quality for testing shall be arranged by the Contractor.

2.7 Testing at site

The following tests are to be carried out after a new pipe is laid, jointed and partially back filled. Portions of the line shall be tested by subjecting the pressure test as the laying progresses before the entire line is completed (the test stretch should be generally exceed 500m), to identify any error of workmanship which can be detected and corrected at minimum cost. For all these tests water of approved quality has to be arranged by the Contractor.

2.8 Pressure test

Pressure test at a pressure of at least double the maximum working pressure shall be carried out. Pipes and joints shall be absolutely water tight under the test. The procedure for pressure testing shall be as follows:

2.8.1 Each valved section of the pipe shall be slowly filled with water and all air shall be expelled from the pipe through the hydrants and blow offs. If these are not available at high places, necessary taping may be made at points of highest elevation before the test is made and plugs inserted after the tests have been completed.

2.8.2 Sufficient backfill shall be placed on the pipe to resist the movement due to pressure while testing. Trench shall be partially backfilled such that the joints, couplings, valves, hydrants or any other fittings shall be left exposed for observations during testing. The specified pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump not be less than 5 minutes.

2.9 Leakage test

After the successful completion of the pressure test. Leakage test shall be conducted at a pressure to be specified by the Engineer for a duration of two hours. The procedure for Leakage test shall be as follows:

2.9.1 Leakage is defined as the quantity of water to be supplied into the newly laid pipe, or any valved section thereof, necessary to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.

2.9.2 No pipe installation shall be accepted until the leakage is less than the number of cm^3/hr. as determined by the following formula:

$qL = (ND\sqrt{P})/3.3$

where

qL = the allowable leakage in cm^3/hr.

N = number of joints in the length of the pipe line.

D = diameter of pipe in mm, and

P = average test pressure during the leakage testing kg/cm^2.

$\sqrt{}$ = under root

2.9.3 Should any test of the pipe laid in position disclosed leakage greater than that obtained by the above formula, the defective joints shall be replaced until the leakage is within the specified allowance.

2.10 Markings

2.10.1 Each pipe shall have cast, stamped or indelibly painted on it the following appropriate marks.

1. Manufacturers name or identification mark
2. The nominal diameter
3. Class reference
4. Mass of pipe
5. The no. of the Indian Standard and
6. The year of manufacture.

2.11 Tyton joints: (Rubber Ring joints)

2.11.1 Tyton joint is sturdy push on type joint. The sockets of the pipes to receive tyton joints are specially designed to contain elongated grooved gasket. The inside contour of the socket bell provides a seat for the circular rubber ring in a modified bulb shaped gasket. An internal ridge in the socket fits into the groove of the gasket. A slight taper on the plain end (chamfer) of the pipe facilitates assembly.

2.11.2 The socket and spigot end of the pipe is cleaned first. Thereafter a thin film of lubricant should be applied to the bulb seating inside the socket, but not to the hard rubber heal. Now the gasket should be held so that it takes a shape of a heart.

2.11.1 The gasket is placed in the socket with bulb towards the back of the socket so that the hard rubber heal engages in the retaining groove. If any loop is left it will be pressed flat for proper fit of gasket in the groove. In case it is difficult to press the loop as it may be in case of larger diameter, a second loop be formed in the opposite side. The two loops are then pressed flat one after the other. A thick film of lubricant should be applied to the inner side of the gasket where the spigot end will come in contact, to facilitate the entry. The spigot end of the pipe should also be lubricated.

2.11.4 After centering the spigot should be inserted far enough into the socket to make contact with the gasket. The spigot end is forced into the socket carefully compressing the gasket till the spigot end reaches near the bottom of the socket. If the assembly is not completed with reasonable force, the spigot should be removed and the position of the gasket examined.

2.11.5 Fork-tool Method for pipes up to 200 mm : In this method a forked tool is used. The forked tool is placed just behind the socket over the pipe. A wire rope is wrapped around the spigot to be joined.

2.11.6 The eye on the end of the rope is hooked to the sliding hook on the rope, the other end is fixed on the fork handle. The for handle is pulled in the direction of insertion of spigot into the socket.

2.11.7 The assembly of the joint can be done by placing the fork on the face of the socket through which the spigot end of the pipe is required to be pulled. The wire rope is wrapped three times, around the plain end, placing the eye over the hook on the handle, holding free end of the rope and pulling on handle to take out plain end.

2.11.8 Jack Method assembly for pipes of 250 mm and above: The jack is placed on the top of the pipe with double hooked on the bottom of the jack placed immediately in the back of the socket of the adjoining pipe and with the hook on the rack extending over the plain end of the entering pipe.

2.11.9 The socket rope is placed under and around the pipe below the double hooks and eye of the rope placed over the hooks. The wire rope is wrapped around the plain end, with one eye hooked at the end of the jack. By the movement of the jack, the plain end is forced in.

2.11.10 When laying on a steep slope, the socket should face upgrade. The tyton joints gaskets and tyton joint pipes should be from the same manufacturer to avoid likely trouble of misfit due to slight variation in sizes.

2.12 Rubber ring:-

2.12.1 Rubber sealing ring for tyton joint shall conform to IS 5382

2.12.2 The rings shall be homogeneous, free from porosity, grit, excessive blooms, blisters or other visible surface imperfections. The fin or flash shall be reduced as much possible and in any case the thickness of it shall not exceed 0.4 mm and the width 0.8 mm. Unless otherwise specified, the materials shall be black.

2.13 Measurement:-

The net length of pipes as laid or fixed should be measured in running meters correct to a cm. specials should be excluded and enumerated and paid separately. The portion of the pipe within the collar at the joints should not be included in the length of pipe work.

2.14 Rates:

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER NO.3
CAST IRON PIPES AND SPECIALS WITH FLANGED JOINTS

3.1 Applicable codes

The laying of CI pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of CI pipes shall be part of this Specification.

Table No. 3.1

I.S. Number	Title
IS 1538 :1993	C.I. fittings for pressure pipes
IS 1638	Specification for rubber and insertions
IS 800:	Code of structural steel in general building construction (for nuts and bolts)
IS 7181:1986 Reaffirmed 2005	Code for double flanged cast iron (horizontal cast) pipes.
IS 1536 :2001	Flanged pipes centrifugally cast with screwed/ welded flange.
IS 11606:1986	Method of sampling of cast Iron pipes & fittings.

3.2 Pipe and fittings shall be as per IS: 1536 and 1538 as described in details in chapter no. 1. Chapter no.1 should be referred for all technical details.

3.2.1 Mass for sockets, pipe barrels and flanges are calculated on the basis of the density of cast iron as 7.15 kg/dm^3.

3.3 Flanged pipes

3.3.1 Flanged pipe centrifugally Cast with Screwed Flange- Class B conforming to IS 1536 shall have specified dimensions (Nominal diameter 'DN', external/outer diameter 'DE', thickness 'e' and mass of the pipe) as given under in table 3.2

Table No.3.2

DN mm	DE	e
Mm	mm	mm
(1)	(2)	(3)
80	98	8.6
100	118	9.0
125	144	9.5
150	170	10.0
200	222	11.0
250	274	12.0
300	326	13.0
350	378	14.0
400	429	15.0
450	480	16.0
500	532	17.0
600	635	19.0
700	738	21.0
750	790	22.0
800	842	23.0
900	945	25.0
1000	1048	27.0
1050	1124	29.00

3.3.2 Flange of pipe:-

3.3.2.1 Tolerances for the external diameter 'D' of flanges of pipe are as under:-

Table No. 3.3

DN	80 to 125	150 to 300	350 to 600	700 to 1000
Tolerance on D	± 4.5	+ 5.5, -2.5	+6.5 , -3.5	+ 7.5, -4.0

3.3.2.2 Tolerances on thickness of flange of pipe are as under:-

Table No.3.4

Type of Flange	**Tolerance**
Screwed on flanges	± (2 + 0.05 b)

b is the thickness of flanged in mm

3.4 Cast iron fittings

3.4.1 Refer to chapter no.1 and IS specification 1538: 1993 Table 2 to 28 for the technical and dimensional details of the flanged fittings.

3.4.2 Mass (Weight) in kg of various flange fittings as per IS: 1538 are tabulated below:-

3.4.2.1 Cast iron flanged socket:-

Refer Table 7 for mass (approx) of heavy weight

Diameter (mm)	**Weight (approx) kg**	
	Heavy	**Medium**
80	13	12
100	16	15
125	20	19
150	26	25
200	37	36
250	62	58
300	79	74
350	100	94
400	123	116
450	142	134
500	173	163
600	234	221
700	306	289
750	347	328

3.4.2.2 Cast iron flanged spigot:-

Refer Table 8 for mass (approx) of heavy weight

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	12	11
100	14	13
125	19	17
150	23	21
200	39	35
250	53	47
300	68	60
350	85	76
400	104	92
450	123	109
500	146	130
600	227	201
700	295	261
750	334	296

3.4.2.3 Cast iron double flanged 90º bend:-

Refer Table 21 for mass (approx) of heavy weight

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	13	12
100	17	16
125	23	21
150	31	29
200	49	45
250	72	65
300	100	90
350	137	123
400	181	162
450	226	201
500	290	258
600	442	392
700	639	566
750	755	668

3.4.2.4 Cast iron double flanged 90º duck foot bend:-

Refer Table 22 for mass (approx) of heavy weight

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	21	20
100	26	25
125	36	34
150	47	45
200	74	70
250	111	104
300	156	146
350	214	200
400	281	262
450	350	325
500	446	414
600	677	627

3.4.2.5 Cast iron double flanged 45º bend:-

Refer Table 23 for mass (approx) of heavy weight

Diameter (mm)	Weight (kg) Heavy
80	14
100	18
125	25
150	34
200	54
250	80
300	112
350	115
400	149
450	185
500	231
600	342
700	485
750	572

3.4.2.6 All flanged cast iron tees:-

Refer Table 24 for mass (approx) of heavy weight

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80x80	21	20
100x80	25	23
100x100	26	24
125x80	32	29
125x100	34	32
125x125	36	33
150x80	41	38
150x100	42	39
150x125	45	41
150x150	47	43
200x80	62	56
200x100	63	57
200x125	66	60
200x150	68	62
200x200	74	67
250x80	89	80
250x100	90	81
250x125	93	84
250x150	96	87
250x200	102	92
250x250	109	99
300x80	122	109
300x100	124	111
300x125	126	113
300x150	129	116
300x200	136	122
300x250	143	129
300x300	151	136
350x200	169	152
350x250	173	156
350x300	188	170
350x350	195	175
400x200	211	189
400x250	215	193
400x300	232	208
400x350	239	214
400x400	246	221
450x250	260	232
450x300	277	247
450x350	284	253
450x400	290	259
450x450	296	265
500x250	315	281
500x300	334	298
500x350	342	305
500x400	349	312
500x450	356	318
500x500	363	325

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
600x300	466	414
600x350	475	424
600x400	485	432
600x450	492	438
600x500	499	445
600x600	516	461
700x350	642	570
700x400	651	578
700x450	660	587
700x500	669	595
700x600	686	611
700x700	707	632
750x400	746	662
750x450	754	670
750x500	766	681
750x600	779	694
750x700	792	707
750x750	805	720
800x400	858	762
800x450	867	770
800x500	877	779
800x600	897	798
800x700	916	817
800x750	928	828
800x800	941	841
900x450	1091	966
900x500	1106	980
900x600	1128	1000
900x700	1149	1020
900x750	1161	1032
900x800	1173	1044
900x900	1190	1061

3.4.2.7 Cast iron double flanged tapers:-

Refer Table 26 for mass (approx) of heavy weight

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
100x80	12	11
125x80	20	18
125x100	22	20
150x80	23	21
150x100	25	23
150x125	27	25
200x100	31	29
200x125	34	31
200x150	37	34
250x125	41	38
250x150	44	40
250x200	50	46

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
300x150	51	47
300x200	58	53
300x250	65	60
350x200	87	79
350x250	96	87
350x300	106	96
400x250	109	98
400x300	120	108
400x350	132	119
450x300	130	117
450x350	145	131
450x400	158	143
500x350	160	144
500x400	174	157
500x450	186	168
600x400	210	190
600x450	222	200
600x500	239	216
700x500	281	254
700x600	317	287
750x600	338	306
750x700	380	344
800x600	368	334
800x700	410	372
800x750	428	388
900x700	458	415
900x750	478	433
900x800	508	461
1000x800	570	518
1000x900	617	560

3.4.2.8 All flanged cast iron crosses:-

Refer Table 25 for mass (approx) of heavy weight

Diameter (mm)	Weight (approx) kg	
	Heavy	Medium
80	27	25
100	34	31
125	46	41
150	60	54
200	93	84
250	135	122
300	180	165

3.4.2.9 All flanged cast iron blank flanges:-

Refer Table 28 for mass (approx) of heavy weight

Diameter (mm)	Weight (kg) Heavy
80	5
100	6
125	8
150	11
200	16
250	23
300	32
350	43
400	55
450	67
500	85
600	126
700	177
750	207
800	245
900	313
1000	406

3.5 Testing of Pipes and fitting :-

3.5.1 Mechanical Tests

3.5.1.1 Mechanical tests are carried out during the manufacture of the pipes & fittings. Two tensile test are made on bars cast from the same metal. For checking the hardness Brinell Hardness tests are carried out by applying pressure for 15 seconds.

3.5.2 Hydrostatic test (Pipes):

To perform the test, the pressure shall be applied internally and shall be steadily maintained for a period of minimum 10 seconds. The pipes shall withstand the pressure test and shall not show any sign of leakage, sweating or other defects. As far as possible the hydrostatic test shall be conducted before coating the pipes.

Table 2 Hydrostatic Test Pressure for Centrifugally Cast Pipes with Screwed on Flanges
Table 12.2 IS 1536 : 2001

Class	Hydrostatic Test Pressure for works, MPa	
	Up to 300 DN	350 to 600 DN[1)]
1	2	3
B	2.5	1.6

2.6.2 Hydrostatic tests at works.

1. For hydrostatic tests, the pipes shall be kept under pressure for 15 seconds, they may be struck moderately with a 700 g hammer. They shall withstand pressure test without showing any leakage or any other defect of any kind. As far as possible the hydrostatic test shall be conducted before given any coating to the pipes. These pipes shall be used upto half the hydraulic test pressure as given in the following table. The hydraulic test pressure for Centrifugally Cast Iron pipes as per IS: 1536, shall be as given below.

Table 2.3
Refer Table 1 IS 1538:1993

Nominal diameter	Test pressure	
	Fittings without Branches or With Branches not Greater than Half the principal Diameter MPa (N/mm^2)	Fittings with Branches greater than Half the Principal Diameter
Upto 300 mm (including)	2.5 (25)	2.5 (25)
Over 300 mm up to 600 mm (including)	2.0 (20)	2.0 (20)
Over 600 mm up to 1500 mm (including)	1.5 (15)	1.0 (10)

3.6 Double flanged cast iron (Horizontal cast) pipes

3.6.1 Double flange cast iron (horizontal cast) pipes 80 mm to 750 mm class B for water supply pressure mains shall conform to IS: 7181

3.6.2 The general requirement relating to the supply of material shall be laid down in IS: 1387-1967.

3.6.3 Grey cast iron used for the manufacture of pipes shall conform to any of the appropriate grades, as specified in IS: 210-1978.

3.6.4 The pipes shall be stripped with all precautions necessary to avoid warping or shrinkage defects. The pipes shall be free from defects, other than unavoidable surface imperfection which result from the method of manufacture and which do not affect the use of the pipes.

3.6.5 The pipe shall be capable of being cut with the tools normally used for installations.

3.6.6 The flange shall be at right angles to the axis of the pipes and machined on face. The bolt holes shall be drilled

3.7 Mechanical Tests

Supplied pipes shall be mechanical tested as per details given in IS: 7181. Test shall be carried out during manufacture of pipes after every 4 hr interval.

3.8 Hydrostatic Test

3.8.1 Pipes shall be tested hydrostatically at a pressure specified Table 3.5. Pipes shall not show any sign of leakage, sweating or other defects of any kind.

Table No. 3.5
Hydrostatic Test pressure for horizontally cast pipes
Refer Table 1 IS 7181-1986

Nominal Diameter DN	**Test Pressure**	**Suggested Maximum Hydraulic working pressure including surge**
(1)	(2)	(3)
	MPa	MPa
Up to and including 300 mm	2.5	1.2
over 300 mm and up to and including 600 mm	2.0	1.0
over 600 mm	1.5	0.6

3.8.2 The pressure shall be applied internally and steadily maintained for a period of 15 second during which pipes may be struck moderately with a 700 g hammer.

3.8.3 Test shall be carried out before the application of surface coating.

3.9 Length and mass:

3.9.1 Length shall be 2.75 or 3m

3.9.2 Nominal thickness dimensions and mass of uncoated pipes and flanged are as under.

Table 3.6
Refer Table 2 IS 7181-1986

Nominal diameter, DN	Barrel			Mass for One flange (Nominal)
	DE	e	Mass for one meter length Nominal	
1.	2.	3.	4.	5
mm	mm	mm	Kg	Kg
80	98	10.0	19.8	3.7
100	118	10.5	25.4	4.2
125	144	11.1	33.1	5.3
150	170	11.7	41.6	6.7
200	222	12.8	60.1	9.3
250	274	14.0	81.8	12.0
300	326	15.2	106.1	14.8
350	378	16.3	133.5	19.0
400	429	17.5	162.6	23.4
450	480	18.7	197.0	26.5
500	532	19.8	229.3	32.1
600	635	22.2	306.5	44.0
700	738	24.5	394.3	59.9
750	790	25.6	443.8	69.7

specific mass of cast iron is taken as 7.15 kg/dm^3

3.10 Tolerances

3.10.1 Tolerances on external diameter of Barrel (DE) of double flanged cast iron (horizontal cast) pipes.

Table No.3.7

Dimension	**Nominal Diameter, DN**	**Tolerance Mm**
External diameter of barrel (DE)	All diameter	± (4.5 + 0.0015 DN)

3.10.2 Tolerances on Thickness: - The tolerances on the wall thickness and flange thickness of double flanged cast iron (horizontal cast) pipes shall be as follows:-

Table No.3.8

Dimension	Tolerance Mm
Wall thickness Flange thickness	-(1+ 0.05e) ±(2 + 0.05ь)
Where e = Thickness of in mm, and ь = Thickness of flange in mm	

3.10.3 Permissible in cast iron double flanged (horizontally cast) pipes deviation from a straight line. The pipes shall be straight. When rolled along two gantries separated by approximately two thirds the lengths of the pipes to be checked, the maximum deviation fm, in millimeters, shall not be greater than 1.25 times the length l, in meters, of the pipe under test, thus fm ≤ 1.25 l.

3.10.4 Tolerances for the various dimensions of flanges not specified above shall be as follows:

Table No. 3.9

Description	Size, DN (mm)	Tolerance (mm)
D (as cast)	Up to 250	+ 3.0 - 1.0
	Above 250	+ 5.0 - 1.5
C	Up to 250	± 1.0
	Above 250	± 1.5
d	Up to 300	+ 2 - 0
	Above 300	+ 3 - 0

3.11 Sampling criteria for the selection/frequency of various tests, shall be as per IS: 11606:1986.

3.12 Flanged joints

3.12.1 Flanged cast iron pipes, screwed / welded flanged cast iron pipes and flanged specials are joint by means of flanges.

3.12.2 The jointing material used between flanges shall be rubber insertion 3 mm thick. Each bolt should be tyton a little at a time taking care to tighten diametrically opposite bolts alternatively. The practice of fully tightening the bolts one after another is highly undesirable.

3.12.3 In addition to flanged pipes and special, flanged joints are also encountered while fixing flanged sluice valves, air valves, hydrants, meter connection which sometime requires their removal for repairs.

3.12.3.1 Flanged joints find their application in vertical inlet and outlet of pipes of over head reservoir, suction pipes of pump where perfectly air tight joint is required to avoid air being sucked in and also where there are vibrations. Flanged jointing is extensively employed for outside work.

3.12.3.2 Overhead pipe lines and also for connection in vertical and confined positions, but are usually not employed for pipe line work below ground like gravity mains etc. Flange joints are expensive and are thus only used for indoor work and under other situations requiring the use of flanged joints as mentioned above.

3.13 Measurement

The net length of pipes as laid or fixed should be measured in running meters correct to a cm. specials should be excluded and enumerated and paid separately. The portion of the pipe within the collar at the joints should not be included in the length of pipe work.

3.14 Rates

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER NO. 4
DUCTILE IRON PRESSURE PIPES AND SPECIAL WITH TYTON JOINTS

4.1 Applicable codes

The laying of DI pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of DI pipes shall be part of this Specification.

Table No. 4.1

I.S. Number	Title
IS: 8329: 2000 Amend No.-1 2000	Centrifugally cost (spun) ductile iron Pressure pipes for water, gas and sewage (third revision)
IS: 9523: 2000	Ductile iron fittings for pressure pipes for water, gas and sewage.
IS: 12288: 1987	Code of practice for use and laying of ductile iron pipes.
IS: 5382: 1985	Rubber sealing rings for gas mains, water mains and sewer (first revision)

4.2 Ductile iron pipes

4.2.1 The pipes shall be centrifugally cast (spun) Ductile iron pipes for water and sewage confirming to the IS 8329: 2000. The pipes used shall be either with push on joints (Rubber Gasket Joints) or Flanged joints. The class of pipe to be used shall be of the class K-7 & K-9.

4.2.2 The pipes shall be coated with bitumen and have factory provided cement mortar lining in the inside as per the provisions of the IS 8329:2000. The pipes are supplied in standard length of 4.00, 5.00, 5.50 and 6.00 meters length with suitably rounded or chamfered ends. Each pipe of the push on joint variety shall also be supplied with a rubber EPDM/(SBR) gasket.

4.2.3 The flanged joints shall confirm to the Clause 6.2 of IS: 8329.The pipe supply shall include one rubber gaskets for each flange.

4.2.4 Specifications of sockets and spigot pipes, classes K7 and K9 are mentioned below.

Table No.4.2
(Refer Table 2 IS 8329-2000)

(in mm)

Nominal Diameter	External Diameter	Barrel wall thickness 'e'	
DN	DE	K7	K9
80	98	5	6.0
100	118	5	6.0
125	144	5	6.0
150	170	5	6.0
200	222	5	6.3
250	274	5.3	6.8
300	326	5.6	7.2
350	378	6.0	7.7
400	429	6.3	8.1
450	480	6.6	8.6

Nominal Diameter	External Diameter	Barrel wall thickness 'e'	
DN	DE	K7	K9
500	532	7.0	9.0
600	635	7.7	9.9
700	738	9.0	10.8
750	790	9.7	11.3
800	842	10.4	11.7
900	945	11.2	12.6
1000	1048	12.0	13.5

4.2.5 Specification of (PN 10) Standard flange Drilling for screwed Flanges and Welded Flange are mentioned below:

(PN 10) Table No.4.3
(Refer Table 3 IS 8329-2000)

(in mm)

Nominal Diameter	Outer diameter of flange D	Holes		Bolt size
DN	D	Number	Dia d)	Metric
80	200	4	19	M16
100	220	8	19	M16
125	250	8	19	M16
150	285	8	23	M20
200	340	8	23	M20
250	395	12	23	M20
300	445	12	23	M20
350	505	16	23	M20
400	565	16	28	M24
450	615	20	28	M24
500	670	20	28	M24
600	780	20	31	M27
700	895	24	31	M27
750	960	24	31	M27
800	1015	24	34	M30
900	1115	28	34	M30
1000	1230	28	37	M33

4.2.6 Specifications of (PN 16) standard Flange Drilling for screwed Flanges and Welded flange are mentioned below:

(PN 16) Table No.4.4
(Refer Table 4 IS 8329-2000)

(in mm)

Nominal Diameter	Outer diameter of flange	Holes		Bolt size
DN	D	Number	Dia(d)	Metric
80	200	8	19	M16
100	220	8	19	M16
125	250	8	19	M16
150	285	8	23	M20
200	340	12	23	M20

Nominal Diameter	Outer diameter of flange	Holes		Bolt size
DN	D	Number	Dia(d)	Metric
250	400	12	28	M24
300	455	12	28	M24
350	520	16	28	M24
400	580	16	31	M27
450	640	20	31	M27
500	715	20	34	M30
600	840	20	37	M33
700	910	24	37	M33
750	970	24	37	M33
800	102	24	40	M36
900	112	28	40	M36
1000	125	28	43	M39

4.3 Coating:

Pipe shall be supplied internally (cement mortar lining) and externally (bituminous coating) coated as under:

4.3.1 Cement Mortar Lining -

4.3.1.1. Cement -the cement used for the lining shall conform to the existing standards on cement, The type of cement to be used is to be mutually decided between the purchaser and manufacturer, Normal recommendations are:

4.3.1.1.1 Portland cement (as per IS 8112 or IS 455) mortar lining perform rather well and have an expected life of approximately 50 years in soft water with moderate amount of aggressive Co_2 and when Ph is within 6 to 9. Longer service life can be obtained by increasing the mortar lining thickness.

4.3.1.1.2 Where cement mortar lining may be exposed to sulphate attack, ordinary Portland cement should be replaced by sulphate resisting Portland cement (as per IS 12330 or IS 6909).

4.3.1.1.3 The sulphate concentration limit for sulphate resisting Portland in approximately 3000 mg/liter, the same as blast furnace slag cement which naturally possess a good resistant to sulphate attack.

4.3.1.1.3 High alumina cement (as per IS 6452) mortar lining is suitable for continuous use of pH between 4 and 12 and no sever damage occur after occasional exposure to pH 3 to 4 and 12 to 13.

4.3.1.1.4 The recommended type of cement used for lining are as given in table 4.5

Recommended type of cement used for lining
Table no 4.5
(Refer Table 14 IS 8329-2000)

	Water characteristics	**Portland**	**Sulphate Resisting Cements (including Blast-Furnace Stag Cement)**	**High alumina Cement**
(1)	(2)	(3)	(4)	(5)
1.	Minimum value of pH	6	5.5	4
2.	Maximum Content (mg/l) of:-			
	Aggressive co_2	7	15	No limit
	Sulphates (so_4)	400	3000	No limit
	Magnesium (Mg^{++})	100	500	No limit
	Ammonium (NH_4)	30	30	No limit

4.3.1.2 Sand

4.3.1.2.1 The sand use shall have a controlled granulometric distribution from fine to coarser elements; it shall be clean and shall be composed of inert, hard, strong and stable granular particles.

4.3.1.2.2 The fine fraction comprising particles passing through a sieve of aperture size 0, 125 mm shall not be more than 10 percent by mass.

4.3.1.2.3 The coarsest fraction (comprising particles which do not pass through a sieve of the aperture size closest to half the normal thickness of the mortar lining) shall not exceed 5% by mass.

4.3.1.3. Water- The water used for the preparation of the mortar shall not contain substances deleterious to the mortar nor to the water it is eventually intended to transport in the pipe. The presence of solid mineral particles is, however, admissible provided that these requirements are still fulfilled.

4.3.1.4. Mortar - The mortar of the lining shall be composed of cement, sand and water. Additives, may be used, provided that they do not prejudice the quality of the coating and that of the transported water.

4.3.1.4.1 The mortar shall be thoroughly mixed and shall have a consistency which results in a dense and homogenous lining.

4.3.1.4.2 The mortar shall contain by mass at least one part of cement to 3.5 parts of sand.

4.3.2 Bituminous Coating-

4.3.2.1. Coating shall not be applied to any pipe unless its surfaces are clean, dry and free from rust.

4.3.2.2 The coating material shall set rapidly with good adherence and shall not scale off.

4.3.2.3 The mean thickness of the coating shall be not less than 70 µm and the local. Minimum thickness shall be not less than 50 µm.

4.3.2.4 Where the coating material has a bitumen base, it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 65°C but not so brittle at a temperature of 0° C as to chip off when scribed with a penknife.

4.3.2.5 When the pipes to be used for conveying potable water the inside coating shall not contain any constituent soluble in such water or any ingredient which could impart any taste or whatsoever to the potable water after sterilization and suitable washing of the mains.

4.3.2.6 Pipes with or without sockets and flanges which are imperfectly coated or where the coating does not set or conform to the required quality, the coating shall be removed and the pipes/flanges recoated.

4.4 Hydrostatic site test pressures and hydraulic working pressure.

4.4.1 Hydrostatic site test pressures and hydraulic working pressure of the newly laid pipe line is specified as under in

Table No.4.6

Refer Amendment No.1, (Annex E -Table 1) : IS 8329-2000

DN	Allowable operating pressure(excluding surge) AOP		Allowable Maximum Operating pressure (Including surge) MOP		Allowable site test Pressure (STP)	
	K7	K9	K7	K9	K7	K9
	MPa		MPa		MPa	
80	0.8	6.4	1.25	7.7	1.75	9.6
100	0.8	6.4	1.25	7.7	1.75	9.6
125	0.8	6.4	1.25	7.7	1.75	9.6
150	0.8	6.4	1.25	7.7	1.75	9.6
200	0.8	6.2	1.25	7.4	1.75	7.9
250	0.8	5.4	1.25	6.5	1.75	7.0
300	0.8	4.9	1.25	5.9	1.75	6.4
350	0.8	4.5	1.25	5.4	1.75	5.9
400	0.8	4.2	1.25	5.1	1.75	5.6
450	0.8	4.0	1.25	4.8	1.75	5.3
500	0.8	3.8	1.25	4.6	1.75	5.1
600	0.8	3.6	1.25	4.3	1.75	4.8
700	0.8	**3.4**	1.25	**4.1**	1.75	**4.6**
750	0.8	**3.3**	1.25	**3.9**	1.75	**4.4**
800	1.0	**3.2**	1.5	**3.8**	**2.0**	**4.3**
900	1.0	**3.1**	1.5	**3.7**	**2.0**	**4.2**
1000	1.0	**3.0**	1.5	**3.6**	**2.0**	**4.1**

4.4.2 Other Test of Pipes :

4.4.2.1 Mechanical test are carried out during the manufacture. One test shall be conducted for every batch of production.

4.4.2.2 Tensile Test shall be conducted by cutting a sample from the spigot end of the pipe. This sample may be cut perpendicular to or parallel with the pipes axis, but in case of dispute the parallel to axis sample shall be used.

4.4.2.3 Two methods of measuring the tensile strength may be used at the manufacturer's option.

4.4.2.4 Method 1 - Machine the test bar to its nominal diameter $\pm$ 10 percent, measure the actual diameter before the test with an accuracy of 0.01 mm and use this measured diameter to calculate the cross-sectional area and the tensile strength; or:

4.4.2.5 Method 2 - Machine the test bar to its nominal area S_0 within a specified tolerance on diameter and use the nominal area to calculate the tensile strength.

4.4.3 Brinell Hardness Test :

4.4.3.1 When tested in accordance with IS 1500, the Brinell hardness shall not exceed 230 HB on the external un-machined surface.

4.5 Marking

4.5.1 Each pipe shall have as cast or stamped or legibly and indelibly painted on it with the following appropriate marks:

(a) Indication of the source of manufacture:
(b) The nominal diameter:
(c) Class reference;
(d) The last two digits of the year of manufacturer:
(e) The non-standard length of the pipe if specially ordered:
(f) Where applicable, an indication of length over which the pipe is suitable for cutting on site: and
(g) A short white line at the spigot end of each pipe with push-on joint in sizes DN 700 and above, to indicate the major axis of the spigot.

4.6 Fittings

4.6.1 Dimensional and other requirement for fittings for specified Diameter shall conform to the details given in tables 15 to 31 section 3 of the IS specification code IS: 9523: 2000.

4.6.2 HYDROSTATIC TEST **–**

For hydrostatic test, the fittings shall be kept under pressure for 10 seconds. They shall withstand the pressure test without showing any sign of leakage, sweating or other defect of any kind. The test shall be conducted before the application of surface coating.

4.6.3 The fittings shall withstand the hydrostatic pressure given in table.4.7
Hydrostatic test pressure for castings

Table No. 4.7
(Refer Table No. 2 IS 9523-2000)

Nominal Diameter DN (mm)	Hydrostatic Test Pressure at works, MPa
Up to and including 300	2.5
Over 300 and up to and including 600	1.6
Over 600 and up to and including 2000	1.0

4.7 Tolerances:

4.7.1 The tolerance on dimensions of barrel and socket for push-on-joint fittings shall be as given in Table 4.8

Table No.4.8
(Refer Table No. 3 IS 9523-2000)

Nominal Diameter	External Diameter DE		Wall Thickness mm		
DN	Nominal	Tolerance	K12	K14	Tolerance
(1)	(2)	(3)	(4)	(5)	(6)
80	98	+1/-2.7	7.0	8.1	-2.38
100	118	+1/-2.8	7.2	8.4	-2.40
125	144	+1/-2.8	7.5	8.7	-2.42
150	170	+1/-2.9	7.8	9.1	-2.45
200	222	+1/-3.0	8.4	9.5	-2.50
250	274	+1/-3.1	9.0	10.5	-2.55
300	326	+1/-3.3	9.6	11.2	-2.60
350	378	+1/-3.4	10.2	11.9	-2.65
400	429	+1/-3.5	10.8	12.6	-2.70
450	480	+1/-3.6	11.4	13.3	-2.75
500	532	+1/-3.8	12.0	14.0	-2.80
600	635	+1/-4.0	13.2	15.4	-2.90
700	738	+1/-4.3	14.4	16.8	-3.00
750	790	+1/-4.4	15.0	17.5	-3.05
800	842	+1/-4.5	15.6	18.2	-3.10
900	945	+1/-4.8	16.8	19.6	-3.20
1000	1048	+1/-5.0	18.0	21.0	-3.30

4.7.2 Tolerances for the various dimensions of flanges shall be as given in tables 4.9 and 4.10

4.7.2.1 Dimensions of standard Flange Drilling for Flange Fittings PN 10

Table No.4.9
(Refer Table No. 4 IS 9523-2000)

(in mm)

Nominal Diameter	Dimensions of flange		Holes	Dia of Holes	Bolt Size, Metric
DN	D (outer dia)	b (Thickness)	No.	Dia (d)	
(1)	(2)	(5)	(7)	(8)	(9)
80	200	16	4	19	M16
100	220	16	8	19	M16
125	250	16	8	19	M16
150	285	16	8	23	M20
200	340	17	8	23	M20
250	395	19	12	23	M20
300	445	20.5	12	23	M20
350	505	20.5	16	23	M20
400	565	20.5	16	28	M24
450	615	21	20	28	M24
500	670	22.5	20	28	M24
600	780	25	20	31	M27
700	895	27.5	24	31	M27
750	960	29	24	31	M27
800	1015	30	24	34	M30
900	1115	32.5	28	34	M30
1000	1230	35	28	37	M33

4.7.2.2 Dimensions of standard Flange Drilling for flange fittings PN 16

Table No. 4.10
(Refer Table No. 5 IS 9523-2000)

(in mm)

Nominal Diameter	Outer Diameter	Holes		Bolt Size, Metric
DN	D	No.	Dia (d)	
(1)	(2)	(3)	(4)	(5)
80	200	8	19	M16
100	220	8	19	M16
125	250	8	19	M16
150	285	8	23	M20
200	340	12	23	M20
250	400	12	28	M24
300	455	12	28	M24
350	520	16	28	M24
400	580	16	31	M27
450	640	20	31	M27
500	715	20	34	M30
600	840	20	37	M33
700	910	24	37	M33
750	970	24	37	M33
800	1025	24	40	M36
900	1125	28	40	M36
1000	1255	28	43	M39

4.7.2.3 Lengths of Fittings

The permissible deviations on the lengths of fittings shall be as under

Deviation on Lengths of Fittings
Table No.4.11
(Refer Table No. 14 IS 9523-2000)

Types of fittings	nominal Diameter DN mm	Deviation in L & H mm
Flange socket, Flanged Spigot, Collars, tapers	80 to 1200	±25
Tees	80 to 1200	± 50/-25
Bends 90º (1/4)	80 to 2000	± (15 + 0.03 DN)
Bends 45º (1/8)	80 to 2000	± (10 + 0.025 DN)
Bends 20º (30) and 11º (15)	80 to 1200	± (10 + 0.02 DN)

4.8 Marking

4.8.1 Each fittings shall have as cast, stamped or indelibly painted on it, the following appropriate marks.

(a) Indication of the source of manufacture.
(b) The nominal diameter
(c) The last two digits of the year of manufacture.
(d) PN rating of flanges when applicable, and
(e) Any other mark required by the purchaser.

4.8.2 Marking may be done on the barrel of castings or on the outside of the sockets.

4.8.3 BIS Certification Marking

The fittings may also be marked with the Standard Mark.

4.8.4 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made there under. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

4.9 Specification for Laying and jointing of Pipe Line System for water Supply.

Code of practice for use and laying of DI Pipes should be as per IS 12288:1987.

4.9.1 Preparatory work:

The contractor will inspect the route along which the pipe line is proposed to be laid. He should observe/find out the existing underground utilities/construction and propose an alignment along which the pipeline is to be laid.

4.9.2 He should make all efforts to keep the pipe as straight as possible with the help of ranging rods. Wherever there is need for deviation, it should be done with the use for necessary specials or by deflection in pipe joints.

4.9.3 The alignment as proposed should be marked on ground with a line of white chalk and got approved from engineer In charge. The contractor will than prepare an L-Section along this alignment showing the location of proposed pipe line. The L-section should also be got approved from the site Engineer. The position of fittings, valves, shall be shown on the plan.

4.9.4 Alignment and the L-sections:

The alignments-section (depth of laying) and location of specials, valves and chambers may be changed at site in co-operation with and after approval of the Engineer in charge.

4.9.5 Transportation of pipes and specials:

4.9.5.1 The contractor has to transport the pipes and other materials form supplier to the site of laying as indicated by the engineer in charge. Pipes should be handled with care to avoid damage to the surface, internal lining and the socket and spigot ends, deformation or bending.

4.9.5.2 Pipes shall not be dragged along the ground or the loading end of a vehicle. Pipes shall be transported on flat bed vehicles/trailers. The bed shall be smooth and free from any sharp objects. The pipes shall rests uniformly on the vehicle bed in their entire length during transportation. Pipes shall be loaded and un-loaded manually or by suitable mechanical means without causing any damage.

4.9.6 Cranes or chain pulley block or other suitable handling and lifting equipment shall be used for loading and un-loading of heavy pipes. However, for pipes up to 400 mm nominal bore, skid timbers and ropes may be used.

4.9.6.1 Where using crane hooks at sockets and spigot ends hooks shall be broad and protected by rubber or similar material, in order to avoid damage to pipe ends and lining. Damage to lining must be repaired before pipe laying. **Pipes shall not be thrown directly on the ground.**

4.9.7 Bedding of the pipes:

4.9.7.1 The pipe shall be laid out along the proposed alignment in a such a manner that they do not create any problem to public and are not damaged.

4.9.7.2 The trench bottom shall be even and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may endure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continues contact between the trench and the entire pipe barrel between socket holes.

4.9.8 Laying and jointing of DI pipes:

4.9.8.1 Pipes should be lowered into the trench with tackle suitable for the weight of pipes. For smaller sizes, up to 200 mm nominal bore, the pipe may be lowered by the use of ropes but for heavier pipes suitable mechanical equipment have to be used.

4.9.8.2 All construction debris should be cleared from the inside of the pipes either before or just after a joint is made. This is done by passing a pull-through in the pipe, or by hand, depending on the size of the pipe. <u>All persons should vacate any section of trench into which the pipe is being lowered.</u>

4.9.8.2.1 On gradients of 1: 15 or steeper, precautions should be taken to ensure that the spigot of the pipe being laid does not move into or out of the socket of the laid pipe

during the jointing operations. As soon as the joint assembly has been completed, the pipe should be held firmly in position, while trench is back filled over the barrel of the pipe.

4.9.8.2.2 The designed anchorage shall be provided to resist the thrusts developed by internal pressure at bends, tees, etc.

4.9.8.2.3 Where a pipeline crosses a watercourse, the design and method of construction should take into account the characteristics of the watercourse to ascertain the nature of bed, scour levels, maximum velocities, high flood levels, seasonal variation, etc. which effect the design and laying of pipeline.

4.9.8.2.4 The socket and spigot end of the pipes shall be brushed and cleaned .The chamfered surface and the end of the spigot end has to be coated with a suitable lubricant recommended by the manufacturer of the pipes. Oil, petroleum bound oils, grease or other material which may damage the rubber gasket shall not be used as lubricant. The rubber gasket shall be inserted into the cleaned groove of the socket. It has to be checked for correct positioning.

4.9.8.2.5 The rubber gaskets shall be kept in their original packing and stored in cool conditions/not exposed to the direct sunlight, should only be taken out when needed.

4.9.8.2.6 The two pipe shall be aligned properly in the pipe trench and the spigot end shall be pushed axially into the socket either manually or with a suitable tool specially designed for the reassembly of pipes and as recommended by the manufacturer. The spigot has to be inserted up to the insertion mark on the pipe spigot. After insertion, the correct position of the socket has to be tested with a feeler blade.

4.9.8.2.6 Deflection of the pipes if-any-shall be made only after they have fully been assembled. The deflection shall not exceed 75% of the values indicated by the pipe manufacturer.

4.10 Joints

4.10.1. In the case of push-on-joints for sizes 'DN 600' and above the sockets may be with or without centering rings.

4.10.1.2 The lengths of the spigot necessary for jointing shall not be less than the length of the socket of the jointing pipe.

4.10.1.3 In case of push-on-joint the spigot end of fitting, if any, shall be suitably chamfered to facilitate smooth entry of spigot in the socket of the pipes or fittings fitted with rubber gasket.

4.10.1.4 In case of flange and mechanical joint casting, the flange shall be at right angle to the axis of the joint. The bolt holes shall be either cored or drilled.

4.10.1.5 The center of bolt holes circle shall be concentric with the bore circle and shall be located of the centre line. Unless otherwise specified by the purchaser. Where there are two or more flanges, the bolt holes shall be correctly aligned between them.

4.10.1.7 For high pressure mains, requiring working pressure greater than 2.4 MPa, suitable flexible joint may be preferred where the joint is restrained against axial movement.

4.10.1.8 Push-on-joint fittings are normally not used for sizes above DN 1600.

4.11 Rubber Gaskets

The material of rubber gaskets for use with mechanical joints and push-on-joints shall conform to IS: 5382. Unless otherwise agreed between the manufacturer and the purchaser. Dimensions of the rubber gasket shall be as per manufacturer's own design.

4.12 Anchoring of the pipeline:

Thrust block shall be provided at each bend, tee, taper, end piece to prevent undue movements of the pipeline under pressure. They shall be constructed as per design of engineer-in-charge according to the highest pressure during operation or testing of the pipes, the safe bearing pressure of the surrounding soil and the friction coefficient of the soil.

4.13 Measurement

The net length of pipes as laid or fixed should be measured in running meters correct to a cm. specials should be excluded and enumerated and paid separately. The portion of the pipe within the collar at the joints should not be included in the length of pipe work.

4.14 Rates

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER NO.5:
UNPLASTICIZED PVC PIPES FOR POTABLE WATER SUPPLY

5.1 Applicable codes:

The laying of Un-plasticized PVC pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of Un-plasticized PVC pipes shall be part of this Specification.

Table No.5.1

I.S. Number	Title
IS 4985: 2000	Specification for un-plasticized PVC pipes for potable water supply.
IS 7634(PT-3): 2003	Code of practice for plastics pipes selection, Handling, Storage and installation for potable water Supply.
IS 7834(PT I to VIII): 1987	Specification for injection moulded PVC socket fittings with solvent cement joints for water supply.
IS 14182:1994	Solvent cement for use with un-plasticized polyvinyl Chloride Plastic pipes and fittings.

5.2 The chief advantage of PVC pipes are Resistance to corrosion, Light weight, Toughness, Rigidity, Economical in laying, jointing and maintenance, Ease of fabrication. Because of their lightweight, PVC pipe are easy to handle, transport, and install.

5.2.1 Solvent cementing technique for jointing PVC pipe lengths is cheaper, more efficient and far simpler. PVC pipes do not become pitted or tuberculated and are unaffected by fungi and bacteria and are resistant to a wide range of chemicals. They are immune to galvanic and electrolytic attack, a problem frequently encountered in metal pipes, especially when buried in corrosive soils or near brackish waters.

5.2.2 PVC pipes have elastic properties and their resistance to deformation resulting from earth movements is superior compared to conventional pipe materials specially AC. Thermal conductivity of PVC is very low compared to metals. Consequently water transported in these pipes remains at a more uniform temperature. These pipes generally come in 6m length.

5.3 Rigid PVC pipes weigh only $1/5^{th}$ of conventional steel pipes of comparable sizes. PVC pipes are available in sizes of outer dia, 20, 25, 32, 50, 63, 75, 90, 110, 140, 160, 250, 290 and 315mm at working pressures of 2,5,4,6, 10 kg/cm² as per IS 4985-1988.

5.4 Classification of pipes

The pipes shall be classified by pressure ratings (working pressures) at 27°C as follows:

Class of pipes	Working pressure (PN)
Class 1	0.25 MPa (2.5 kg/cm^2)
Class 2	0.4 MPa (4.0 kg/cm^2)
Class 3	0.6 MPa (6.0 kg/cm^2)
Class 4	0.8 MPa (8.0 kg/cm^2)
Class 5	1.0 MPa (10.0 kg/cm^2)
Class 6	1.25 MPa (12.5 kg/cm^2)

5.5 DIMENSIONS OF PVC PIPES

5.5.1 The mean outside diameter, outside diameter at any point and their tolerances shall be as given in table 5.2.

5.5.2 Mean outside diameters

The permissible variation (d_{em} _ d_n) between the mean outside diameter (d_{em}) and the nominal outside diameter (d_n) of a pipe shall be positive in the form +x, where x is less than or equal to the greater of the following two values:

a) 0.3 mm, and

b) 0.003 d_n rounded off to the next higher 0.1 mm.

5.5.3 Wall thickness

The wall thickness of plain pipe and the plain portion of socket ended pipe shall be as given in table. 5.2.

5.5.3.1 Tolerance on wall thickness.

5.5.3.1.1 For pipes of minimum wall thickness 6 mm or less, the permissible variation between the minimum wall thickness (e_{min}) and the wall thickness at any point (e), ($e-e_{min}$) shall be positive in the form of +y, where y= 0.1 e_{min} + 0.2 mm

5.5.3.1.2 For pipes of minimum wall thickness greater than 6 mm, the permissible variation of wall thickness shall again be positive in the form of +y, where y would be applied in two parts.

5.5.3.1.3 The average wall thickness shall be determined by taking at least six measurements of wall thickness round the pipe and including both the absolute maximum and the absolute minimum values. The tolerance applied to this average wall thickness from these measurements shall be within the range 0.1 e_{min} + 0.2 mm (see table 5.2)

5.5.3.1.4 The maximum wall thickness at any point shall be within the range 0.15 e_{min}. (see table 5.2)

5.5.3.1.5 The results of these calculation for checking tolerance shall be rounded off to the next higher 0.1 mm

Table No. 5.2
(Refer Table No. 1 IS 4985-2000)

Nominal outside Diameter (Nominal size)	Mean outside Diameter		Outside Diameter At any point		Working Pressure, MPa								
	Min	Max	Min	Max	Class3 (6kg/sqcm) 0.60			Class 4 (8kg/sqcm) 0.80			Class 5 (10kg/sqcm) 1.00		
					Avg	Min	Max	Avg	Min	Max	Avg	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
90	90.0	90.3	88.9	91.1	3.7	3.1	3.7	4.6	4.0	4.6	5.7	5.0	5.7
110	110.0	110.4	108.6	111.4	4.3	3.7	4.3	5.6	4.9	5.6	7.0	6.1	7.1
125	125.0	125.4	123.5	126.5	5.0	4.3	5.0	6.4	5.6	6.4	7.8	6.9	8.0
140	140.0	140.5	138.3	141.7	5.5	4.8	5.5	7.2	6.3	7.3	8.7	7.7	8.9
160	160.0	160.5	158.0	162.0	6.3	5.4	6.2	8.2	7.2	8.3	9.9	8.8	10.2
180	180.0	180.6	177.8	182.2	7.0	6.1	7.1	9.0	8.0	9.2	11.1	9.9	11.4
200	200.0	200.6	197.6	202.4	7.7	6.8	7.9	10.0	8.9	10.3	12.3	11.0	12.7

5.6 Length of pipe

The effective length of pipes shall be 4, 5, or 6 meters. For plain ended pipes the overall length shall be measured from end to end. For socketed pipe for solvent cement jointing the effective length of pipe shall be determined by subtracting from the overall length, the socket length.

5.6 Dimensions of sockets pipes:-

5.6.1 The sockets formed at the ends of the pipes shall be parallel to the axis of the pipe. The minimum length of any socket shall be = 0.5 x nominal outside diameter of the pipe +6 mm.

5.6.2 Sockets for solvent cement jointing – these shall conform to dimensions given in Table 5.3.

Table No.5.3
All dimensions in millimeters
(Refer Table No. 3 IS 4985-2000)

Normal size DN	Socket Length L_S	Mean socket internal diameter at Mid-point of socket Length, d_M	
	Min	Min	Max
(1)	(2)	(3)	(4)
90	51.0	90.1	90.3
110	61.0	110.1	110.4
125	68.5	125.1	125.4
140	76.0	140.2	140.5
160	86.0	160.2	160.5
180	96.0	180.2	180.5
200	106.0	200.3	200.6

5.6.3 The minimum length of any socket shall be Ls = 0.5xdn+6mm

5.7 Pipe ends:-

The ends of the pipes meant for solvent cementing (both plain and bell ended) shall be cleanly cut and shall be reasonably square to the axis of the pipe or may be chamfered at the plain.

5.8 Physical and chemical characteristics

5.8.1 Visual appearance

5.8.2 The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects. Slight shallow longitudinal grooves or irregularities in the pipe shall be permissible provided the wall thickness remains within the permissible limits.

5.8.3 Opacity:-

The wall of the plain pipe shall not transmit more than 0.2 percent of the visible light falling on it when tested in accordance with IS: 12235 (Part-3)

5.8.4 Effect on water:-

The pipe shall not have any detrimental effect on the composition of water flowing through them.

5.9 Marking

5.9.1 Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at intervals of not more than 3 meters, in colour. The marking shall show the following:

a) Manufacturer's name or trade-mark
b) Out side diameter,
c) Class of pipe and pressure rating,
c) Batch or lot number, and
e) The word plumbing in the case of plumbing pipes.

5.9.2 The information according to 5.9.1 shall be marked in colours as mentioned below:-

Class	Colour
Class 3	Green
Class 4	brown
Class 5	Yellow

5.9.3 In case of hot embossing, pipe shall also be provided near the end with circumferential colour band as mentioned above in clause 5.9.1, to identify the class of pipe.

5.10 Handling and storage

5.10.1 Because of their lightweight, there may be a tendency for the PVC pipes to be thrown much more than their metal counterparts. This should be discouraged and reasonable care should be taken in handling and storage to prevent damage to the pipes.

5.10.2 On no account should pipes be dragged along the ground. Pipes should be given adequate support at all times.

5.10.3 These pipes should not be stacked in large piles, specially under warm temperature conditions, as the bottom pipes may be distorted thus giving rise to difficulty in pipe alignment and jointing. For temporary storage in the field, where racks are not provided, care should be taken that the ground is level, and free from loose stones. Pipes stored thus should not exceed three layers and should be so stacked as to prevent movement. It is also recommended not to store one pipe inside another. It is advisable to follow the practices mentioned as per IS: 7634-Part-I.

5.11 Testing of Pipes :-

5.11.1 Reversion Test

When tested by the immersion method prescribed in IS 12235 (Part 5), a length of pipe 200 $\pm$ 20 mm long shall not alter in length by more than 5 percent. In the case of socket end pipes, this test shall be carried out on the plain portion of the pipe taken at least 100 mm away from the root of the socket.

5.11.2 Vicat Softening Temperature

When tested by the method prescribed in IS 6307, the vicat softening temperature of the specimen shall not be less than 80^0C.

5.11.3 Sulphated Ash Content Test

When tested the sulphated ash content in the pipe shall not exceed 11 percent.

5.11.4. Hydrostatic Characteristics

When subjected to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (Part 8), the pipe shall not fail during the prescribed test duration. The temperatures and duration of the test shall conform to the requirements given as per Table 5.4. The test shall be carried out not earlier than 24 h after the pipes have been manufactured.

Table No. 5.4
(Refer Table No. 6 IS 4985-2000)
Requirements of Pipes for Internal Hydrostatic Pressure Test

Test	Test Temperature (Min.) ^{0}C	Test Duration (Min. Holding Time) h	Test Pressure (Min.) MPa
1	2	3	4
Type test	60	1000	1.16 x PN (MPa)
Acceptance test	27	1	4.19 x PN (MPa)

5.12 Fittings:-

5.12.1 Size of Fittings **–**

The sizes of the fittings shall be designated by the diameters of their sockets. The inside diameters of the sockets of the fittings shall correspond to the outside diameters of the pipes given in IS: 4985-1988. The general requirement of the pvc socket fittings shall conform to IS: 7834 (part-1) 1987.

5.12.2 Minimum thickness:-Thickness at any place in a fitting shall not be less than 3 mm.

5.12.3 **Socket length and diameter at Mid-point of socket Length**

5.12.3.1 The minimum socket length of any fittings shall be as given by the expression L= 0.5 D + 6 mm with a minimum of 12 mm.

Where:-

L = socket length, and

D = nominal inside diameter of fittings (corresponding to the outside diameter of the pipe)

5.12.3.1.2 The socket length is applicable to socket fittings for pipes of any diameter under pressure. The minimum socket lengths based on the formula in 8.3.1 for socket.

5.12.3.2 The maximum and minimum dimensions of mean inside diameter at mid-point of socket depth shall comply with those given in table 5.4.

Table No. 5.4
Socket dimensions
All dimensions in millimeters.
(Refer Table No. 1 IS 7834 (part-1) -1987)

Nominal Size	**Minimum Socket Length**	**Mean socket internal diameter at Mid-Point of socket Length**	
		Minimum	Maximum
(1)	(2)	(3)	(4)
90	51	90.1	90.3
110	61	110.1	110.4
125	69	125.1	125.4
140	76	140.1	140.5
160	86	160.2	160.5
180	96	180.2	180.5
200	106	200.3	200.6

5.12.4 Marking for fittings

5.12.4.1 All fittings shall be clearly and indelibly marked at a prominent place visible even after the installation of the fittings with the following:

a) Manufacturer's identification mark, and

b) Size of the fitting and the appropriate class (working pressure) of IS: 4985-2000 to which the pressure rating of the fitting corresponds.

5.12.4.2 PVC fittings also conforming to specific requirements as prescribed in the relevant parts of the standard may also be marked with the standard Mark.

5.12.5 Specific requirements for various pvc socket fittings with solvent cement joints for water supplies shall be as mentioned below:

Table No.5.5

S.No	Type of fittings	Relevant IS code
1.	45º Elbows	IS: 7834 (Part-2)-1987
2.	90º Elbows	IS: 7834 (Part-3)-1987
3.	90º Tees	IS: 7834 (Part-4)-1987
4.	45º Tees	IS: 7834 (Part-5)-1987
5.	Sockets	IS: 7834 (Part-6)-1987
6.	Unions	IS: 7834 (Part-7)-1987
7.	Caps	IS: 7834 (Part-8)-1987

5.13 Solvent cement jointing

5.13.1 PVC solvent cement is quick drying, therefore it shall be applied as quickly and carefully as possibly and in consistence with good workmanship. For larger sizes, it is advisable for two workers to work simultaneously on the pipe and socket.

5.13.2 Solvent cement shall conform to IS:14182.

5.13.3 Dip the applicator brush in the solvent cement and apply a liberal coat of cement to the end of the pipe up to the insertion depth.

5.13.4 Apply a uniform thin coat of cement inside the socket, working axially from the inside of the socket to the outside. Do not apply any cement on the shoulders of the socket (socket-to-pipe transition area). Care should be taken not to apply excess cement inside the socket. Excess cement in the socket will be pushed further into the pipe during assembly and cause the pipe to soften and weaken at that point. Hot and dry climates generally require slightly thicker coatings of solvent cement.

5.13.5 In climates with large differences between day and night temperatures, it is advisable to make joints early in the morning or in the evening when it is cooler. Thus, the joints are prevented from being pulled apart if the pipes contract.

5.13.6 For pipe installation solvent glued spigot is inserted in the socket up to the shoulder and then after a quarter (90º) turn is given to evenly distribute the cement over the treated surface.

5.13.6.1 Within 20 second after the last application of solvent cement, insert the pipe in to socket in a single steady and every controlled but forceful action. Press it in fully until it bottoms. No. hammer blows should be used. If there is any sign of drying of the cement coat before insertion; the surface should be re-coated, avoiding application of excess cement in the socket. Once the insertion is complete, hold in place for 1 min without shifting the pipe in the socket.

5.13.7 Immediately after assembly, wipe the excess solvent cement from the pipe at the end of the socket. A properly made joint will have a uniform bead around its entire perimeter. Any gaps in this bead may be indicative of an improper joint due to insufficient cement or the use of a lighter-bodied cement than the one recommended.

5.14 Trench:-

(See Drawing No.-3)

5.14.1 Location: Drinking water pipelines should not be located below sewerage pipelines. Where a pipeline runs parallel to other pipelines or cables, the distance between them should not be less than 0.4 m.

5.14.2 At points of congestion, a distance of 0.2 m should be maintained unless steps are taken to prevent direct contact.

5.14.3 Width: Trenches should be of adequate width to allow the burial of pipe, while being as narrow as practical. If expansion and contraction are not problems and snaking of pipe is not required, minimum trench widths may be obtained by jointing the pipe outside the trench and then lowering the piping into the trench after the testing. A trench width of two or three times the pipe diameter is a good rule of thumb. Narrow (unsupported) trench width and supported trench width shall be as given under:

Table No.5.6

Nominal pipe size (Diameter in mm)	Unsupported Narrow Trench Width (Minimum)		Supported Trench Width, (Minimum)	
	Number of pipe Diameter	Width (mm)	Number of pipe Diameter	Width (mm)
90	5.0	450	10.0	900
110	4.0	450	8.2	900
125	4.0	500	7.2	900
140	3.9	550	6.4	900
160	3.5	560	5.6	900
180	3.2	580	5.0	900
200	3.0	600	4.5	900

5.14.4 Where necessary to prevent cave-ins, trench excavations in unstable soil shall be adequately supported. As backfill is placed and sheeting withdrawn, the void left by the withdrawn sheeting shall be filled and compacted before withdrawing the next increment.

5.14.5 Trench Bottom

5.14.5.1 The trench bottom shall be constructed to provide a firm, stable and uniform support for the full length of the pipeline. There should be no sharp objects that may cause point loading.

5.14.5.2 Any large rocks, hard pan, or stones larger than 20 mm should be removed to permit a minimum bedding thickness of 100-150 mm under the pipe.

5.14.5.3 For pipes of diameters 100 mm or greater, bell holes in the bedding, under each socket joint, shall be provided by removing some of the bedding material, to accommodate the larger diameter of the joint and to permit the joint to be made properly.

5.14.6 Excavated material should be deposited at a sufficient distance from the trench so that damage is not caused to the pipe line through falling stones/debris.

5.14.7 Prepare the bedding by laying on soft soil and alternatively compacting and watering sparingly until an effective thickness of 100 to 150 mm is achieved.

5.15 Laying

5.15.1 Lay the pipe in the trench after ensuring that bell holes have been provided for at the appropriate places in the bedding (Pipes of diameter 110 mm or less, with no live load application, do not require bell holes in the trench bottom).

5.15.2 These have to be refilled carefully after testing of the pipeline and prior to complete backfilling of the trench.

5.15.3 Though not essential, the pipes should be laid with the spigots entered into the sockets in the same directions as the intended flow of water.

5.16 Minimum cover:

5.16.1 A minimum cover of 0.9 m when truck traffic is expected.

5.16.2 A minimum cover of 1.8 m when heavy truck or locomotive traffic (dynamic loads) is expected. Usually pipe below 2.0 m of cover are not affected significantly by dynamic loads. If the application prevents deep burial of the pipe and heavy traffic passing over the pipe is expected, it would be advisable to use steel or reinforced concrete casing to prevent damage to the pipe.

5.17 Anchoring

5.17.1 The purpose of the anchor block is to transfer the total thrust to the trench sides. It is therefore important to take account of the load-bearing capacity of the surrounding ground.

5.17.2 Recommended mixture for concrete is one part cement, two parts washed sand and two parts gravel.

5.17.3 Where concrete would be in direct contact with the pipe or fittings, these should be wrapped with a compressible material, for example rubber sheet or foamed polyethylene sheet, to accommodate creep and prevent the occurrence of high local stress concentrations.

5.18 Back-filling

5.18.1 The first side fill or hunching layer should be placed by hand and compacted in layers under the lower quadrants of the pipe up to the spring level (half the vertical diameter) of the pipe.

5.18.2 Compaction can be done by careful trampling with the feet or with trampling tool.

5.18.3 Care should be taken to leave adequate area around the joint free of backfill to allow for inspection during testing of the pipeline.

5.18.4 Successive layers of backfill of 75 mm thickness may then be placed over and compacted to a height above the crown of not less than 150 mm. Light vibrating machinery may be used, but not directly above the pipe.

5.18.5 On completion of the surround to the pipe, suitable excavated material may be then replaced as backfill in 250 mm compacted layers up to the top of the trench.

5.18.6 No heavy compaction equipment to be employed until there is at least 300mm of fill above the crown of the pipe.

15.19 Measurement

15.19.1 The net length of pipes as laid or installed shall be measured in running meters correct to a cm. Specials shall be excluded and enumerated and paid separately under the relevant item. The portion of pipe at the joints (inside the joint) shall not be included in the length of the pipe work. Excavation, refilling, masonry and concrete work (as required) shall be measured and paid for separately under relevant item of work.

15.20 Rates:

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER NO.6
CAST IRON VALVES

6.1 Applicable codes :

The Sluice valves, Butterfly valves, Air valves & Non return valves for water works purposes shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of Sluice valves, Butterfly valves, Air valves & Non return valves pipes shall be part of this Specification.

Table No.6.1

I.S. Number	Title
IS 14846: 2000 Super seeding IS 780:1984 & IS 2906:1984	Sluice valves for water works purposes (50 to 1200mm size)
IS 13095: 1996	Butterfly valves for General purposes
IS 2685: 1971	Code of practice for selection, installation and maintenance of sluice valves.
IS 5312: 2003 (Part I & II)	Non return valve/reflux valve.
IS 14845: 2000	For air valve.

6.2 Sluice Valves for water works purposes. *(See Drawing No.-4 & 5)*

6.2.1 The sluice valves are used in a pipe line for controlling or stopping flow of water. These shall be of specified size and class and shall be of inside non-raising screw type up to 300mm size and raising or non-raising screw type above 300mm with either double flange or double socket ends and cap or hand wheel.

6.2.2 The body, domes covers, wedge gate spindle, nut, valve seat and stuffing box shall be of good quality. The bodies, spindles and other parts shall be truly machined with surface smoothly finished. The area of the water way of the fittings shall be not less than the area equal to the nominal bore of the pipe details of component are given in table 6.2.

Table No.- 6.2
Materials for component Parts of Sluice Valve

S.No.	Component	Preferred Material	Grade or Designation	Alternative Material	Grade or Designation
i)	Body, bonnet, dome, stool cover, wedge, stuffing box, gland, thrust plate and cap.	Grey cast iron	FG 200	Spheroidal or Nodular iron cast steel	260-300/12 or 500/2
ii)	Hand wheel	Grey cast iron	FG 200	Mild steel cast steel Nodular iron	F 410 WA 230-450W 400/12
iii)	Stem	Stainless steel	12Cr 13 04Cr 18Ni 10 04Cr 17 Ni 12 MO 2	High Tensile Brass Stainless steel	HT 2 FHTB 2 20Cr13
iv)	Wedge nut, shoe, channel	Leaded tin bronze	LTB-2	High Tensile Brass Phosphor bronze	HTB 2 FHTB -2
v)	Body seat ring, wedge facing ring and bushes	Leaded tin bronze	LTB-2	Alloy steel	Gr. 1 Gr. 4 Gr. 10 04Cr 18Ni 10
vi)	Bolts	Carbon steel	Class 4.6	Stainless steel	
vii)	Nuts	Carbon steel	Class 4.0	Stainless steel	
vii)	Gasket	Rubber	Type B	Neoprene Rubber	
ix)	Gland packing	Jute and hemp		Rubber	Type –B
x)	Gear	Spheroidal graphite iron	Gr. 500/7	Alloy steel	40 Ni 2Cr M20 28 Gr B
xi)	Gear housing	Grey cast iron	FG 200	Cast steel S.G. iron	230-450 W 400/12
xii)	Pinion & pinion shaft	Wrought carbon steel	C55 Mn 75	Alloy steel Stainless steel	40 ni 12Cr 1 MO 28 04Cr18 Ni10

6.2.3 The valve shall be marked with an arrow to show the direction of turn for closing of the valve.

6.2.4 Sluice valves are designated by nominal pressure (PN) as under

Nominal Pressure MPa	Nominal size mm
PN 1.0	50 to 1200
PN 1.6	50 to 600

6.2.5 The dimension of the sluice valve assemblies shall be as per table 2 & 3 of IS 14846. The flanges and their dimensions of drilling shall be in accordance with IS : 1538.

6.2.6 Testing

6.2.6.1 The test pressure and maximum working pressure for the two classes of sluice valves shall be as tabulated below:-

Table No.6.3

PN rating of valve	Test pressure, MPa		Max. working Pressure, MPa	Test Duration min
	Body	Seat		
PN 1.0	1.5	1.0	1.0	5
PN 1.6	2.4	1.6	1.6	2

6.2.7 Coating

6.2.7.1 All coatings shall be carried out after satisfactory testing of the valves prior to dispatch. All the unmachined ferrous surfaces of the valve (both inside and outside) shall be thoroughly clean, dry and shall be free from rust and grease

before painting. All exposed machined ferrous surfaces shall be painted with one coat of aluminum red oxide primer conforming to IS 5660.

6.2.7.2 Two coats of black japan conforming to Type B of IS 341 or paint conforming to IS 9862 or IS 2932 shall be applied by brush or spray for exterior application in colour as approved by the purchaser.

6.2.8 Marking

6.2.8.1 The following information shall be cast on each valve body in raised letters.

(a) The manufacturer's name or trade-mark:
(b) The nominal pressure of valve (PN 1.0 or PN 1.6);
(c) Size of valve (mm);
(d) Heat number of cast;
(e) Year of manufacture;

In addition each valve shall bear conspicuously upon it prior to dispatch;

(f) Serial number in puch, on top of flanges: and
(g) Where a valve has been tested for only open-end test, it should be marked "O" distinctly and permanently on flanges adjacent to serial number.

6.2.8.2 Each sluice valve shall be marked with the Standard Mark.

6.2.9 Installation of sluice valves:

6.2.9.1 Sluice valves shall normally be installed with spindle vertical on horizontal pipes except on vertical pipes spindle shall be horizontal. On slopes, the sluice valves may preferably be kept vertical if slope is nominal and gradient can be adjusted with the help of connecting pipes on either sides.

6.2.9.1.1 It shall be ensured while fixing sluice valves in pipe line below ground level that a clear space of about 200 mm is available between the top of the sluice valve spindle and surface box, so that valve cap may be easily provided when surface box is kept in flush with road level.

6.2.9.2 It is most important to ensure that:

a) All grit and foreign matters are removed from the inside of the valves before placing in pipes, and
b) All the four faces are thoroughly cleaned and coated with a thin layer of mineral grease.

6.2.9.3 It is important to check tightening of gland with a pair of inside calipers. Clearance between the top of the stuffing box and the underside of the gland should be uniform on all the sides.

6.2.9.4 Gland should not be tightened too hard. The pressure applied should be just enough to stanch leakage.

6.2.9.5 Hemp packing should be adequately soaked in grease and should not be allowed to remain dry.

6.2.9.6 The valves should be tightly closed when being installed, as this keeps the valves rigid and prevents any foreign matter from getting in between the working parts of the valves.

6.2.9.7 While installing flanged valves, each flange bolt should be tightened a little at a time, taking care to tighten diametrically opposite bolts alternately. The practice of fully tightening the bolts one after the other is highly undesirable.

6.2.9.8 After installation of the valve, the valve and the pipe line should be flushed with water to remove any foreign matter that may be present in them.

6.2.9.9 If any leak is detected at the valve seats, applying extra torque on the valve spindle to set right the valve is not good practice, the valve seats should be examined and, if necessary, repaired by scraping or replacing where necessary.

6.2.9.10 Valves in exposed positions should be protected in cold weather where there is a likelihood of their becoming frozen and bursting.

6.2.9.11 Surface boxes conforming to IS: 3950-1966 should be provided to cover the valve chamber for the safety and easy identification of the valves.

6.2.9.12 The direction of opening and closing should be clearly indicated.

6.2.9.13 Suitable identification plate should be provided as near to the actual location of valves as possible.

6.2.9.14 Care should be taken to ensure that the joining material sits squarely between the flanges of the valve and pipe lines or tails without obstructing the water way. It is to be ensured that there are no kinks in the joints material as might allowed leakage in service.

6.2.9.15 Maintenance of sluice valve should be done periodically as per guide line in IS 2685:1971 chapter 4.

6. 3 Air Valve

6.3.1 Air valves are to be used for evacuation of accumulation of air in water mains under pressure, for the exhaust of air when such mains are being charged with water and for inlet of air when they are emptied of water.

6.3.2 There are two types of air valves generally use. Single air valves with single ball and double air valve with double ball. The single ball type can have either large orifice or small orifice, the former being only suitable for emptying and filling of pipe line and latter for discharging small quantities of entrained air in the pipe.

6.3.3 Double air valves are commonly available which are suitable for dual purpose with a large orifice and a small orifice in one unit, with a common connection

with the main. For large aqueduct pipe line, a triple orifice air valve is available with two large orifices and one small orifice.

6.3.4 For high pressure, stainless steel floats are used instead of vulcanite-covered balls. In case of high velocity air discharge, special design of air valves are also available. Under such situation if usual type of air valves are used there is danger that the ball might be carried to its seat by the air stream before the accumulated air has been completely exhausted.

6.3.5 Single air valves of small sizes are provided with stop cock or peet valves with the inlet of the air valve, whereas double air valves are provided with a standard sluice valve fixed, with inlet flange of the air valve or with integral valve, Regular maintenance at least on annual basis in necessary to ensure that the balls are free to move and that the seat do not leak. In very cold weather it is necessary to drain the chamber of valves to avoid any damage due to frost.

6.3.6 Construction of water tight chamber around the air valve when fixed in street is necessary to avoid the admission of any polluted water.

6.3.7 The pressure ratings for single air valve and double air valve are as mentioned below :

Table No.6.4

Type of valve	**Max working pressure, bar gauge**	**Hydrostatic test pressure in bar gauge**	
		Shell	**Seat**
a). Single Air Valve (screwed)	(Size 1") -10 (Size ½"-3/4")-5	16	10
b) Double air valve (flange faced)	(size 40 to 200 mm) -10	16	10
c) Kinetic air valve	(size 80 to 200 mm) 10	16	10

Note : 1 Bar = 0.9869 atm and
1 atmosphere = 1.000 kg/cm²
= 14.22 PSI

6.3.8 Kinetic Air Valve:

6.3.8.1 When ordinary single air valve is used, the air or water from the rising main is admitted in the ball chamber of the air valves from one side of the ball. This arrangement has disadvantage, i.e. once the ball goes up, it does not come down even when the air accumulates in the ball chamber and also due to the air rushing in, it stirs the ball making it stick to the upper opening which does not fall down unless the water pressure in the main drops down.

6.3.8.2 The kinetic air valve overcomes these problems because the air or water enters from the bottom side of the ball and the rushing around the ball exerts the pressure and loosens the contact with the top opening and makes the ball to drop down.

6.3.8.3 The valve consists of a chamber carrying a floating ball which seals off the orifice when water rises in the chamber. The float is made of seasoned timber core and provided with vulcanized cover for large opening chamber and a rubber core in case of small ones.

6.3.8.3.1 The vulcanized float sits under normal service condition against a valve seat of moulded rubber of special composition. The valve opens only when the pressure inside the pipe line reduces approximately to that of atmosphere during filling or emptying out operations.

6.3.8.3.2 The air accumulated at the highest points gets compressed and exerts pressure on the rubber ball and causes it to depress throwing open the orifice through which the accumulated air escapes.

6.3.8.3.3 Air valves shall be installed on top of air valve tees. It should conform to IS 14845:2000.

6.4 Butterfly valves

6.4.1 Butterfly valves are used to regulate stop the flow especially in large size conduits. They are sometimes cheaper than sluice valves for larger sizes and occupy less space.

6.4.2 Butterfly valves with no sliding parts have the advantages of ease of operation, compact size, reduced chamber or valves house and improved closing and retarding characteristics.

6.4.3 These would involve slightly higher head loss than sluice valves and also are not suitable for continuous throttling. The sealing is sometime not as effective as for sluice valves especially at high pressures.

6.4.4 They also offer a fairly high resistance to flow even in fully open state because the thickness of the disc obstruct the flow even when it is rotated to fully open position. Butterfly valves as well as sluice valves are not suited for operation in partly open position as the gates and seatings would erode rapidly. Both types require high torques to open them against high pressure, they often have geared hand wheels or power driven actuator.

6.4.5 Butterfly Valves with loose sealing ring are sometimes not effective, especially at higher pressures. Butterfly valves with fixed liner can overcome this shortcoming, further the butterfly valves with fixed liner needs no frequent maintenance for replacement of sealing ring as in the case of butterfly valves with loose sealing ring.

6.4.6 Valve shall be placed on a support of concrete so that non shear stress is in the flanges. In case of axial thrust due to closure of a valves against pressure the valve shall be anchored in the support in a suitable manner to transfer the thrust into the floor slab of the chamber.

6.4.7 Nominal sizes :-

6.4.7.1 The range of nominal valve size (DN) in mm shall be as follows:
40, 50, 65, 80, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800 and 2000.

6.4.8 Nominal Pressures :-

6.4.8.1 Valves shall be designated by nominal pressure (PN) defined as the maximum permissible working pressure (MPa) at 20^0C temperature as follows:
PN 0.25, PN 0.6, PN 1.0, PN 1.6, PN 2.5 and PN 4.0

6.4.8.2 The class designations for valves specified by nominal pipe sizes shall be class 125, class 150 and class 300.

6.4.9 Direction

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

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

6.4.10 Testing

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

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

6.4.10.3 Body Test: Completely assembled valve shall be tested as follows:

6.4.10.3.1 The body ends shall be blanked so that the valve as subjected to the full pressure in all directions induced by the test pressure. Wafer valves may be tested in any suitable manner agreed between the purchaser and the manufacturer.

6.4.10.3.2 The valve disc shall be in slightly open position and pressure equivalent to 1.5 times the maximum permissible working pressure shall be applied with water. The duration of this test shall be as in Table. 6.5

Table 6.5

Nominal Dia	Minimum Test Duration in Minutes for	
	Body Test	Seat Test When Applicable.
Upto and including 50	0.25	0.25
65 to 150	1	1
200 to 300	2	2
350 to 1000	5	2
1200 to 2000	5	3

6.4.11 Marking

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

6.6 Non return valve: *(See Drawing No.-4)*

6.5.1 A device provided with a disc hinged on one edges so that it opens in the direction of normal flow and closes with reversal of flow. Non return valve are 3 types: 1 swing check type cast iron reflex valve. 2. Gun metal non return valve. 3. Cast steel reflex valve.

6.5.2 The reflux valves are swing type gate valves with a flap hinged at its top and the flow in the forward direction causing the flap to swing open. The amount of opening depends upon the velocity of flow and the weight of flap. With the decrease of velocity, the opening reduces and it closes down preventing any back flow during reversal of flow.

6.5.3 The main consideration for the selection of reflux valve should always be that it should not close down without heavy shock. If it closes with a shock it may lead to development of severe water hammer.

6.5.4 Single check-type Reflux Valves (Cast iron):

6.5.4.1 (Non-return valves) Single Door Pattern should conform to IS: 5312 (Part-I)

6.5.4.2 General: The body, door, cover and hinge are of cast iron to IS: 1210. Body ring, door faces, bearing bushes are of gun metal, hinge pins, door pins and door suspension pins are of high tensile brass or chromium steel (minimum 12 % chrome) and air release plugs galvanized cast iron. Reflux valves shall be designated by nominal pressure (PN) defined as maximum permissible gauge pressure.

6.5.4.3 Size of valve 50mm to 600mm.

6.5.5. Swing check type reflux (non return valves) multi door pattern conforming to IS 5312 (Part-2)

6.5.5.1 Class of valves **–** Class of reflux valves shall be designated by nominal pressure (PN), defined as the maximum permissible gauge working pressure in MPa as follows: PN 0.6 and PN 1

6.5.5.2 The materials used for the manufacture of different component parts of valves shall conform to requirements given in table 6.6.

Table No.6.6
Material for different component parts of reflux valves IS 5312 (Part-2)

S.No.	Component	Basic Material	Alternative Materials
i).	Body with hinge and diaphragm	Grey cast iron	a) S.G. iron b) Cast steel
ii).	Hinge pin	High tensile brass	Stainless steel
iii).	Bolts	Carbon steel	----------
iv).	Nuts, nuts for hinge pins	Carbon steel	----------
v).	Bearing bushes	Leaded tin bronze	a) Austenitic iron b) PTFE/Rein- forced PTFE
vi).	Face and seat rings	Leaded tin bronze	a) Austenitic stainless steel b) Stainless steel
vii)	Flange jointing material	Rubber	b)

6.5.7 The dimensions of the valve shall be as under: table 6.7

Table No.6.7 IS 5312 (Part-2)

Size	Length over Flange (A)	Overall Height (B)	Height of Centre from Duck Foot (C)
500	815	1150	600
600	914	1333	685
700	1000	1446	750
750	1045	1446	750
800	1118	1634	850
900	1250	1570	815
1000	1250	1730	915

6.5.8 Tolerances- The tolerance on the face-to-face dimensions shall be as follows:
Table No.6.8

Face-to-Face Dimensions	**Tolerances**
400 mm	±2 mm
Above 400 mm up to and including 600 mm	±3 mm
Above 600 mm up to and including 800 mm	± 4 mm
Above 800 mm up to and including 1000 mm	± 5 mm

6.5.9 Mass of valve– The minimum finished mass of the valves shall be as under: IS 5312 (Part-2)

Table No.6.9

Nominal Size of Valves (mm)	Min Mass (kg)
500	1450
600	2040
700	2250
750	2450
800	2540
900	3480
1000	4000

6.5.10 Testing– Before coating each valve shall be subject to hydrostatic test shall be carried out with water. Test pressures and duration of test shall be as specified in Table No.6.10

Table No.6.10
Test Pressure (Gauge) and test duration of Valves IS 5312 (Part-2)

PN Rating of Valve	Test	Test Pressure (Gauge), Min	Test Duration (Min)
		MPa	Minutes
PN 0.6	Body test	0.9	2
	Seat test	0.6	2
PN.1	Body test	1.5	2
	Seat test	1.0	2

6.6 Measurement

Sluice valves, butterfly valves, air valves and non returns valves shall be measured in numbers and shall be paid for including the cast the insertions and fasteners including labour as per item. Excavation refilling masonry and concrete work. Whenever required shall be measured and paid for under the relevant item of work.

6.7 Rates:

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER -7
GALVANIZED IRON PIPES, SPECIALS AND GUN METAL/BRASS METAL FITTINGS

7.1 Applicable codes

The laying of GI pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of GI pipes, fittings & specials shall be part of this Specification.

Table No. 7.1

I.S. Number	Title
IS: 1239 (PT-1): 2004	Mild steel tubes, tubular, and other wrought steel fittings, part 1 mild steel tubes.
IS: 1239 (PT-II): 1992 --	Do—part 2 mild steel tubular and other wrought steel pipe fittings.
IS: 1978: 1982	Line pipes
IS: 4736: 1986	Hot-dip zinc coatings on mild steel tubes.
IS 778: 1984	Copper alloy gates, globe and check valves for water works purposes.
IS 2692: 1989	Ferrules for water services.

7.2 Gate valve – as per IS: 778-1984

7.2.1 A valve through which the flow of fluid is controlled by means of a gate in the form of a wedge or disc between the body ends which are in line with each other; the gate is actuated by a stem whose axis is at right angles to that of the body ends. In the gate valves, the fluid pressure acts on one side of the gate and there is no change in the direction of flow.

7.2.2 Globe valve (or Screw down stop valve) –
(See Drawing No.-6)
A valve having generally a spherical body in which the body ends are in line with each other and the disc is lifted from or lowered on to the body seat by a stem whose axis is at right angles to that of the body ends. In globe valves, the pressure acts on the underside of the valve disc and there is a change of direction of flow inside the valve body.

7.2.3 Angle valve –
A valve having generally a spherical body in which the body ends are at right angles to each other and the disc is lifted from or lowered the body seat by a stem whose axis is in line with that of one body end.

7.2.4 Check valve (or Non-return valve)-
A valve which permits fluid to flow in one direction but checks all return flow. It is operated by pressure alone, having no external means of control. The flow is controlled by means of a disc raising and falling on to a seat with the fluid pressure (lift check); the flow may also be controlled by means of a flap swinging up and down with pressure on to a seat (swing check).

7.2.5 End-to-End Dimension **–**
The distance between the two planes per pendicular to the valve axis located at the extremities of the body end ports of straight type screwed end valves.

7.2.6 Face-to-end Dimension **–**
The distance between the two planes per pendicular to the valve axis located at the extremities of the body end ports of straight type flanged valves.

7.2.7 Centre-to-End Dimension **–**
The distance between the two planes located at the extremity of either body end port and perpendicular to its axis in the case of angle type screwed ends valves.

7.2.8 Centre-to-Face dimensions-
The distance between the two planes located at the extremity of either body end port and perpendicular to its axis in the case of angle type flanged valves.

7.3 Classification of valves: The valves shall be of two classes as under:-

7.3.1 Class 1 valves- Valves of this class are suitable for non-shock cold working pressure up to 1.0 MPa (cold service means a temperature not exceeding 45c˚).

7.3.1.1 Class 2 valves- Valves of this class are suitable for non-shock cold working pressure up to 1.6 MPa.

7.4 Types of valves:-

Valves shall have screwed or flange ends, integral or renewable body seats and screwed-in-, screwed-on or bolted bonnets or covers.

7.4.1 Gate valves- The gate valves shall be of the following types, having inside screw with rising or non-rising stem or outside screw with rising stem.

a) Solid Wedge Type **–** (in which the gate shall be one-piece and solid except for the ole not more than 2 mm in the diameter for the spindle for the size of up to and including 25 mm, and not more than 3 mm for sizes above 25 mm to accommodate the spindles; and in which no material has been removed from the surface of the gate.):
b) Split wedge type; and
c) Double disc type

7.4.2 Globe Valves- The globe valves shall be of the following types having rising stem with inside or outside screw:
a) Straight type, and
b) Right angle type.

7.4.3 Check valves – The check valves shall be of the following types:
a) Swing type (for use with the axis of the body end ports horizontal or vertical)
b) Lift type with disc or ball check (for use with the axes of the body end ports horizontal or vertical or in applications where the axis or the body end ports are at right angles.
Note : Swing check valves may also be used in vertical direction when the flow is in the upward direction.

7.5 Materials of valves

7.5.1 The materials used for the manufacture of different component parts of the valves shall conform to the requirements given under-

Table 7.2
Material for component parts of gate globe and check valves

SL. No.	Component	Material	Conforming To
1	i) Body	a) Brass	DCB 2 of IS: 1264-1981[1]
		b)Leaded tin bronze	LTB 2 of IS: 318-1981[2]
2	ii) Bonnet or cover	a) Leaded tin bronze	Do
		b) Forged brass	$CuZn_4$ 2pb2 or IS: 3488-1980[3]
		c) Brass	DCB 2 of IS: 1264-1981[1]
3	iii) Stuffing box, disc hinge, check nut, stem nut, disc retaining nut, gland, gland nut, gland flange, body seat rings and disc or wedge facing rings(where renewable)	a) Leaded tin bronze	LTB 2 of IS: 318-1981[2]
		b) Extruded brass rod	Type I or Type II (Half hard) of IS: 319-1974[4]
		c) Forged brass	$CuZn_4$ 2pb2 or IS: 3488-1980[3]
		d) Brass	DCB 2 of IS: 1264-1981[1]
4	iv) Stem, hinge pin and plug	a) Extruded brass rod	Type II (Half hard) of IS: 319-1974[4]
		b) High-tensile brass	HT 1 or HT 2 of IS: 320-1980[5] FHTB 1 and FHTB 2 of IS : 6912-1973[6]
		c) Forged brass	$CuZn_4$ 2 Pb2 of IS: 3488-1980[2]
5	v) Ball (for ball type check valves)	Chromium steel	IS: 4398-1972[7]
6	vi) Bolts, nuts	Mild steel	Property clauses 4.6 and 4 of IS: 1367-1967[8]
7	vii) Hand wheel	Cast iron	FG 200 of IS: 210-1978[9]
8	viii) Gasket	Compressed asbestos fibre	Grade C of IS: 2712-1971[10]
9	ix) Gland packing	a) Hemp and jute	IS: 5414-1969[11]
		b) asbestos	IS: 4687-1980[12]
10	x) Spring	Phosphor bronze wire	IS: 7608-1975[13]
11	xi) Seating ring	Synthetic rubber	IS: 5192-1975[14]

7.5.2 Flanged body Ends – The flange of flanged end valves shall be integral with the body and machined flat.

7.5.2.1 The flange dimensions shall comply with the values given in Table 7.3

Table No. 7.3
Flange dimensions for class 1 and class 2 valves:
(All dimensions are in millimeters)

SL No.	Nominal Size	Diameter of flange	Thickness of Flange	Diameter of Belt Circle	No. of Holes	Diameters of Holes
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	15	95 ± 1	6+ 1.5 , --0	65	4	14
ii)	20	105 ± 1	6+ 1.5 , --0	75	4	14
iii)	25	115 ± 1	8+ 1.5 , --0	85	4	14
iv)	32	140 ± 1	8+ 1.5 , --0	100	4	18
v)	40	150 ± 1	9+ 1.5 , --0	110	4	18
vi)	50	165 ± 1	11+ 1.5 , --0	125	4	18
vii)	65	185 ± 1	13+ 1.5 , --0	145	4	18
viii)	80	200 ± 1	13+ 1.5 , --0	160	8	18
ix)	100	220 ± 1.5	16+ 1.5 , --0	180	8	18

7.5.3 The holes in flanges shall be drilled unless otherwise stated by the purchaser.

7.5.4 Face to face dimensions of flanged valves are given below:-

Table No. 7.4
All dimensions in millimeters

Type	Design	Clas	Dimensions for nominal size of valve								
			15	20	25	32	40	50	65	80	100
Gate Valve	i) Screwed-in bonnet integral seat	1,2	72	76	90	100	110	120	140	150	190
	ii) Screwed-in bonnet renewable seat	2	----	---	----	---	120	135	155	165	205
	iii) Screwed-on bonnet integral seat	2	80	90	100	110	120	135	165	185	----
	iv) Screwed-on bonnet renewable seat	2	----	----	----	-----	130	150	180	200	-----
	v) Bolted bonnet, integral or renewable seat	2	----	-----	-----	-----	130	150	180	200	240
Globe Valves & Lift check valves (straight)	i) Screwed-in bonnet integral seat	1,2	75	85	95	100	120	145	165	185	216
	ii) Screwed-on bonnet integral or renewable seat	2	80	95	115	130	145	170	205	225	280
	iii) Bolted bonnet, integral or renewable seat	2	12	120	140	150	155	170	200	240	270
Swing check valves	i) Screwed-in bonnet integral seat	1,2	80	90	110	120	135	170	185	205	250
	ii) Screwed-in bonnet renewable seat	1,2	----	----	----	----	135	170	185	205	250
	iii) Bolted bonnet, integral or renewable seat	2	----	-----	----	-----	135	170	185	205	250
Note : 1 Wherever dimensions are not given, those sizes are not generally manufactured those designs. Note : 2 A tolerance of ± 1.5 mm shall be permissible on above dimensions											

7.6 Testing of valves:-

7.6.1 General –

Unless otherwise specified, all tests, except material tests, shall be made at the manufacturer's works, and shall be conducted in the presence of the purchaser's representative when so specified in the order.

7.6.2 Material Tests –

Material tests required shall be those given in the corresponding material specifications referred to in table 1. The material shall be certified by the suppliers with regard to their compliance to specifications laid down for them and tests shall be made at the manufacturer's works, if facilities are available.

7.6.3 Body Test (Hydrostatic)-

All valves when completely assembled shall be subject to a hydrostatic body test at the manufacturer's works to the test pressure for the period given in table 7.5 and shall show no leakage when pressure is applied to the inlet end, outlet end is blanked and valve is fully open.

7.6.4 Back Seat Test –

Back seat test pressure shall be same as for the body. There shall be no leakage through the stuffing box when valve is fully open and pressure applied to the inlet end and outlet end blanked. The leakage in this test shall be seen with gland packing removed or gland loosened Back seat test shall be applicable for gate and globe valves only.

7.6.5 Seat Test (Hydrostatic) – After being subjected to the body test, seats of valves shall be tested hydrostatically to the pressure for the period specified in table 7.5. The pressure shall be applied to each side of the gate of gate valves in closed position, underside of the globe valve and outlet side of the check valve. In each case the other end of the valve shall be open to atmosphere. Seats of check valves shall also be tested to one-fourth of the maximum cold working pressure. The valves under the eat test pressure shall not show any leakage more than that specified in IS: 6157- 1971

Table No. 7.5
Test pressure and test duration of valves

Class of valve	**Test**	**Test pressure Min**	**Test duration Min**
(1)	(2)	(3)	(4)
		MPa	Minutes
Class 1	Body test	1.5	2
	Seat Test	1.5	2
Class 2	Body test	2.4	2
	Seat test	1.6	2

7.7 Galvanized mild steel pipes

7.7.1 The pipes (tubes) shall be galvanized mild steel hot finished seamless (HFS) or welded (ERW) HRIW or HFW screwed and socketed conforming to the requirements of IS 1239 Part-1 for light, medium & heavy grade. They shall be of the diameter (nominal bore) specified in the description of the item, the sockets shall be designated by the respective nominal bores of the pipes for which they are intended.

7.7.2 Galvanizing shall conform to IS 4736 : The zinc coating shall be uniform adherent, reasonably smooth and free from such imperfections as flux, ash and dross inclusions, bare batches, black spots, pimples, lumping runs, rust stains bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanized in and out and free from cracks, surfaces flaws, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the tube.

7.7.3 Specifications of light, medium and heavy pipes shall be as below:

Dimensions and Nominal mass of Steel Tubes-**Light**

Table No. 7.6
(Refer Table No.-3 IS 1239 (Part-1) -2004)

Nominal Bore	**Outside Diameter**		**Thickness**	**Mass of Tube**	
	Maximum	Minimum	mm	Plain End	Screwed and Socketed
Mm	mm	mm	mm	Kg/m	Kg/m
(1)	(2)	(3)	(4)	(5)	(6)
6	10.1	9.7	1.8	0.360	0.363
8	13.6	13.2	1.8	0.515	0.519
10	17.1	16.7	1.8	0.670	0.676
15	21.4	21.0	2.0	0.947	0.956
20	26.9	26.4	2.3	1.38	1.39
25	33.8	33.2	2.6	1.98	2.00
32	42.5	41.9	2.6	2.54	2.57
40	48.4	47.8	2.9	3.23	3.27
50	60.2	59.6	2.9	4.08	4.15
65	76.0	75.2	3.2	5.71	5.83
80	88.7	87.9	3.2	6.72	6.89
100	113.9	113.0	3.6	9.75	10.0

Dimensions and Nominal Mass of steel Tubes- **Medium**

Table No.7.7

(Refer Table No.-4 IS 1239 (Part-1) -2004)

Nominal Bore	**Outside Diameter**		**Thickness**	**Mass of Tube**	
	Maximum	**Minimum**	**mm**	**Plain End**	**Screwed and Socketed**
mm	mm	mm	mm	Kg/m	Kg/m
(1)	(2)	(3)	(4)	(5)	(6)
6	10.6	9.8	2.0	0.404	0.407
8	14.0	13.2	2.3	0.641	0.645
10	17.5	16.7	2.3	0.839	0.845
15	21.8	21.0	2.6	1.21	1.22
20	27.3	26.5	2.6	1.56	1.57
25	34.2	33.3	3.2	2.41	2.43
32	42.9	42.0	3.2	3.10	3.13
40	48.8	47.9	3.2	3.56	3.60
50	60.8	59.7	3.6	5.03	5.10
65	76.6	75.3	3.6	6.42	6.54
80	89.5	88.0	4.0	8.36	8.53
100	115.0	113.1	4.5	12.2	12.5
125	140.8	138.5	4.8	15.9	16.4
150	166.5	163.9	4.8	18.9	19.5

Dimensions and Nominal Mass of steel Tubes- **Heavy**

Table No. 7.8

(Refer Table No.-5 IS 1239 (Part-1) -2004)

Nominal Bore	**Outside Diameter**		**Thickness**	**Mass of Tube**	
	Maximum	**Minimum**	**mm**	**Plain End**	**Screwed and Socketed**
mm	mm	mm	mm	Kg/m	Kg/m
(1)	(2)	(3)	(4)	(5)	(6)
6	10.5	9.8	2.6	0.487	0.490
8	14.0	13.2	2.9	0.765	0.769
10	17.5	16.7	2.9	1.02	1.03
15	21.8	21.0	3.2	1.44	1.45
20	27.3	26.5	3.2	1.87	1.88
25	34.2	33.3	4.0	2.93	2.95
32	42.9	42.0	4.0	3.79	3.82
40	48.8	47.9	4.0	4.37	4.41
50	60.8	59.7	4.5	6.19	6.26
65	76.6	75.3	4.5	7.93	8.05
80	89.5	88.0	4.8	9.90	10.1
100	115.0	113.1	5.4	14.5	14.8
125	140.8	138.5	5.4	17.9	18.4
150	166.5	163.9	5.4	21.3	21.9

7.7.4 Tolerances on thickness and Mass of pipes

The following manufacturing tolerances shall be permitted on the tubes and sockets.

A) Thickness:

(1) Welded tubes;

a. Light tubes + not limited
- 8 percent

b.	Medium and heavy Tubes	+ not limited - 10 percent
(2)	Seamless tubes	+ limited - 12.5 percent

B) Mass:

(1)	Single tube (Light series)	+ 10 percent - 8 percent
(2)	Single tube (Medium and Heavy series)	± 10 percent
(3)	For quantities per Load of 10 tones, Min (light series)	+ 7.5 percent - 5 percent
(4)	For quantities per Load of 10 tones, Min (medium and heavy series)	± 7.5 percent

7.8 Joints

7.8.1 All screwed tubes shall be supplied with pipe threads conforming to IS 554. Gauging in accordance with IS 8999 shall be considered as an adequate test for conformity of threads of IS 554.

7.8.2 Unless specified otherwise, tubes shall be supplied screwed with taper treads and fitted with one socket having parallel thread. The socket shall conform to all requirements (except 6.4) of IS 1239 (part 2).

7.8.3 In case of light tubes the application of taper pipe threads may be modified by permitting the outside diameter of the tubes to be within the limits shown in col. 2 and 3 of table 7.6 . Where the tube approaches the lower limit of outside diameter, some incomplete threads (perfect at root and imperfect at the crest) may be expected from and beyond the gauge plane. Such incomplete treads, shall not be regarded as justification for rejection of the tubes. Also the minimum length of threads in light tubes shall be 80 percent of that specified in IS 554.

7.8.4 The plain end pipes shall be supplied with square cut. However, bevel end may also be supplied on mutual agreement between the purchaser and the manufacturer

7.9 Sampling of pipes:

Lot for the purpose of drawing samples all tubes bearing same designation and manufactured under a single process shall be grouped together to constitute a lot. Each lot shall be sampled separately and assessed for conformity to this specification. Sampling of tubes shall conform to IS 4711.

7.10 Testing of Pipes :

Following tests shall be conducted by the manufacturer on tubes.

7.10.1 The tensile strength shall be at least 320 MPa (320 N/mm²). The test shall be carried out on full section or strip cut from the selected tubes in accordance with IS 1608 and IS 12278.

Notes: 1. For welded tubes, the strip tensile test specimen shall not contain the weld.

2. For galvanized tubes, zinc coating may be removed by stripping prior to tensile test.

7.10.2 The elongation percent on a gauge length of 5.66 S_O, where S_O is the original cross-sectional area of the test specimen, shall be as follows:

	Nominal Bore	Elongation Percent, Min
(a)	For steam services for all sizes	20
(b)	For other services :	
	(1) Up to and including 25 mm	12
	(b) over 25 mm up to and including 150 mm	20

7.10.3 Bend Test on Tubes Up to and including 50 mm Nominal Bore.

When tested in accordance with IS 2329 the tubes shall be capable of withstanding the bend test without showing any signs of fracture or failure. Welded tubes shall be bent with the weld at 90^0 to the place of bending. The tubes shall not be filled for this test.

7.10.4 The maximum permissible pressure and temperature for tubes with screwed and socketed joints shall be as given under.

7.10.5 For tubes fitted with appropriate flanges or suitably butt welded together, the maximum permissible pressure shall be 2.06 MPa and the maximum permissible temperature 260^0C.

Table No 7.9

Maximum Permissible Pressure and Temperature for Tubes with Steel Couplings or Screwed and Socketed Joints

(Refer Table No. 6 IS 1239 (Part-1) - 2004)

Nominal Bore mm	Maximum Permissible Pressure MPa	Maximum Permissible Temperature ^{0}C
1	2	3
Up to and including 25 mm	1.20	260
Over 25 mm up to and including 40 mm	1.03	260
Over 40 mm up to and including 80	0.86	260

Nominal Bore mm	Maximum Permissible Pressure MPa	Maximum Permissible Temperature ^{0}C
mm		
Over 80 mm up to and including 100 mm	0.69 0.83	260 177
Over 100 mm up to and including 125 mm	0.69	171
Over 125 mm up to and including 150 mm	0.50	160
Note :- 1 MPa = 1 N/mm² = 0.102 0 kg/mm²		

7.11 Marking

7.11.1 Each tube shall be marked with manufacturer's name or trade-mark, IS NO. that is, IS 1239 (Part 1) and class of tubes, that is, L,M, and H, for light, medium and heavy class.

7.11.2 The different classes of tubes shall be distinguished by colour bands, which shall be applied as follows before the tubes leave the manufacturer's works:

(a) Light tubes - Yellow
(b) Medium tubes - Blue
(c) Heavy tubes - Red

7.12 Types of Fittings

7.12.1 Dimensions of the fittings shall be as per IS: 1239 (Part-II): 1992 Table 1, to 28.

7.12.2 Manufacture: Tubular's conforming to this standard shall be made from tubes which comply with all the appropriate requirements of IS 1239 (Part 1): 1990

7.12.3 Socket: Socket shall be manufactured from mild steel by any of the following processes:

a) Hot-finished seamless (HFS),
b) Electric resistance welded (ERW),
c) High frequency induction welded (HFIW), and
d) Hot-finished welded (HFW),

Where ever, tubular are supplied with sockets, the dimensions of socket shall be as under :-

Table No.- 7.9

Nominal Bore	Minimum Outside Diameter A	Minimum Length B
(1)	(2)	(3)
6	15	19
8	18.5	27
10	22	28

Nominal Bore	Minimum Outside Diameter	Minimum Length
15	27	37
20	32.5	39
25	39.5	46
32	49	51
40	56	51
50	68	60
65	84	69
80	98	75
100	124	87
125	151	96
150	178	96

Tapping of socket shall be done from one end only.

7.12.4 Other Fittings

Other wrought steel pipe fittings shall be manufactured from mild steel by any approved process.

7.12.5 Unless otherwise specified by the purchaser, all fittings shall be manufactured with thread connection, complying with the requirements of IS 554: 1985.

7.12.6 The steel from which the fittings are made, when tested in accordance with IS 1894: 1972 shall show on test a minimum tensile strength of 320 MPa.

7.13 Dimensions of tubular:

7.13.1 Pieces:

Pieces shall conform to the dimensions given in table 1 IS: 1239 (Part 2) : 1992

7.13.2 Nipple**:**

Close taper and running nipples shall be make only from heavy tubes. Barrel nipples shall be made either from medium or heavy tubes. The dimensions of nipples shall be as given in table 2 IS: 1239 (Part 2) : 1992

7.13.3 Long screws (Connectors)

Long screws (connection) shall be make only from heavy tube and shall be supplied single or double, as may be specified, and shall conform ok the appropriate dimensions given in Table No. 3 of IS: 1239 (Part 2) : 1992

7.13.4 Bends and springs

Bends and springs shall conform to the appropriate dimensions given in Table 4. of IS: 1239 (Part 2) : 1992 shall be fitted with sockets sand back nuts conforming to the requirements given in 8.3.2.

7.14 Return bends

Return bends shall be made from heavy tubes, supplied with socket at one end if so specified by the purchaser, and shall conform to the dimensions given in Table 5. IS 1239 (Part-2): 1992. The ends of the bends shall be parallel within $\pm 1.5^0$.

7.15 Test on Fittings and Sockets

7.15.1 The fittings and sockets before they leave the works, shall be subjected to either of the following pressure tests, as mutually agreed between the purchaser and the manufacturer:

7.15.1.1 The ends of fittings and sockets when subjected to the required pressure, after having been made up wrench tight with the prior application of lubricant, or sealant, or by any other appropriate method shall not show any leakage. The test shall be carried out after the fittings and sockets have been screwed and before any protecting coating other than galvanizing has been applied.

7.15.1.2 The sample size and the acceptance criteria for the pressure test shall be given in Table 30 below.

7.15.2 Expansion Test on Sockets

At the option of the manufacturer any one of the tests described in 7.14.2.1 shall be carried out.

7.15.2.1 Drift Expanding Test

It shall be carried out on sockets, tubes, blanks, or sockets in accordance with IS 2335: 1963. On a conical mandrel having an included taper on diameter 1 in 16 and the minimum increase in outside diameter after expansion shall be as follows:

Nominal Bore mm	Percentage of Expansion Min
Upto and including 25	2-0
32 to 40	1.5
50 to 80	1.0
100 to 150	0.5

Table No.- 7.10

Scale of Sampling and Acceptance Criteria for Pressure Test

Lot Size	Stage	Sample Size	Cumulative Sample Size	Acceptance Number	Rejection Number
(1)	(2)	(3)	(4)	(5)	(6)
Upto 1000	First	13	13	0	2
	Second	13	26	1	2
1001 to 3000	First	20	20	0	2
	Second	20	40	1	2
3001 to 5000	First	32	32	0	3
	Second	32	64	3	4
5001 to 10000	First	50	50	1	4
	Second	50	100	4	5
10001 and above	First	80	80	2	5
	Second	80	160	6	7

7.15.2.2 Taper Screw Plug Test

Sockets shall be capable of withstanding the expansion test as described below without showing any sign of fracture or failure.

7.15.2.2 The test shall consist of screwing the selected socket on a taper screw plug.

7.15.2.2 The threads of socket shall be thoroughly clean and free from foreign matter. Should the threads show sign of burr, this shall be removed by means of a pipe thread tap. The threads of the socket and the end of the test plug shall be lubricated with oil, and the socket shall then be screwed on to the test plug between the jaws of a vice, or other suitable fixtures, and by rotating the socket with both hands. The socket shall then be further rotated either by means of a pipe wrench of an adequate length to operative the test with gradual turning or by a power machine giving an appropriate leverage. The wrench shall not be hammered.

7.15.2.3 The plugs shall be manufactured from steel and shall be hardened to give a Vickers hardness between 700 and 800 HV when determined by applying a load of 30 kgf in accordance with IS 1501 (Part 1) : 1984.

7.15.2.4 The dimensions of plug shall conform with those given in Table 31. The threads shall be ground after the plugs are case hardened, and the thread form and angle of taper shall be in accordance with the appropriate dimensions and tolerances specified in IS 554:1985.

7.15.2.5 For routine testing, use may be made, if so desired, of unhardened steel plugs in accordance with the dimensions given in Table 31 and having machined threads, the thread form and angle of taper being in accordance with the appropriate dimensions and tolerance specified in IS 554:1985.

7.15.2.6 In case of dispute, however in the test shall be carried out with the hardened plugs specified in 7.14.2.3 and 7.14.2.4.

7.16 Ferrules

7.16.1 The ferrules for connection with C.I. main shall generally conform to is 2692. It shall be of non ferrous materials with a C.I. bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting off the water supply to the communication pipe, if and when required.

7.16.2 Ferrules shall be of 8,10,15,20,25,32,40 and 50mm. nominal sizes.

7.16.3 The nominal sizes of the ferrule shall be designated by the nominal bore of the inlet connection.

7.17 Laying and jointing of GI pipes

7.17.1 The galvanized pipes and fittings shall be laid in trenches. The widths and depths of the trenches for different diameter of pipes shall be as given in Table No.7.11

Table No.7.11

Dia of pipe (mm)	Width of Trench (mm)	Depth of Trench (cm)
15 to 50	30	60
65 to 100	45	75

7.17.1.1 At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with the general specifications for earth work in trenches.

7.17.1.2 When excavation is done in rock, it shall be cut deep enough to permit the pipe to be laid on a cushion of sand minimum 7.5 cm deep.

7.18 Jointing

7.18.1 The pipes shall be cleaned and cleared of all foreign matter before being laid. While jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe.

7.18.2 The end shall than be screwed in the socket, tee etc., with the pipe wrench. Care shall be taken that all pipes and fittings are properly jointed so as to make the joints completely water tight and pipes are kept at all times free from dust and dirt during fixing. Burr from the joint shall be removed after screwing. After laying, the open ends of the pipe shall be temporarily plugged to prevent access of water, soil or any other foreign matter.

7.19 Testing of joints

7.19.1 The pipes and fittings after they are laid and jointed shall be tested to hydraulic pressure of 6 kg/sq. cm (60 meter head). The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw off taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually.

7.19.2 Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test plump having been stopped, the test pressure should be maintained without loss for at least half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing. Pipes or fittings which are found leaking shall be replaced and joints found leaking shall be redone, without extra payment

7.20 Measurement

7.20.1 The length shall be measured in running meter correct to a cm for the finished work. It shall include G.I. pipe and G.I. fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, but exclude brass or gun metal taps (cocks), valves, units, lead connection pipes etc.

7.20.2 All pipes and fittings shall be classified according to their diameters, method of jointing and fixing substance, quality and finish. In case of fittings of an equal bore the pipe shall be described as including all cuttings and waste. In case of fittings of unequal bore, the largest bore shall be measured.

7.20.3 G.I. union shall be measured and paid for separately.

7.21 Rates

7.21.1 The rate shall include the cast of the material and labour involve in all the operation described in the item. The rate shall not include excavation in trenches, painting of pipes and sand filling all around the pipes unless otherwise specified.

CHAPTER NO.8
HDPE PIPES, MDPE PIPES & SPECIALS AND ZERO VELOCITY VALVES

8.1 Applicable Codes

The following standards, unless otherwise specified herein, shall be referred. In all cases the latest revision of the Codes shall be referred to. If requirements of this specifications conflict with the requirements of the standards /Codes, this specification shall govern.

Table No.- 8.1

Code No.	Title/Specification
IS 4984 amendment No.2 1995	High Density polyethylene pipes for Water Supply
IS 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS 7634	Laying & jointing of polyethylene (PE) Pipes
ISO 4427	Medium Density Polyethylene Pipes for Water Supply
IS 2530	Methods of test for polyethylene moulding materials and polyethylene compounds
IS 4905	Methods for random sampling
IS 9845	Method of analysis for the determination of specific and/or overall migration of constituents of plastics material and articles intended to come into contact with foodstuffs.
IS 10141	Positive list of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water.

Specification of Pipes :

8.2 Colour

8.2.1 The colour of the pipe shall be black

8.2.2 Each pipe shall contain minimum three equispaced longitudinal stripes of width 3 mm (Min) in blue colour. These stripes shall be more than 0.2 mm in depth. The material of the stripes shall be of the same type of resin, as used in the base compound for the pipe.

8.3 Dimensions of pipes and ovality of pipe

8.3.1 Ovality shall be measured at the manufacture's end as the difference between maximum outside diameter and minimum out-side diameter measured at the same cross section of the pipe, at 300mm away from the cut end. For pipes to be coiled, the ovality shall be measured prior to coiling For coiled pipes, however, re-rounding of pipe shall be carried out prior to the measurement of ovality.

8.3.2 Outside diameter, tolerance and ovality of pipes shall be as per table 8.2.

Tolerance and ovality is given below

Table 8.2

(Refer Table No. 2 IS 4984-1995)

S.No	Outside Diameter (mm)	Toleran (only positive tolerances) (mm)	Ovality (mm)
1	20.0	0.3	1.2
2	25.0	0.3	1.2
3	32.0	0.3	1.3
4	40.0	0.4	1.4
5	50.0	0.5	1.4
6	63	0.6	1.5
7	75.0	0.7	1.6
8	90.0	0.9	1.8
9	110.0	1.0	2.2
10	125.0	1.2	2.5
11	140.0	1.3	2.8
12	160.0	1.5	3.2
13	180.0	1.7	3.6
14	200.0	1.8	4.0
15	225.0	2.1	4.5
16	250.0	2.3	5.0
17	280.0	2.6	9.8
18	315.0	2.9	11.1
19	355.0	3.2	12.5
20	400.0	3.6	14.0
21	450.0	4.1	15.6
22	500.0	4.5	17.5
23	560.0	5.0	19.6
24	630.0	5.7	22.1
25	710.0	6.4	24.9

8.4 Wall thickness as per allowable hydrostatic design stress-

8.4.1 The minimum & maximum wall thickness of pipe for the PE100 grade of pipe as per IS : 4984 for PN6, PN8 & PN10 shall be as per table 8.3.

Table No.- 8.3

(Refer Table No. 5 (Amendment No.2) IS 4984-1995)

Nominal Dia	Wall Thickness of pipes					
	PN 6		PN 8		PN 10	
DN	Min	Max	Min	Max	Min	Max
1	2	3	4	5	6	7
20	-	-	-	-	-	-
25	-	-	-	-	-	-
32	-	-	-	-	2.4	2.9
40	-	-	2.4	2.9	3.0	3.5
50	2.3	2.8	3.0	3.5	3.7	4.3
63	2.9	3.4	3.8	4.4	4.7	5.4

Nominal Dia	Wall Thickness of pipes					
	PN 6		PN 8		PN 10	
DN	Min	Max	Min	Max	Min	Max
1	2	3	4	5	6	7
75	3.5	4.1	4.5	5.2	5.6	6.4
90	4.1	4.8	5.4	6.2	6.7	7.6
110	5.0	5.7	6.6	7.5	8.1	9.2
125	5.7	6.5	7.5	8.5	9.2	10.4
140	6.4	7.3	8.4	9.5	10.3	11.6
160	7.3	8.3	9.6	10.8	11.8	13.2
180	8.2	9.3	10.8	12.1	13.3	14.9
200	9.1	10.3	12.0	13.4	14.8	16.5
225	10.3	11.6	13.5	15.1	16.6	18.5
250	11.4	12.8	15.0	16.7	18.4	20.5
280	12.8	14.3	16.8	18.7	20.6	22.9
315	14.4	16.1	18.9	21.0	23.2	25.8
355	16.2	18.1	21.2	23.6	26.2	29.1
400	18.2	21.2	23.9	27.7	29.5	34.2
450	20.5	23.8	26.9	31.2	33.1	38.8
500	22.8	26.5	29.9	34.6	36.8	42.6
560	25.5	29.6	33.5	38.8	41.2	47.6
630	28.7	33.3	37.7	43.6	46.4	53.6
710	32.3	37.4	42.4	49.0	52.3	60.4

8.5 Length of straight Pipe & marking on pipe

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

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

(a) Manufacturer's name/Trade-mark,
(b) Designation of pipe
(c) Lot No./Batch No.
(d) BIS certification marking on each pipe.

8.6 Coiling

8.6.1 The pipes supplied in coils shall be coiled on drums of minimum diameter of 25 times the nominal diameter of the pipe ensuring that kinking of pipe is prevented.

8.6.2 Pipe beyond 110 mm dia shall be supplied in straight length not less than 6m

8.7 Appearance

8.7.1 Pipe shall be free from all defect including indentation, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusion that due to Their nature degree or extent detrimentally affect the strength and Serviceability of the pipe.

8.7.2 The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant IS code or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and perpendicular to the axis of the pipe.

8.8 Marking :

8.8.1 Each straight length of pipe shall be clearly marked in indelible ink/paint on either end and for coil at both ends or hot embossed on white base every meter throughout the length of pipe/coil with the following information:
(a) Manufacturer's name/Trade-mark.
(b) Designation of pipe
(c) Lot number/Batch number.

8.8.2 BIS Certification Marking
Each pipe may also be marked with Standard Mark.

8.9 Testing of Pipe :

8.9.1 HDPE pipes are subjected to following tests :-

8.9.1.1 Internal pressure creep rupture test

8.9.1.2 Longitudinal Revision Test

8.9.1.3 Overall Migration Test

8.9.1.4 Density

8.9.1.5 Melt Flow Rate (MFR)

8.9.16 Carbon Black Content and Dispersion

8.10 Handling, Transportation storage and Lowering of pipes.

8.10.1 If transportation of HDPE pipes from a distance greater than 300km than pipes shall be received only when bare coils of pipe have been wrapped with hessian cloth.

8.10.2 The truck use for transportation of the PE pipes shall be exclusively used of PE pipes only with no other material loaded-especially no metallic, glass and wooden items. The truck shall not have sharp edges that can damage the pipe.

8.10.3 At the time of opening coils it must be remembered that the coiled under tension and must be open in control manner. Straight length should be stored on horizontal racks giving continuous support. Loss/damages during transit, handling, storage will be to the contractor's account.

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

8.10.5 Pipes must no be stored or transported where they are exposed to heat sources likely to exceed 60º C.

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

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

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

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

8.10.10 Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.

8.11 **Lowering, Laying of pipes**

8.11.1 IS: 7634 shall be applicable. Before using the pipe following precautions/check shall be taken.

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

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

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

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

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

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

8.11.8 The flexibility of polyethylene pipes allows the pipe to be cold bend. The fusion jointed PE pipe is also flexible as the plain pipe. Thus the total system enables

directional changes within the trench without recourse to the provision of special bends or anchor blocks. However, the pipe should not be cold bend to a radius less than 20 times the OD of the pipe.

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

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

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

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

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

8.12 jointing of pipes

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

8.13. **Belding :-**

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

8.14 Back Filling

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

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

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

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

8.15. Compaction:-

8.15.1 Vibratory methods should be used for compaction. Compaction within distances of 15 cm to l45 cm from the pipe should be usually done with hand tempers. The backfill material should be compacted not less than 95 % of maximum dry density.

8.16 Fittings and specials

All HDPE fittings/specials shall be fabricated or injection moulded at factory as per IS: 8360 (Part-I & Part-III) and as per IS: 8008 (Part-I to Part-IX) fittings will be butt welded on the pipes or other fittings by use of heat fusion.

8.17 HDPE bends and tee.

HDPE bends and tee shall be plain square ended conforming to IS: 8360 (Part I,II&III). Bends may be fabricated by jointing several small section of pipe to reach the required angel. Tees may be moulded or fabricated from pipes elements.

8.18 HEPE Reducer must be moulded and shall be plain square ended as per IS: 8008 (Part-1 & VII)

8.19 HDPE stub ends-

HDPE stub ends shall be square ended conforming to IS: 8008 (Part-I & VII) specification stub ends will be welded on the pipe. Flange will be of slip on flange type as given in clause 15.16 below.

8.20 Slip on Flanges

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

8.21 Jointing Procedure

Jointing between HDPE pipes and specials shall be done as per the latest IS: 7643 part II. Method of jointing between the pipes to pipes and pipes to specials shall be with butt fusion welding using automatic or semi automatic, hydraulically operated, superior quality butt fusion machines which will ensure good quality butt fusion welding up to of HDPE pipes.

8.21.1 The commonly used joints are as follows :-
8.21.1.1 Insert type joints.
8.21.1.2 Compression fittings.
8.21.1.3 Fusion welding.
8.21.1.4 Threaded Joints
8.21.1.5 Flanged joints, and
8.21.1.6 Telescopic joints.

8.21.2 “There are insert type of fittings of both plastic and metals available for use with PE pipes. In corrosive locations plastic fittings are preferred because of their high resistance to corrosion. In less corrosive conditions gun metal fittings are

frequently used and in normal or slightly corrosive environments, brass fittings are commonly employed. In certain cases, threaded malleable cast iron fittings are used.

8.21.3 Insert Type Joints (see Fig.1)

8.21.3.1 These are commonly used for MDPE pipes where in a serrated PE or metallic fitting is inserted into the pipe and tightened by a clip.

8.21.3.2 The outer serrations of HDPE/metal insert type fittings lock into the PE pipes to prevent their coming out under sudden pressure surge. If the pipe bore is slightly undersized, a little heating by immersion in boiling water in case of MDPE and oil bath (130^0C) in case of HDPE would soften the pipe to enable insertion of fittings. If the bore of the pipe is loose, the bore clip of worm drive type will secure the fitting and ensure a leak proof joint. The insertion of these fittings into the bore of the pipe is done with hand pressure only. As a measure of safety, worm drive type clip should be used in all cases. This type of jointing is used normally in small diameter pipes up to 110mm.

8.21.4 Compression Fittings

8.21.4.1 They are used for MDPE and HDPE joints. They are detachable joints and are made of metals or plastics.

8.21.4.2 In the majority of cases the metal fittings are based on the type of compression fittings commonly used with copper tubes. In this type of joint the dimensions of the pipe are generally not altered. The joint is effected by an internal liner and a compression ring or sleeve which shrinks and therefore compresses the pipe wall on to the liner, thus gripping to the wall of the pipes. The liner and compression sleeve may also be a integral unit (see Fig. 2).

8.21.4.3 In other case the flared pipe wall is compressed on a conica insert either by two male and female threaded metallic nuts (see Fig.3A) or by backing loose flanges (see Fig. 3B). The water seal is made by compression of ends of PE flared pipe between sloping surface of metallic nuts/flanges and conical inserts.

8.21.4.4 Compression Joints with Collar/Pipe Ends and Flat Gaskets – Aluminum alloy or brass fittings with male and female coupling parts are available for jointing with metallic fittings. The male and female ends of the coupling are inserted face to face on two ends of the pipes to be jointed. Collars are made on the pipe ends by heating the ends with hot plate or electric coil. The two collars are brought together and the female end of the coupling is tightened on the male end. A water tight seal is made between the flanges. This is a detachable type of jointing and is practicable up to 50mm dia pipes (see Fig.4)

8.21.5 Fusion Welding

8.21.5.1 Fusion welding is commonly used in HDPE and is permanent type of joint.

8.21.5.2 Procedure of Butt Welding of HDPE pipes.

8.21.5.3 The pipe should be cut square and the face of the pipe should be slightly scraped prior to welding to remove oxidized layer. At the time of welding, leveling of the pipes is essential particularly in case of larger diameter pipes. Welding temperature should be 200^0C and surfaces of heating mirror should be $210^0 \pm 5^0$C [heating mirror is a metallic plate heated up to the required temperature either by electrical coil embedded inside or by blow torch. The word mirror has come because this heating plate radiates heat (see Fig.5).]

The pipes to be welded should be held on either side of the heating mirror with only contact pressure of about 20 kPa (0.2 kgf/cm²). When the rim of molten material is found, the pipes are removed from the heating mirror and immediately the joint is made by application of moderate pressure of approximately 1 to 2 kg/cm² for 2 to 3 seconds. The initial heating time for achieving molten rim, varies from 1 to 5 min depending upon the pipe wall thickness and size.

8.21.5.3.1 Cautions

(a) It is essential to see that the rim formed is not excessive.

(b) While jointing, the pressure should be maintained until the joint is luke-warm and after the pressure is relived, the joint allowed to cool completely.

(c) The mirror should be kept exactly around 210^0C which needs about 30 minutes time (for electrical mirror). It is also essential to see that the temperature is maintained constant by the proper setting of regulator. For detecting the correct temperature crayon chalk is used. For example at 210^0C the colour of crayon dot on the mirror changes within 2 seconds. But the dot made should be thin and if not, time taken will be more, indicating a wrong temperature.

8.21.5.4 Strength – A satisfactory butt welded joint of HDPE will have the strength factor of one. Temperature is of primary importance and weld efficiency may decrease if the temperature does not fall with in the range of 200 ± 10^0C.

8.21.6 Flanged Joints

8.21.6.1 These are used for jointing MDPE and HDPE pipes particularly of larger size to valves and vessels and large size metal pipes where strength in tension is required.

8.21.6.2 It consists of flanges either loose or welded to the pipe ends. It is recommended that suitable metallic backing plates be used to support the polyethylene flanges to enable them to be bolted together. Injection moulded polyethylene flanges with metal inserts of 6 to 9 mm thickness may also be used. In most cases, sealing is improved by incorporating a natural or synthetic rubber gasket between polyethylene flanges (see Fig 6.).

8.21.7. Telescopic Joint

8.21.7.1 Any joint (socket and spigot type) that permits sliding of the free end (spigot end) inside the socket with a rubber or suitable gasket, without any leakage is called telescopic joint.

8.21.7.2 The socket could be an integral part of the pipe at one end or two ends or a special coupler into which the free ends (spigot ends) of the pipes are pushed to achieve a water tight joint.

8.21.7.3 These joints are normally weak in longitudinal pull and hence need anchoring wherever such a tendency of longitudinal pull is likely in the pipe line. In the case of telescopic joints, one external anchorage is generally necessary at each end of the pipe line, at valve and at all changes of direction. The supports of the side connection should ensure that excessive lateral bending does not occur. In small diameter the coupler itself could be modified to have a split, threaded, grip type gasket of hard materials in addition to "O" ring type of rubber gasket (for water tightness) to prevent any slipping out of the free end of the pipe in longitudinal pull.

8.22 Test to Establish Perfectibility/portability of work

Specimen of pipe shall be tested to establish the suitability for use in carrying portable water

(i) Smell of the extract
(ii) Clarity of the colour of the extract
(iii) Acidity and Alkality
(iv) Global migration UV absorbing material Heavy metals
(v) Unreacted monomers (styrens) and biological tests

8.23 Hydraulic Test

After laying the pipe hydraulic test shall be done to conform the quality of work and material. There shall not be any signs of localized swelling, leakage or weeping. It should conform to IS : 4984 & IS 7634.

8.24 Measurement

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

8.25 Rates

The rate shall include the cast of the material and labour involve in all the operation describe in the item.

8.26 MDPE Pipes & Specials

8.26.1 Scope

8.26.1.1 This specification covers the requirements for successfully designing, manufacturing, supplying, laying, jointing and testing at works and site of Medium Density Polyethylene Pipes used for water supply upto 50mm dia pipes.

8.26.2 Applicable Codes

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

Code No.	Title/Specification
ISO 4427	Medium Density Polyethylene Pipes for Water Supply
IS 2530	Methods of test for polyethylene moulding materials and polyethylene compounds
IS 5382	Rubber sealing rings for gas mains, water mains and sewers.
IS 4905	Methods for random sampling
IS 7634	Laying & Jointing of Polyethylene (PE) Pipes
IS 9845	Method of analysis for the determination of specific and/or overall migration of constituents of plastics material and articles

	intended to come into contact with foodstuffs.
IS 10141	Positive list of constituents of polyethylene in contact with food stuffs, pharmaceuticals and drinking water.
IS 10146	Polyethylene for its safe use in contact with foodstuff, Pharmaceuticals and drinking water.

8.26.3 Colour

8.26.3.1 The colour of the pipe shall be blue.

8.26.4 Materials

8.26.4.1 The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not given rise to unpleasant taste or odour, cloudiness or discoloration of water.

8.26.4.2 Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any internationally reputed organization as per the satisfaction of the engineer in charge.

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

8.26.5 Jointing of Pipes

8.26.5.1 The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for MDPE pipe as per ISO 4427 & ISO 14236 shall be selected considering the existing working condition, pressure and flow of liquids.

8.26.6 Compression Fittings

8.26.6.1 The Compression fitting should be as per following guidelines :

8.26.6.1.1 The body of the compression fittings should be made from Poly Propylene.

8.26.6.1.2 Compression fittings should be manufactured in accordance with ISO 14236 for use with HDPE/MDPE/GI pipes.

8.26.6.1.3 All types of compression fittings shall be certified by the International laboratories like KIWA, DVGW and WRC for drinking water usage.

8.26.6.1.4 The fitting body shall be opaque. The composition of the plastics parts exposed to sun/ultra-violet radiation shall include UV stabilizer.

8.26.6.1.5 The minimum bore of the fittings shall be such that there shall be no obstruction for the passage of water from the pipe to pipe fitting.

8.26.6.1.6 The fittings shall conform to the requirements for leak tightness for 1 hour when the pipe and fittings are assembled and hydraulically tested to the working pressure of the pipe.

8.26.6.2 The material used for manufacture of Compression Fittings and the material of the PP fitting components, which are in contact with the water, shall not contain toxic additives. The PP compression fittings shall be certified by the International laboratories like KIWAQ, DVGW and WRC for drinking water usage. A certification to that effect shall be submitted by the vendor of the fittings.

8.26.6.3 PP Saddles

8.26.6.3.1 The body of the tapping saddle should be made from Poly propylene.

8.26.6.3.2 The rubber ring to arrest leakage, provided around the tapping location of the saddle shall be made with Neoprene.

8.26.6.3.3 The fasteners used to fix the saddle to the PE water mains shall be maid with stainless steel/carbon steel.

8.26.6.3.4 The tapping saddles be suitable to tap PE water mains of diameter 63 to 200mm and the pressure rating of the saddle shall be PN16.

8.26.6.4 Electrofusion Saddles

8.26.6.4.1 The Electrofusion saddle should confirm to PrEN 12201-3.

8.26.6.4.2 It should be manufactured from virgin compounded blue/black resign or natural resign with blue or black master batch.

8.26.6.4.3 The body of the tapping saddle should be made from Poly Propylene.
The tapping saddles shall be suitable to tap PE water mains of diameter 63 to 200mm and the pressure rating of the saddle.

8.26.7 Tests to Establish Portability of work

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

8.26.7.1.1 Smell of the extract

8.26.7.1.2 Clarity of the colour of the extract

8.26.7.1.3 Acidity and alkality

8.26.7.1.4 Global migration UV absorbing material Heavy metals

8.26.7.1.5 Unreacted monomers (styrens) and Biological tests.

8.27 Measurement

8.27.1 The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item.

8.27.2 The portion of the pipes at the joints (inside the joints) shall not be included in the length of pipe work.

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

8.28 Rates

The rate shall include the cast of the material and labour involve in all the operation describe in the item.

8.29 Zero Velocity Valves

8.29.1 Construction:

8.29.1.1 Body: The Spring Loaded self-actuating Zero Velocity valve has an outer fabricated casing ('Main Body') in which a 'Central Rod' is held by struts. In order to create an annular flow the included angle of the cone at upstream of the disc should be 50-60° and the cone at downstream of the cone should be 20-30°. The barrel at inlet and outlet of the valve should suit the pipe diameter. The barrels should have minimum length of 250 mm to 500 mm based on the size of valve for the ease of installation.

8.29.1.2 The total length of the valve should be as per the table below:

Diameter (mm)	Total length of valve (mm)
500	1850
550	1850
600	1920
650	1950
700	2000
750	2100
800	2300
850	2300
900	2150
950	2300
1000	2400

Dim Tol +/- 15 mm max

8.29.1.3 The valve should be provided with 2 to 4 (four) Nos. of hand holes of adequate size to facilitate insertion and removal of springs by hand (if required) without removing the valve from line. A suitable cover shall be provided on each of the hand hole.

8.29.1.4 A 'Bypass pipe' with a Valve of 80 NB for 500 - 650 mm, 100 NB for 700 – 950 mm and 150 NB for 1000 mm and above should be provided for connecting upstream and downstream sides of Zero Velocity valve should be provided. Minimum two plugs should be provided to mount Pressure gauges at the upstream and downstream of the valve.

8.29.1.5 Adequate transportation support should be provided on the valve as an integral part of the valve.

8.29.1.6 Internal: Closing Disc is mounted on 'Central Rod' cladded with Stainless Steel (SS as per AISI304) for the adequate length so that the disc moves on the cladded portion. Bush of the disc should be lined securely with Brass sleeve (minimum 3 mm thick) for smooth sliding of the disc.

8.29.1.7 Disc is held in closed position by a adequate number of 'Stainless Steel Springs' (SS as per AISI304). The anti-rotation guides should be provided on the edge of 'Central Disc' with minimum resistance to flow and minimum possibility to lock during sliding of the disc. The 'Anti Rotation Guide' should be cladded with Stainless Steel Strip (SS as per AISI304) and 'Guide Fork' lined with brass liners. The valve should be provided with a 'Stationary Central Dome' to create an annular streamlined passage for smooth flow of water.

8.29.1.8 Painting: 2 (Two) coats of Coal tar Epoxy Paint from inside and outside.

Material of Construction of principal parts:

S. No.	ITEMS	MATERIAL
a	Entry Barrel	Shell and Cone
b	Exit Barrel	Shell and Cone
c	Lap	Ring
d	Guide	Dome
e	Central Shaft (S.S. Lined)	MS IS:2062 Fe. 410W A
f	Spring	S.S. 304

g	Bypass Pipe	Carbon Steel IS1239(part-I)/ASTM 106 B
h	Bush for Disc	(With Brass inner Bush)
i	Bush for	supporting ribs
j	Hand Hole	MS IS:2062 Fe. 410W A

8.29.1.9 Inspection and Testing:

The Zero Velocity Valves shall be subjected to Hydrostatic body test by applying the rated pressure for the hydrostatic test. Both the ends (upstream and downstream) of the valve shall be closed using the dish/dummy ends. In case of more than one valves of same size and pressure rating, the valves can be joined together from barrel (or bolted in case of flange ended valves). The Bypass pipe along with valve will be mounted the zero velocity valve. The bypass valve shall be kept in open condition during the testing. A pressure gauge shall be mounted on the Zero Velocity Valve to check the applied hydrostatic test pressure. The 'Test pressure' specified in the approved GA drawing shall be applied using the hand pump or motor pump for a duration of 15 (fifteen) Minutes. No water leakage is permissible through the main body of the zero velocity and bypass valve during the above period.

8.30 Measurement

Zero Velocity valves shall be measured in numbers and shall be paid for including the cast the insertions and fasteners including labour as per item. Excavation, refilling, masonry and concrete work. Whenever required shall be measured and paid for under the relevant item of work.

8.31 Rates:

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER - 9
GRP PIPES AND SPECIALS

9.1 Applicable Codes

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

Table No.9.1

IS 12709 : 1994	GRP Pipes, Joints and Fittings for use for Potable Water Supply.
IS 14402 : 1996	Glass Fibre reinforced plastics (GRP) Pipes, Joints and fittings for use for sewerage, industrial waste and water (other than Potable).
IS 13916 : 1994	Installation of GRP Piping system –code of practice.
IS 5382 : 1985	Rubber sealing rings for gas mains, water mains and sewers.
American Water Works Association (AWWA) 950	For fiber glass pressure pipe.
American Society for Testing & Material (ASTM) 2563	Standard practice for clarifying visual defects in glass reinforced plastic laminated parts.
ASTM 3517	Specification for fiber Glass Pressure Pipes.
ASTM D 5421	Standard specification for contact molded “Fiber glass” flanges.
British Standard (BS) -5480	Specification for Glass Fibre resin forced Plastic Pressure Pipes, Joints & Fittings.

Other codes not specifically mentioned here but pertaining to the use of GRP pipes form part of these specifications.

9.3. GRP Pipes

Fiber glass reinforced plastic (GRP) pipes is a matrix of composite of glass fiber, thermosetting, polyester resin and filters. The pipes so manufactured are light in weight and have smooth interior surface. A tubular product containing glass fiber reinforcements embedded in or surrounded by cured thermosetting resin. The composite structure may contain aggregate (siliceous), fillers, thixotroic agents. Thermoplastic or thermosetting liner and/or surface layer may be included.

9.4 Terminology

Bedding is the sound granular material directly beneath the pipe in the trench bottom. Bedding includes the basic trench foundation ‘E’ if required plus especially prepared layer of sand ‘F’ on which pipe will rest.

9.4.1 Coupling Area of joint
This is the space inside the socket in which the rubber ring gasket operates.

9.4.2 Groove
This is a seating made by turning to lodge the rubber ring gasket. It possesses the section laid down in the design and is machined at one end of each pipe section or in the coupling as the case may be.

9.4.3 Pipe Zone
It is the trench cross section area from the bottom of the pipe to a minimum of 300 mm above the top of the pipe and is filled with sound granular soil.

9.4.4 Ring deflection
It means an out of round condition not exceeding 5 % of the diameter of a pipe section as a result of external loads imposed upon it.

9.4.5 Rubber Ring Gasket or packing
This is a rubber ring having the section, diameters and hardness specified by the design and forms the hydraulic seal for the pipes

9.5 Workmanship

9.5.1 Pipe shall be free from all defect including indentation, delimitation, bubbles, pinholes, cracks, pits, blisters, foreign inclusion and resin starved areas that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per ASTM 2563, BS 5480 & IS 12709.

9.5.2 The inside surface of each pipe shall be free of bulges, dents, ridges and other defects that result in a variation of inside diameter of more than 3.2 mm from that obtained on adjacent unaffected portions of the surface. No glass fiber reinforcement shall penetrate the interior surface of the pipe wall.

9.5.3 Pipes for used for sewerage, Industrial waste and water (Other than Potable) shall be as per IS 14402 : 1996. Workmanship shall be as per following tabulated detailed

Table 9.2 Allowable Defects (Sewerage Pipes)

Name	Definition	Visual Acceptance Levels
Chip	A small piece broken off an edge or surface	Maximum dimension of break, 6.5mm
Crack	An actual separation of the laminate, visible on opposite surfaces, and extending through the thickness	None
Crack, surface	Crack existing only on the surface of the laminate	maximum length, 6.5 mm
Fracture	Rupture of laminate surface without complete penetration	Maximum dimension, 29 mm

Name	Definition	Visual Acceptance Levels
Lack of fillout	An area, occurring usually at the edge of a laminated plastic, where the reinforcement has not been wetted with resin.	Maximum diameter, 9.5 mm
Pimple	Small, sharp, or conical elevation of the surface of a laminate.	Maximum diameter, 3.0 mm
Resin-pocket	An apparent accumulation of excess resin in a small localized area within the laminate.	Maximum diameter, 6.5 mm
Wash	Area where the reinforcement of moulded plastic has moved inadvertently during closure of the mould resulting in resin-rich areas.	Maximum diameter, 29 mm
Wormhole	Elongated air entrapment which is either in or near the surface of a laminate and may be covered by a thin film of cured resin.	Maximum diameter, 6.5 mm
Scratch	Shallow mark, groove, furrow, or channel caused by improper handling or storage.	Maximum length, 25 mm, maximum depth, 0.255 mm

9.6 CLASSIFICATION

9.6.1 Five pressure classes of pipes namely, PN 3, PN 6, PN 9, PN 12 and PN 15 correspond to the working pressure ratings of 300, 600, 900, 1200 and 1500 kPa respectively.

9.6.2 Lengths : Pipes shall be supplied in nominal lengths of 6m, 9m and 12m. A maximum of 10 percent of the pipe section may be supplied in random lengths.

9.7 Soundness

Each length of pipe and fittings of nominal diameter up to 1400 mm shall withstand without leakage or cracking the internal hydrostatic test pressures as specified in Table 16.2 for the applicable class when tested. For pipes of nominal diameter above 1400 mm, the frequency of hydrostatic leak tests shall be as agreed between the manufacturer and the purchaser.

Table No. – 9.3
Hydrostatic Design Pressures
(Refer Table No.7 IS 12709-1994)

Pressure Class	Hydrostatic Design Pressure
PN	kPa
3	540
6	1080
9	1620
12	2160
15	2700

9.8 Marking

9.8.1 Both ends of pipe shall be marked with bold letters not less than 12mm in height and in a colour and type that remains legible under normal handling and installation procedures. The marking shall include the following:

i) The manufacturer's name or trade-mark,
ii) The nominal pipe diameter,
iii) Class of pipe (pressure and stiffness), and
iv) Batch No. or date of manufacture.

9.8.2 BIS Certification Marking- Pipes may also be marked with the Standard Mark.

9.9 Rubber ring Gaskets.

Appropriate EPDM Rubber Ring Gaskets conforming to IS 5382 for GRP pipe shall be selected.

9.10 Fittings and specials

9.10.1 All GRP fittings, such as bends, tees, junction and reducers and specials such as puddles etc. shall be equal or superior in performance to pipe of the same classification and shall be smoothly finished internally.

9.10.2 GRP fittings are not subject to tests for strength and it is essential that external restraint be considered for installation. All GRP fittings are to be manufactured in factory's wherever possible fittings and specials should be fabricated /manufactured by approved pipe manufacturer only. Only specific required fittings should be fabricated/ laminated at site after permission from engineer in charge.

9.10.3 **Dimensions of all fittings should be approved by engineer in charge. Each fitting shall be supplied with necessary coupling and flanges.**

9.10.4 Fittings Made from Straight Pipe: The fittings shall be fabricated from complete pipes or portions or straight pipe complying with this standard as applicable for the pipe classification.

9.10.4.1 The fitting shall comply with the declared design requirement and be suitably mitered. The miter shall be over wrapped externally and, if practicable internally with woven roving and/or chopped strand mat to ensure the longitudinal and circumferential tensile strength is at least equal by design to that of the pipe with which the fittings is to be used.

9.10.4.2 All fittings should have sufficient end length of pipe to accommodate over wrapped length of fitting and pipe.

9.10.4.3 Fittings made by moulding: Moulded GRP fittings shall be made by hand lay-up, contact Moulding, hot or cold press moulding or tape winding.

9.11 Tolerances for GRP Fitting

9.11.1 Except for flanged pipe work, which may require closer tolerances, the permissible deviations from the stated value of the angle of change of direction of a fittings such as a bend, tee or junction shall not exceed ± 1.

9.11.2 Except for flanged pipe work, which may required closer tolerance, the permissible deviations on the manufacturer's declared length of a fitting, exclusive of the socket where applicable, shall be ± 25 mm taken from the point of intersection to the end of the fitting.

9.12 Jointing of Pipes

The pipe shall have a jointing system that shall provide for fluid tightness for the intended service conditions. Appropriate jointing for GRP pipe as per IS 12709 shall be selected considering site and working condition, pressure and flow of liquids.

9.13 . Tests to establish pot ability of water

9.13.1 Pipe specimen shall be subjected to tests as per IS 12709-1994 specified below in order to establish the suitability of these pipes for use in carrying potable water.

i) Smell of the extract,

ii) Clarity of the colour of the extract,

iii) Acidity and alkality,

iv) Global migration,

v) UV absorbing material,

vi) Heavy metals,

vii) Unreacted monomers (styrenes), and

viii) biological tests.

9.14 GRP Pipes conforming to IS 14402 : 1996 for use for Sewerage Industrial waste and water (other than potable) shall not be tested as mentioned above at 9.13.1. This pipes may be used for raw water pumping also. **While placing order for procurement of pipes relevant code should be clearly mentioned according to the purpose for which pipes are to be used.**

9.15 Transportation, storage & lifting of pipe

9.15.1 All pipes section and fittings shall be supported on timber saddles spaced at 4m in centers with a maximum overhang of 2 m. Stock height should not generally exceed 2m. Pipes shall be strapped to the vehicle over the support points using non-metallic pliable straps or ropes only. These may be canvas or

polyester belts with a minimum width of 10 cms or nylon ropes with a minimum diameter of 30 mm.

9.15.2 Steel cables or ropes shall not be used for lifting and transportation of pipes.

9.15.3 Ropes shall not pass through the section of the pipes end to end. Pipes and fittings with diameters of less than 1 m may be stored directly on sandy soil the ground should be flat and free from sharp projection and stones/rocks bigger than 40mm in diameter or of other potentially damaging debris.

9.15.4 Straight continuous lengths of pipe may be lifted at one point. However, owing to its very smooth surface it is usually safer for the pipe to be lifted at two points.

9.15.5 Pipe assemblies fabricated in multiple sections or special places shall be lifted with two or more lifting points.

9.15.6 Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted.

9.15.7 Pipes of different diameters may be nested to reduce the transportation cost and space. Denesting accomplished by starting with smallest size by lifting accomplished by starting with smallest size by lifting slightly with an inserted padded beam to suspend and carefully moving it out of the bundle without touching the other pipes.

9.16. Stacking of different diameter pipes by nesting however, is not permitted, except in their original transport packing.

9.17 Excavation and preparation of trench

9.17.1 The surface at the trench grade should be continuous, smooth and free of big rocks more than 1.5 times the thickness of the pipes if rounded, or more than 1.0 times the thickness of the pipe if they have sharp edges and may cause point loading on the pipe.

9.17.2 When ledge rock, hardpan, big rocks, timber or other foreign materials are to be found, it is advisable to pad the trench bottom with sand or compacted fine grained soils at least 15cm thick so as to provide an adequate foundation.

9.17.3 The width of the trench at top of the pipe should not be greater than necessary to provide adequate room for jointing the pipe in the trench and for compacting the backfill in the zone of the pipe at the side thereof. If necessary, bell holes are permissible at the joints.

9.17.4 Trench depth should be determined by the intended service, properties, size of the pipe and local conditions, such as properties of soil and combination of static and dynamic loading. It should be ensured that the burial depth is sufficient to prevent the conveyed fluids from being effected by frost penetration.

9.17.5 Local, state and other safety regulations/laws should be followed, required, necessary measures should be taken to support the trench walls with sufficient strength to protect the employees working in the trench.
For Detail as per IS: 13916. 1994

9.18 Bedding and Back filling

9.18.1 The pipe should be uniformly and continuously supported through its whole length with firm stable bedding material. Pipe bedding material should be sand or gravel as per the requirements on the backfill material.

9.18.2 The bedding should be placed so as to give complete contact between the bottom of the trench ands the pipe and should be compacted to provide a minimum compaction corresponding to 90% maximum dry density [see IS 2720 (Part 7) : 1980]

9.18.3 If the pipe is supported on grade elevation with use of timber or of tapered wedges, they must be removed and not left in place. They can usually be pulled out after the bedding has been compacted to the specified minimum compaction. The voids from which the timber has been removed must be properly filled and compacted.

9.18.4 Back filling should be placed in layers not exceeding a depth per layer which can be compacted to a minimum of 85% maximum dry density [see IS 2720 (Part 7):1980] Lift should normally not be greater than 30 cm in height and the height differential on each side of the pipe should be limited ok this amount so as to prevent lateral movement of the pipe.

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

9.18.5.1 It is very important that the pipe zone backfill material does not wash a way or migrate into the native soil. Like wise, potential migration of the native soil into the pipe zone backfill must also be prevented.

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

9.19. Laying of pipes

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

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

9.19.3 All the pipes and fittings shall be lifted with pliable strips, slings or ropes. These may be canvas or polyester belts with a minimum width of 10 cms or nylon ropes with a minimum diameter of 30 mm. Steel cables or ropes shall not be used for lifting and transportation of pipe. Ropes shall not pass through the section of the pipe end to end.

9.19.4 Straight continues lengths of pipe may be lifted at one point. However, owing to its very smooth surface it is usually safer for the pipe to be lifted at two points.

9.19.5 Pipe assemblies fabricated in multiple sections or special places shall be lifted with two or more lifting points.

9.19.6 Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or facture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.

9.19.7 As directed by the engineer, moorum/sand bedding has to be done in case of rock strata. At other places, consolidation of bottom depth to the required grade will be done, as far as possible.

9.19.8 The trench shall be kept free of water till the jointing has been properly done. In addition, the provisions of IS: 13916 shall also be adhered to.

9.20 Hydrostatic Tests :

9.20.1 Completed pipe in joints shall be hydrostatically tested for leakage prior to acceptance and service. It shall be done regularly as installation proceeds. Installation should never exceed testing by more than 1 km.

9.20.2 Leak detection testing shall be carried out at a test pressure corresponding to 1.5 times the pressure class of the pipe/fittings. The test pressure shall be maintained for a period of 24 hours. Each full length pipe section, fittings and joint shall be leak tight.

9.21 Measurement

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm. specials shall be excluded and measured and paid separately under the relevant item. The portion of the pipe at the joints (inside the joints) shall not be included in the length of pipe work. Excavation, refilling, masonry and concrete work wherever required shall be measured and paid for separately under relevant item of work.

9.22 Rates

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER -10
ASBESTOS CEMENT PRESSURE PIPES, JOINTS AND FITTINGS FOR WATER SUPPLY AND ACP PIPES AND FITTING FOR SEWERAGE

10.1 Applicable Code:

The laying of ACP pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of ACP pipes, fittings & specials shall be part of this Specification.

Table No.10.1

IS: 1592 -2003	Code of practice for asbestos cement pressure pipes and joints
IS:5531 -1988	Specification for cast iron specials for asbestos cement pressure pipes
IS : 6908-1991:-	Asbestos Cement Pipes and Fittings for Sewerage and Drainage
IS:6530 – 1972	Code of practice for laying of asbestos cement pressure pipe
IS: 5382- 1985	Rubber rings for water mains, sewer mains and gas mains
IS: 8794 – 1988	Detachable joints for AC pressure pipes
IS: 10292- 1988	Rubber rings for detachable joints for AC pressure pipes

10.2 Manufacturing Process of Asbestos Cement Pressure Pipes

10.2.1 Asbestos cement pressure pipes shall be made from a thorough and homogeneous mixture of asbestos fiber and 33 grade ordinary Portland cement conforming to IS 269 or 43 grade ordinary Portland cement conforming to IS 8112 or 53 grade ordinary Portland cement conforming to IS 12269.

The Mazza process employs vat and sieve cylinder for converting Asbestos Cement slurry into thin lamina ranging between 0.25mm to 0.35mm thickness. The lamina so formed is then transferred to an endless synthetic felt which moves over powerful vacuum boxes to facilitate dewatering of individual lamina to a desired level. The dewatered lamina is then wrapped on a hollow steel cylinder called mandrel under a high pressure ranging between 60Kg/Cm^2 to 25Kg/Cm^2. The pipes are dried in a heating tunnel having temperature 70^0 Centigrade to 90^0 Centigrade before extraction of the mandrel so as to prevent deformation of the pipes.

10.2.2 Classification

10.2.2.1 Pipes of nominal diameter up to 1000 are classified according to the works hydraulic test pressure given in Table No.10.2.

Table No. 10.2

(Refer Table No.1 IS 1592-2003)

S.No.	Classes	Works Hydraulic Test Pressure, TP (MPa)
1	**2**	**3**
(i)	10	1.0
(ii)	15	1.5
(iii)	20	2.0
(iv)	25	2.5

10.2.3 Nominal diameter

10.2.3.1 The nominal diameter of the pipes corresponds to the internal diameter expressed in millimeters, tolerances excluded. The series of nominal diameters is given in Table No.- 10.3.

Table No.- 10.3

All dia in millimeters.

(Refer Table No.3 IS 1592-2003)

50	400
60	450
80	500
100	600
125	700
150	750
200	800
250	850
300	900
350	1000

10.2.4 Length

10.2.4.1 The nominal length of the pipes refers to the length measured between the extremities for pipes with plain ends. It shall not be less than 3 m for pipes with a nominal diameter equal to or less than 200 mm; and not less than 4 m for pipes with a nominal diameter exceeding 200 mm.

10.2.5 Tolerances

10.2.5.1 External diameter of finished ends

Tolerance on the external diameter at 100mm from ends shall be as follows:

(Refer Clause 3.4.1.4 IS 1592-2003)

Nominal Diameter mm	Tolerances mm
50 to 300	± 0.60
350 to 500	± 0.80
600 to 700	± 1.0
750 to 1000	± 1.5

10.2.6 Tests :-

10.2.6.1 The acceptance tests shall be carried out at the manufacturer's works on pipes, coated or otherwise, sufficiently matured. The number of tests shall be as specified in IS 7639.

(a) Compulsory tests:

(1) Works hydraulic pressure tightness test on all pipes.
When nominal diameters exceed 1000 mm, this test may be replaced by a suitable method of control as agreed to between the purchaser and the manufacturer.

(2) Hydraulic pressure bursting test for all diameters.

(3) Transverse crushing test for all diameters.

(4) Longitudinal bending test. Test limited to pipes of 150mm diameter and less.

(b) Optional tests at purchaser's request

(1) Hydraulic pressure bursting non-immersed test to be done at random at the purchaser's store.

(2) Line test to be done as per 11.6 of IS 6530 on 100 m length of laid pipeline for at least each size ordered above 5000 m. This is to be done at random at factory of origin.

10.2.7 Marking

10.2.7.1 Each pipe shall be legibly and indelibly marked with the following information:

(a) Indication of the source of manufacture;
(b) Date of manufacture and batch number;
(c) Nominal diameter;
(d) Class of pipe;
(e) Pictorial warning sign as given in IS 12081 (Part 2).

10.2.7.2 BIS Certification Marking
Each pipe may also be marked with the Standard Mark.

10.3 Joints

10.3.1 Types and Material

10.3.1.1 Two types of joints are normally provided with asbestos cement pressure pipes as under;

(a) Asbestos cement coupling with rubber sealing rings.
(b) Cast iron detachable joints with rubber sealing rings and bolts and nuts.

10.3.2. Asbestos cement pressure pipes shall be joined with asbestos cement coupling with rubber sealing rings. However, in case of breakage in running pipe line or special cases of maintenance or construction joints or jointing of specials the cast iron detachable joints with rubber sealing rings and bolts and nuts can also be used.

10.3.3 The composition of asbestos cement couplings should conform to 10.2.1. The dimensions and weight of these couplings should be as given in Annex. B of IS

1592-2003. The tolerances on the internal diameters should be as given in Annex. B. of IS 1592-2003.

10.3.4 The assembled joint should be flexible and capable of with standing the specified hydraulic pressure of the pipes on which they are to be used when the pipes are set at the maximum permissible angular deviation indicated by the manufacturer.

10.3.5 Sealing rings used should be of rubber of a type suitable for use with the liquid to be conveyed and should conform to IS 5382, unless otherwise agreed to between the purchaser and the manufacturer. They shall also be suitable for use with the type of jointing device selected. If the pipes are to be used to convey potable water, the rings shall not affect its suitability for human consumption.

10.3.6 The cast iron detachable joints should conform to IS 8794.

10.4 Marking;

10.4.1 Each joint coupling shall be legibly and indelibly marked with the following information:

(a) Indication of the source of manufacturer.
(b) Batch number;
(c) Nominal diameter,
(d) Class of coupling
(e) Pictorial warning sign as given in IS 12081 (Part 2)

10.5 Plain ended cast iron fittings:

10.5.1 Plain ended cast iron fittings should be as per IS: 5531. Their weights should not be less than as specified in the code. Fittings having weight more than specified weight as per IS: 5531 may be excepted if all other specification/Dimensions are as per the code.

10.5.2 Weight of some of the fittings are mentions as under:

10.5.2.1 Weight of cast iron Plain ended 90° Bend

Table No.-10.4

(Refer Table No.1 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 mm	7.60	7.60	8.70
100 mm	10.30	10.60	13.0
125 mm	14.10	14.80	18.0
150 mm	19.0	21.00	25.70
200 mm	32.50	36.50	44.70
250 mm	48.60	53.40	65.40
300 mm	69.50	78.00	95.80
350 mm	94.60	105.00	128.00

10.5.2.2 Weight of cast iron plain ended 45° Bend

Table No.-10.5

(Refer Table No.2 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 mm	7.70	7.70	8.80
100 mm	10.00	10.40	12.80
125 mm	13.40	14.00	17.20
150 mm	17.50	19.60	23.90
200 mm	27.50	32.60	40.20
250 mm	41.00	45.80	56.50
300 mm	56.70	65.2	80.70
350 mm	74.80	85.0	105.0

10.5.2.3 Weight of cast iron plain ended 22½° Bend

Table No.-10.6

(Refer Table No.3 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 mm	5.70	5.70	6.50
100 mm	7.40	7.70	9.60
125 mm	9.60	10.20	12.70
150 mm	12.30	14.40	17.80
200 mm	20.00	24.00	30.00
250 mm	28.00	32.70	41.10
300 mm	37.90	46.40	58.50
350 mm	48.80	59.0	74.5

10.5.2.4 Weight of cast iron plain ended 11½° Bend

Table No.-10.7

(Refer Table No.4 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 mm	4.70	4.70	5.30
100 mm	6.00	6.30	8.80
125 mm	7.70	8.30	10.40
150 mm	9.80	11.80	14.70
200 mm	15.60	19.70	25.00
250 mm	21.40	26.10	33.40
300 mm	28.40	37.00	47.50
350 mm	35.80	46.10	59.30

10.5.2.5 Weight of cast iron plain ended Tees Body & Branch

Table No.-10.8

(Refer Table No.9 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 x 80mm	9.7	9.7	11.1
100 x 80 mm	12.1	12.6	14.5
100 x 100 mm	13.5	13.9	17.2
125 x 80 mm	15.7	16.0	19.0
125 x 100 mm	17.1	17.7	22.6
125 x 125 mm	18.9	19.9	24.40
150 x 80 mm	22.2	24.2	29.3
150 x 100mm	23.1	25.3	31.0
150 x 125 mm	24.4	26.7	32.7
150 x 150 mm	26.0	29.1	35.6
200 x 80 mm	37.3	41.4	50.4
200 x 100 mm	38.3	42.6	52.2
200 x 125 mm	39.7	44.1	54.0
200 x 150 mm	41.4	47.3	57.0
200 x 200 mm	45.9	52.1	64.0
250 x 80 mm	56.40	61.2	74.6
250 x 100 mm	57.5	62.4	76.4
250 x 125 mm	59.1	64.1	78.4
250 x 150 mm	60.8	66.6	81.5
250 x 200 mm	65.6	72.5	88.8
250 x 250 mm	70.8	77.9	95.7

10.5.2.6 Weight of cast iron plain ended 300x80 to 350 mm Tees Body & Branch

Table No.-10.9

(Refer Table No.9 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
300 x 80 mm	81.6	90.1	110
300 x 100 mm	82.7	91.3	112
300 x 125 mm	84.3	93.1	114
300 x 150 mm	85.1	94.6	116
300 x 200 mm	91.4	102	125
300 x 350 mm	96.8	108	132
300 x 350 mm	103	116	143
350 x 200 mm	123	135	165
350 x 250 mm	129	141	172
350 x 300 mm	136	150	183
350 x 350 mm	143	158	194

10.5.2.7 Weight of cast iron plain ended Crosses

Table No.-10.10

(Refer Table No.7 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 x 80 mm	12.2	12.2	13.9
100 x 100 mm	16.8	17.3	21.5
125 x 125 mm	23.4	24.6	30.2
150 x 150 mm	32	31.1	44.2
200 x 200 mm	56.4	64.7	79.2
250 x 250 mm	86.4	95.9	118
300 x 300 mm	126	143	176
350 x 350 mm	173	194	237

10.5.2.8 Weight of cast iron plain ended Reducers

Table No.-10.11

(Refer Table No.6 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
100 x 80mm	8.3	8.4	10.0
125 x 80 mm	9.6	9.90	11.80
125 x 100 mm	10.6	11.0	13.5
150 x 80 mm	11.1	12.1	14.5
150 x 100 mm	12.1	13.2	16.3
150 x 125 mm	13.4	14.7	18.0
200 x 100 mm	16	18.2	22.5
200 x 125 mm	17.3	19.6	24.2
200 x 150mm	18.8	21.9	27
250 x 125 mm	21.2	23.8	29.6
250 x 150 mm	22.7	26.1	32.4
250 x 200 mm	26.5	31	38.6
300 x 150 mm	27.2	32.5	40.6
300 x 200 mm	31.1	37.5	46.8
300 x 250 mm	34.8	41.5	50
350 x 200 mm	51.7	58.9	72.3
350 x 250 mm	57.7	65.2	80.2
350 x 300 mm	64.5	73.9	91.0

10.5.2.9 Weight of cast iron Plain end adapter

Table No.-10.12

(Refer Table No.8 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 mm	7.40	7.40	7.90
100 mm	9.00	9.10	10.20
125 mm	11.30	11.70	13.00
150 mm	14.3	15.30	17.10
200 mm	20.6	22.70	25.80
250 mm	34.40	36.80	42.30
300 mm	43.50	47.8	55.30
350 mm	54.40	59.50	68.80

10.5.2.10 Weight of cast iron Plain end plugs

Table No.-10.13

(Refer Table No.5 IS 5531-1988)

Diameter	Weight in Kg		
	Class 10	Class 15	Class 20
80 mm	3.40	3.40	3.70
100 mm	4.70	4.90	5.50
125 mm	6.40	6.80	8.10
150 mm	8.60	10.20	12.10
200 mm	15.2	18.60	22.40
250 mm	22.30	26.40	31.70
300 mm	31.50	39.1	46.90
350 mm	41.90	51.30	61.40

10.5.3 Marking;

10.5.3.1 Each special shall have cast stamped or indelibly painted on it the following;

(a) Manufacturer's name, initials or identification mark;
(b) Nominal diameter;
(c) Class reference;
(d) Last two digits of the year of manufacture;
(e) Any other mark, if required by the purchaser.

10.5.3.2 Marking may be done on the barrels of the specials.

10.6 Storage of pipes and accessories at site of works

10.6.1 **Unloading** :- To avoid any costly handling, the pipes shall be unloaded directly at site if the trenches are ready.

10.6.2 Pipes weighing up to 60 kg shall be handled by two persons by holding, them in loops, formed with ropes and sliding over planks set not steeper than 45°. The planks shall be sufficiently rigid and two ropes shall always be used to roll

the pipes down the planks. The ropes should be tied on the side opposite the unloading. Only one pipe shall be unloaded at a time.

10.6.3 Under no circumstances shall the pipes be thrown down from the carriers or be dragged or rolled along hard surfaces.

10.6.4 The pipes shall be checked for any visible damage (such as broken edges, cracking or spelling of pipe) while unloading Any pipe which shows sufficient damage shall be discarded.

10.6.5 Storing

10.6.6 Each stack shall contain only pipes of same class and size.

10.6.7 Storage shall be done on firm level and clean ground. Wedges shall be provided at the bottom layer.

10.6.8 The stack shall be in pyramid shape or the pipes laid length wise and crosswise in alternate layers. The height of the stack shall not exceed 1.5 m.

10.6.9 Cast iron detachable joints and fittings shall be stacked under cover and separated from the asbestos cement pipes and fittings.

10.6.10 Rubber rings shall be kept clean, away from grease, oil, heat and light.

10.7 Cutting of Pipes

10.7.1 Cutting of pipes may be necessary when pipes are to be laid in lengths shorter than the lengths supplied such as while salvaging the pipes with damaged ends or while replacing cast iron accessories like tees, bends, etc, at fixed positions in the pipeline.

10.7.2 A line shall be marked around the pipe with a chalk piece at the point at the point where the cut is to be made. The line shall be so marked that the cut is truly at right angle to the longitudinal axis of the pipe.

10.7.2.1 The pipe shall be rigidly held on two parallel rafters nailed to cross beams, taking care that the portion to be cut does not overhang and the cut mark is between the two rafters.

10.7.2.2 The pipe shall be neatly cut at the chalk mark with carpenter's saw or hack-saw having a long blade, by slowly rotating the pipe around its longitudinal axis so as to have the uncut portion on top for cutting.

10.7.2.3 Cutting of the pipe at the overhang should as far as possible be avoided, it is dangerous as an overhanging end is liable to tear off due to its weight before the cut is completed

10.8. Trenches

10.8.1 The trenches shall be so dug that the pipes may be laid to the required alignment and at required depth.

10.8.1.1 Width- The width of the trench above pipe level shall be as small as possible but shall provide sufficient space necessary for jointing the pipes. The trench width shall be such as to provide a space of 300 mm on either side of the pipe.

10.8.1.2 Depth – The pipe shall have a minimum soil cover of 750 mm when laid under foot paths and side walks, 900 mm when laid under roads with light traffic or under cultivated soils and 1.25 m when laid under roads with heavy traffic. When the soil has a poor bearing capacity and is subject to heavy traffic, the pipes shall be laid on a concrete cradle. An extra trench depth of 100 mm shall be provided for each jointing pit.

10.9 Excavation

10.9.1 The excavation of the trench shall be so carried out that the digging of the trenches does not get far ahead of the laying operations.

10.9.2 The wall of the trench shall be cut generally to a slope of ¼ : 1 or ½ : 1 depending on the nature of the soil.

10.9.3 If the trench bottom is extremely hard or rocky or loose stony soil, the trench should be excavated at least 150 mm below the trench grade.

10.9.4 Rocks, stone or other hard substances from the bottom of the trench shall be removed and the trench brought back to the required grade by filling with selected fine earth or sand (or fine moorum if fine soil or sand is not available locally) and compacted so as to provide a smooth bedding for the pipe.

10.9.5 Where excavation requires blasting operation it shall be ensured that no pipes are stacked in the vicinity and completed pipeline in the vicinity have already been covered before starting of blasting operations; to prevent damage to the exposed pipes.

10.9.6 Roots of trees within a distance of about 0.5 m from the side of the pipeline shall be removed or killed.

10.9.7 The excavated soil shall preferably be deposited on one side of the trench, so that it leaves a bench of about 0.5 m facilitating the workmen to move along the trench without any difficulty.

10.9.8 In places of heavy or light traffic the excavated soil shall be on the traffic side for the protection of the traffic from accidents. The other side of the trench may be used for placing pipes and other accessories.

10.9.9 To protect person from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways.

10.9.10 During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately.

10.9.11 Where loose earth is encountered during excavation and where the trench is very deep, the side walls shall be properly shored for the safety of workmen.

10.9.12 The bed of the trench shall be excavated to the pipe grades so that uniform support is assured for the full length of the pipe.

10.10 Laying

10.10.1 The pipes shall be lowered into the trenches either by hand passing or by means of two ropes. One end of each rope shall be tied to a wooden or steel peg driven into the ground and the other end shall be held by men which when slowly released will lower the pipe into the trench.

10.10.2 The pipe shall rest continuously on the bottom of the trench. The pipes shall not rest on lumps of earth or on the joints. Four-meter long wooden templates may be used to check the level of the bed. Clearance of approximately 100 mm in depth and width equal to length of the collar plus 30 mm on both sides shall be provided at the joint which shall be refilled form sides after the joint is made.

10.10.3 In unstable soils, such as soft soils and dry lumpy soils it shall be checked whether the soils can support the pipelines and if required suitable special foundation shall be ensured.

10.10.4 Some clayey soils (for example black cotton soil)are drastically affected by extremes of saturation and dryness. In changing from totally saturated to a completely dry condition, these soils are subjected to extra ordinary shrinkage.

10.10.5 This shrinkage is usually seen in the form of wide and deep cracks in the earth surface and may result in damages to underground structures, including pipe materials. The clay forms a tight gripping bond with the pipe, subjecting it to excessive stresses as the clay shrinks.

10.10.6 In such areas, it is recommended that in such cases an envelope of a minimum 100 mm of tamped sand shall be made around the pipeline to avoid any bonding.

10.10.7 In place where rock is encountered, cushion of fine earth or sands shall be provided for a depth of 150 mm by excavating extra depth of the trench, if necessary, and the pipes laid over the cushion, where the gradient of the bed slopes is more than 30˚ it may be necessary to anchor a few pipes against their sliding downwards.

10.11 Jointing

10.11.1 Before commencing jointing, the pipes shall be cleaned; the joints and the ends of the pipe shall be cleaned, preferably with a hard wire brush to remove loose particles.

10.11.2 Cast Iron Detachable Joints

10.11.2.1 The joint shall consist of a central collar, two rubber rings, two flanges of cast iron and the required number of bolts and nuts.

10.11.2.2 One flange and rubber flange shall be placed on end of the pipe already laid, and the other flange, rings and central collar shall be slipped on to the pipe to be assembled.

10.11.2.3 The rubber ring shall be kept positioned at half the collar width less 2.5 mm from the end of the pipe already laid.

10.11.2.4 The other pipe shall be brought nearer leaving a gap of 5 mm between the two pipe ends. This gap will facilitate maneuvering of deflection at joints after assembly and will take care of an expansion in the pipeline.

10.11.2.5 The collar shall be slided to sit square around the rubber ring on pipe 1, and then the rubber ring shall be rolled on pipe 2 sit around the collar.

10.11.2.6 The flanges shall be moved on both ends to enclose rubber rings. The fastening bolts shall be inserted through the holes of the flanges and the bolts shall be tightened alternately and evenly for proper sitting of the joints.

10.12 Asbestos Cement Coupling

10.12.1 This joints shall consist of three rubber rings and an asbestos cement coupling machined on the inside

10.12.2 The rubber rings shall be sealed in their respective grooves, after cleaning the coupling and rubber rings. The machined ends of the pipe and end rings in the coupling shall be suitably lubricated with a soft soap solution or other lubricant. Then, the assembly shall be made by pushing with a crow-bar or using a pipe puller.

10.12.3 The joints shall be made by keeping the pipes in one line. Any permissible deflection at the joint shall be made after completion of the joint only.

10.13 Detachable joints and rubber rings for the detachable joints shall conform to IS: 8794 and IS: 10292 respectively.

10.14 Laying of fittings –

10.14.1 All cast iron fittings shall be plain ended to suit the outside diameter of asbestos cement pressure pipes and to the class and diameter of pipe manufactured. When using such cast iron, fittings, they are jointed by cast iron detachable joints only. For any cast iron specials having flange, they are jointed in the pipeline with cast iron flange adaptors having one end flanged and the other plain ended.

10.15 Thrust Block

10.15.1 Thrust block are required to transfer the hydraulic thrust from the fitting or pipe on to a larger load bearing soil section.

10.15.2 Thrust block shall be installed wherever there is a change in the direction of the pipeline, size of the pipeline or the pressure-line diagram, or when the pipeline ends at a dead end.

10.15.3 Thrust block shall be constructed taking into account the pipe size, water pressure, type of fitting, gravity component shell when laid on slopes, and the type of soil. The location of thrust block for various types of fittings is given in Fig-8

10.15.4 When a fitting is used to make a vertical bend, it shall be anchored to a concrete thrust block designed to have enough weight to resist the upward and outward thrust.

10.15.4.1 Similarly at joints, deflected in vertical plane, it shall be ensured that the weight of the pipe, the water in the pipe and the weight of the soil over the pipe provide resistance to upward movement. If it is not enough, ballast or concrete shall be placed around the pipe in sufficient weight to counteract the thrust.

10.15.5 When the line is under pressure there is an outward thrust at each coupling. Good soil, properly tamped is usually sufficient to hold pipe from side movement.

10.15.5.1 However, if soft soil condition is encountered, it may be necessary to provide side thrust blocks or other means of anchoring. In such cases only the pipe on each side of the deflected coupling shall be anchored without restricting the coupling.

10.15.6 Pipes on slopes need be anchored only when there is a possibility of the backfill around the pipe sloping down the hill and carrying the pipe with it. Generally for slopes up to 30° good well drained soil, carefully tamped in layers of 100 mm under and over the pipe, right up to the top of the trench will not require anchoring.

10.15.6.1 For steeper slopes, one out of every three pipes shall be held by straps fastened to vertical supports anchored in concrete.

10.16 Service Connections

10.16.1 When the pipe is used in distribution house service, connections shall be provided through a saddle piece.

10.16.1.1 The saddle piece consists of two straps which envelopes the portion of pipe from where connection is to be given. The hole of required size shall be drilled through the pipe and the boss provided in the top strap. Ferrule piece shall be connected after making threads in the boss and pipe. Suitable rubber packing

shall be used between the straps and the pipe to provide cushioning as well as sealing against leakages.

10.16.2 The size of the hole drilled in the pipe shall be limited to those given in Table 10.14

Table 10.14
Size of Hole Drilled in pipe

Pipe size	Maximum Size of Drilled Hole
mm	mm
80 and 100	20
125 and 150	25
200	35
250 and above	50

10.17 Back Filling and Tamping

10.17.1 Back filling shall follow pipe installation as closely as possible to protect pipe from falling boulder, eliminating possibility of lifting of the pipe due to flooding of open trenches and shifting pipe out of line by caved in soil.

10.17.2 The soil under the pipe and coupling shall be solidly tamped to provide a firm and continuous support for the pipeline. Temping shall be done either by tamping bars or by using water to consolidate the back fill material.

10.17.3 The initial back fill material used shall be free of large stones and dry lumps. In stony areas the material for initial back fill can be shave from the sides of the trenches. In bogs and marshes, the excavated material is usually little more than vegetable matter and this should not be used for bedding purposes.

10.17.4 The initial back fill shall be placed evenly in a layer of about 100mm thick. This shall be properly consolidated and this shall be continued till there is a cushion of at least 300 mm of cover over the pipe.

10.17.5 If it is desired to observe the joint or coupling during the testing of mains they shall be left exposed. Sufficient back fill shall be placed on the pipe to resist the movement due to pressure while testing.

10.17.6 Balance of the back fill need not be so carefully selected as the initial material. However, care shall be taken to avoid back filling with large stones which might damage the pipe when spaded into the trench.

10.17.7 Pipes in trenches on a slope shall have extra attention to make certain that newly placed back fill will not become a blind drain in effect because until back fill becomes completely consolidated there is a tendency for ground or surface water to move along this looser soil resulting in a loss of support to the pipe. In such cases, the back fill should be tamped with extra care and the tamping continued in 100 mm layers right up to the ground level.

10.18 Testing

10.18.1 It is recommended to test the portions of the line by subjecting to pressure test as in table 10.15, as the laying progresses before the entire line is completed.

10.18.1.1 Usually the length of the section to be tested shall not exceed 500m.

10.18.2 The pipes shall be tested as specified in IS: 5913-1970 in the factory and hence the purpose of field testing is to check the quality of workman ship and also to check whether the pipes have been damaged in transits as such, the test pressure shall be kept as 1.5 times the actual operating pressure, unless a higher test pressure is specified. However, it may be noted that the test pressure during the field test shall not exceed the values given in Table 10.15

Table No.10.15
Test Pressure for Pipes

Class of Pipes	Maximum field Test Pressure kgf/cm²
5	3.75
10	7.50
15	11.25
20	15.00
25	18.75

10.18.3 Prior to testing enough back fill shall be placed over the pipeline to resist upward thrust. All thrust blocks forming part of the finished line shall have been sufficiently cured and no temporary bracing shall be used.

10.18.4 The open end of the section can be sealed temporarily with an end cap having an outlet which can serve as an air relief vent

10.18.5 The blind face of the end cap shall be properly braced during testing by screw jacks and wooden planks or steel plate.

10.18.6 The section of the line to be tested shall be filled with water manually or by a low pressure pump. Air shall be vented from all high spots in the pipeline before making the pressure strength test because entrapped air gets compressed and causes difficulty in raising the required pressure.

10.18.7 Asbestos cement pipes always absorb a certain amount of water. Therefore, after the line is filled, it should be allowed to stand for 24 h, before pressure testing and the line shall be again filled.

10.18.8 The test pressure shall be gradually raised at the rate of approximately one kg/cm²/min.

10.18.9 The duration of the test period if not specified shall be sufficient to make a careful check on the pipeline section.

10.18.9.1 After the test has been completed, the trench shall be filled back.

10.19 Disinfection of pipeline before commissioning

10.19.1 Pipelines carrying potable water shall be suitably disinfected before commissioning.

10.20 Measurement

10.20.1 The net length of pipes as laid or installed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item. Excavation, refilling, masonry and concrete work (as required) shall be measured and paid for separately under relevant item of work.

10.21 Rates :

10.21.1 The rate shall include the cast of the material and labour involve in all the operation describe in the item.

10.22 Asbestos Cement Pipes and Fittings for Sewerage and Drainage IS : 6908-1991:-

10.22.1 Pipes :- The Pipes shall be made from a thorough and homogeneous mixture of clean asbestos fiber, 33 grade ordinary Portland cement conforming to IS : 269 : 1989 or Portland slag cement conforming to IS 455:1989 or Portland pozzolana cement conforming to IS 1489:1976, and water. Addition of siliceous filler is also permissible.

The Mazza process employs vat and sieve cylinder for converting Asbestos Cement slurry into thin lamina ranging between 0.25mm to 0.35mm thickness. The lamina so formed is then transferred to an endless synthetic felt which moves over powerful vacuum boxes to facilitate dewatering of individual lamina to a desired level. The dewatered lamina is then wrapped on a hollow steel cylinder called mandrel under a high pressure ranging between 60Kg/Cm^2 to 25Kg/Cm^2. The pipes are dried in a heating tunnel having temperature 70^0 Centigrade to 90^0 Centigrade before extraction of the mandrel so as to prevent deformation of the pipes.

10.22.2 The pipes shall be seamless, compact and homogeneous. Their internal surface shall be regular and smooth.

10.23. Classification :
The pipes shall be classified according to their crushing strength as under:

Class – 1	60 kN/m^2
Class – 2	90 kN/m^2
Class - 3	120 kN/m^2

10.24 Thickness:

10.24.1 The nominal thickness of the pipes is the thickness of the barrel of the pipe, excluding the machined ends.

10.24.2 The thickness of the barrel of the pipes may be verified from test pieces sampled from transverse crushing test.

10.24.3 Where pipe ends are not machined, the thickness of the barrel of the pipes shall be measured at a distance not less than 100mm from the ends.

10.25 Length :

10.25.1 The nominal length of the pipes should preferably be not less than 3m for pipes with a nominal diameter equal to or less then 200mm and 4m for pipes with a nominal diameter exceeding 200mm.

10.26 Tests shall be conducted for Physical Mechanical and Chemical characteristics as under :-

10.26.1 Hydraulic test

10.26.2 Transverse Crushing Strength

10.26.3 Longitudinal Bending Strength

10.26.4 Acid Resistance Test

10.27 Fittings

10.27.1 Composition

The fittings shall comply with the requirements of clause 10.22.1.

10.27.2 The basic types of fittings are bends, angle junctions, equal or unequal tees double sockets, sleeves and saddles.

10.27.3 The nominal diameter of the fittings shall correspond to the nominal diameters of the pipes.

10.27.4 The thickness of the barrel of the fittings shall be a least equal to that specified by the manufacturer for the corresponding pipe.

10.27.5 The variation of the internal diameter shall be same as for the corresponding pipes.

10.27.6 The tolerance on the nominal thickness of the fittings shall be as under :

Upper deviation	:	Free
Lower deviation	:	- 1.5mm

10.27.7 Tests shall be conducted for Physical Mechanical and Chemical characteristics as under :-

10.27.7.1 Hydraulic test

10.27.7.2 Transverse Crushing Strength

10.27.7.3 Acid Resistance Test

10.28 Joints : Two types of joints are normally provided with asbestos cement pipes as under :

10.28.1 Asbestos cement couplings with rubber sealing rings, and

10.28.2 Cast Iron detachable joints with rubber sealing rings and bolts and nuts.

10.29 Measurement

10.29.1 The net length of pipes as laid or installed shall be measured in running meters correct to a cm. Specials shall be excluded and measured and paid separately under the relevant item. Excavation, refilling, masonry and concrete work (as required) shall be measured and paid for separately under relevant item of work.

10.30 Rates :

10.30.1 The rate shall include the cast of the material and labour involve in all the operation describe in the item.

CHAPTER NO- 11
SALT GLAZED STONEWRE (GSW) PIPES (SP 1 CLASS WITH 16KN/m)

11.1 Applicable code:

The laying of GSW pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of GSW pipes, fittings & specials shall be part of this Specification.

Table No.11.1

I.S. Number	Title
IS: 651-2007	Code for salt glazed stoneware pipes and fittings.
IS: 4127-1983	Code of practice for laying of glazed stoneware pipes.

11.2 Glazed stone ware pipes and fittings:

11.2.1 Class of pipes based on crushing strength of the pipes GSW pipes are classified as under:-

Table No.11.2
(Refer Clause 7.6 IS 651-2007)

Internal Diameter	Class		
mm	SP 1 KN/m	SP 2 KN/m	SP3 KN/m
Up to 150	16	18	21
200-300	16	21	24

11.2.2 The length of barrel of straight and tapers of pipes and half section channels (excluding the internal depth of the socket) shall be 600 mm ,750 mm, 900 mm and 1000 mm.

11.2.3 The length of junction shall be 600 mm, 750 mm, or 900 mm.

11.2.4 The permissible tolerance on length shall be within -1.5 % and + 4 % of length.

11.2.5 The maximum permissible deviation from straightness of the barrel of the pipe, measured on the inside of the curve and tested by means of a straight edge, shall be 1 % of length of the pipe.

11.2.6 The interior and exterior surfaces of the pipes and fittings which remain exposed after jointing are glazed. The portion which remains covered after jointing may or may not be glazed.

11.2.7 Hydraulic test, absorption test, test for acid resistant, Test for alkali resistant and crushing strength test shall be carried out as provided in clause 7 of the IS: 651: 2007

11.2.8 A right hand fittings is such that when viewed from the spigot towards the socket, the arm of a junction or the socket of a bend projects to the right.

11.2.9 A left hand fittings is such that when viewed from the spigot towards the socket, the arm of a junction or the socket projects to the left.

11.2.10 All pipes and fittings should be sound and free from visible defect.

11.2.11 The glazed of pipes and fittings shall be free from crazing.

11.2.12 The pipes and fittings shall give a sharp clear sound when struck with a light hammer.

11.2.13 Dimensions of barrels and sockets shall be as under:

Table No.- 11.2 (in mm)

(Refer Table No.-1 IS 651-2007)

S. No.	Internal Diameter	Class	Mean Thickness of Barrel and of socket	Internal depth of socket	Excess shoulder Measurement	Length of Grooving of spigot
			Min	Min	Min	Min
1	2	3	4	5	6	7
i)	100	SP1	12	50	10	75
		SP2	14	55	11	82.5
		SP3	18	60	14	90
ii)	150	SP1	15	57	11	85.5
		SP2	16	60	12	90
		SP3	20	62	12	93
iii)	200	SP1	16	63	12	94.5
		SP2	18	65	13	97.5
		SP3	22	68	15	102
iv)	230	SP1	19	63	12	94.5
		SP2	21	65	14	97.5
		SP3	24	68	16	102
(v)	250	SP1	20	70	16	105
		SP2	22	66	17	99
		SP3	26	69	18	103.5
(vi)	300	SP1	25	70	16	105
		SP2	24	72	18	108
		SP3	28	74	19	111

11.3. Marking of pipes and fittings:

11.3.1 Every pipe and fittings shall have legibly impressed upon it before firing the following:

a) Name or trade-mark of the manufacturer,

b) Size (Internal dia),

c) Class of pipe.

11.3.2 Each pipe and fittings may also be marked with the standard mark (ISI Marked).

11.4 Pipes and fittings:

11.4.1 The internal diameter of barrels of straight pipes, junctions and bends of size 100mm to 300mm shall be as per table 9.2.

11.4.2 The internal diameter of the barrels of straight pipes for pipes of 100 mm to 350 mm shall be within ±3 % of the diameter.

11.4.3 The mean thickness of the barrel and the socket of the pipes junctions and bends shall not be less than mean thickness given in col 4 of Table 1 of IS:651 : 2007. Such mean thickness of the barrel or sockets of any individual pipe junctions and bends shall be ascertained by making several minimum 4 measurements and adding the measured minimum thickness (not in the groove) to the maximum thickness and dividing the sum by two. The mean thickness of the barrel and socket shall be determined separately.

11.4.4 The difference between the minimum and maximum measured thickness of barrel and sockets mentioned in para 11.4.2 shall not exceed ±3 % (in mm) for 100-350 mm diameter of pipes.

11.4.5 Tolerance on angles of bends shall be within ±3º.

11.4.6 Socket

11.4.6.1 The interior of the socket shall be conical, having a minimum taper of 1 mm, measured on the diameter, per 15 mm length, thus the diameter of a socket 50 mm deep will be at least 3 mm greater at the top than at the bottom. The depth of the sockets shall be in accordance with as given in Table 11.2.

11.4.6.2 The width of the shoulder of socket of any individual pipe or fitting shall exceed the mean thickness of the barrel by not less than the values given in Table 11.2. If rubber ring joints are used, taper may not be provided.

11.4.7 Grooving:-

11.4.7.1 The interior of the socket and exterior of the spigots shall be grooved circumferentially, and such grooving on the spigot shall be for a length equal to one and half times the depth of sockets, and the depth of such grooves shall be between 1 mm to 2.5 mm. If rubber ring joints are used, as agreed to between the manufacturer and the buyer, grooving may not be provided.

11.4.8 Bends :-

11.4.8.1 Dimensions of bends shall be in accordance with tables 2 to 6 of IS: 651:2007.

9.4.8.2 The barrel and branches of half section channel junctions may be of any of the diameters shown in col.2 of table 9.2. But the diameter of the branches shall not exceed that of the barrel diameter. The angle at junction shall be 45º ±3º or 90º ±3º.

11.4.8.3 The taper pipes and half section tapers channels may be in any normal combination of diameter and lengths.

11.5 Loading and Unloading

At every point of loading or unloading, pipes or casting must be handled by approved lifting tackles. Unloading by rolling down planks or any other form of inclined ramp will not be allowed unless the written consent of the engineer to the method proposed has been obtained. Pipes are to be carefully stacked on site with timber packing under and between the pipes. The pipes are to be laid up at the gradients beginning at the lower end. No pipe is to be laid until the trench has been excavated to its required depth for a distance of 20m, in front of the pipe to be laid. (this distance may very as directed by the Engineer.

11.6. Laying

11.6.1 Handling of Stoneware pipes into Trench in shallow trenches manual handling is enough, but in deep trenches they should be lowered into the trench by means of ropes. Under no circumstances shall the pipes be dropped or dumped into the trench.

11.6.2 Detection of Cracks in pipes and fittings: The pipe and fittings shall be inspected for defects, and be rung with a light hammer preferably while suspended to detect cracks.

11.6.3 Cleaning pipes and fittings: All lumps, blisters and excess coating material shall be removed gently from the socket and spigot end of each pipe and the outside of the spigot and the inside of the socket shall be wiped clean and dry before the pipe is laid.

11.6.4 Placing the pipes in Trench: Every precaution shall be taken to prevent foreign materials from entering the pipes when it is being placed in the line. Normally the socket ends should face the up-stream. When the line runs uphill the socket ends should face the up-grade.

11.6.5 After placing a length of pipe in the trench on concrete bedding where that is specified, the spigot end shall be centered in the socket and the pipe forced home and aligned to gradient. The pipe shall be secured in place with approved backfill material or concrete tamped under it except at the socket. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the joint space (see Drawing No.-8).

11.6.6 At time when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or canvas or other means approved by the site engineer.

11.6.7 Sight rails shall be provided at all changes of directions or gradients at distances of about 30 m along straight lengths. The centre line shall be marked

on each horizontal rail which is fixed at true level. All inverts shall be laid there from with the help of proper boning rods.

11.6.8 Cutting of pipes: The cutting of pipe for inserting, fittings or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or cement lining so as to leave smooth and at right angles to the axis of the pipe.

11.6.9 Pipelines Crossing Railway Lines: Irrigation channels or similar works the administrative authority should consult the appropriate authorities before preparing plans and specification for this part of work.

11.6.10 Connection to an Existing sewer: The connection to an existing sewer shall be done through manholes.

11.6.11 Connection to manholes: Before connecting a pipe to a manhole, a relieving arch or any other similar protection device should be made in the manhole for the safety of the pipe.

11.6.12 Strength and loading of stone ware pipes : The superimposed load should not normally exceed 1600 kg per meter length, which is the minimum crushing strength specified in IS: 651. The superimposed load on a laid pipe may be calculated by Marston's formula, given below:

$$W = C \ w \ B^2$$

Where

W= Load on pipe in kilogram/linear meter.

C= coefficient which depends upon the ratio of depth of trench to the trench width and the filling materials. Value of "C" is given in table 11.3.

W= weight of filling materials in kg/m³ given in table 11.4.

B= width of trench in meters.

Table 11.3
VALUE OF "C"

Ratio of Depth to Trench Width	Sand And Damp Top- Soil	Saturated Topsoil	Damp Clay	Saturated Clay
1	**2**	**3**	**4**	**5**
0.5	0.46	0.46	0.47	0.47
1.0	0.85	0.86	0.88	0.90
1.5	1.18	1.21	1.24	1.28
2.0	1.46	1.50	1.56	1.62
2.5	1.70	1.76	1.84	1.92
3.0	1.90	1.98	2.08	2.20
3.5	2.08	2.17	2.30	2.44
4.00	2.22	2.83	2.49	2.66
4.5	2.34	2.47	2.65	2.87
5.0	2.45	2.59	2.80	3.03

WEIGHT OF COMMON FILLING MATERIALS

Table 11.4

Material	Weight Kg/m³
Dry sand	1600
Ordinary (damp) sand	1840
Wet Sand	1920
Damp clay	1920
Saturated clay	2080
Saturated topsoil	1840
Sand and damp soil	1600

11.7 Jointing:

11.7.1 The stoneware pipes shall be cement jointed or provided with bituminous.

11.7.2 The materials shall consist of the following.
(a) Spun yarn or tarred gaskets.
(b) Cement.
(c) Sand

11.7.3. In each joint, spun yarn soaked in neat cement slurry or tarred gasket shall be passed round the joint and inserted in it by means of a caulking tool. More yarn or gasket shall be added if necessary and shall be well caulked. Yarn or gasket so rammed shall not occupy more then one fourth of the depth of socket.

11.7.4 Cement mortar (1:1) (one part of cement to one part of sand) shall be slightly moistened and carefully inserted by hand into the remaining space of the joint after caulking of yarn or gasket. The mortar shall than be caulked into the joint with a caulking tool. More cement mortar shall be added until the joint space has been completely filled with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degrees (IS 4127-1983)

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

11.7.6 The approximate quantity of cement and spun yarn required for each joint for certain common sizes of pipes are given below for guidance.

Table 11.5

Nominal Dia of Pipe mm	Cement Kg	Spun Yarn Kg
100	1	0.25
150	1.5	0.35
200	2	0.70
250	2.5	0.80
300	3.25	1.10
350	4.5	1.25
400	5.5	1.50

11.7.7 The joint with cast iron or concrete pipes shall be made with cement joints.

11.8 **Testing:**

11.8.1 Each section of sewer shall be tested for water tightness preferably between manholes.

11.8.2 Before commencing the hydraulic test the pipelines shall be filled with water for about a week before commencing the application of pressure to allow for the absorption by pipe wall.

11.8.3 The sewers are tested by plugging the upper end with a provision for an air out let pipe with stopcock. The water is filled through a funnel connected at the lower end provided with a plug. After the air has expelled through the air out let, the stop cock is closed and water level in the funnel is noted after 30 minutes and gravity of water required to restore the original water level is determined. The pipe line under pressure is then inspected while the funnel is still in position. There shall be no any leaks in the pipe or joints (small sweating on the pipe surface is permitted).

11.8.4 Any sewer or part there of that does not meet the test shall be emptied and repaired or re-laid as required and tested again..

11.8.5 The leakage of quantity of water to be supplied to maintain the test pressure during the period of 10 minutes shall not exceed 0.2 liters/mm dia. of pipe per kilometer length per day.

11.8.6 It should be done as per clause 7.1.5 of CPHEEO manual on sewerage and sewage treatment.

11.9 Refilling:

11.9.1 No trench shall be filled in unless the sewer stretches have been tested and approved for water tightness of joints. However partial filling may be done keeping the joints open to avoid disturbance. Soft material screened free from stones or hard substances shall first be used and hand pressured under and around the pipes to half their height.

11.9.2 Similarly soft material shall be put up to a height of 30cm above top of pipe and then this will be moistened with water and well rammed. The reminder of the trench can be filled with hard material, in stages, each not exceeding 60 cm. At each stage the filling shall be well rammed, consolidated and completely saturated with water and then only further filling shall be continued. It should be done as per procedure given in clause 7.1.9 of CPHEEO manual on sewerage and sewage treatment.

11.10 **Measurement:**

11.10.1 The mode of payment shall be as per the running meter of the pipes provided, laid, lowered and jointed. Retention money for testing to be kept at 10% of

valve of items of work. After satisfactory test of the complete system to the satisfaction of the site Engineer.

11.11 **Rates :**

11.11.1 The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER NO- 12
UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U)PIPES, DWC PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEM

12.1 Applicable code:

The laying of PVC-U pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of PVC-U pipes, fittings & specials shall be part of this Specification.

Table No.12.1

I.S. Number	Title
IS : 15328 : 2003	Unplasticized Non-Pressure Polyvinyl Chloride (PVC-U) Pipes for use in underground drainage and sewerage system.
IS : 7634 (PT-3) : 2003	Code of practice for plastics pipes selection, Handling, Storage and installation for potable Water Supply.
IS: 14182 : 1994	Solvent Cement for use with uplasticized polyvinyl chloride pipe and fittings.
EN 13476-1	Plastics piping Systems for non-pressure underground drainage and sewerage- Structured-wall piping systems of Polyethylene (PE) Part 1 : General requirements and performance characteristics
EN 13476-3	Plastics piping Systems for non-pressure underground drainage and sewerage- Structured-wall piping systems of Polyethylene (PE) Part 3 : Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B

12.2 Specification for Unplasticized Non-Pressure, Polyvinyl Chloride (PVC-U) Pipes

12.2.1 **Scope:**

12.2.1.1 Integral sockets for either solvent-cement welding or for jointing with elastomeric sealing rings pipes made of unplasticized polyvinyl chloride (PVC-U) of nominal outside diameters ranging from 110 mm up to and including 630 mm, intended for underground (buried) non-pressure gravity drain and sewer applications for transportation of soil and waste discharge of domestic origin, surface water (storm water).

12.3 Terminology:

12.3.1 Nominal size (DN)- The numerical designation for the size of a pipe, other than a pipe designated by thread size, which is a convenient round number approximately equal to the manufacturing dimension in millimeters.

12.3.2 Nominal outside Diameter (d_n) – The specified outside diameter in millimeters assigned to the nominal size.

12.3.3 Outside Diameter at Any point (d_e)- The value of the measurement of the outside diameter of a pipe through its cross-section at any point of the pipe, rounded off to the next higher 0.1 mm

12.3.4 Mean outside Diameter (d_{em}) - The quotient of the outer circumference of a pipe and 3.142 (π) in any cross-section, rounded off to the next higher 0.1 mm.

12.3.5 Minimum Mean outside Diameter ($d_{em,min}$)- The minimum value of the mean outside diameter as specified for a given nominal size.

12.3.6 Maximum Mean outside Diameter ($d_{em,max}$)- The maximum value of the mean outside diameter as specified for a given nominal size.

12.3.7 Inside Diameter of a socket (d_s) – the value of the measurement of the inside diameter of the socket at any point in any cross-section of the socket.

12.3.8 Mean Inside Diameter of a socket (d_{sm}) – The earth metical mean of four measurements, taken at 45º to each other, of the inside diameter of the socket in the same cross-section of the socket.

12.3.9 Nominal wall thickness (e_n) – A numerical designation of the wall thickness of a component which is a convenient round number, approximately equal to the manufacturing dimensions in millimeters.

12.3.10 Wall thickness at any point (e) – the value of the measurement of wall thickness at any point around the circumference of a pipe, rounded off to the next higher 0.1 mm.

12.3.11 Minimum wall thickness at any point (e_{min}) – The minimum value for the wall thickness at any point around the circumference of a pipe, rounded off to the next higher 0.1 mm.

12.3.12 Maximum wall thickness at any point (e_{max}) – The maximum value for the wall thickness at any point round the circumference of a pipe, rounded off to the next higher 0.1 mm.

12.3.13 Mean wall thickness (e_m) – The arithmetical mean of at least four measurements regularly spaced around the circumference and in the same cross-section of a pipe, including the measured minimum and the measured maximum values of the wall thickness in the cross-section, rounded off to the next higher 0.1 mm.

12.3.14 Maximum mean wall thickness ($e_{m,\ max}$) – The maximum value for the mean wall thickness around the circumference of a component, as specified.

12.3.15 Tolerance – The permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value.

12.4 Dimensions of Pipes:

12.4.1 Mean outside diameter- The mean outside diameter, outside diameter at any point and tolerances shall be as given in table 1 of IS 15328 and shall be measured according to the method given in IS: 12235 (part-1).

12.4.2 Wall thickness- The nominal wall thickness, e, shall be in accordance with table 2 of IS 15328. Tolerances in outside diameters shall be those given in IS 4985

12.4.3 Length of pipes:

12.4.3.1 Effective length (L_e) of pipe with sockets is considered to be the distance between ends minus the socket depth. The length may be supplied as agreed to between the purchaser and the manufacturer.

12.4.4 Dimensions of Integral Sockets and Spigots ends: The Basic dimensions shall be in accordance with Tables 3 and 4.

12.4.4.1 Wall Thickness of Sockets: $e_{2\,min} = 0.9e$ and $e_{3\,min} = 0.75e$

12.4.4.2 e_{3min} applies only to those parts of the sealing ring zone where the fluid contained within the pipe comes into contact with the fluid, that is beyond the designated ring seal point, walls thinner than e_3 are permitted.

12.4.4.3 If retaining caps or rings are provided, they can be made to other designs or from polymers other than unplasticized polyvinyl chloride, provided that the finished joint conforms to the same functional test requirements.

12.4.4.4 When a sealing ring is retained by means of a retaining ring or cap, the wall thickness of the area shall be calculated by addition of the wall thickness at the corresponding places of the socket and the retaining ring or cap.

12.5 Physical characteristic

12.5.1 Colour- The colour of the pipes shall be dark (any shade of brown). The pipe shall be uniformly coloured throughout the entire wall. Slight variations in the appearance of the colour are permitted.

12.6 Marking

12.6.1 Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at intervals of not more than 3 m. but at least once per pipe, in the colour so that it differs from the basic color of the pipe.

12.6.2 The marking shall be legible without magnification. The marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipe. Marking by indentation reducing the wall thickness not more than 0.15 mm shall be deemed to conform to this clause without infringing the requirements for the wall thickness.

12.6.3 The marking shall show the following:

a) Identification of the source of manufacturer.
b) Outside diameter,
c) Stiffness class, and
d) Batch or Lot number.

12.6.4 BIS Certification Marking

12.6.4.1 Each pipe may also be marked with the standard Mark.

12.7 Solvent cement jointing

12.7.1 PVC solvent cement is quick drying, therefore it shall be applied as quickly and carefully as possibly and in consistence with good workmanship. For larger sizes, it is advisable for two workers to work simultaneously on the pipe and socket.

12.7.2 Solvent cement shall conform to IS:14182.

12.7.3 Dip the applicator brush in the solvent cement and apply a liberal coat of cement to the end of the pipe up to the insertion depth.

12.7.4 Apply a uniform thin coat of cement inside the socket, working axially from the inside of the socket to the outside. Do not apply any cement on the shoulders of the socket (socket-to-pipe transition area). Care should be taken not to apply excess cement inside the socket. Excess cement in the socket will be pushed further into the pipe during assembly and cause the pipe to soften and weaken at that point. Hot and dry climates generally require slightly thicker coatings of solvent cement.

12.7.5 In climates with large differences between day and night temperatures, it is advisable to make joints early in the morning or in the evening when it is cooler. Thus, the joints are prevented from being pulled apart if the pipes contract.

12.7.6 For pipe installation solvent glued spigot is inserted in the socket up to the shoulder and then after a quarter (90^o) turn is given to evenly distribute the cement over the treated surface.

12.7.7 Within 20 second after the last application of solvent cement, insert the pipe in to socket in a single steady and every controlled but forceful action. Press it in fully until it bottoms. No. hammer blows should be used. If there is any sign of drying of the cement coat before insertion; the surface should be re-coated, avoiding application of excess cement in the socket. Once the insertion is complete, hold in place for 1 min without shifting the pipe in the socket.

12.7.8 Immediately after assembly, wipe the excess solvent cement from the pipe at the end of the socket. A properly made joint will have a uniform bead around its entire perimeter. Any gaps in this bead may be indicative of an improper joint due to insufficient cement or the use of a lighter-bodied cement than the one recommended.

12.8 Trench:-

(See Drawing No.3)

12.8.1 Location: Drinking water pipelines should not be located below sewerage pipelines. Where a pipeline runs parallel to other pipelines or cables, the distance between them should not be less than 0.4 m.

12.8.2 At points of congestion, a distance of 0.2 m should be maintained unless steps are taken to prevent direct contact.

12.8.3 Width: Trenches should be of adequate width to allow the burial of pipe, while being as narrow as practical. If expansion and contraction are not problems and snaking of pipe is not required, minimum trench widths may be obtained by jointing the pipe outside the trench and then lowering the piping into the trench after the testing. A trench width of two or three times the pipe diameter is a good rule of thumb. Narrow (unsupported) trench width and supported trench width shall be as given under:

Table No.12.2

Nominal pipe size (Diameter in mm)	Unsupported Narrow Trench Width (Minimum)		Supported Trench Width, (Minimum)	
	Number of pipe Diameter	Width (mm)	Number of pipe Diameter	Width (mm)
90	5.0	450	10.0	900
110	4.0	450	8.2	900
125	4.0	500	7.2	900
140	3.9	550	6.4	900
160	3.5	560	5.6	900
180	3.2	580	5.0	900
200	3.0	600	4.5	900

12.8.4 Where necessary to prevent cave-ins, trench excavations in unstable soil shall be adequately supported. As backfill is placed and sheeting withdrawn, the void left by the withdrawn sheeting shall be filled and compacted before withdrawing the next increment.

12.9 Trench Bottom

12.9.1 The trench bottom shall be constructed to provide a firm, stable and uniform support for the full length of the pipeline. There should be no sharp objects that may cause point loading.

12.9.2 Any large rocks, hard pan, or stones larger than 20 mm should be removed to permit a minimum bedding thickness of 100-150 mm under the pipe.

12.9.3 For pipes of diameters 100 mm or greater, bell holes in the bedding, under each socket joint, shall be provided by removing some of the bedding material,

to accommodate the larger diameter of the joint and to permit the joint to be made properly.

12.9.4 Excavated material should be deposited at a sufficient distance from the trench so that damage is not caused to the pipe line through falling stones/debris.

12.9.5 Prepare the bedding by laying on soft soil and alternatively compacting and watering sparingly until an effective thickness of 100 to 150 mm is achieved.

12.10 Laying

12.10.1 Lay the pipe in the trench after ensuring that bell holes have been provided for at the appropriate places in the bedding (Pipes of diameter 110 mm or less, with no live load application, do not require bell holes in the trench bottom).

12.10.2 These have to be refilled carefully after testing of the pipeline and prior to complete backfilling of the trench.

12.10.3 Though not essential, the pipes should be laid with the spigots entered into the sockets in the same directions as the intended flow of water.

12.11 Minimum cover:

12.11.1 A minimum cover of 0.9 m when truck traffic is expected.

12.11.2 A minimum cover of 1.8 m when heavy truck /locomotive traffic is expected.

12.11.3 **If due to the side conditions deep burial of the pipe is not possible and heavy traffic is expected over the pipe, it is advisable to use steel or reinforced concrete casing (sleeve) to prevent damage to the pipe.**

12.12 Anchoring

12.12.1 The purpose of the anchor block is to transfer the total thrust to the trench sides. It is therefore important to take account of the load-bearing capacity of the surrounding ground.

12.12.2 Recommended mixture for concrete is one part cement, two parts washed sand and two parts gravel.

12.12.3 Where concrete would be in direct contact with the pipe or fittings, these should be wrapped with a compressible material, for example rubber sheet or foamed polyethylene sheet.

12.13 Back-filling

12.13.1 The first side fill or hunching layer should be placed by hand and compacted in layers under the lower quadrants of the pipe up to the spring level (half the vertical diameter) of the pipe.

12.13.2 Compaction can be done by careful trampling with the feet or with trampling tool.

12.13.3 Care should be taken to leave adequate area around the joint free of backfill to allow for inspection during testing of the pipeline.

12.13.4 Successive layers of backfill of 75 mm thickness may then be placed over and compacted to a height above the crown of not less than 150 mm. Light vibrating machinery may be used, but not directly above the pipe.

12.13.5 On completion of the surround to the pipe, suitable excavated material may be then replaced as backfill in 250 mm compacted layers up to the top of the trench.

12.13.6 No heavy compaction equipment to be employed until there is at least 300mm of fill above the crown of the pipe.

12.14 Performance requirement of solvent cement joints-

12.14.1 Internal Hydrostatic Pressure- when assembled according to the manufacturer's instructions, the joint shall withstand an internal pressure of up to and including 0.05 MPa (0.5 bar) for a minimum period of 15 min without leakage.

12.14.2 Internal Negative Hydrostatic Pressure (Internal Vacuum)- when assembled according to the manufacturer's instructions, the joint shall withstand an internal negative pressure (internal vacuum) of up to and including 0.03 MPa (0.3 bar) for a minimum period of 15 min without leakage.

12.14.3 Leak tightness of Elastomeric sealing Ring Type socket joints : The method of testing of joints under positive internal pressure and with Angular deflection is given in detail in Annexure-A.

12.15 Measurements:

The lengths of pipe shall be measured in the running meters nearest to a cm as laid, lowered and jointed from in side of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes.

12.15.1 All fittings such as bends, junction, etc., which shall not be measured separately. Excavation, refilling, shoring and timbering in trenches and cement concreting where ever required shall be measured separately under relevant item of work.

12.15.2 Security money for testing should be kept at 10 % of the value of the work. After testing of the complete sewerage system to the satisfaction of the engineer in-charge the same shall be released.

12.16 Rate

12.16.1 The rate shall include the cost of material and labour involved in all the operation described above including the cost of concrete which shall be paid separately.

12.17 DWC Pipes for use in underground Sewerage System

12.17.1 Technical Specification

12.17.1.1 Class SN 8 Structured Double Wall (Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene Piping System for non-pressure underground Sewerage & Drainage Applications

12.17.2 Scope

This specification covers the requirements for manufacturing, supplying, transportation, handling, stacking, installation, jointing, and testing of Class SN 8 Structured Double Wall (Non-Smooth External Annular Corrugated wall & Smooth Internal wall) Polyethylene Piping System for non-pressure underground Sewerage & Drainage Applications herein after called the *DWC PE Piping System.*

12.17.3 Applicable Codes

The manufacturing, testing at factory, supplying, transportation, handling, stacking, installation, jointing, and testing at sites shall comply with all currently applicable statutes, manuals, regulation, standards & codes. In particular, in addition to all relevant National Standards, following International standards with latest revisions shall be referred. If requirements of these specifications are at variance with any other standards, this particular document shall govern the proceedings.

EN 13476-1	Plastics piping Systems for non-pressure underground drainage and sewerage-Structured-wall piping systems of Polyethylene (PE) Part 1 : General requirements and performance characteristics
EN 13476-3	Plastics piping Systems for non-pressure underground drainage and sewerage-Structured-wall piping systems of Polyethylene (PE) Part 3 : Specifications for pipes and fittings with smooth internal and profiled external surface and the system, Type B

Other International Codes / Standards (EN/ ISO) which are integral part of above two standards as normative references form a significant portion of this specification document.

12.17.4 Manufacturing

The DWC PE Piping System of stiffness class designation SN 8 shall confirm to the European Union standards as mentioned above and shall be configured as per the indicative Cross-sectional Drawing (Fig 3) annexed herewith. Each pipe shall be coupler (on-line or off-line) and spigot type along with rubber sealing ring (as designated under above international specifications).

12.17.5 Transportation

The arrangement of loading the pipes in a telescopic manner is advised, i.e. smaller diameters inserted into the next higher sizes of pipes. While loading the pipes onto the truck, care should be taken that the coupler- end should be arranged alternatively in the corresponding layers so as to avoid the damage to the coupling/ socket ends.

12.17.6 Handling

Following Recommendations shall be followed while handling the pipes:

- Adherence to National Safety requirements
- Pipes to be smoothly lowered to the ground
- Pipes should not be dragged against the ground to avoid the damages to the Coupler/pipes.
- 800mm and larger diameter pipes are carried with Slings at two points spaced approximately at 3 Meters apart
- For smaller diameters (400mm – 800mm) one lift point shall be sufficient & can be handled either manually or mechanically
- Do not use a loading Boom or Fork Lift directly on or inside pipe.

12.17.7 Pipe Storage at Site

- Stockpiling shall be done temporarily on a Flat Clear Area as per Fig. 1 & 2.
- For avoiding collapse of Stacks, use Wooden Posts or Blocks
- Stacking shall not be higher than 2.5 Meters
- While stacking, alternate the socket/coupler ends at each row of stacked pipes as per Fig. 2.

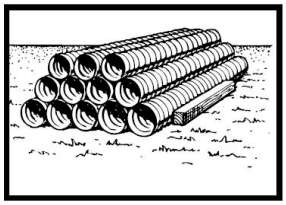


Fig 1

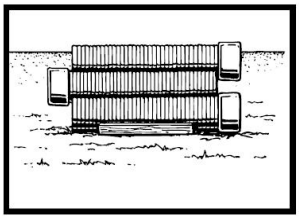


Fig 2

12.17.8 Lowering, Laying & jointing of Pipes

The width of a Sewer Trench depends on the soil condition, type of side protection needed and the working space required at the bottom of Trench for smooth installations. Increase in width over required minimum would unduly increase the load on pipe and cost of road restoration. Considering all above factors, the Minimum Trench Width is specified as per Table below :-

Indicative Minimum Trench Widths**	
Pipe Diameter (mm)	Trench Width (M)
75-170	0.6
250	0.7
400	0.9
600	1.2
800	1.3
1000	1.8

**In actual practice the trench width can be as narrow as possible but adequate to allow the workmen to execute the job satisfactorily.

The pipe segment between two manholes shall be laid approximately in straight line without any vertical undulations. However, on the strength of its flexibility, the DWC PE Piping system can be laid in very smooth curve if found

necessary. The piping system shall rest on the carefully prepared bedding portion of the Backfill Envelope (ref fig. III, Annexure I) and at appropriate jointing locations the trenches shall be excavated deeper to accommodate the bulges of coupler-spigot joints. However, special care shall be ensured as mentioned below:-

- Excavation of trenches shall be carried out in accordance with the drawing & specifications and as directed by the field engineer as well.
- The piping system shall be laid and jointed in true to gradient with the help of sight rails and boning rods as detailed in CPHEEO, MoUD, GoI Manual on Sewerage and sewerage treatment. The levels need be checked with calibrated modern Levelling Instrument. Specific care shall be taken to prevent entry of sand / mud /slush/ any other foreign material etc into the system during the installation operation.

The structural property of the system suggests that a minimum cover of 300 mm adequate even for maximum quantum of superimposed (live) load.
In case of wider trenches than required (above table), the permission of the competent authority shall be necessary.

The bedding area (ref. fig. III) is an essential portion of Back fill Envelope and shall be constructed with proper bedding material as computed in accordance with appropriate international code of practice for structural bedding design mentioned in the list of normative references under EN 13476.The bedding shall be laid to specified thickness and gradient with proper manual compaction of the aggregate.

The moulded on-line coupler (or separate coupler integrated to the pipe in case of lower sizes) will have a suitable internal surface for push-fitting the said end over the spigot end of the next pipe. On first valley of the corrugation of said spigot end (destined to receive the pushed coupler) the sealing rubber ring of standard (EN 13476) quality shall be placed so that the coupler end of the pipe smoothly but tightly slides over the sealing ring for making an absolute watertight joint. Similar system is also used for fabricated accessories or moulded fittings required such as Tee, Bends, Elbows, Reducer end caps for the purpose of installation of the system related to drainage/sewerage.

12.17.9 Jointing

For quality connections following steps are to be ensured, failing which the performance aspects are to be severely compromised:-

- The non-coupler (socket) end needs to be thoroughly cleared and shall be free from any foreign material
- Clean and lubricate the coupler end of the pipe, if required.
- Lubricate the exposed Gasket in the same manner, if required.
- Keep the non-coupler end free from dirt, backfill material, and foreign matter so that the joint integrity is not compromised.
- Push the coupler into non-coupler and align properly. Always push coupler end into non-coupler end.

For smaller diameter pipes simple manual insertion shall be sufficient. It should be ensured that the coupler end is adequately 'homed' within non-coupler end to ensure installation and tight joining seal. Therefore prior to insertion always place a 'Homing Mark' on appropriate corrugation of the 'Non-Coupler End'.

12.17.10 Construction of backfill envelope and final backfilling of the trenches

DWC PE Piping System with well compacted Backfill Envelope along with the bottom and sides of trench (native soil) work together to support soil overburden and superimposed (traffic) loads. The carefully constructed Backfill Envelop has three distinct but non-isolated stages (Ref. enclosed C/S Drawing III, Annexure I).The construction need to be done stage by stage as per the sequence stated below:

- Bedding portion
- Up to Haunch level
- Remaining portion

The material for backfill envelop shall be in accordance with the structural design of flexible buried conduit as per relevant international codes mentioned in the list of Standards as normative references of EN 13476 /1 & 3. It can be the same material that were removed in the course of excavation or it can be fine sand/course sand/gravel / moram /other form of course / fine aggregates depending on the effected Design Load [Overburden + Superimposed (Live) load]. However, in no circumstances, the flexible pipe should not be embedded in cement concrete (un- reinforced or reinforced) which invariably induces undesired rigidity in the system.

- The remaining portion of backfilling which do not contribute to the structural integrity of the system may be the materials that were removed in the course of excavation or any other foreign material as may be required to suit the particular site condition. These materials shall consist of at least clean earth and shall be free from large clod or stone above 75 mm, ashes, refuse and other injurious materials.
- After completion of lying of pipes, etc, first the Backfill Envelope shall be constructed as per design around the pipe. Voids must be eliminated by knifing under and around pipe or by some other indigenous tools.
- The compaction, by hand rammers or compactors with necessary watering to a possible maximum level of proctor density shall be ensured.
- Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However, partial filling may be done keeping the joints open.
- Precautions shall be taken against floatation (if at all necessary) as per the specified methodology and the minimum required cover. For indicative Drawing See Fig IV, Annexure II.

12.17.11 Continuity Test /Hydraulic Testing

Continuity of the pipe segments in between two manholes is required to be ensured in the same modality as practiced for non-pressure RCC pipeline. Hydraulic testing of pipes shall be done, if specifically asked for by the client for any specific stretch. The procedure for hydraulic testing shall be similar to that for non-pressure RCC pipes.

12.17.12 Measurements:

The lengths of pipe shall be measured in the running meters nearest to a cm as laid, lowered and jointed from in side of one manhole to the inside of the other manhole. The length shall be taken along the centre line of the pipes.

12.17.12.1 All fittings such as bends, junction, etc., which shall not be measured separately. Excavation, refilling, shoring and timbering in trenches and cement

concreting where ever required shall be measured separately under relevant item of work.

12.17.12.2 Security money for testing should be kept at 10 % of the value of the work. After testing of the complete sewerage system to the satisfaction of the engineer in-charge the same shall be released.

12.17.13 Rate

12.17.13.1 The rate shall include the cost of material and labour involved in all the operation described above including the cost of concrete which shall be paid separately.

CHAPTER - 13

REINFORCED CEMENT CONCRETE (RCC) PIPES :

13.1 Applicable code :

The laying of RCC pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of RCC pipes, fittings & specials shall be part of this Specification.

Table No.13.1

I.S. Number	Title
IS: 458 : 2003 Amend. No.-1-April 2005	Specification for Concrete Pipes (with and Without Reinforcement).
IS: 5382 : 1985	Specification for Rubber Sealing Rings for Gas Mains, Water Mains and Sewers
IS : 783 : 1959	Code of practice for laying of concrete pipes.

13.2 Reinforced cement concrete pipes

13.2.1 Reinforce cement concrete pipes are widely use for water supply, sewer, converts and irrigation use. Spigot & socket ended pies are widely use for sewerage & water supply. Dimensions of the spigot and socket for various classes of pipes such as NP2,NP3 and NP4 etc. shall be as per details given in tables 12 ,13,14,17,18 and 19 of IS: 458/2003. Rubber rings use for joining of these pipes shall be as per type 2 of IS: 5382.

13.2.2 Reinforcement cages for pipes shall be throughout the pipes barrel. Reinforcement cages shall either be spiral or circular rings and straights of hard steel wire or mild steel rods.

13.2.3 Wall thickness and strength test requirements for NP2,NP3, and NP4 type of reinforce concrete non pressure pipes are given in table 13.2, 13.3 & 13.4 respectively.

Table No. 13.2
(Refer Table 2 IS 458 - 2003)

NP2 RCC Pipe

Diameter	Thickness	Strength Test Requirements for Three Edge Bearing Test.	
mm	mm	Load to produce 0.25 mm Crack	Ultimate Load
		KN/linear meter	KN/linear meter
80	25	10.05	15.08
100	25	10.05	15.08
150	25	10.79	16.19
200	25	11.77	17.66

Diameter	Thickness	Strength Test Requirements for Three Edge Bearing Test.	
mm	mm	Load to produce 0.25 mm Crack	Ultimate Load
		KN/linear meter	KN/linear meter
225	25	12.26	18.39
250	25	12.55	18.83
300	30	13.48	20.22
350	32	14.46	21.69
400	32	15.45	23.18
450	35	16.18	24.27
500	35	17.16	25.74
600	45	18.88	28.32
700	50	20.35	30.53
800	50	21.57	32.36
900	55	22.80	34.20
1000	60	24.27	36.41
1100	65	25.50	38.25
1200	70	26.97	40.46
1400	75	29.42	44.13
1600	80	32.12	48.18
1800	90	35.06	52.59

Table No. 13.3
(Refer Table 3 IS 458 - 2003)
NP3 RCC Pipe

Diameter	Thickness	Strength Test Requirements for Three Edge Bearing Test.	
		Load to produce 0.25 mm Crack	Ultimate Load
mm	mm	KN/linear meter	KN/linear meter
80	25	13.00	19.50
100	25	13.00	19.50
150	25	13.70	20.55
200	30	14.50	21.75
225	30	14.80	22.20
250	30	15.00	22.50
300	40	15.50	23.25
350	75	16.77	25.16
400	75	19.16	28.74
450	75	21.56	32.34
500	75	23.95	35.93
600	85	28.74	43.11
700	85	33.53	50.30
800	95	38.32	57.48
900	100	43.11	64.67
1000	115	47.90	71.85
1100	115	52.69	79.00

Diameter	Thickness	Strength Test Requirements for Three Edge Bearing Test.	
		Load to produce 0.25 mm Crack	Ultimate Load
mm	mm	KN/linear meter	KN/linear meter
1200	120	57.48	86.22
1400	135	67.06	100.60
1600	140	76.64	114.96
1800	150	86.22	129.33

Table No. 13.4
(Refer Table 6 IS 458 - 2003)
NP4 RCC Pipe

Diameter	Thickness	Strength Test Requirements for Three Edge Bearing Test.	
		Load to produce 0.25 mm Crack	Ultimate Load
mm	mm	KN/linear meter	KN/linear meter
80	25	22.1	33.15
100	25	22.1	33.15
150	25	23.3	34.95
200	30	24.60	36.90
225	30	25.2	37.80
250	30	25.2	38.25
300	40	26.4	39.60
350	75	29.8	44.70
400	75	33.9	50.90
450	75	36.9	55.30
500	75	40.0	61.20
600	85	46.3	69.40
700	85	52.2	78.30
800	95	59.3	89.10
900	100	66.3	99.40
1000	115	72.6	108.90
1100	115	80.4	120.60
1200	120	88.3	132.40
1400	135	104.2	156.40
1600	140	119.6	179.50
1800	150	135.3	203.00

13.3 Length of pipe

13.3.1 For NP2 Pipe- Soft grade mild steel wire spirals may be used for pipes of internal diameters 80 mm, 100 mm and 150 mm only, by increasing weight to 140/84.

13.3.2 For NP3 pipes – The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for internal diameter of pipe up to 250 mm and up to 3 m effective length for higher diameter pipes.

13.3.3 For NP4 Pipe – The longitudinal reinforcement given in this table is valid for pipes up to 2.5 m effective length for internal diameter of pipe up to 250 mm and up to 3 m effective length for higher diameter pipes.

13.3.4 Class NP3 and NP4 pipes of nominal internal diameter 900 mm and above, the effective length may also be 1.25m.

13.4 Workman ship and Finish

13.4.1 Finish- Pipes shall be straight and free from cracks except that craze cracks may be permitted.

13.4.2 The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench, no opening between ends in contact shall exceed 3 mm in pipes up to 600 mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

13.4.3 The outside and inside surfaces of the pipes shall be dense and hard and shall not be coated with cement wash or other preparation unless otherwise agreed to between the purchaser and the manufacturer or the supplier.

13.4.4 The inside surface of the pipe shall be smooth. For better bond, inner surface of the collar may be finished rough.

13.4.5 The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

13.4.6 Pipes shall be free from local dents or bulges greater than 3.0mm in depth and extending over a length in any direction greater than twice the barrel wall thickness.

13.4.7 Pipes may be repaired, if necessary, because of accidental injury during manufacture or handling and shall be accepted if in the opinion of the purchaser, the repairs are sound and appropriately finished and cured, and the repaired pipe conforms to the requirements of this specification.

13.4.8 The deviation from straight in any pipe throughout its effective length, tested by means of a rigid straight edge as described in IS 3597 shall not exceed, for all diameters, 3mm for every meter run.

13.5 Tolerances :

13.5.1 The following tolerances shall be permitted: Table No. 4.5

Table 13.5
(Refer Clause 8.2 IS 458 - 2003)

S .No.	Dimensions	Tolerances
i)	Overall length	± 1 % of standard length
ii)	Internal diameter of pipes:	
	a) Up to and including 300 mm	± 3 mm
	b) Over 300 mm and up to and including 600 mm	± 5 mm
	C Over 600 mm	± 10 mm
iii)	Barrel wall thickness:	
	a) Up to and including 30 mm	+ 2 mm - 1 mm
	b) Over 30 mm up to and including 50 mm.	+ 3 mm - 1.5 mm
	c) Over 50 mm up to and including 65 mm.	+ 4 mm - 2 mm
	d) Over 65 mm up to and including 80 mm.	+ 5 mm - 2.5 mm
	e) Over 80 mm up to and including 95 mm.	+ 6 mm - 3 mm
	f) Over 95 mm	+ 7 mm - 3.5 mm

13.6 Sampling and inspection

13.6.1 In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this specification shall be ascertained on the basis of tests on pipes selected from it.

13.6.2 The number of pipes to be selected from the lot shall be in accordance with column 1 and 2 of Table 9 of IS: 458

13.6.3 Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every "rth" pipe be selected till the requisite number is obtained, "r" being the integral part of N/n where "N" is the lot size and "n" is the sample size.

13.6.4 All the pipes selected as per 13.6.3 shall be inspected for dimensional requirements, finish and deviation from straight.

13.6.5 The number of pipes to be tested shall be selected in accordance with class 9.1 of IS: 458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in 12.6.4.

13.6.6 A lot shall be considered as conforming to the requirements of IS: 458 if the following conditions are satisfied.

13.6.6.1 The number of defective pipes (those not satisfying one or more of the requirements for dimensions, finish and deviation from straight) shall not be more than the permissible number given in column 3 of Table 9 of IS: 458.

13.6.6.2 All the pipes tested for various tests satisfy corresponding requirements of the tests.

13.6.6.3 In case the number of pipes not satisfying requirements of any one or more tests, one or two further sample of same size shall be selected and tested for the test or tests in which failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

13.7 Marking :

13.7.1 The following information shall be clearly marked either on pipe or on collar.

13.7.2 Name of manufacturer:

13.7.3 Class and size of pipe/collar;

13.7.4 The words "SPUN PIPE" or VIBRATED CAST PIPE (UNREINFORCED) OR VIBRATED CAST PIPE (REINFORCED) as may be applicable, for pipes: and

13.7.5 Date of manufacture.

13.7.6 Marking shall be clearly marked on outside only for pipes upto and including 350mm internal diameter & both outside and inside for pipes above 350mm internal diameter. The information shall be clearly marked on the outside for collars.

13.7.8 Each pipe / collar may also be marked with the Standard Mark.

13.8 Handling and laying of pipes

(See Drawing No.-9)

13.8.1 Reasonable care shall be exercised in loading, transporting and unloading of concrete pipes. Handling shall be such as to avoid impact. Gradual unloading by inclined plane or by chain block is recommended.

13.8.2 If the sides of the trench are not vertical, the toes of the side slopes shall end at the top the pipe, and practically vertical sided trench shall be dug from these down to the sub grade.

13.8.3 Trench shall be of sufficient width to provide a free working space on each side of the pipe. The free working space shall be, preferably, not more than one-third of the diameter of the pipe and not be less than 15cm on either side.

13.8.4 Pipes shall be lowered into the trenches carefully. Mechanical appliances may be used.

13.8.5 Pipes shall be laid true to line and grade as specified.

13.8.6 Laying of pipes shall always proceed upgrade on a slope. If the pipes have spigot and socket joints, the socket ends shall face upstream. In the case of pipes, with joints to be made with loose collars, the collars shall be slipped on

before the next pipe is laid. Adequate and proper expansion joints shall be provided, wherever necessary.

13.8.7 The sections of the pipe shall be joined together in such a manner that there shall be as little unevenness as possible along the inside of the pipe.

13.8.8 In case where the foundation conditions are unusual, such as in the proximity of trees or poles, under existing or proposed tracks, under manholes, etc, the pipe shall be encased in low strength concrete bedding or compacted sand or gravel.

13.8.9 In place where the natural foundation is inadequate, the pipes shall be laid either in a concrete cradle supported on proper foundations or on any other suitably designed structure.

13.8.9.1 If concrete cradle bedding is used, the depth of concrete below the bottom of the pipe shall be at least one-fourth of the internal diameter of the pipe subject to a minimum of 10 cm and a maximum of 30 cm.

13.8.9.2 The concrete shall extend up the sides of the pipe at least to a distance of one-fourth of the outside diameter for pipes 30 cm and over in diameter. The pipe shall be laid in this concrete bedding before the concrete has set.

13.8.10 Pipes laid in trench in earth shall be bedded evenly and firmly and as far up the haunches of the pipes as to safely transmit the load expected from the backfill through the pipe to the bed.

13.8.10.1 This shall be done either by excavating the bottom to the trench to fit the curve of the pipe to form an even bed. Necessary provision shall be made for joints wherever required.

13.9 Jointing of pipes:

(See Drawing No.-10)

13.9.1 Spigot and socket joint-this joint is composed of specially shaped spigot and socket ends on the RCC pipes. The RCC pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipes.

13.9.1.1 The manufacturer's instructions shall be used, and the manufacturer's instructions shall be deemed to form a part of this Specification. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

13.9.2 Collar joints (for existing sewer lines or were rubber ring joints can not be provided)

13.9.2.1 The jointing material for collar joints shall be cement and sand in the proportion of 1:2

13.9.2.2 Slightly dampened mix of cement and sand (1:2) shall be rammed with caulking irons into the space between the pipe and the collar from both sides of the collar.

13.9.2.3 Jointing material shall be added and caulked until the space of joint has been completely filled with tightly caulked mortar.

13.9.2.4 The joint shall be neatly finished in level with the collar edge.

13.9.2.5 The section of the pipe shall be jointing together in such a manner that there shall be as little unevenness as possible along the inside of the pipe.

13.9.2.6 Every joint shall be kept wet for about ten days for maturing. The section of the pipe line laid and jointed shall be covered immediately to protect it from weather effects. A minimum cost of 10 CM is considered adequate. The joint may be kept exposed for observation.

13.10 Cleaning of pipes

13.10.1 As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by Engineer. Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipe line shall be securely closed to prevent entry of mud, silt etc.

13.10.2 If as a result of the removal of any obstruction Engineer in-charge considers that damages may have been caused to the pipe lines he shall be entitled to order the stretch to be tested immediately. If the test prove unsatisfactory contractor shall amend the work and carry such further tests, as ordered by the Engineer.

13.10.3 It shall be ascertained by the contractor that each stretch from manhole to manhole or the stretch as directed by the engineer in-charge is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sun light or other means.

13.11 Testing at work site :-

13.11.1 Each section of sewer shall be tested for water tightness preferably between main holes. In case of cement mortar joints, the sewer line shall be tested three days after the cement mortar joints have been made.

13.11.2 The pipe line shall be filled with water for about a week before commencing the application of pressure to allow for the absorption by pipe wall.

13.11.3 The pipe line shall be tested by plugging the upper end with a provision for an air outlet pipe with stop cock.

13.11.4 The water shall be filled through a funnel connected at the lower end provided with a plug. After expelling the air through the air outlet, the stop cock shall be closed and water level in the funnel shall be raised to 2.5 m above the invert at the upper end.

13.11.4.1 Water level in the funnel is noted after 30 minutes and the quantity of water required to restore the original water level in the funnel is determined.

13.11.4.2 The pipe line under pressure is then inspected while funnel is still in position. There shall not be any leaks in the pipe or joints (small sweating on the pipe surface is permitted).

13.11.5 Any sewer or part thereof that doesn't meet the test shall be emptied and repaired or re-laid as required and tested again.

13.11.6 In testing pipe lines, a seepage allowance of 2.5 liters per kilometer per hour per centimeter diameter of the pipe shall be permissible.

13.11.7 Ex filtration test for detection of leakage shall be carried out at a time when the ground water table is low.

13.11.8 Air testing shall be done particularly in large diameter pipes when the required quantity of water is not available for testing. It is done as per procedure given in CPHEEO manual.

13.12 Back filling of trenches:

13.12.1 The method of backfilling to be used shall vary with the width of trench, the character of material excavated, the method of excavation and degree of compaction required.

13.12.2 In open country, it shall be sufficient to mound the trench and after natural settlement return to re-grade the areas.

13.12.3 In developed streets, it shall be compacted to minimize the load.

13.12.4 Soft material screened free from stones or hard substances shall first be used and hand pressed under and around the pipes to half the height.

13.12.5 Similar soft material shall then be put up to a height of 30 cm. above the top of pipe and this will be moistened with water and well rammed.

13.12.6 The remaining trench can be filled with hard material, in layers each not exceeding 60 cm. At each stage the filling shall be well rammed, consolidated and completely saturated with water and then only further filling shall be continued.

13.13 Measurement

13.13.1 Reinforce cement concrete pipes should be measured according to the work actually done and no allowance should be made for any waste in cutting to the

exact length required. The measurement for pipes should be in running meters nearest to a cm. as laid or fixed, from inside of one manhole to the inside of the other manhole.

13.13.2 The length shall be taken along with center line of the pipes overall fittings such as bends, collars, junctions etc which shall not be measured separately.

13.13.3 Excavation, refilling, shoring and timbering in trenches and cement concreting wherever required shall be measured separately under relevant items of work.

13.14 Rates:

13.14.1 The for providing, laying and jointing of RCC pipes shall be inclusive of the cost of collars/Rubber rings, jointing material, testing and the extra excavation require for ordinary bedding of pipes and also for collars and pipe sockets if any.

13.14.2 Any damage caused to the pipe line during the execution of work or during cleaning/Testing of the pipe line, contractor shall replace the damaged pipe line and retest the same at its own cast. No extra payment shall be made to the contractor for this work.

13.14.3 Water for testing of the pipe line shall be provided by the contractor at his own cost.

Chapter - 14
SEWER APPURTENANCES

14.1 Applicable codes

The cast iron cover and frames/precast concrete cover and frames shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of cast iron cover and frames/precast concrete cover and frames fittings & specials shall be part of this Specification.

Table No.14.1

IS: 1726	Cast iron covers and frames – Specification
IS:12592	Pre-cast concrete covers and frames – Specification

14.2 SEWER APPURTENANCES

General Sewer Appurtenances are Manholes, Inverted Siphons, Storm Water Inlets, Sewer Ventilators. Manholes are the most essential items in any sewerage system.

14.3. Manholes:-

(See Drawing No.-11 to 15)

Manholes is the essential ancillary structure in any sewerage system. They shall be provided for inspection, testing, cleaning, repairing and removal of obstruction from sewer line.

14.3.1 Manholes is built at every change of alignment, gradient or diameter, at the head of all sewer and branches and at every junction of two or more sewers, on sewer, which is to be cleaned manually or which cannot be entered for cleaning or inspection.

14.3.2 Covers and frame shall conform to IS: 1726 for cast iron and IS: 12592 for pre-cast concrete covers and shall be of the following grades and types.

Table No.14.2

Grades	Grade Designation	Type/shape of cover	Load (kN)	Diameter of Block (mm)
1	**2**	**3**	**4**	**5**
Light Duty	LD-2.5	Rectangular, Square, circular	25	300
Medium Duty	MD-10	Rectangular, circular and square (for pre-cast concrete manhole covers)	100	300
Heavy Duty	HD-20	Circular-square, Rectangular, (Scrapper manhole)	200	300
Extra Heavy Duty	EHD-35	Circular, Square, Rectangular,(Scrapper Manhole)	350	300

14.3.3 Spacing of Manholes : -

Pipe dia (mm)	Max. Spacing (mt)
Upto 900	30
900 to 1500	90-150
1500 to 2000	150-200
Above 2000	300

14.3.4 At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible.

14.3.5. Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer-in-Charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.

14.3.6. Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

14.3.7. Sewers of unequal sectional area shall not be jointed at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least 2/3 the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

14.3.8. No drain from house fittings, e.g. gully trap or soil pipe, etc to manhole shall normally exceed a length of 6 m unless it is unavoidable.

14.3.9. Manholes 90 x 80 cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes 1.2 m X 90 cm are generally constructed for main drainage work for depths less than 1.5m.

14.3.10. Manhole 1.4 m x 90 cm is of the arched type and is generally constructed for main drainage works where depth is 1.50 m or more. The width of manholes shall be increased more than 90cm on bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side of the channel is minimum 20 cm.

14.3.11. Manholes 1.5m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450mm in the same manner as in the case of rectangular manholes.

14.3.12 Before deciding size of manholes, Local Municipal Bye Laws shall be consulted. When manholes are constructed on foot path, these shall be

provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

14.3.4 Types of manholes- Following is the general classification of manholes-

14.3.4.1 Straight-through manholes-The simplest type of manhole is that built on a straight run of sewer with no side junctions. Where there is a change in the size of sewer, the soffit or crown level of the two sewers should be the same, except where special conditions require otherwise.

14.3.4.2 Junction Manholes**-** A manhole should be built at every junction of two or more sewers, and the curved portions of the inverts of tributary sewers should be formed within the manhole.

14.3.4.2.1 To achieve this with the best economy of space, the chamber may be built of a shape other than rectangular. The soffit of the smaller sewer at a junction should be not lower than that of the larger sewer, in order to avoid the surcharging of the former when the letter is running full, and the hydraulic design usually assumes such a condition.

14.3.4.2.2 The gradient of the smaller sewer may be increased from the previous manhole sufficiently to reduce the difference of invert level at the point of junction to a convenient amount.

14.3.4.3 Side Entrance Manholes: In large sewer or where it is difficult to obtain direct vertical access to the sewer from ground level, owing to existing services, gas, water etc. the access shaft should be constructed in the nearest convenient position off the line of sewer and connected to the manhole chamber by a lateral passage.

14.3.4.4 In the tunneled sewer the shaft and the lateral access heading may be used as a working shaft, the tunnel being broken out from the end of the heading, or alternatively the shaft and heading may be used as a working shaft, the tunnel being broken out from the end of the heading, or alternatively the shaft and heading maybe constructed after the main tunnel is completed, provision having been made for breaking in from the access heading to build the chamber.

14.3.4.5 The floor of the side-entrance passage, which should fall at about 1 in 30 towards the sewer, should enter the chamber not lower than the soffit level of the sewer. In large sewer where the floor of the side entrance passage is above the soffit either steps or a ladder (which should be protected either by a removable handrail or by safety chains) should be provided to reach the benching.

14.3.5. Drop Manholes-

(See Drawing No.-16)

The term drop manhole is used to indicate the manhole on sewer line which is constructed to provide a connection between the high level branch sewer to

extent of about 500 mm to 600 mm above the main sewer to low level man sewer with a minimum amount of disturbance.

14.3.5.1 The construction of drop manhole avoids unnecessary steep gradient of branch sewer and it thus reduces the quantity of earthwork.

14.3.5.2 When a sewer connects with another sewer, where the difference in level between water lines (peak flow levels) of main line and the invert level of branch line is more than 600 mm or a drop of more than 600 mm is required to be given in the same sewer line and it is uneconomical or impractical to arrange the connection with in 600 mm a drop connection shall be provided for which manholes maybe built incorporating a vertical or nearly vertical drop pipe from the higher sewer to the lower one.

14.3.5.2.1 This pipes maybe either outside the shaft and enclosed in concrete or supported on brackets inside the shaft, which should be suitably enlarged. If the drop pipe is outside the shaft, a continuation of the sewer should be built through the shaft wall to form a rodding and inspection eye, which should be provided with a half blank flange.

14.3.5.2.2 If the drop pipe is inside the shaft, it should be in cast iron and it would be advantageous to provide adequate means for rodding and water cushion of 150 mm depth should also be provided. The diameter of the backdrop should be at-least as large as that of the incoming pipe

14.3.5.3 The drop pipe should terminate at its lower end with a plain or duck-foot bend turned so as to discharge its flow at 45 degree or less to the direction of the flow in the main sewer and the pipe, unless of cast iron, should be surrounded with 150 mm of concrete.

14.3.5.4 In the case of sewer over 450 mm in diameter the drop in level maybe accomplished by one of the following methods: -

14.3.5.4.1 A. cascade: -
This is a steep ramp composed of steps over which the flow is broken up and retarded. A pipe connecting the two levels is often concreted under the steps to allow small flow to pass without trickling over the steps. The cascade steps maybe made of heavy-duty bricks of class- I quality (IS: 2180-1985) cement concrete with granolithic finish or dressed granite.

14.3.5.4.2 B Ramp: -
A ramp maybe formed by increasing the grade of the last length of the upper sewer to about 45 degrees or by constructing a steeply graded channel or culvert leading from the high level to the low level sewer. In order to break up the flow down the ramp and minimize the turbulence in the main sewer the floor of culvert ramp should be obstructed by raced transverse ribs of either bricks or concrete at 1.50m intervals and a stilling pool provided at the bottom of the ramp.

14.3.5.4.3 **(c)** By drop in previous successive manholes instead of providing the total drop require at the junction manholes, the same may be achieved by giving smaller deeps in successive manhole preceding the junction manhole. Thus, for example, if a total drop of 2.4m is required to be given, 0.6m drop maybe given in each of the previous three manholes and the last 0.6m-drop maybe given at the junction manhole.

14.3.6. Scraper (Service) Type Manhole: -
All sewers above 450mm diameter should have manhole at intervals for 110 to 120 m of scraper type. This manhole should have clear opening of 1200 X 900 mm at top to facilitate lowering of buckets.

14.3.7. Flushing manholes

14.3.7.1 Where it is not possible to obtain self-cleaning velocities due to flatness of the gradient specially at the top end of branch sewer which receive very little flow, it is essential that same form of flushing device be incorporated in the system.

14.3.7.2 This can be done by making grooves at intervals of 45 to 50m in the main drains in which wooden planks are inserted & water allow to head up which will rush on with great velocity when the planks are removed.

14.3.7.3 Alternatively, an overhead water tanks is built, from which connection are made through pipe flushing hydrants to rush water to the sewer. The relevant Indian standard IS: 4111(part two).Flushing can be very conveniently accomplished by use of fire hydrant or tanker.

14.3.7.4 Where flushing manhole is provided, they are located generally at the head of a sewer. Sufficient velocity shall be imparted in the sewer to wash away the deposited solid. The flush is usually effective up to a certain distance after which the imparted velocity gets dissipated.

14.3.7.5 The automatic systems which are operated by mechanical units gets often corroded by the sewer gases and do not generally function satisfactorily and hence are not recommended. Care should be exercised to be ensuring that there is no possibility of back flow of sewer into the water supply mains.

14.4 Constructional Details: -
Manhole is usually constructed directly over the centre line of the sewer they are usually constructed with brickwork. However in areas where sewers are to be laid in high water condition manhole shall be constructed in R.C.C. They are circular, rectangular or square in shape. Manholes should be of such size as will allow necessary cleaning and inspection of manholes.

14.4.1 Rectangular Manholes - The minimum internal sizes of rectangular manholes between brick face should be as follows:

14.4.1.1 For depth of manholes less than 0.9m, 900mm x 800mm

14.4.1.2 For depths of manholes from 0.9m and up to 2.5m, 1200mm x 900mm

14.4.2 Arch type manholes - For depth of 2.5m and above, arch type manholes can be provided and the internal size of the chambers between brick faces shall be 1400mm x 900mm. The width of manhole chamber on bends and junction of pipes with diameter greater than 450mm should be suitably increased to 900mm or more so that benching width on either side of the channel at-least 200mm.

14.5 Circular manholes -

14.5.1 Circular manholes are longer than rectangular and arch type manhole and thus they are preferred over rectangular as well as arch type manholes. The circular manholes can be provided for all depths starting from 0.9m circular manholes are straight down in lower portion and slanting in top portion so as to narrow down the top opening equal to internal dia. of manhole over.

14.5.2 Depending upon the depth of manhole, the diameter of manhole changes. The internal diameter of circular manholes may be kept as following for verifying depths.

14.5.2.1 For depths 0.9m and up to 1.65mm, 900mm diameter.
14.5.2.2 For depths above 1.65m and up to 2.30m, 1200mm diameter.
14.9.2.3 For depths above 2.30m and up to 9.0m, 1500mm diameter.
14.5.2.4 For depths above 9.0m and up to 14.0m, 1800mm diameter.
(See drawings at the ends of the specification.)

14.5.3 If the sewer is constructed in a tunnel, the manhole should be located at the access or working shaft and the manhole chamber maybe constructed of a size to suit the working shaft or vice-versa.

14.5.3.1 The width/diameter of the manhole should not be less than internal diameter of the sewer +150mm benching at both sides (150mm$_+$ 150mm) The opening for entry into the manhole (without cover) should be such minimum diameters as to allow a workman with the cleaning equipments into the interior of the manhole without difficulty. A minimum clear opening of 60cm preferably circular is recommended. Suitable steps usually cast iron shall be provided for entry.

14.5.3.2 Access shaft for large sewers - Access shaft shall be circular in shape and shall have a minimum internal dia of 750mm, where the depth of the shaft exceeds 3m suitable dimensions shall be provided to facilitate cleaning and maintenance.

14.5.3.3 Access shaft where built of brick work should be carvel led on three sides to reduce it to the size of the opening in the cover frame and to provide easy access on the fourth side iron step or ladder .In determining sizes the dimensions of the maintenance equipments likely to be used in sewer, shall be kept in mind.

14.5.3.4 Where the diameter of the sewer is increased, the crown of the entering & leaving pipes shall be fixed at the same level and necessary slopes given in the invert of the manhole chamber. In exceptional cases and where unavoidable the crown of the entering sewer maybe fixed at lower level but in each cases the peak flow level of the two sewer shall be kept the same.

14.5.3.5 A slab of plain cement concrete at least 150mm thick should be provided at the base to support the walls of the manhole and to prevent the entry of foul water.

14.5.3.5.1 The thickness of the base shall be suitably increased up to 300mm, for manholes on large dia sewers, with adequate reinforcement provided to withstand excessive uplift pressures. In the case of larger manholes, the flow in the sewer should be carried in **U**-Shaped smooth channel constructed integrally with the concrete base of the manhole.

14.5.3.5.2 The side of the channel shall be equal to the dia. of the largest sewer pipe. The adjacent floor should have a slope of 1 in 10 draining to the channel. Where more than one sewer enters the manhole the flow through channel should be curved smoothly and shall have sufficient capacity to carry the maximum flow.

14.5.3.6 It is desirable to place the first pipe joint outside the manhole as close as practicable. The pipe shall be built inside the wall of the manhole flush with the internal periphery protected with an arch of masonry or cement concrete to prevent it from being crushed.

14.5.3.7 The sidewalls of the manhole are usually constructed of cement brickwork 250mm thick and corbelled suitably to accommodate the frame of the manhole cover.

14.5.3.8 The inside and outside of the brickwork should be plastered with cement mortar 1:3 (1 cement: 3 coarse sand). Inside finished smooth with a coat of neat cement.

14.5.3.9 Where subsoil water condition exist, a richer mix may be used and it shall further be water proofed with adequate quantity addition of approved water proofing compound as per manufacturer's specifications.

14.6 Hazards & Safety of manhole work:-
The element of the sewer maintenance is ignored very often, which requires careful attention and protective measures is the manhole work.

14.6.1 The staff should be trained for the comparatively easy act of removing a manhole cover, not only to avoid smashed toes and fingers, but also to prevent more serious back injuries.

14.6.2 In addition, the approaching drivers on the road should be warned from a distance about the manhole work in progress by installation of suitable signals of light.

14.6.3 The most serious hazards of manhole work are however flammable gas and oxygen deficiency. The workers should be thoroughly trained to carry out simple tests on every manhole before entry to detect oxygen deficiency, combustibles, carbon monoxide or hydrogen sulphide.

14.6.4 Ventilate the sewer line by opening two or three manholes on both the sides where work is to be carried out. This is more important when adequate blowers for ventilating sewers are not available. The manholes should be opened at least one hour before start of operations. The opened manholes should be properly fenced to prevent any person, especially children, accidentally falling into the sewer. Dummy covers with BRC welded fabric can be used.

14.6.5 Where it is desirable to use the blowers, operate these for at least 30 minutes before start and during cleaning operations to ventilate the lowest working levels.

14.6.6 Use safety harness and life line before entering the sewer line. Two helpers at the top should be provided for each person. The person standing at the top must send signals at every few minutes interval to the person in the manhole to ensure safety.

14.6.7 Test manhole rungs or steps for structural safety before using.

14.6.8 Ensure that, where portable ladders are used, they are properly seated or fixed.

14.6.9 Ensure that no material or tools are located near the edge which can fall into the manhole and injure the workman.

14.6.10 Lower all tools to the workman in a bucket.

14.6.11 Use lighting equipment which must be explosion and fire proof.

14.6.12 Use Gas masks when men have to enter into the sewer line.

14.7 Covers and frames: -

14.7.1 The size of manhole covers should be such that there should be clear opening of not less than 560mm diameter for manholes exceeding 0.9m depths.

14.7.2 When cast iron manhole covers and frames are used they shall confirm to IS 1726 (parts 1 to 7). The frames of manhole shall be firmly embedded to correct alignment and level in plain concrete on the top of masonry. After completion of the work, manhole covers shall be sealed by means of thick grease.

14.7.3 Where sewer are to be laid in high subsoil water conditions, manholes maybe constructed in R.C.C. of grade M20 or 1:1.5:3. The manholes in this type of construction preferably shall be circular.

14.7.4 Heavy reinforced concrete covers with suitable lifting arrangements could also be used instead of C.I manhole covers. However pre-cast cement concrete covers reinforced by materials other than mild steel should be used provided that those are properly tested & certified for use by competent authority. Fibre reinforcement plastic covers (FRP) conforming to relevant IS: may be used wherever such covers are available.

14.8 Inverted siphon

14.8.1 The main purpose of installation of inverted siphons is to carry the sewer line below obstructions such as ground depressions, streams, rivers, railway etc.

14.8.2 In the course of laying sewers, at times it is found necessary to cross obstructions like nallah etc. Such obstruction shall be crossed by means of "Inverted Siphon" i.e. by laying the sewer under the obstruction and regaining as much elevation as possible after the obstruction is passed .

14.8.3 As the siphons are depressed below the hydraulic grade line, maintenance of self cleaning velocity at all flows is very important. Two considerations, which govern the profile of a siphon are (i) provision for hydraulic losses and (ii) Provision of cleaning.

14.8.3.1 It is not possible to give side connections to the inverted siphon.

14.8.4 Design aspect:

14.8.4.1 The inverted siphon usually consists of siphon tubes or pipes which may be of cast-iron, concrete of steel.

14.8.4.2 The inverted siphon is constructed between inlet and outlet chambers. It is generally made up of two sloping lengths which are connected by a flat length.

14.8.4.3 If the length of siphon is more, it is essential to provide a ventilating shaft along the siphon to avoid the formation of air-lock in the siphon.

14.8.4.4 The siphon should be so designed that a self-cleansing velocity of about 900 mm per second is achieved during the period of minimum discharge.

14.8.4.5 For this purpose, the siphon is usually made of three pipe sections-one for carrying minimum discharge, the other for maximum discharge and the third for combined flow in monsoons. The inlet chamber contain three channels, one for each pipe section. When channel no. 1 overflows, the sewage enters channel no.2 and pipe no. 2 comes into commissions, similarly, when channel no.2 also overflows, the sewage enters channel no.3 and pipe no.3 comes in to commission.

14.8.4.6 For sanitary sewer, only two sections shall be required-(i) for minimum dry weather flow (ii) for maximum dry weather flow.

14.8.4.7 The changes of direction in inverted siphons should be easy and gradual.

14.8.4.8 The design of siphon should be made on the basis of pipe running full under pressure, It is therefore necessary to know the maximum available head. Also the losses of head due to friction, bends, etc. should be properly worked out and should be accordingly adjusted in the design of siphon.

14.8.4.9 The inlet chamber should be provided with screens to remove silt, grit etc. from sewage before it enters the siphon.

14.8.4.10 It is advisable to provide a diversion for the siphon. Hence, when the siphon is choked up due to any reason, the flow of sewage can be diverted.

14.9 Construction

14.9.1 To ensure self-cleaning velocities for the wide variations in flows, generally, two or more pipes not less than 200mm dia are provided in parallel so that up to the average flows, first pipe is used and when the flow exceeds the average, the second and subsequent pipes take the balance flow.

14.9.2 Siphons may need cleaning other than gravity sewers and hence should not have any sharp bends either horizontal or vertical. Only smooth curves of adequate radius should be used. The design criteria for inverted syphons are given in IS: 411 part -III. It is necessary to have a self-cleaning velocity of 1.0 mps for the minimum flow to avoid deposition in the line.

14.9.3 Provision should be made for isolating the individual pipes as well as the siphon to facilitate cleaning.

14.9.4 It is desirable to provide a course screen to prevent the entry of rags etc, into the siphon.

14.9.5 Inlet and outlet chambers: -

14.9.6 In the multiple pipe siphon, the inlet should be such that the pipes coming to action successively as the flow increases. This may be achieved by providing lateral with heights kept in accordance with the depth of flow at which one or more siphon pipes functions. In the two-pipe siphon, the first should take 1.25 to 1.5 times the average flow and second should take the balance of the flow.

14.9.7 A manhole at each end of the siphon should be provided with clearance for rodding. The design of inlet and outlet chambers should allow sufficient room for entry for cleaning and maintenance of siphons. The outlet chambers should be so designed as to prevent the flow of sewage into pipes, which are not being used at the time of minimum flow.

14.10 Hatch box:

Hatch boxes of adequate size in manholes shall be provided on the pipes so as to give access into the pipes for rodding.

14.11 By pass:

By pass arrangements should be provided from the inlet chamber and if required special arrangements should be made for pumping the sewage to the lower reach of sewer line. Alternatively a vacuum pump maybe provided at the outlet to overcome maintenance problems arising out of dogging and silting of siphons. If it is possible a blow off may be installed at the low point to facilitate emergency maintenance operations.

14.12 Storm water inlets:-

14.12.1 There are device meant to admit the surface runoff to the sewers and form a very important part of the systems. Their location and design should therefore be given careful considerations.

14.12.2 Storm water inlets maybe categorized under three major groups viz. curb inlets, gutter inlets and combination inlets, each being either depressed or flush depending upon their elevation with reference to the pavement surface.

14.12.3 The actual structure of an inlet is usually made of brickwork. Normally cast-iron gratings conforming to IS: 5961 shall be used In case there is no vehicular traffic, fabricated steel gratings maybe used. The clear opening shall not be more than 25mm. The connecting pipe from the street inlet to the main street sewer should not be less than 200mm in dia. and should have sufficient slope.

14.12.4 Maximum spacing of inlets would depend upon various conditions of road surface, size and type of inlet and rainfall. A maximum spacing of 30m is recommended.

14.13 Sewer ventilators:-

In a modern, well designed sewerage system, there is no need to provide ventilation on such elaborate scale considered necessary in the past, especially with the present day policy to omit intercepting traps in house connections.

14.13.1 The ventilating columns/shafts are not necessary where intercepting traps are not provided. It is necessary however, to make provision for the escape of air to take care of the exigencies of full flow and also to keep the sewage as fresh as possible especially in outfall sewers. In case of storm sewers providing ventilating manhole covers can do these.

14.13.2 Provision -Ventilating columns/ shafts shall be provided at an internal of 180m in all mains intercepting and outfall sewers, near the manholes.

14.13.3 The connections of house drains to the sewer shall be allowed without the use of any intercepting trap and thus permitting ventilation of laterals and branch sewers via. house drains and their ventilating pipes.

14.13.4 Construction-The ventilating shaft shall consist of vertical columns of R.C.C. or cast iron about 6 to 8 meter in height and about 100 to 150mm in diameter

(opening) at the top, the diameter increasing uniformly towards the bottom for stability.

14.13.5 The shaft shall be provided with a Crowell or fitted with a wire ground at the top.

14.14 Cleaning/Maintenance of Sewers :-

14.14.1 Sewer inspections and maintenance should be planned. The whole sewerage systems should be marked on a plan and divided into sections and areas, which are placed under a maintenance gang. The maintenance gang preferably consists of a supervisor or mate with at least 6 skilled sewer men. The area under each gang will depend on the size of the sewer, depth to which it is laid, the spacing of manholes, the condition of sewer line (whether surcharged or not) whether cleaning is being done by manual labour or by mechanical sewer machines etc. In case, house gully traps are to be maintained, special gang of one or two persons who will clean these traps regularly in a phased or planned manner is necessary.

14.14.2 The work of each sewer maintenance gang would consists of the following.

14.14.2.1 Check manhole condition for deposition of silt, flow, new connections done, damaged walls or steps, manhole covers, clogged vertical pipes in drop manholes etc. While the cleaning of the manhole, pipes etc., will be undertaken by the gang, repairs etc. may be reported to be handled by a separate construction gang of mason and helpers. It is preferable that the repair gang comes out on the work when the sewer cleaning or maintenance gang is working, so that brick bats, debris mortar etc., which fall in the manhole are removed there and then. This will cause a major blockage if the same is allowed to flow into the sewer line, which usually occurs when repairs are done separately. In such cases, a couple of sewer men should be deputed to clean the manhole of the debris immediately after repair work is completed.

14.14.2.2 Check the sewer line between two successive manholes for silting and flow conditions and remove the deposited silt and.

14.14.2.3 Check for any harmful and extraneous matter entering into the sewer line so that further investigation for the cause and location can be determined.

14.14.2.4 Check air release valves in rising or force mains, sluice gates or stoppage in the sewer lines, overflow arrangements etc.

14.14.2.5 A record of daily work done by the gang, and also a record of work done on the sewer lines should be maintained so that chronic trouble spots may be investigated and remedial action taken.

14.15 Sewer Cleaning Equipment and Procedures :-

14.15.1 Sewer cleaning works require usual implements like pick axes, manhole guards, tripod stands, danger flags, lanterns, batteries, safety lamps, lead

acetate paper, silt drums, ropes, iron hooks, hand carts, plunger rods, observation rods, shovels etc.

14.16 Portable Pump Set

14.16.1 In cases where sewers are blocked completely and sewage has accumulated in manholes, the collected sewage has to be pumped out to tackle the sewer blockage. Such pumps should be of non-clogging type preferably on four wheel trailers for the larger sizes and should be provided with a self priming unit to save time and effort. Small pneumatic pumps can be used where high lifts are required and the volume of liquid to be pumped is not large, such as when pumping out flooded basements and dewatering deep trench excavations. In case of very deep manholes, non-clog submersible pumps may be used.

14.17 Manila Rope and Cloth Ball

14.17.1 The most common way of cleaning small diameter sewers upto 300mm dia is by the use of a manila rope and cloth ball. Flexible bamboo strips tied together are inserted into the sewer line by a person on top. If necessary, another man inside the manhole helps in pushing the rod through the sewer line. When the front end of the bamboo strip reaches the next manhole, a thick manila rope is tied to the rear end of the bamboo splits.

14.17.1.1 The bamboo splits are then pulled by another man in the downstream manhole and pushed through the sewer line. As the rope is pulled, the ball sweeps the sewer line and the accumulated grit is carried to the next manhole where it is removed out by means of buckets. This operation is repeated between the next manholes until the stretch of sewer line is cleaned.

14.18. Sectional Sewer Rods

14.18.1 These rods are used for cleaning small sewers. The sewer rods may be of bamboo or teakwood or light metal usually about one meter long at the end of which is a coupling which remains intact in the sewer but can be easily disjointed in the manhole. Sections of the rods are pushed down the sewer.

14.18.1.1 The front or the advancing end of the sewer rod is generally fitted with a brush, a rubber ring for cleaning or a cutting edge to cut and dislodge the obstructions. These rods are also useful to locate the obstruction from either manholes in case, that particular portion of the sewer has to be exposed for attending to the problem.

14.19 Roding Machine with Flexible Sewer Rods

14.19.1 This consists of a machine which rotates a flexible rod to which is attached the cleaning tool such as auger, corkscrew or hedgehog and sand cups (Fig. 8.2). The flexible rod consists of a series of steel rods with screw couplings. The flexible rod is guided through the manhole by a bend pipes. The machine rotates the rod with the tool attached to one end, the other being fixed to the machine. The rotating rod is thrust into the bent pipe manually with clamps with long handles holding the rod near the couplings.

14.19.1.1 As the rod is thrust inside, the machine also is drawn towards the manhole. The rod is pulled in and out in quick succession when the tool is engaging the obstruction, so as to dislodge or loosen it. When the obstruction is cleared, the rod is pulled out by means of clamps keeping the rod rotating to facilitate quick and easy removal. The various tools attached to the rods are shown in Fig. 8.3.

14.20 Scraper

14.20.1 This method is used for sewers of diameter larger than 750mm. The scraper is an assembly of wooden planks of slightly smaller size than the sewer to be cleaned. Where the scrapers cannot be lowered through the opening of a manhole, the scraper has to be assembled inside the manhole. The scraper chains, attached to a control chain in the manhole into which it is lowered, is then connected to a winch in the next downstream manhole by means of chains.

14.20.1.1 The winch is then revolved to push the debris ahead of the scraper. The heading up of the flow behind the scraper and the water dropping from the top of the scraper will also assist in pushing it in the forward direction. This ensures that the bottom and the sides of the sewer are cleaned thoroughly. The scraped debris is removed manually.

14.20.2 Circular scrapers are used on small sewers below 350mm dia for cleaning the body of the line. They are commonly known as discs and these discs are either of collapsible type made out of metal or a wooden pair separated about 200mm apart by steel rods.

14.21. Automotive Suction and Jetting Machine :

14.21.1 The high velocity sewer cleaner makes use of high velocity water jets to remove and dislodge obstructions, soluble grease, grit and other materials from sanitary, storm and combined sewerage systems. It combines the functions of a roding machine and gully emptier machine. Basically it includes a high pressure hydraulic pump capable of delivering water at variable pressure upto about 80 kg/cm² through a flexible hose to a sewer cleaning nozzle.

14.21.1.1 The nozzle has one forward facing hole and a number of rear ward facing holes. The high pressure water coming out of the holes with a high velocity breaks up and dislodges the obstructions and flushes the materials down the sewer. Moreover by varying the pressure suitably, the nozzle itself acts as a jack hammer and breaks up stubborn obstructions. (A separate suction pump or air flow devices may also be used to suck the dislodged material).

14.21.2 The entire equipment is usually mounted on a heavy truck chassis with either a separate prime mover or a power take off for the suction device. The high pressure hose reel is also hydraulically driven. The truck also carries fresh water tanks for the hydraulic jet and a tank for the removed sludge and the various controls grouped together for easy operation during sewer cleaning. The manufacturer's operating and servicing manuals should be carefully followed for best results in the use of the machine.

14.22. Automotive Suction Machine :

14.22.1 Suction units create vacuum required for syphoning of mud, slurry, grit and other materials from sanitary, storm and combined sewerage systems. The vacuum created is such as to syphon the materials from the deep manholes catch-pits, septic tanks etc. having depth ranging from 1m to 8m in normal cases with an option to suck additional 4m with the help of special accessories for the purpose. The unit can be vehicle or trolley mounted.

14.22.2 Silt and heavy particles settled at the bottom can be agitated and loosened by pressurised air with the help of the pump and then sucked in a tank. Once the silt tank is full, the effluent is discharged in the nearby storm water drain or manhole and the operation is repeated till the manhole is cleared off the silt. The silt deposited in the tank is then emptied at the predetermined dumping spot.

14.23 Emergency Maintenance

14.23.1 Emergency maintenance becomes necessary for removal of obstruction in sewers caused by excessive silt accumulation or damage leading to the break down of the system with flows much lower than the normal.

14.23.2 The sewer gang for this type of work should consist of specially trained men who are aware of the hazards and capable of coping with situations calling for prompt action. The supervision in this case should be entrusted to a responsible person well-versed in the use of the special sewer cleaning equipments, safety equipments and in first aid.

14.23.3 For locating the exact position of blockage, it is necessary to commence observation from the overflowing manholes down the line until the first manhole with little or no flow is reached. The section between this manhole and the one immediately upstream is the one which is blocked and requires to be tackled.

14.23.4 In the case of simple blockages, the split bamboo rods can be effectively used. The end of the bamboo rod is tied with cloth to make a small ball of 30 to 50mm thick and is inserted into the sewer line from the lower manhole where there is little or no sewage flowing. The bamboo rods are then inserted and pushed until the place of blockage is reached.

14.23.4.1 The rod is then pulled out a little and struck against the blockage with a jerk. This is repeated a number of times till the blockage is removed. In case of a persistent blockage, flexible bamboo splits are inserted from the upper manhole also. This can be done by an experienced person even though the manhole is filled with sewage. The operation of striking against the blockage is carried out simultaneously from both ends continuously till it is removed.

14.23.5 Sectional sewer rods with a cutting edge are also used where available. A ferret in conjunction with a fire hose is also used for removing sand blockages.

Sewer jetting machines and gully emptiers are successful and effective also in removing blockages.

14.23.6 When the above methods are not successful or damage to the sewer is suspected, the location of the blockage can be found by the use of sectional rods from either end of the blocked sewer. Once this is located, the sewer length near the blockage can be exposed by open excavation to examine and set right the sewer line. Before puncturing the sewer line, foundation concrete for a new manhole is laid and the walls of the manholes are raised to a height to contain the sewage.

14.23.6.1 The sewer is then punctured and the headed up sewage flows down to normal, after which the top of the sewer is completely broken and a channel formed in the manhole. The sides of the manhole are then raised upto the ground level and the manhole completed as in normal construction.

14.23.7 If the damage to the sewer is extensive and is caused poor foundation then the stretch between the two manholes may have to be relaid on a proper foundation.

14.23.8 In the case of a small diameter sewer which is broken to remove the blockage, repair can be affected by using a piece of pipe one size larger than the one being repaired. The patch should be the shape of the cut and near the same size and should be well cemented on with cement mortar.

14.24. S.W. Gully Trap :

(See Drawing No.- 17)

Gully traps shall conform to IS 651. These shall be sound, free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear tone when struck with light hammer. There shall be no broken blisters.

Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.50 Kg and the frame not less than 2.70 Kg. The grating, cover and frame shall be of sound and good casting and shall have truly square machines seating faces.

14.25. Fixing S.W. Gully Trap

(See Drawing No.-18 & 19)

14.25.1 Excavation: The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the Engineer-in-Charge.

14.25.2 Fixing: The gully traps shall be fixed on cement concrete foundation 65 cm square and not less than 10 cm thick. The mix for the concrete will be 1:5:10 (1 cement : 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes described above.

14.25.3 Brick Masonry Chamber : After fixing and testing gully and branch drain, a brick masonry chamber 300 x 300mm (inside) in brick work of specified class in cement mortar 1:4 (1 cement : 4 fine sand) shall be built with a half brick thick brick work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber wall and the trap shall be filled in the with cement concrete 1:5:10 (1 cement : 5 fine sand: 10 graded stone aggregate 40mm nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement : 3 coarse sand), finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

C.I. cover with frame 300 x 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) and rendered smooth. The finished top of cover shall be left about 4 cm above the adjoining ground level so as to excluded the surface water from entering the gully trap.

14.25.4 Measurement: The work shall be enumerated. Excavation shall be measured separately under relevant item of earth work.

14.25..5 Rate : The rate shall include the cost of materials and labour involved in all the operations described above, except earth work which shall be paid for separately.

14.26 Measurement

14.26.1 Manhole shall be enumerated under relevant items. The depth of the manhole shall be reckoned from the top level of C.I. cover to the invert level of channel. The depth shall be measured correct to a cm. The extra depth shall be measured and paid as extra over the specified depth.

14.26.2 The manhole covers shall be enumerated under relevant items.

14.27 Rates

The rate shall include the cast of the material and labour involved in all the operation described in the item.

CHAPTER NO.15
CIVIL WORKS FOR WATER SUPPLY AND SEWERAGE

15.1 Applicable codes

The earth work, steel, cement, bricks sand & aggregates etc shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of earth work, steel, cement, bricks sand & aggregates etc pipes, fittings & specials shall be part of this specification.

Table No. 15.1

IS Code Number	Title
IS 1200 (Pt.1) : 1992 Reaffirmed 1997	Method of measurement of earth work
IS 1200 (Pt.27)	Method of measurement of earth work (by Mechanical Appliances)
IS 1786	Steel
IS 269	Ordinary Portland cement
IS 1077 : 1992 Reaffirmed 2002	Common burnt clay building Bricks
IS 4081	Safety code for Blasting & related drilling operations
IS 3764 : 1992 Reaffirmed 1996	Excavation work – Code of safety
IS 2062 : 1999 Reaffirmed 2004	Steel for General Structural Purposes
IS 1542 : 1992 Reaffirmed 2003	Sand for plaster
IS 383 : 1970 reaffirmed 2002	Coarse and Fine aggregates from natural sources for concrete

15.2 Definitions

15.2.1 Deadmen or Tell tales: Mounds of earth left undisturbed in pits dug out for borrowing earth.

15.2.2 Lead : All distances shall be measured over the shortest practical route and not necessarily the route actually taken. Route other than shortest practical route may be considered in cases of unavoidable circumstances and approved by engineer-in-charge along with reasons in writing.

15.2.3 Carriage by manual labour shall be reckoned in units of 50 meters or part thereof.

15.2.4 Carriage by animal and mechanical transport shall be reckoned in one km. unit. Distances of 0.5 km. or more shall be taken as 1 km. and distance of less than 0.5 km. shall be ignored. However, when the total lead is less than 0.5 km., it will not be ignored but paid for separately in successive stages of 50 meters subject to the condition that the rate worked on this basis does not exceed the rate for initial lead of 1 km. by mechanical/animal transport.

15.2.5 Lift: the vertical distance for removal with reference to the ground level. The excavation up to 1.5 meters depth below the ground level and depositing the excavated materials up to 1.5 meters above the ground level are included in the rate of earth work. Lifts inherent in the leads due to ground slope shall not be paid for.

15.3 Earth Work :

15.3.1 Classification of soil

15.3.1.1 The earth work shall be classified under the following categories and measured separately for each category:

15.3.2 Soft/loose soil : Generally any strata, such as sand, gravel, loam, clay, mud, black cotton moorum, shingle, river or nallah bed boulders, siding of roads, paths etc. and hard core, macadam surface of any description (water bound, grouted tarmac etc.) lime concrete mud concrete and their mixtures which for excavation yields to application of picks, shovels, jumper, scarifies, ripper and other manual digging implements.

15.3.3 Soil requiring use of picks, scarifies or jumpers to loosen stiff clay gravel cobble stones, soling on the road sides, WBM (water bound macadam) etc are known as hard soil.

15.3.4 Mud : Mixture of soil and water in a semi solid state is called mud.

15.3.5 Ordinary rock (Not requiring blasting):
Generally any rock which can be excavated by splitting with crow bars or picks and does not require blasting, wedging or similar means for excavation such as lime stone, sand stone, hard late rite, hard conglomerate and un-reinforced cement concrete below ground level.

15.3.6 Hard rock (Requiring blasting)

15.3.6.1 Generally any rock or boulder for the excavation of which blasting is required such as quartzite, granite, basalt, reinforced cement concrete (reinforcement to be cut through but not separated from concrete) below ground level and the like.

15.3.6.2 Hard rock (blasting prohibited) :

15.3.6.2.1 Hard rock requiring blasting as describe above but where the blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging, use of rock hammers and cutters or any other agreed method.

15.4 **Blasting**

15.4.1 where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the engineering-charge in writing for resorting to blasting operation.

Note: In ordinary rock blasting operations shall not be generally adopted. However, the contractor may resort to blasting with the permission of the engineer-in-charge, but nothing extra shall be paid for such blasting operations.

15.4.2 The contractor shall obtain license from the competent authority for undertaking blasting work as well as for obtaining and storing the explosive as per the explosive Act, 1884 as amended up to date and the explosive rules, 1983. The contractor shall be responsible for the safe transportation, storage and custody as per explosive rules and proper accounting of the explosive material.

15.4.3 Fuses and detonators shall be stored separately and away from the explosives. The engineer-in-charge or his authorized representative shall have the right to check the contractor's store and account of explosives. The contractor shall provide necessary facilities for this.

15.4.4 The contractor shall be responsible for any damage arising out of accident to workmen, public property due to explosive during blasting operation.

15.4.5 BLASTING

15.4.5.1 Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer-in-Charge in writing for resorting to blasting operation.
Note: In ordinary rock blasting operations shall not be generally adopted. However, the contractor may resort to blasting with the permission of the Engineer-in-charge, but nothing extra shall be paid for such blasting operations.

15.3.5.2 The contractor shall obtain license from the competent authority for undertaking blasting work as well as for obtaining and storing the explosive as per the Explosive Act, 1884 as amended up to date and the Explosive Rules, 1983. The contractor shall purchase the explosives fuses, detonators, etc. only from a licensed dealer.

15.3.5.2.1 The contractor shall be responsible for the safe transportation, storage and custody as per explosive rules and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives. The Engineer-in-Charge or his authorized representative shall have the right to check the contractor's store and account of explosives. The contractor shall provide necessary facilities for this.

15.3.5.3 The contractor shall be responsible for any damage arising out of accident to workmen, public or property due to storage, transportation and use of explosive during blasting operation.

15.3.6 Blasting operations shall be carried out under the supervision of a responsible authorized agent of the contractor (referred subsequently as agent only), during specified hours as approved in writing by the Engineer-in-Charge. The agent shall be conversant with the rules of blasting. In case of blasting with dynamite or any other high explosive, the position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the contractor's agent. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the agent shall inspect the holes to

ensure that drilling has been done only at the marked locations and no extra hole has been drilled.

15.3.6.1 The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole.

15.3.6.2 The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable a semi-circular nitch shall be cut in one piece of fuse about 2 cm deep from the end and the end of other piece inserted into the nitch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

15.3.6.3 The maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited.

15.3.6.4 Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations have been done by the agent for the misfired boreholes.

15.3.6.4.1 The contractor's agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator. After this a fresh detonator, primer and fuse shall be placed in the misfired holes and fired, or

15.3.6.4.2 The holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15 cm away and parallel to it. This hole shall be charged and fired. The misfired holes shall also explode along with the new one.

15.3.6.5 Before leaving the site of work, the agent of one shift shall inform the another agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent.

15.3.6.6 The Engineer-in-Charge shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

15.3.7 General Precautions

15.3.7.1 For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site,

except those who actually ignite the fuse, shall withdraw to a safe distance of at least 200 metres from the blasting site. Audio warning by blowing whistle shall be given before igniting the fuse.

15.3.7.2 Blasting work shall be done under careful supervision and trained personnel shall be employed. Blasting shall not be done with in 200 meters of an existing structure, unless specifically permitted by the Engineer-in-Charge in writing.

15.3.7.3 All procedures and safety precautions for the use of explosives drilling and loading of explosives drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081, safety code for blasting and related drilling operation.

15.4 **Shoring & timbering**

15.4.1 General **–**All trenches in soil more than 1.5 m deep shall be securely shored and timbered. Sal wood shall be used for shoring and timbering a trench.

15.4.2 All trenches in friable or unstable rock exceeding 2 m in depth shall be securely shored and timbered. The shoring shall extend at least 30 cm above the vertical sides. Shoring and timbering shall be carried along with the opening of a trench.

15.5 Precautions regarding measurement of earth work :

15.5.1 The following work shall not be measurement separately

15.5.1.1 Setting out works, profiles, etc :

15.5.1.2 Site clearance, such as cleaning grass and vegetation:

15.5.1.3 Unauthorized bettering or benching or excavation;

15.5.1.4 Forming (or leaving) 'dead men' and 'tell tales' in borrow pits and their removal after measurements;

15.5.1.5 Forming (or leaving) steps in sides of deep excavation and their removal after measurements;

15.5.1.6 Excavation for insertion of planking and strutting;

15.5.1.7 Unless otherwise specified, removing slips or falls in excavations; and

15.5.1.8 Bailing out or pumping of water in excavation from rains.

15.6 Measurement of excavation in trenches including rock cutting

15.6.1 In uniform ground areas excavation in trenches, the measurement of the cutting of trenches shall be made in cum.

15.6.2 In areas were the ground is uniform, levels shall be taken before the start and after the completion of the work to determine the quantity of excavation in trenches.

15.6.3 Where soft/disintegrated rock and hard rock are mixed the measurement for the total quantity shall be made by method (18.6.1) and/or (18.6.2) given above. The hard rock excavated shall be stacked and measured in stack. The quantity of the hard rock excavated shall be arrived at by applying pre-

accepted deductions (stated as a percentage) for voids. From the total quantity of the mixture the quantity of hard rock excavated thus arrived at shall be deducted to work out the quantity of the soft/disintegrated rock excavated.

15.6.4 Where hard/dense soil, soft/disintegrated rock and hard rock are mixed, the measurement for the total quantity should be made by methods (18.6.1) and/or (18.6.2) given above.

15.6.4.1 If possible after the removal of the hard/dense soil the levels of the exposed rocks surface shall be taken and the quantity of the hard/dense soil removed, worked out from the difference between the original levels and new levels.

15.6.4.2 If this is not possible the excavation should be completed leaving tell & tales, and from the cross & section of these tall & tales, the area of the hard/dense soil excavated should be shall be worked out and then the volume of the hard/dense soil excavated arrived at.

15.6.4.3 Quantity of hard/dense soil shall than be deducted from the total quantity of hard rock and soft/disintegrated rock. The quantities of hard rock and soft/disintegrated rock should then be separated as in (14.6.3) above by stacking the hard rock separately.

15.6.5 Where soft/loose soil, hard/dense soil, soft/disintegrated rock and hard rock are mixed, the measurements of the entire quantity shall be made by methods (14.6.1) and/or (14.6.2) given above.

15.6.5.1 The separate quantities of soft/loose soil and hard/dense soil shall be worked out from the cross & section based on dead men or tell-tales as mentioned in (14.6.4) in case of hard/dense soil. The total quantity of soft/loose and hard/dense soil shall then be deducted from the total excavation to arrive at the total quantity of rock excavated.

15.6.5.2 The quantities of soft/disintegrated rock and hard rock excavated be worked out separately as in case of (14.6.3) above.

15.7 Refilling

Refilling and ramming of excavated earth where not described with the item of excavation shall be measured in cubic meters and shall include, spreading in layers not exceeding 200 mm in depth, watering, well ramming and leveling.

15.8 Excavation for manholes

15.8.1 The excavation for manholes shall be true to dimensions and levels show on the plans or as directed by the Engineer-in-Charge.

15.8 Sand

15.8.1 Sand is the fine aggregate which is obtained either from natural source like river bank or from pits etc. Sand can also be produce by crushing stone or gravels. It should pass through 4.75 mm IS sieve.

15.8.2 Sand should be free from clay, dust or silt. The permissible limit for the same is 5 % by weight.

15.8.3 Sand should be free from organic impurities as determined is in accordance with IS: 2386 (Part-II)

15.8.4 For plaster sand used should conform to IS:1542 /1960

15.8.5 For masonry work sand used should conform to IS: 166/1965

15.9 Coarse aggregate

15.9.1 Coarse aggregate should retain on 4.75 mm IS sieve.

15.9.2 (a) Uncrushed gravel/Stone obtain from natural sources,
(b) crushed gravel/stone obtain from crushing of gravel/hard stone or
(c) partially crushed gravel/stone by mixing of the above two (a & b) is called coarse aggregate

15.9.3 It should not contain coal, lignite, pyrites mica , shale, clay, soft fragments, and other organic impurities

15.9.4 It should not content any material which is liable to cause detrimental effect on steel reinforcement.

15.9.5 The maximum quantity of deleterious material should not exceed the limits as shown in table 1 of IS:383/1970, when tested in accordance with IS:2386/1963.

15.9.6 The crushing value of the aggregate should not exceed 45% when deter mind in accordance with the IS: 2386 (Part-IV)-1963 for concrete other than wearing surfaces and 30% for concrete for wearing surfaces such as runways, roads and pavement.

15.9.7 The coarse aggregate shall satisfy the following requirement of grading.

Table No.15.1
I.S. Sieve Percentage by Weight Passing the sieve

	40 mm	**20 mm**	**12.5 mm**
63 mm	100	-----	--
40 mm	95-100	100	--
20 mm	30-70	95-100	100
12.5 mm	---	---	90-100
10 mm	10-35	25-55	40-85
4.75 mm	0—5	0-10	0-10

15.10 Steel

15.10.1 Steel shall be free from imperfect edges, surface flaws, rough/jagged and other harmful defects.

15.10.2 It shall conform to IS: 1786 when used for RCC works.

15.11 Water

15.11.1 Water should be free from oils, acids, salts and other organic material/ substances which may be harmful to concrete.

15.12 Cement

15.12.1 33 grade ordinary Portland cement conforming to IS:269 shall used for various works.

15.12.2 43 grade ordinary Portland cement conforming to IS:269 shall used for various works. It should when tested for setting time by the vicat apparatus method

described in IS 4031 (Part-5) : 1988, have (a) initial setting time of not less than 30 minutes and (b) final settings time of not more than 600 minutes

15.12.3 53 Grade ordinary Portland cement conforming to IS:269 shall used for various works. It should when tested for setting time by the vicat apparatus method described in IS 4031 (Part-5) : 1988, have (a) initial sating time of not less than 30 minutes and (b) final settings time of not more than 600 minutes.

15.13 Bricks

15.13.1 common burnt clay bricks should be as per IS:1077 classes of common burnt bricks used in water supply are as under :-

15.13.2. Class: Classes of Common Burnt Clay Bricks:

Table No.15.2

Class Designation	**Average Compressive strength not less than**	
	N/mm²	**Kgf/cm² (aprox)**
25	25.0	250
20	20..0	200

15.13.3 Dimensions:

Table No.15.3

Length (L)	**Width (W)**	**Height (H)**
mm	**mm**	**mm**
190	90	90
190	90	40

15.13.4. Tolerances :

18.. For modular size
length 3720 to 3880 mm (3800 ± 80 mm)
Width 1760 to 1840 mm (1800 ± 40mm)
Height 1760 to 1840 mm (1800±40 mm)
(For 90 mm high bricks)
760 to 840 mm (800±40 mm)
(For 40 mm high bricks)

15.14 Specification for m.s. stop dam shutter

Stop dam shutter shall be following two types :

A. M.S. stop dam shutter (kari shutter)
B. M.S. stop dam shutter 8 mm plate (4 fixed sizes)

18.. M.S. stop dam shutter (kari shutter)

15.14.1 Scope :-
It is a fabricated shutter of M.S. sheet & M.S. sections. Used for storing the post monsoon rain water. Stop dam shutter comprising of MS. Skin plate/M.S. shutter (with frame & rubber seal) and embedded part.

15.14 .2 Size :-
Generally size of the such stop dam shutter shall be between 0.5 sq.mt. to 3.00 sq. mts. According to the specific requirements of the consignee (i.e. Height x

Width of the M.S. plate shutter) The height of the shutter shall not be more than 2.0 mts. And width shall not be more than 1.5 mtrs.

15.14.3.1 M S shutter plate (Skin plate) :-
The thickness of MS plate shutter shall be 6.0 mm.

15.14.3.2 Shutter frame :
Shutter frame shall be fabricated from MS Angle size 35x35 mm.

15.14.3.3 Stiffener:
For strengthening of shutter vertical and horizontal stiffener of Flat Iron size 35x5mm shall be provided for width more than 1.0 mtrs. One horizontal stiffener of channel 75x40 mm at center shall be provided.

The center to center distance between two vertical/Horizontal stiffener shall not be more than 30 cms.

15.14.3.4 Rubber seal: Good quality musical node type rubber seal on vertical sides and the bottom of the shutter shall fitted with suitable rubber seal. These rubber seal shall be fixed with the help of 20x5 mm M.S. strip & Nut bolts, at center to center distance not more than 15 cms.

15.14.3.5 Suitable Nut and bolt with washers shall be provided according to the number of clamps.

15.15 Embedded part:-

The embedded part shall provide the sealing surface for the rubber seal fixed with shutter. Embedded parts consisting of two vertical post & base seal of angle iron size 65x65x5 mm. these embedded parts shall be grouted in the concrete column with suitable angle iron hold fast. Vertical post shall have clamp angle of size 75x75x8 mm of 75 mm length rigidly welded at a distance not more than 450 mm centre to center. These clamping angles must be in alignment with clamping channels welded to shutter. The projected leg of angle iron clamp shall have vertical slot of 14 m width to accommodate vertical alignment. The detail of clamping and sealing arrangement should be as per practice.

15.16 M.S. stop dam shutter-8mm plate (4 fixed sizes)

15.16.1 M.S. Stop dam gate is fabricated from M.S. plate and different MS sections with rubber seal and brass strip for storing the post monsoon rain water.

15.16.2 Fabrication & description of gate:-

(i) Skin plate: The MS skin plate of 8 mm thick shall be welded on upstream side of the frame.

ii) Fixed frame: Vertical member of fixed frame shall be made from MS Angle 75x75x5mm and bottom member shall be made of thick section made from angles of 75x75x5 mm size to be used as base for resting of gates.

iii) Stiffener on shutter: Vertical made of MS flat 50x6mm and horizontal made of joist ISLC 100 (100x50mm)

iv) Cleat: Cleat should be made from MS Angle 75x75x5 mm.

v) Cleat bolt of size M-10

vi) Sealing: On the vertical and bottom side of the shutter. Musical node type rubber seal shall be fitted. In case of double panel shutter. 10 mm thick flat rubber shoot shall be used between two panels with a stopper of MS plate welded throughout the width to prevent rubber seal from coming out by water pressure.

vii) Brass strip: Brass strip of size 32x5mm shall be riveted (on 3 sides) with rivets spacing of 100mm. on fixed resting angle of frame (load bearing) on which brass or rubber scale of shutter shall rest.

15.16.4. Paint:-
Each part except rubber seal after proper deburing degreasing shall be painted with two coat of red oxide paint.

15.17 Laying of pipes and fittings / specials

15.17.1 Specification of laying of pipe and specials have been given in each chapter. On the basis of the currently applicable standards and regulations for various type/class of pipes detailed general specification are prepared in following paragraphs.

15.17.2 Applicable codes:-

Table No.15.5

IS: 3114 : 1994	Code for laying of cast iron pipes
IS:12288	Code for laying of ductile iron pipes
IS: 3764 : 1992	Safety code for excavation work.
IS: 6530 :	Code for laying of asbestos cement pressure pipes
IS: 4127 :	Code for laying of glazed stone ware pipe
IS: 783	Code for laying of concrete of pipes
IS: 5822 :	Code for practice for laying of welded steel pipes

The laying of pipes and fittings / specials shall comply with all currently applicable statutes, regulations, standards and codes.

15.18. Alignment and the L-sections : The alignment and L-sections and locations of specials, valves and chambers shown in the drawing may be changed at site in co-ordination with and approval of the site engineer.

15.17.3 Carting and Handling:

15.17.3.1 Pipes and fittings / special shall be transported from the to the work sites, at places along the alignment of pipe line as directed by Engineer. Contractor shall be responsible for the safety of pipes and fittings / specials in transit, loading / unloading.

15.17.3.2 Every care shall be exercised in handling pipes and fittings / specials to avoid damage. While unloading, the pipes and fittings / specials shall not be thrown from the truck on the hard surfaces. They should be unloaded on timber with steadying ropes or by any other approved means.

15.17.3.3 Padding shall be provided between coated pipes, fittings / specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to the other. In case of

spigot & socket pipes while unloading as for as possible pipes shall be unloaded on one side of the trench only.

15.17.3.4 The pipes shall be checked for any visible damage (such as broken edges, cracking or splaying of pipes) while unloading. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings / specials along concrete and similar pavement with hard surfaces shall be prohibited.

15.17.3.5 Wherever a section of pipe, or a fitting is to be lifted or moved, it shall be handled carefully with belt slings. The belts shall be constructed so that no metal bears against the pipe and so that the bearing is uniform. The width of the belts shall be adequate to prevent any damage to the pipe coating.

15.17.3.6 The pipe section may at no time be dropped but shall be lowered care fully in to position and may not be slided along the ground. If it is to be rolled, it may be done only on slides or ground specially prepared so as to prevent any damage to the coating.

15.17.3.7 All State and local laws be observed during transportation. The contractor shall secure permits and licenses and provide all signals, guards and lights that may be required. Upon delivery the pipe sections and fittings shall be placed on specially prepared ground to protect them from distortion and damage. The ground shall be prepared so that they will rest evenly and will have uniform bearing throughout their lengths. Valve and sluice gates shall be placed on blockings.

15.17.4 Storage

15.17.4.1 Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable.

15.17.4.2 The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stack shall not exceed 1.5m.

15.17.4.3 Fittings/special shall be stacked under cover and separated from pipes. Valves and sluice gates shall be placed on blocking.

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

15.17. 5 Laying

15.17.5.1 Excavation

15.17.5.2 Before excavating the trench the alignment of pipeline shall be approved by Engineer. The excavation of trenches and pits for manholes / chambers shall be carried out in accordance with the specification and shall be done such that it does not get far ahead of laying operation as approved by Engineer.

15.17.5.3 To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work until it is safe for the traffic to use the roadways. The Contractor shall provide sign boards at salient points in streets and keep men to guide the traffic at his own cost. The relevant Indian Standards and the rules and regulations of local authorities in regard to safety provisions shall be observed.

15.17.5.4 Trial pits may be dug by the contractor, without being directed to do so, along the lines of the trenches as shown on the drawings in advance of the excavations for the purpose of satisfying himself as to the location of under ground obstructions or conditions.

15.17.5.5 The contractor shall proceed with caution, in any excavation and shall use every means to determine the exact location of underground structures, pipelines, conduits etc., prior to excavation in the immediate vicinity thereof. The contractor shall be solely responsible for the cost of protection or repair or replacement of any structure, pipeline, conduit etc., above or below ground which may be broken or otherwise damaged by his operation.

15.17.5.6. Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm in diameter or less than 1.2 m above the surface of the ground.

15.17.5.6.1 There shall be two rails, one near the top of the posts and the other about 50 mm above the ground and each shall be of 50 mm to 70 mm in diameter and sufficiently long to run from post to post to which it shall be bound with rope.

15.17.5.7 The method of projecting rails beyond the posts and tying them together where they meet will not be allowed on any account. All along the edges of the excavated trenches a bank of earth about 1.2 m high shall be formed where required by engineer for further protection.

15.17.5.8 The lighting, barricading, guarding of the trenches and the maintenance of watchmen shall be done by the contractor at his cost. At every 30 meters interval and at every change in the gradient, sight rails shall be provided and fixed by the contractor at his own cost.

15.17.5.9 The sight rails and boning rods for checking the excavation and inverts of the pipes shall be of the quality approved by the Engineer. In all streets in the City/Town at every 15 meters interval, blank board shall be provided by the contractor at his won cost, to facilitate crossing of the trench by the public residing on the either side.

15.17.5.10. The road metal and also the rubble packing shall first be stripped of for the whole width of the trench / pit and separately deposited in such place or places as may be determined by engineer.

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

15.17.5.12.1 Water pipes, drains, sewers, etc. if met with during excavation shall be properly maintained by contractor, by means of shoring, strutting, planking over, padding or otherwise as engineer may direct, and shall be protected by contractor from damage during the progress of the work.

15.17.5.13. Wherever extra width of excavation shall be necessary for shoring and strutting, of the trenches on account of the nature of the soil, such extra width required to accommodate the shoring boards shall not be paid for separately and the rates quoted for trench work shall be deemed to be inclusive of all such incidental work.

15.17.5.14. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structures/pipelines of water, gas, sewage etc.

15.17.5.15. Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than [External diameter of pipe in mm + 600 mm] + [400 mm for every 1500 mm Depth of cutting] or as specified in the cross section Drawing (in case there is any difference, the latter shall prevail).

15.17.5.16. In case additional width is required it shall be provided only in the top portion from the ground level up to 300 mm above the crown of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry or otherwise at the discretion and to the satisfaction of Engineer.

15.17.5.17 If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings / specials and the space resulting shall be refilled with lean cement concrete of adequate depth, properly consolidated to give the curved seating.

15.17.5.17.1 The bottom of the trench shall be properly trimmed to permit even bedding of the pipeline. Bottom of trenches / pits shall be saturated with water and well rammed wherever Engineer may consider it necessary to do so.

15.17.5.18 For laying of pipes larger than 1200 mm in diameter, in earth and moorum, the curvature of the bottom of the trench should match the curvature of the pipe as far as possible, subtending an angle of 120 degrees at the centre of the pipe.

15.17.5.19. Wherever a socket or collar of pipe or fitting / special occurs a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand, all around the socket in order to make the joint and the grip shall be maintained clear until the joint has been tested.

15.17.5.20. When welding is to be carried out with the pipes and special in the trench, additional excavation of not more than 60 cm in depth and 90 cm in length shall be made at joints in order to facilitate welding

15.17.5.21. The excess excavated material shall be carried away from site of works to a place up to a distance as directed by Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic.

15.17.5.21.1 If the instruction from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by Engineer at contractor's risk and cost and any claim or dispute shall not be entertained in this respect.

15.17.5.22 Refilling of trenches, where the excavation is in rock shall be with the surplus soft soil from pits located within 200 meters from the reach in question.

15.17.5.23 It is to be distinctly understood that no extra payment shall be made for the excavation from borrow pits located with in 200 meters for obtaining earth for refilling, any instructions of the Engineer to bring earth from beyond 200 meters for refilling shall be detailed in writing and a separate extra payment shall be made for the additional conveyance. No. payment shall be made for disposal of soil for excavation, surplus to or unsuitable for filling.

15.17.6 Work included in Excavation

15.17.6.1 Following items are included in the excavation unless otherwise directed.

15.17.6.2 Removing all surface obstructions including shrubs, jungle etc.,

15.17.6.3. Making all necessary excavations true to line and grade,

15.17.6.4 Furnishing and installing all shoring and bracing as necessary or as directed,

15.17.6.5 Pumping and bailing out water to keep trenches free of water during pipe laying and jointing and thereafter until joints mature,

15.17.6.6 Providing for uninterrupted surface water flow during work in progress,

15.17.6.7 Providing for disposing off water flows from storm, drains, nallas or other sources, suitably,

15.17.6.8 Protecting all pipes, conduits, culverts, railway tracks, utility poles, wire fences, buildings, and other public and private property adjacent to or in the line or work,

15.17.6.9 Removing all shoring and bracing which is not ordered to be left in place or not required by the project plans or specification to remain in place,

15.17.6.10 Hauling away and disposing of excavated materials not necessary or else unsuitable for back filling purposes. The extra excavated soil will have to be properly dressed in soil banks along with the trench as directed,

15.17.6.11 Back filling the trenches as directed or as per specifications.

15.17.6.12 Restoring all property damaged or disturbed by these construction activities to the condition as near its original conditions as possible.

15.17.6.13 Restoring the surface and repairing off all roads, streets, alleys, walks, drives, working spaces, and right of way to a conditions as good as prior to excavation.

15.17.7 Change of Trench Location

15.17.7.1 In case the Engineer orders that the location of trench be moved a reasonable distance, on account of the presence of an obstruction or due to such other cause or if a changed location is authorized at the contractor's request, the contractor shall not be entitled to extra compensation or to a claim for damage.

15.17.7.2 If however such change is made at the orders of the Engineer, which involves abandonment of excavation together with the necessary back fill, will be measured, classified and paid for in the same manner as for other trench excavation and back fill of the same character.

15.17.7.3 In case the Trench is abandoned in favour of new location at the contractor's request, after its approval, the abandoned excavation and back fill shall be at contractor's expense.

15.17.8 Minimum earth cover

15.17.8.1 If a profile is not furnished for a pipeline, the main will be constructed with a minimum earth cover of 1000 mm from the top of the pipeline, unless otherwise indicated on plans and ordered by the Engineer.

15.17.9 Dewatering

15.17.9.1 During the excavation, if subsoil water is met with, contractor shall provide necessary equipment and labourers for dewatering the trenches / pits by bailing out water or water mixed with clay. If pumping out subsoil water is found to be necessary, contractor shall provide sufficient number of pumps for the same.

15.17.9.2 In both the above cases the excavation shall be done to the required level and the pipes shall be laid to proper alignment and gradient. Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by Engineer.

15.17.9.3 In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer / drain, contractor shall take necessary permission from the local authorities.

15.17.9.4 The contractor shall be responsible for the adequate pumping, drainage and bailing out of water from the excavation. Failure to make such provision which

results in unsuitable sub grade conditions, and which well require any special foundations as directed by the Engineer, such foundations shall be placed at the entire cost of the contractor and will not be measured or paid for as separate pay items.

15.17.9.5 If the contractor selects to under cut the trench and use gravel or tile bailing, drainage of well pointing, the additional work will be considered as incidental work and additional compensation will not be allowed.

15.17.10 Special foundation in poor soil

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

15.17.10.2 During the progress of the work, should the foundation for the pipeline be in soft, yielding or spongy materials which are unsuitable for the sub grade of the pipeline and which is not the result of the contractor's negligence, to make proper provisions for adequate drainage of the excavation, the contractor shall remove such unsuitable sub grade materials to the depth directed by the engineer. The contractor shall fill the excavated depth in the manner hereinafter described or as directed by the Engineer.

15.17.10.3 The contract unit for foundation shall be one cubic meter. The foundation will be measured for payment complete in place. The contract unit price shall be the total compensation for furnishing all labour, tools, materials, equipment and incidentals necessary to complete the work, including all excavation and disposal of surplus material.

15.17.10.4 Gravel Foundation

15.17.10.4.1 The space resulting from removal of unsuitable materials shall be filled with gravel. No extra payments will be made on this account, except for lead charges if any beyond 50m

15.17.10.5 Rock Foundation

15.17.10.5.1 The space resulting from the removal of unsuitable materials shall be filled with crushed stone, local lime stone rock, free from loamy soil, clay and vegetable matter, graded in size from 25 mm to 30 mm in general.

15.17.11. Wooden shoring

15.17.11.1 Contractor shall suitably design polling boards, walling and struts to meet different soil conditions that might be encountered in excavating trenches / pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work.

15.17.11.2 Any inconvenience and / or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by contractor shall be his sole responsibility. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

15.17.11.3 If a portion of shoring to be left in the trenches / pits at such places, where it is absolutely necessary to do so as to avoid damage which may be caused to building, cables, gas-mains, water-mains, sewers, etc. in close proximity of the excavation, by pulling out the shoring from the excavations. Contractor shall not claim, on any reason, whatsoever for the shoring which may have been left in.

15.17.12 Steel plate shoring

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

15.17.13 Bedding

15.17.13.1 The bedding for pipe shall be provided as specified in the drawings or as per directions of engineer.

15.17.13.2 The trench bottom shall be even and smooth so as to provide a proper support for the pipe over its entire length, and shall be free from stones, lumps, roots and other hard objects that may endure the pipe or coating. Holes shall be dug in the trench bottom to accommodate sockets so as to ensure continues contact between the trench and the entire pipe barrel between socket holes.

15.17.14 Concrete cushion, embedment and encasement.

15.17.14.1 Concrete embedment and encasement wherever required, shall be constructed as per the details given in approved drawings or as directed by the engineer, where concrete bedding is to be placed beneath the pipeline, the sub-grade shall be prepared to dimensions as shown in the drawings.

15.17.14.2 The bottom of the trench may be sloped on the sides or kerbed, but the thickness of concrete shall be as specified in the drawings or as directed by the Engineer. Dry mix will not be permitted.

15.17.14.3 For earth, granular material or concrete embedment, each pipe section shall have uniform bearing on the sub grade for the full length of the pipe barrel, suitable excavation shall be made to receive the pipe, bell or collar and allow adequate room for proper workmanship in making the joint.

15.17.14.4 Adjustment to line and grade shall be made by scraping away or filling in with gravel or concrete and not by wedging or blocking up to bell. Pipe sockets and barrels shall be clean and free from dirt at the time of jointing.

15.17.14.5 The concrete for bedding portion will be mixed moist or damp to give a slump of not more than 25 mm and for sides and top portions of encasement, if specified, will be mixed to obtain a slump between 25 mm and 80 mm.

15.17.14.6 All water in the trench must be disposed off prior to placing of concrete. There should be no cleavage line between the bedding concrete and the side embedment concrete.

15.17.14.7 Clear out space shall be left for jointing and lowering pipe in place and bringing to grade by tamping under pipe or removing excess concrete under pipe. After the joint is made, the remainder of the concrete embedment may then be poured and thoroughly tamped to make bond with original concrete.

15.17.14.8 Care must be exercised in tamping to prevent lifting of the pipe out of alignment or grade. Back filling shall be done in a careful manner and such time after the concrete cushion, embedment or encasement is placed, as not to damage the concrete in any way.

15.17.14.9 All pipes shall be so laid that the contact in the joint between the two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawing and the curves are flat, standard pipe will be used with the outside adage of the joint pulled away from the seat to make a smooth joint.

15.17.14.10 Where curves are sharp, standard or specially made bends will be used. Openings at end of day's work openings in tees, deep cut connections, shall be capped and sealed.

15.17.15. Laying of pipes and specials

15.17.15.1 All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure / pipe line of water, gas, sewage, etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Engineer. Pipes and fittings / specials shall be carefully lowered in the trenches.

15.17.15.1.1 The pipes and special shall be stacked along the alignment in advance with utmost care during the transit so that they are not damaged. Any damage due to these reasons shall be contractor's liability.

15.17.15.1.2 The pipe shall be lowered and laid only after the trenches are finally ready and levels duly checked by the Engineer. It shall be seen that no damaged pipe is lowered in the trench. Every precaution shall be taken to prevent foreign materials from entering the pipes when they are being placed in the line.

15.17.15.2 Normally the socket ends shall face the upstream. When any portion of the excavation shall have been carried down to the necessary depth, the contractor shall obtain permission from the Engineer before commencing the laying of pipes or concrete or the construction of masonry.

15.17.15.3 Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings / special shall be made by contractor. In no case fittings / special shall be dropped. Slings of canvas or equally non abrasive material of suitable width or special attachment to fit the ends of pipes and fittings / special shall be used to lift and lower the coated pipes and fittings / special.

15.17.15.3.1 The pipes and fittings / specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect crack, wherever applicable. If doubt persist, further confirmation shall be done by pouring a little paraffin / kerosene on the inside of the pipe at the suspected spot. No sign of paraffin / kerosene should appear on the outside surface.

15.17.15.3.2 Pipes and fittings / special damaged during or aligning shall be rejected by Engineer.

15.17.15.4 All the pipes are to be laid perfectly true both in alignment and to gradient specified. Pipes in a trench shall be laid and fitted previous to the jointing being commenced.

15.17.15.4.1 In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipe line runs uphill in which case the socket ends should face the upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient.

15.17.15.4.2 The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings / special which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipes and fittings / special of proper dimensions to ensure such uniform space. Precaution shall be taken to prevent dirt from entering the jointing space.

15.17.15.4.3 At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by engineer. During the period that plug is on, the contractor shall take proper precautions against floatation of the pipe owing to entry of water into the trench.

15.17.15.4.4 Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted, the deflection allowed at joints shall not exceed $2\frac{1}{2}^0$ in the case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipe shall be laid such that the marking on pipes appears at the top of the pipes.

15.17.15.5 Properly fitted temporary wooden stoppers shall be provided to close the ends of all incomplete pipe lines. The stoppers are only to be removed when pipes are being laid and jointed. Pipe laying and jointing shall be started and completed only section wise as per the instruction of the engineer.

15.17.15.5.1 During the progress of pipe laying the open ends of pipe shall be closed and water tight. Sight rails shall be provided at all change of direction or gradients at distance of @ 30 m along straight lengths.

15.17.15.5.2 All the invert levels shall be confirmed from the sight rails with the help of proper boning rods as per the standard practice. The pipe shall be jointed with cement mortar 1:1 and proper caulking shall be done. After a particular section of the pipe is laid and jointed hydraulic testing shall be done section wise.

15.17.15.6 Just prior to placing each pipe section in the line, damaged coating shall be repaired and the interior shall be cleaned off all foreign materials. Cleaning shall be accomplished by brushing, blowing with compressed air and washing with water or as specified by the Engineer.

15.17.15.7 The item for laying of pipe line also includes labour work for lowering, laying and jointing various pipes including jointing with specials, leveling, etc. The contractors shall transport pipes and specials from stores, for their various sections in such quantities as may be required for laying.

15.17.15.7.1 Ordinarily no surplus stock shall remain on completion of any section. In case however, such pipe etc. become surplus in any sections, the contractor shall remove the same to the next section for use in the work.

15.17.15.7.2 It is likely that on completion of the whole work, some pipes and specials etc. may become surplus at the site and the contractors shall arrange to hand over the same in good condition to the Engineer or to return to the store.

15.17.15.7.3 The contractor shall supply a list of stock so returned to the engineer. No extra payment shall be made to the contractors for these works. The rates for laying the pipes shall cover the cost of loading, transporting and unloading as may be required.

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

15.17.16 Jointing

15.17.16.1 Pipes shall be laid to the lines and grades given in the plans, with the ends abutting to form a even joint without shoulders or unevenness of any kind along the invert of the pipes. No joint shall be made under water. The ends of the pipes shall be dry and kept clean before and during laying and jointing operations.

15.17.16.2 All joint work shall be done in an approved manner by skilled workmen so that the completed pipeline shall have a continuous, smooth and uniform interior surface. Extruded joint material shall be removed from the interior of the pipe. In cold weather protective measures must be taken to ensure a satisfactory joint.

15.17.16.3 Jointing for pipes and fittings / special shall be done in accordance with the relevant specifications depending on type of pipes being used.

15.17.17 Thrust Block, Anchor Block, Valve Room, Manholes, Head walls, Saddle supports etc. *(See Drawing No.-20 for Thrust Block)*

15.17.17.1 The contractor shall build manholes, inlet manholes, inlets, junction chambers, headwalls, culverts, anchor blocks, thrust block and such other miscellaneous structures that may be required at the locations shown by the engineer and of such forms, dimensions and materials as are shown in the standard detail or as may be specified or directed. These structures shall also include the installation of such specials and connections to pipes and other structures as may be required to complete the constructions as shown in the drawings.

15.17.18 closure sections and connections to structures

15.17.18.1 Closure sections shall be constructed where required by the contractor's operations. Connections to pipe specials shall be made as approved by the Engineer. Lining and coating of the pipe lines, which must be cut to provide for closure pieces or to permit the proper location of valves structure shall be repaired by the contractor. No separate payment will be made for closure pieces installed. But the same will be measured as it is a pipe in place and along the pipeline .

15.17.19 Temporary stoppages of work

15.17.19.1 At times when pipe laying is not is progress, or at the end of the day's work, the open end of pipe shall be closed by a watertight plug or other means approved by Engineer. During the period that plug is on, the contractor shall take proper precautions against floatation of the pipe owing to entry of water into the trench.

15.17.20 Testing and Commissioning
(See Drawing No.-21)

15.17.20.1 Testing and commissioning of pipes shall be done in accordance with the relevant specification.

15.17.21 Water Tightness test.

15.17.21.1 All hydraulic structures, either water supply or drainage etc., such as sewer lines, joints etc., or any other liquid containers shall have to be tested for water tightness.

15.17.21.2 The contractor shall give all such hydraulic tests by making his own arrangements for water filling and disposal of water after the test and shall repeat this test, if necessary, until the requisite test results are obtained without any claim for extra cost or compensation. The water tightness test shall be conducted as specified in IS: 4127-1967.

15.17.21.4 The contractor may use at the time of construction, for increasing the water tightness, approved proprietary chemicals only with the permission of the engineer to serve the purpose of the contractor to facilitate such type of work for his own convenience and advantage.

15.17.21.5 But in all such cases, the contractor will not be entitled to any extra rate. The contractor shall see that every effort is made to make structures and fixtures water tight, by resorting to such chemicals and making efficient use of proportion and grading of materials etc., as provided originally in the specifications.

15.17.22 Backfilling

15.17.22.1 Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipe line. The tamping around the pipe shall e done by had or other hand operated mechanical means. The water content of the soil shall be as near to the optimum moisture content as possible.

15.17.22.2 Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Back filling shall be consolidated by watering, ramming, care being taken to avoid damage to the pipe line. In case of mild steel pipes / special, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipe line to aid alignment, these timers shall be removed before backfilling.

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

Reinstatement of road/footpath shall be done as per the requirements of the concerned authority & specification of the works.

Water Supply pipes lines should be disinfected before commissioning.

15.17.24 **Measurement**

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

a). Length shall be measured as per actual length of pipe.
b) Fittings and specials shall be measured by numbers.
c) Width and cross section shall be taken as per the drawing.
d) Measurement of depth shall be taken as per average depth of trench from ground level to invert of pipe plus thickness of bedding.

15.17.24.2 Measurement for pipes and fittings / specials shall be in accordance with the relevant clause of specification for specified types of pipes.
Excavation of asphalt road and reinstatement of road shall be measured on per square metre basis and the length and width at top of trench shall be considered same as those mentioned for excavation of trench.

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

15.18 Rate

Rate shall include the cost of all the materials and labour involved in all the operations described above.

CHAPTER -16
MISCELLANEOUS

Applicable Code :

All the applicable codes shall comply with all currently applicable statutes, regulations, standards and codes. In particular the standards mention in chapters 1 to 16 shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned but pertaining to the use of items given in this chapter shall be part of this Specification.

16.1 Cutting of cast iron pipe:

16.1.1 The cutting of C.I. Pipes becomes necessary for putting valves, C.I. special etc. It Should be carried out in such way that damages are not caused to the pipes. Cutting should be at right angle to the axis of the pipe. Pipe cutting may be done by chisel or by cutting machine.

16.1.2 Cutting of pipe can also be carried out by the electric arc. Cutting may be done by using a steel or carbon rod also. This should be done by trained personnel.

16.1.3 Chamfering of C.I. Pipes ends by files/grinder is necessary to prevent damage to the rubber ring and smooth fitting of joints.

16.2 Cutting and Threading of G.I. Pipes

16.2.1 Where the pipes have to be cut or rethreaded, the ends shall be carefully filed out so that no obstruction to bore is offered.

16.2.2 The end of the pipes shall then be carefully threaded conforming to the requirements of IS 554 with pipe dies and taps in such a manner that will not result in slackness of joints when the two pieces are screwed together.

16.2.3 The taps and dies shall be used only for straightening screw threads which have become bent or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in a water tight joint. The screw threads of pipes and fitting shall be protected from damage until they are fitted.

16.3 Cutting of PVC/PVC-U pipes

16.3.1 Cutting of PVC pipe should be done on a jig so that the cut surface is perpendicular to the axis of the pipe. It should be ensured that the pipe is marked around the entire circumference so that proper cut is maintained.

16.3.2 Use a fine-toothed hand saw and a miter box or a power saw with wood-working blades with a suitable guide. The cutting must not raise a burr or ridge on the cut end of the pipe.

16.3.3 Failure to remove the ridge will result in cement in the fitting or socket being scraped away from the jointing surfaces, leading to a dry joint with probability of joint failure.

16.3.4 Remove all burrs and ridges with a debarring knife, file, or abrasive paper.

16.3.5 A chamfer prevents the cement film from being wiped off into the interior of the socket during assembly. Pipe and must be chamfered at an angle of 15 degree with a file, To provide and approximately 2mm wide, 15^0 chamfer on pipe ends.

16.4 Cutting of asbestos cement pressure pipe

16.4.1 The pipe should be rigidly held on two parallel rafters nailed to cross beams, taking care that the portion to be cut does not overhang and the cut mark is between the two rafters.

16.4.2 The pipes should be neatly cut at the chalk mark with carpenter's saw or hack-saw having a long blade, by slowly rotating the pipe around its longitudinal axis so as to have the uncut portion on top for cutting.

16.4.3 Cutting of the pipe at the overhang should as for as possible be avoided, it is dangerous as an overhanging end is liable to tear off due to its weight before the cut is completed.

16.4.4 Cut should always be perpendicular/at right angle to the axis of the pipe.

16.5 Cutting of Ductile iron pipes

16.5.1 The cutting of ductile iron pipe should be done in such a manner so that no damage is caused to the pipe/cement lining and cut surfaces of the pipe is smooth and perpendicular (at right angles) to the axis of the pipe.

16.5.2 This could be done either by use of chisel or by other suitable mechanical means.

16.6 Cutting of Glazed stoneware pipes

16.6.1 The cutting of pipe for inserting, fitting or closure pieces shall be done in a neat and workmanlike manner without damage to the pipe or glazing so as to leave a smooth end at right angles to the axis of the pipe

16.7 Manufacture of Mild Steel Plate Specials :

16.7.1 During the course of execution, it sometimes becomes necessary to provide a non-standard special to fit into the pipeline. This can be conveniently made out of steel plates. An item to cover such emergency is also provided for in the schedule. Similarly, item to provide a mild steel flange has also been introduced to cover the specific requirement during execution.

16.7.2 An item for laying and jointing steel pipes, incorporating field welding has also been introduced to cover the special requirements during execution.

16.8 All materials shall conform to relevant ISS.

16.9 Cast Iron Manhole Covers and Frames

16.9.1 When cast iron manhole covers and frames are used they shall confirm to IS 1726 (parts 1 to 7). The frames of manhole shall be firmly embedded to correct alignment and level in plain concrete on the top of masonry. After completion of the work, manhole covers shall be sealed by means of thick grease. Provision for providing and fixing including labour and material has been made.

16.9.2 Manhole covers and frame shall be manufactured from appropriate grade of grey cast iron not inferior than FG 150 grade of IS 210.

16.9.3 They shall be cleanly cast and shall be free from air and sand holes, cold shuts and warping.

16.9.4 Covers shall have on its operative top a raised chequered design to provide for an adequate no-slip grip. The rise of chequres shall be not less than 4 mm.

16.9.5 Key holes, Keys and lifting devices shall be provided in the manhole covered to facilitate their placement in the frames and their operative maintenance.

16.9.6 Manhole covers and frames shall be coated with material having base with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to temperature of 63^0C and shall not be so brittle as to chip off at temperature of 0^0C.

16.9.7 Size and shape and performance requirement of manhole covers and frames shall conform to IS 1726.

16.9.8 Each manhole covers and frame shall have cast on them the following information:

(a) Manufacturer's name or trade-mark.

(b) Grade designation

(c) Date of manufacturer

(d) The words SWD or 'Sewer' to denote 'storm water drain' or 'sewer' respectively.

(e) Identification marks as required by Engineer-in-Charge.

16.9.9 The cover shall be gas tight and water tight.

16.9.10 The sizes of covers specified shall be taken as the clear internal dimensions of the frame.

16.9.11 The approximate weight of the various type of manhole covers and frames shall be as per IS 1726.

16.9.12 The cover shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner.

16.9.13 Provision has also been made for the labour component of the fixing of C.I. manholes cover with frames. This items does not including cost of C.I. manholes covers with frames and other material required.

16.10 Any pavement, fence, or other property and surface structures are damaged, or disturbed during the course of the work, such property and surface structures shall be made good after completion of work. It shall be restored to a condition equal to that before the work began.

16.11 No Permanent pavement shall be restored unless and until, in the opinion of the Engineer in charge the condition of the backfill is such as to properly support the pavement.

16.12 The width of pavement removal along the normal trench for the installation of the pipe shall not exceed the width of the trench specified by more then 15 CM on each side of the trench.

16.13 Wherever in the opinion of the Engineer in charge existing conditions make it necessary or advisable to remove additional pavement, it shall be removed as directed by the Engineer in charge.

16.14 All construction material, and all tools and temporary structures shall be removed form the site as directed by the Engineer in charge.

16.15 All dirt, rubbish and excess earth form the excavation shall be taken off to a specified dumping site as directed by Engineer in Charge.

16.16 The construction site shall be kept clean to the satisfaction of the Engineer-in-charge.

16.17 Measurement

16.17.1 All earth work like excavation of trench for laying of pipe line shall be measured in cum.

16.17.2 All filling works shall be measured in cum.

16.17.3 Cutting of pipe shall be measured per cut basis.

16.17.4 Dismantling of old pipe shall be measured in meter correct to the centimeter.

16.17.5 Fabrication of M.S. pipes & special shall be weight in kilogram.

16.17.6 Providing and fixing C.I. Man holes covers & precast reinforced cement concrete manholes covers shall be enumerated.

16.18. Rates

The rate shall include the cast of the material and labour involved in all the operation described in the item. The rates include all tools and plants, chain, pulley blocks, other appliances etc. required for execution of the works.

CHAPTER NO. 17
DRILLING OF TUBE WELLS

17.1 Applicable codes

The construction & testing of tube wells, mild steel tubes, unplastized PVC screen and casing pipes, gravels and hand pump etc shall comply with all currently applicable statutes, regulations, standards and codes. In particular the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the standards/codes shall be referred to. Other IS: Codes not specifically mentioned here but pertaining to the use of construction & testing of tube wells, mild steel tubes, unplastized PVC screen and casing pipes, gravels and hand pump etc shall be part of this specification.

Table 18.1

IS: 2800 (part-1):1991 (Reaffirmed 2001)-	Code of practice for construction & testing of tube wells/Bore wells
IS: 2800 (part-II): 1979 (Reaffirmed 1999)-	Code of practice for construction & testing of tube wells/Bore wells.
IS: 1239 (Part-I & II) - 1990	Mild steel tubes, tubular & other wrought steel fittings-specification
IS : 4985 : 2000	Specification of un-plasticized PVC Pipes for potable water supply.
IS:11189-1985 (Reaffirmed 1999):	Method of tube well development
IS:4097-1988 (Reaffirmed 1999):	Specification for gravel for use as pack in tube wells.
IS: 15500 (Part-I to VIII)	Deep well hand pumps, components and special tools- specification.
IS: 12818 : 1992	Unplasticized PVC screen and casing pipes for bore/tube well-specification.

17.2 The rates of drilling work have been worked out on the basis of the working rates of the drilling rigs, labour charges, fuel charges and rates of other miscellaneous items.

17.3 The drilling shall be done in accordance with the specification.(Refer annexure A also) Specifications for the drilling of tube wells in general are as mentioned under:-

17.4 A bore hole vertical within the prescribed non-vertical limits drilled up to designed depth in alluviums or rocky areas.

17.5 Installation of requisite well assembly i.e. housing pipe, blind pipe, slotted pipe of strainers, bail plug and other accessories.

17.6 Placing of suitable gravel pack (in case of gravel, packed tube wells). Placing of suitable sand pack (in case of sand packed tube wells).

17.7 Development of tube-well with object of(Refer annexure A also):-

17.7.1 Producing effect of natural gravel pack (in case of naturally packed design.)

17.7.2 Producing maximum sand free yield of water for the specified standard draw down in alluvium and rocky areas.

17.8 Conducting yield test by over pumping of the tube well(Refer annexure A also).

17.9 Installation of suitable submersible pump assembly as specified and comprising of i) submersible pump/ ii) Motor iii) Riser/Colum Pipeline iv) Airline v) Sluice and Reflux valve. Alternatively installation of hand pump India mark II including construction of platform and necessary drainage arrangement if yield of the tube well is not enough for installation of submersible pump.

17.10 Strata:-

17.10.1 Rocky area shall mean, area where the strata essentially comprises of the rock formation. Rock may be with or without fissures and faults, joints and bedding planes, may have fractured and weathered zones. Rocks may be soft, medium or hard, and comprise of shale sand stones, lime stones, dolomites, quart-sites, basalts, granites, schist, fillets, slates, gneisses and their intercalation, intrusive and conglomerates of these, but shall exclude clays, sands, pebbles, cobbles and boulders moorum and silt stones.

17.10.2 All alluvium areas shall mean areas where the strata comprises of loose, unconsolidated materials like clays, sits and gravels, pebbles, cobbles and boulders.

17.11 Verticality and alignment :-

17.11.1 Verticality of a tube well means verticality of casing pipe or housing pipe up to 200 mm dia and up to 30 m depth in one direction and in one plane and up to 50 m depth for casing pipes of more than 200 mm dia.

17.11.2 The bore hole should be in a vertical alignment so that installation of vertical turbine pump or submersible pump can be done in the tube well without any difficulty. Alignment means plumbness and straightness of the tube well. Plumbness refers to the variation with the depth of the actual centre line of the tube well from the true vertical line drawn through the centre of the tube well from top, down to its depth. Straightness merely considers whether actual centre line of the tube well is straight or otherwise. Thus a tube well may be straight but not in plumb, since its alignment may be displaced in one direction or other from the vertical.

17.11.3 The limits of verticality of shallow and deep tube wells are specified in the table given below:-

Table No.- 17.2

S.No	Types of tube well	Dia of bore	Dia of casing	Permissible limit of verticality in 30 m depth (all in one direction)
1.	Shallow	Up to 30 cm	15 cm	15 mm
2.	Shallow & deep	37.2 cm or 40 cm	20 cm	30 mm
3.	Deep	45 cm or more	25 cm or more	50 mm

17.12 Casing pipe:-

17.12.1 Pipe or casing pipe-Blind pipe or casing pipe is provided in non-aquifer-portion and below housing pipe and up to slotted pipe. The casing pipe of specified diameter shall be lowered up to a minimum depth of 9 meters below ground level to prevent pathogen bacteria from entering in to the well and there by prevent the water from possible pollution. If the collapsible strata in overburden continue beyond 9 meters depth than the casing pipe shall be lowered up to rock level and embedded ink rock in a depth of 0.15 meter. The casing pipe shall also be extended above ground level in a height of about 0.3 meter. Pipe material shall conform to IS: 1239 (Part-I) 1990 mild steel tube, tubular and other wrought steel fittings/ IS: 12818: 1992 Unplasticized PVC screen and casing pipes for tube wells

17.12.2 Slotted pipe:-

The screen or slotted pipe should be provided against the required thickness of aquifer in order to allow ground water to be pumped into the tube well. The length of the slotted pipe should be decided by the thickness of the aquifer portion needed to be tapped and normally the screen should be provided against coarsest and bottom most aquifer layer. The upper one and unwanted aquifer layers should be made up by smallest feasible dia casing pipe. Pipe material shall conform to IS: 1239 (Part-I) 1990 mild steel tube, tubular and other wrought steel fittings/ IS: 12818: 1992 Unplasticized PVC screen and casing pipes for tube wells

17.13 Gravel Packing:-

17.13.1 The term gravel packing is used to the placing of uniform gravel adjacent to the well screen. The thickness of the pack ranges from 75mm to 150 mm depending upon design.

17.13.2 The gravel selected for packing tube wells shall be consist of hard quartz with an average specific gravity of not less than 2.5. The quartz shall be of sub rounded to rounded grains with minimum angular features. The gravel shall be free from impurities, such as shale, mica, felspar, clay, sand, dirt, loan, hematite and organic materials.

17.13.3 The main purpose of gravel pack is to enable water bearing formation to yield sand free water to its maximum capacity.

17.13.4 Fine enough to prevent the passage through its pores of particles from the formation materials.

17.13.5 Course enough to give a lesser resistance so that the head loss in flow of water through it should be relatively small.

17.13.6 Gravels shall be as specified in IS 4097: 1988 (Reaffirmed - 1993).

17.14. Tube wells drilled shall be perfectly vertical. The rates for drilling are inclusive of the verticality test required to be conducted. All the drilling shall be as per IS: 2800 (Part-I): 1979: tube well construction (First Revision) (Reaffirmed 1885) the testing of the tube well shall be as per IS: 2800 (Part-II) 1979: Tube well testing (First Revision) (Reaffirmed 1990).

17.15. The rates for drilling provided in the are inclusive of depreciation charges of all the machinery, tools & plants required for drilling operation, transportation of drilling machine, erection of machine at site, removal of machine from site after completion, cost of water, cost of drilling mud, fuel, labour and all other unforeseen items for drilling work and clearance of site after completion of work.

17.16 For location/Selection of site resistively survey shall be carried out by a well qualified and experienced geo hydrologist. Resistively meter shall be provided by the concerned Geo hydrologist.

17.17 The diameter of ordinary tube wells constructed for installation of hand pumps shall be 125 mm up to bottom level of the casing pipe and 115 mm in the rock below the casing. Such tube wells shall be designated as 125/115 mm dia ordinary tube wells.

17.18 The ordinary tube wells constructed for installation of hand pumps in the basaltic rock area where intertrappean formation (collapsible strata between the rocks) is present. The nominal diameter of the tube well up to the level of intertrappean formation shall be 150 mm.

17.18.1 The intertrappean formation shall be encased by 125 mm dia G.I. casing pipe. Therefore, the finished nominal diameter of tube well in the intertrappean formation the nominal diameter of tube well shall be 115 mm. Such tube wells shall be designated as 150/125/115 mm dia ordinary tube wells.

17.19 The nominal diameter of ordinary tube wells constructed for installation of power pumps shall be 150 mm or 200 mm for the entire depth depending upon the type and size of pump to be installed in the tube well. Such tube wells shall be designated as 150 mm dia ordinary tube well & 200 mm dia ordinary tube wells.

17.20 The gravel packed tube wells shall be constructed in alluvial formation, suitable for such tube wells, in which the fine and uniform sand is present in the water

bearing aquifer. Such tube wells shall be constructed by direct circulation rotary drilling method or reverse circulation rotary drilling method using suitable rotary drilling machine.

17.21 The diameter of boreholes for construction of 100 mm, 150 mm & 200 mm finished nominal diameter gravel packed tube wells shall be 300 mm, 350 mm and 400 mm respectively exclusive of pipe wall thickness. The thickness of the gravel shroud around the screen shall generally be not less than 10 cm. Such tube wells shall be designated as 300 (100) mm dia, 350 (150) mm dia, 400(200) mm dia gravel packed tube wells.

17.22 The gravel tube packed tube wells shall be constructed only after obtaining the technical clearance of drawing & design of gravel packed tube well from the competent authority.

17.23 The rates for drilling work are inclusive of the collection of samples of soil/rock cuttings not less than 100 grams from different strata to be collected at every 3 meter depth for initial 15 meters depth and at each 10 meters depth after 15 meter and at the change of strata also and depositing the same with the Engineer in charge, duly marked and packed in polythene bags.

17.24 Screen length :-
The length of strainer is usually determined from the thickness of the aquifer encountered. It is not necessary to screen the whole depth of the aquifer and only that depth should be screened, which will be enough theoretically for about 200% of the desired discharge. Wherever a full aquifer has been drilled through, the screened portion of the aquifer may be limited as follows:-

17.24.1 In fine sand gravel aquifers, only 40% of the aquifer need be screened.

17.24.2 In coarse to medium sand grade aquifer, a maximum of 60% of the aquifer be screened.

17.24.3 Thickness of aquifer % of screen length

Less than 7.5	70
7.5 to 15m	75
Above 15m	80

17.24.4 1.5 m long bail plug of M.S. blind pipe with close bottom and lifting hook of 20 mm dia bars or bail plug of approved type shall be provided at the bottom of screen pipe.

17.24.5 Standard slot size for 150 mm dia 4.85 mm thick slotted pipes of slot size 76.2 mmx3.2 mm.
Design pattern (staggered and vertical)

(i) No. of slots per set	3
(ii) No. of sets per row	11
(iii) No. of rows per m	13

	(iv) No. of slots per m	429
	(v) % Area of opening at	22.2% inner face

17.24.6 Slot size 72.5 x 1.6 mm

(i) No. of slots per set	5
(ii) No. of sets per row	12
(iii) No. of rows per m	13
(iv) No. of slots per m	780
(v) % Area of opening at	19.2% inner face

17.25 Lowering of casing pipe:

17.25.1 The lowering and fixing of casing pipe in ordinary tube well and lowering of casing assembly in the gravel packed tube wells shall be done in the presence of authorized representative of the engineer in charge of work.

17.25.2 The contractor shall have to ensure that the slotted pipe strainers are lowered at the proper places. The contractor shall see that the joints of the pipes are rigid, water tight and free from kinks. Immediately after lowering the assembly the contractor shall furnishes a chart showing the aquifers positions in the well and the location ware slotted pipes or strainers are placed.

17.25.3 The G. I. casing pipe to be lowered and fixed in intertrappean formation shall be jointed by welding only. In the case of gravel packed tube well it shall be ensured by the contractor that the slotted pipes or screened pipes shall be lowered in the tube well at the locations of water bearing aquifers as per design. The contractor shall also ensure that joints of the pipes in casing assembly are rigid and water tight and a bail plug is properly fixed in the bottom of casing assembly.

17.26 The development of tube well shall be continued during drilling operation. At the time of flushing by compressor the discharge from tube well during the development process shall also be measured by 'V' notch for yield and shall be recorded on regular intervals for which no separate payment shall be made. In case of gravel packed tube wells, development by compressor for minimum eight hours after completion of drilling of tube well shall be done and paid for.

17.27. The development of ordinary tube wells (other than gravel packed tube well) shall be done by the drilling machines during the drilling operations and no separate payment for development of such ordinary tube wells shall be made. The development of all type of the tube wells shall be done as per IS specification (IS 11189-1985)

17.28 The tube well shall be disinfected after completion of yield test using bleaching powder solution as per the direction of Engineer in charge.

17.29 The installation of hand pump over the tube well shall be carried out as per IS specifications IS 15500 (Part 1 to 8) : 2004.

17.29.1 All the exterior parts of pump coming in contact with the water shall be thoroughly cleaned and dusted with bleaching powder. The hand pump after installation shall be tested for its proper installation by operating it continuously at least for four hour and measuring the rate of discharge from hand pump.

17.29.2 The rates for the item of installation of hand pump and yield test by hand pump given in this unified schedule of rates shall be applicable.

17.29.3 For construction of platform and drain for the hand pump, the contractor shall use only steel plate frame shuttering designed as per the dimensional requirement of platform and drain. This shuttering shall be got approved from the Engineer-in-Charge.

17.30 In case of construction of platforms in areas having black cotton soil, the top thirty centimeters of the black cotton soil shall be excavated and replaced with morrum boulder, duly rammed and watered in layers, prior to the construction of such platforms including drain, pedestal and washing platform. Rates for these works have been provided for in the USOR.

17.31 Rates do not cover labour charges for the installation of submersible pump set as per the yield of the tube well, cast of the submersible pump set, panel board, pipes, obtaining electrical connection for the purpose etc.

17.32 Measurement:

Depth of the bore shall be measured in meter correct to a cm. Length of the casing pipe, slotted pipe shall be measured in running meter correct to a cm. Gravels shall be measured cubic meter deducting the voids.

17.33 Rates:

The rate shall include the cast of the material, labour involved, cost of fuel, depreciation on machinery and tools and plan in all the operation describe in the item.

Annexure: A

DRILLING OF TUBE WELL

1. General:

1.2 Bored wells are tubular wells drilled into permeable layers to facilitate abstraction of groundwater through suitable strainers inserted into the well extending over the required range or ranges of the water bearing strata. There are a variety of methods for drilling such wells through different soil and for providing suitable strainers with gravel shrouding where necessary.

1.3 Bored wells useful for obtaining water from shallow as well as deep aquifers are constructed employing open end tubes, which are sunk by removing the material from the interior, by different methods.

1.3.1 The deeper strata are usually more information and extensive than strata near the surface, so that in regions already explored, deep wells can be sunk with far more certainty of success than is usually the case with shallow wells.

1.3.2 Methods of sinking deep wells are in many respects different from those already described and matters of spacing, pipe friction, arrangement of connections, etc., are much more important than in the shallow wells.

1.4 For bored wells, the hydraulic rotary method and the percussion method of drilling such wells through hard soils are popular. For soft soils, the hydraulic jet method, the reverse rotary recirculation method and the sludge method are commonly used.

2. Direct Rotary Method

2.1 With the hydraulic direct rotary method, drilling is accomplished by rotating suitable tools that cut, chip and abrade the rock formations into small particles.

2.1.1 The equipment used consists of a derrick, suitable cable and reels for handling the tools and lowering the casing into the hole, a rotary table for rotating the drill pipe and bit, pumps for handling mud laden fluid and a suitable source of power.

2.1.2 As the drill bit attached to the lower end of the drill pipe is rotated, circulating mud is pumped down the drill pipe, out through opening in the bit and up the surface through the space between the drill pipe and the walls of the hole. pipe and bit, pumps for handling mud laden fluid and a suitable source of power.

2.1.3 As the drill bit attached to the lower end of the drill pipe is rotated, circulating mud is pumped down the drill pipe, out through opening in the bit and up the surface through the space between the frill pipe and the walls of the hole.

2.1.4 The mud laden fluid removes the drill cutting from the hole and also prevent caving plastering and supporting the formation that have been penetrated. For soft and moderately hard materials drilling tools shaped like the tails of a fish, the ‘fishtail bit’ is used. In hard rock a ‘rock bit’ or ‘roller bit’ is substituted. This bit has a series of toothed cutting wheel that revolve as the drill pipe is rotated.

2.2 Water wells drilled by the hydraulic rotary method generally are cased after reaching the required depth, the complete string of casing being set in one continuous operation.

2.2.1 If the water-bearing formation lies so deep that it probably cannot be reached by a hole of uniform diameter, the hole is started one or more sizes larger than the size desired through the water-bearing formation. Separate strings of casing are used as required through the separate sections of the hole.

2.2.2 If the formation is so well consolidated that the hole will remain. Open without casing, a well may be finished with one string of casing and well screen.

2.3 This method is most suitable for drilling deep holes in unconsolidated formations. It is unsuitable for drilling in boulders and hard rocks due to slow progress and high cost of bits.

2.3.1 It is also unsuitable for drilling in slanted and fissured formations and serious lost circulation zones. Mud drilling is harmful in low pressure formations due to mud invasion.

2.3.2 The hydraulic rotary drilling generally requires large quantity of water which may have to be brought from long distances, if not locally available. Because of adding large quantities of water and sand or clay to the drill cutting, the hydraulic rotary method is less suitable for obtaining accurate logs of the strata encountered.

2.4 A recent advance is the use of organic drilling fluids instead of inorganic and permanently gelatinous clays such as bentonite. The organics are almost completely self-destructive within a period of few days which means no drilling mud's are left in the pores of the aquifer and, therefore, almost always higher yield are obtained with accompanying lesser development expenditures. In addition to higher specific capacities, cleaner holes (More cutting settle on the surface equipment) and faster drilling rates also result.

3. Percussion Method

3.1 In the percussion method of drilling, the hole is bored by the percussion and cutting action of a drilling bit that is alternately raised and dropped. The drill bit, a club like, chisel-edge tool, break the formation into small fragment, and the reciprocating motion of the drilling tools mixes the loosened material into a sludge that is removed from the hole at intervals by a bailer or a sand pump.

3.1.1 The drilling tools are operated by suitable machinery; which is usually of the portable type mounted on a truck or a trailer so that it can be moved readily from job to job.

3.1.2 This method is best suited for drilling on boulder, slanted and fissured formation and lost circulation zones. Rate of drilling in alluvial formation,

particularly those having clay or sticky shale strata, is much lower as compared to direct or reverse rotary method.

3.1.3 Percussion drilling in hard rock is a slow process and is being gradually replaced by pneumatic rotary drilling because of economy and speed of completion regardless of the higher initial cost.

3.2 **'Pneumatic Drilling'**

Pneumatic drilling with top-hammer and eccentric bit and pneumatic drilling with down the-hole hammer are the two principal method available for drilling in consolidated (hard rock) formation:

3.2.1 **Down-the-Hole Hammer**

3.2.1.1 This drilling method, called DTH for short; permits rapid and effective drilling in rock and through over-burden which is not susceptible to collapse. In this method the impact mechanism blows directly on the drill bit and accompanies it down into the hole compressed air for the impact mechanism is supplied through drill tubes which are jointed as required as the drilling advances.

3.2.1.1.1 The same air is, after it has passed the hammer, made use of for flushing. The necessary rotation is supplied from a rotation unit connected to the upper drill tube.

3.2.1.2 As the drill tubes are not required to transmit the violent impact energy of the hummer, they can be manufactured with large diameter and still be relatively thin walled.

3.2.1.2.1 This gives the method better flushing characteristics than conventional top hammer drilling. Theoretically the rate of penetration is independent of the hole depth with the DTH method no water is required during drilling. The equipment is also cheaper and lighter as a much smaller compression is required than for top hammer drilling.

4. Casing of wells

4.1 Well in soft soils must be cased throughout. When bored in rock, it is necessary to case the well at least through the soft upper strata to prevent caving. casing. Casing is also desirable for the purpose of excluding surface water and it should extend well into the solid stratum below. Where artesian conditions exist and the water will eventually stand higher in the well than the adjacent groundwater, the casing must extend into and make a tight joint with the impervious stratum; otherwise water will escape into the ground above.

4.2 If two or more water bearing strata are encountered, the water pressures in different strata are likely to be different, that from the lower usually being the greater.

4.2.1 Where different pressures thus exist, it is only possible to determine their amount by separately testing each stratum as reached, the others being cased

off. This operation is an essential part of the boring and should be carefully performed. Important differences in quality and yields are discovered in this way.

4.3 When quality stratification exists, which may be ascertained from geophysical logs or drill-stem rests, blank casings should be provided against zones containing undesirable quality of water and the annular space between the casing and hole wall should be sealed with cement grout or packers. This will ensure that the fresh water aquifers are not contaminated by leakage.

4.4 Large casing is generally made of welded or riveted steel pipe. For smaller sizes of pipes which are to be driven, the standard wrought iron pipe is ordinarily used, but for heavy driving extra strong pipe is necessary.

4.4.1 The life of good heavy pipes is ordinarily long but they are liable to rapid corrosion due to the presence of excess amount of carbonic acid. The use of rust resisting alloys would be economical is such special cases. Non-reinforced plastic, usually PVC, casing up-to 100 mm dia and reinforced plastic casing and fiber glass for longer dia up to 400 mm are coming into vogue.

5. Well Strainer and Gravel Pack

5.1 In providing the strainer arrangement are constructed whereby water is admitted and sand or gravel excluded, it is desirable to make the openings of the strainer as large as practicable in order to reduce friction, while at the same time preventing entrance of any considerable amount of sand.

5.2 The openings in well strainers are constructed in such a fashion as to keep unwanted sand out of the well while admitting water with the least possible friction.

5.2.1 In fine uniform strata, the opening must be small enough to prevent the entrance of the constituent grains. Where the aquifer consists of particles that very widely in size, however, the capacity of the well is improved by using strainer opening through which the finer particles are pulled in to the well, while the coarser ones are left behind with increased void space.

5.2.2 A graded filter is thereby created around, with the aid of back-flushing operations or by high rates of pumping.

5.3 The selection of the well screen is important on it depends the capacity and the life of the well. The size of the openings may be selected, after a study of the mechanical analysis of the aquifer, to permit the passage of all fine particles representing a certain percentage, by weight, of the water-bearing material.

5.3.1 It is common practice to use openings that will pass about 70 percent or more of the sand grains in the natural aquifer whose uniformity coefficient should range between 2 to 2.5. For soil with a uniformity coefficient less than 1.5, gravel shroud should be used.

5.3.2 The shape of the openings should be such as to prevent clogging and bridging, which can be diminished by V-shaped openings with the larger end towards the inside of the well. Long, narrow, horizontal or vertical slotted pipes are preferred for large diameters. The openings should be placed as close together as the strength of the screen will permit.

5.4 The total area of the openings in a screen should be such as to maintain an entrance velocity less than necessary to carry the finest particle of sand that is to be excluded by the screen.

5.4.1 In general, it should be less than about 4 to 6 cm per second with gravel shrouding. It is generally desirable that the length of the screen is made slightly less than the thickness of the aquifer penetrated and placed centrally in respect of the aquifer.

5.4.2 The length, diameter and total area are inter-dependent dimensions that must be adjusted to give the desired entrance velocity. Some margin of safety in screen size is desirable to allow for incrustation and clogging and to prolong the life of the screen.

5.5 Where the water-bearing sand stratum contains little or no gravel, it is very advantageous to insert a layer of fine gravel between the strainer and the sand strata, thus permitting the use of larger orifices in the strainer and greatly decreasing ground friction.

5.5.1 The gravel wall so provided may very in the thickness to suit the size and depth of the boring. It may very from 10 cm to 25 cm, but it is usually 10 cm. The size of the gravel to be provided would be decided by the particle size distribution in the layer penetrated and the slot size in the well screens proposed to be adopted.

5.5.2 Since screen sizes can now be custom-tailored to fit any grading of desired gravel, there is a shift from the former multiple (Concentrically placed) gravel packs to single ones.

5.6 Well effectiveness and performance may be adversely affected if the gravel pack ratio, that is, the mean size of gravel divided by mean size of formation material, exceeds 5. Beyond this limit, wells may require longer time for development or, if the ratio is excessive, they may turn out to be sand pumpers ultimately resulting in failure. The gravel size should be related to the size of the formation material in the finest section of the aquifer material against which screen is provided.

5.7 In gravel packed wells the screen size should be related to the gravel in about the same manner as it is related to the aquifer material in a non-gravel pack (for natural pack) well, i.e. it should correspond to the size that separates 90 percent of coarser fractions of gravel.

5.7.1 **Bimetal strainers**

For small driven tube wells generally of 3 cm to 5 cm dia, the strainers are generally of bimetal-sometimes called jacketed strainers. It consist of a galvanized iron pipe with about 300 rectangular slots of 1 cm x 1 ½ cm in a standard length of pipe of 1.8 m, having an area of opening of about 17 % covered with a brass wire-mesh or 24 or 32 mesh which again is enveloped by a perforated brass metal sheet of 26 gauge, having about 2 to 3 holes of 3 mm dia per cm^2 or an area of opening of about 18.5 %. The effective area of opening resulting is roughly 5 to 7 %. These are available up to 150 mm dia. Gravel shrouding is not essential for this type of strainer.

5.7.2 **Monometal strainers**

The monometal type is of a single metal with diameters in the range 30 mm to 300 mm usually fabricated from brass sheets 2 or 3 mm thick. These have V-shaped slots of varying sizes to permit a proper selection of strainer to suit the sand size in the aquifer. Slot 2.5 mm wide and 30 mm long are usual.

5.7.2.1 A thin gravel shroud (50 to 75 mm) is also provided in some cases. Some times the brass monometal strainer is strengthened with an inner G.I. slotted pipe for greater rigidity and longer service.

5.7.3 **Slotted pipe strainers**

5.7.3.1 Galvanized iron or brass pipes having bigger slots about 3 mm in width and 750 mm length are provided in conjunction with pea gravel shroud, 100 mm to 250 mm thick.

5.7.3.2 The slots are V-shaped with the smaller opening on the outside. The gravel shroud makes it possible to use strainers with large sized slots and abstract a larger sized slots and abstract a larger yield than is otherwise possible. The slots are preferably to be kept horizontal with un-slotted strips left between successive rows or columns of slot.

The advantage with this type of strainer over the other is that there is less damage by galvanic action or chock age due to incrustation.

5.7.3.3 Strainers of different makes are marketed claiming specific advantage for each. One such is a slotted mild steel pipe or, coated with special anti-corrosive plastic paint and provided with an enveloping graded sand shroud bounded with heat resistant, water repellant Plastic.

5.7.3.4 Strainers made of special alloys such as stainless steel (type 304 and 316), monelmatel red brass etc., are also used where indicated and if available.

5.7.3.5 High density polythene or PVC and metal combined strainers are gaining popularity in view of their non-choking, non-corroding and non-incrusting properties which give long and uninterrupted service.

5.7.3.6 Lowering of well assembly:

5.7.3.6.1 The contractor shall develop the well with his own equipment by such as would extract maximum practical quantity of sand, drilling and unwanted fine material in order to bring the well to maximum yield per m of draw down and to sand free condition. Compressed air, surge block or pump may be used for development work. This work must be done in a manner that does not cause undue settlement and disturbances of the strata's above the water bearing formation.

5.7.3.6.2 The well shall be developed either by surging and agitating or by over pumping and back washing with an airlift and high velocity jetting, etc. any other acceptable method may also be adopted. This development process shall be continued until the stabilization of sand and gravel pack has taken place.

5.7.3.6.3 The development of the tube-well by over-pumping should be done at 15% to 25 % higher discharge than the expected discharge from the tube-well. The final discharge should be free form sand with a maximum tolerance of 20 parts of sand in one million part of water by volume after 20 minutes of starting the pump.

5.8 Abandoned wells- A well declared as abandoned by the Engineer-in-charge due to non-verticality, caving in or any other defects attributable to the poor workmanship of the contractor, unsuitability of his equipment shall be termed abandoned well. No payment for this shall be due to the contractor. In such a case, the well assembly if lowered (complete or incomplete) will have to be pulled out and retrieved by the contractor at his own cost.

5.9 Erection of Pump and Accessories.- The contractor shall install in the tube well suitable pump and motor and their accessories as may be supplied from sub-divisional stores by the Engineer-in-charge. The store will have to be lifted from sub-divisional stores by the contractor, labour charges only will be paid for erection work. Contractor shall very carefully and diligently do the work of erecting all the components in the pump assembly such as:-

(1) Pump.
(2) Motor.
(3) Column pipe, delivery pipes, bends, valves etc.
(4) Electric water level guard with signal cable and electrode.
(5) Air line.
(6) Water level gauge.
(7) Pressure gauge.
(8) Irrigation panel.

The column pipes should be truly vertical without any kinds and securely jointed so as to preclude any chances of pump failing and resulting in the well being declared as abandoned in cases of the pump cannot be retrieved.

5.10 Disinfection:

5.10.1 The well shall be disinfected as per requirements, after completion of test for yield. All the exterior parts of the pump coming in contact with the water shall

be thoroughly cleaned and dusted with powdered chlorine compound. In fact it should be disinfected every time a new pump is installed or the one replaced after repair.

5.10.2 A stock solution of chlorine may be prepared by dissolving fresh bleaching powder. For obtaining an applied standard concentration of 50 ppm, 1 liter of the stock solution shall be used to treat 300 liters of water.

ANNEXURE-2

STRATA – CHAT

Name of local body ……..……District ……..

Ward Number …… Mohalla/Basti……

Name of Contractor ……. Registration no. of machine

Work Order No…… Date ……..

Date of starting of Tube well construction …….

Date of completion of tube well construction ……..

Name of Sub-Engineer in charge of work ……

Measurement Book Number ……..

Exact location of drilling ……..

G		L	Details
Depth		Strata	1. Type of tube well ……..... 2. Diameter of tube well …… 3. Total depth of tube well …… 4. Details of casing pipe Type (G.I./UPVC/BLANK/SLOTTED) Diameter …….. mm Length …….. meter 5. Static water level in the tube well …… 6. Type of pump installed …….. 7. Length of riser pipe installed Type (G.I./UPVC) …… 8. Yield of tube well …… 9. Draw down at above yield ……..

Signature of contractor

Signature of
Sub Engineer
Office……

Signature of
Assistant Engineer
Office ……

ANNEXURE -3

RESISTIVITY SURVEY REPORT

Name of local body ……..……District ……..

Ward Number …… Mohalla/Basti……..

Name of Contractor ……. Registration no. of machine

Work Order No…… Date ……..

Date of Survey ……..

Name of Geohydrologist ……

Model No. & Make of Resistively meter used for sounding ……

Maps (Not to scale) Showing the location of survey point (To be attached separately in A-4 size sheet.

…….? ……	……..	?.....	?.....	…….?	
A		M	O	N	B

DATA SHEET OF FIELD MEASUREMENTS

S.No.	AB/2 Meters	MN/2 Meters	Spacing factor K K = 3.14 (AM/AN)/MN	Measured resistance (OHMS)	Resistively OHM-M

Location

Interpretation Report

Possible Strata expected at the spot

S.No.	Possible Strata Form	Depth below Ground Level		Remark
		To		

Recommendation :-

Signature of Geohyrologist

ANNEXURE-4

YIELD TEST OF TUBE WELLS

Name of local body ……..……District ……..

Ward Number …… Mohalla/Basti……..

Name of Contractor .....…… Registration no. of machine

Work Order No…… Date ……..

Date of yield test ……

Diameter of tube well …… Depth of tube well ……

Static water level in tube well ……

Type and K.W. of pumping set used for yield test ……..

Type of measuring device used for measurement of discharge ……..

Depth at which the pumping set installed ……

Time at which the yield test started ……

Date Sheet of field measurement

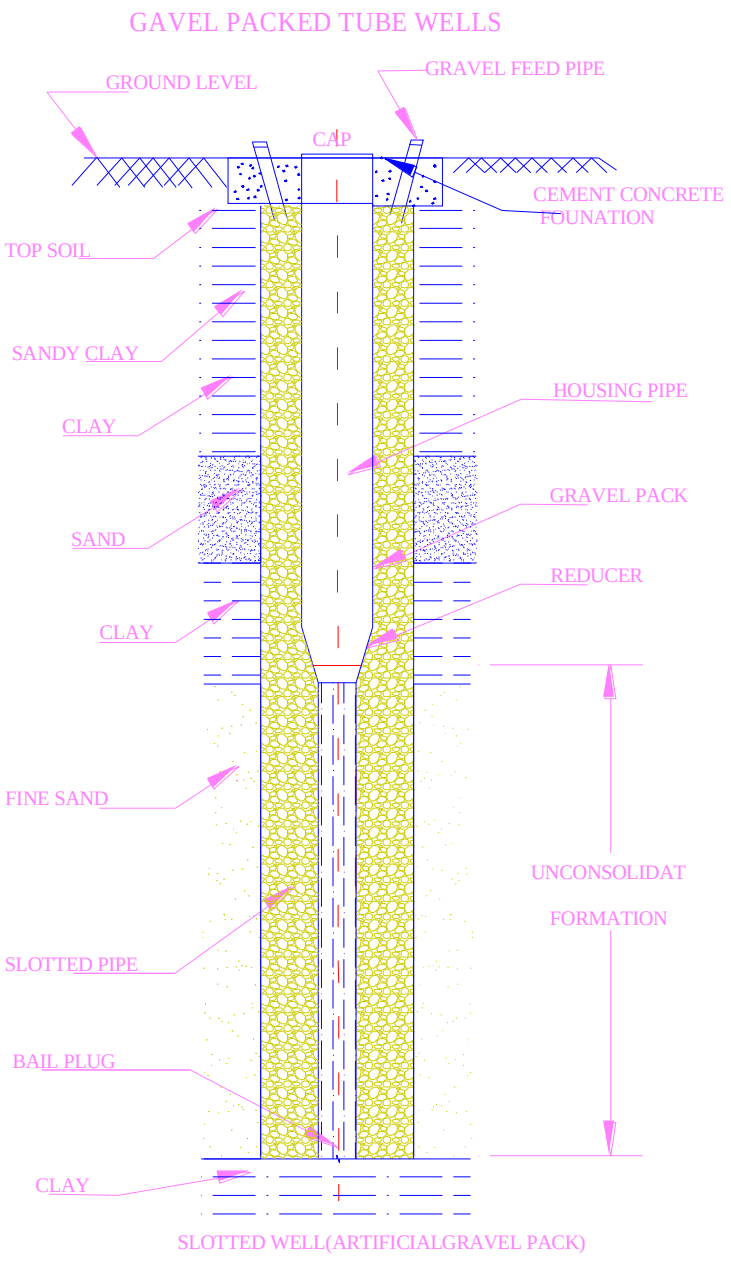
S.No.	Time	Water level in the tube well measured from top of casing pipe	Discharge of tube well
1 2 3			

Signature of Contractor

Signature of Sub-Engineer

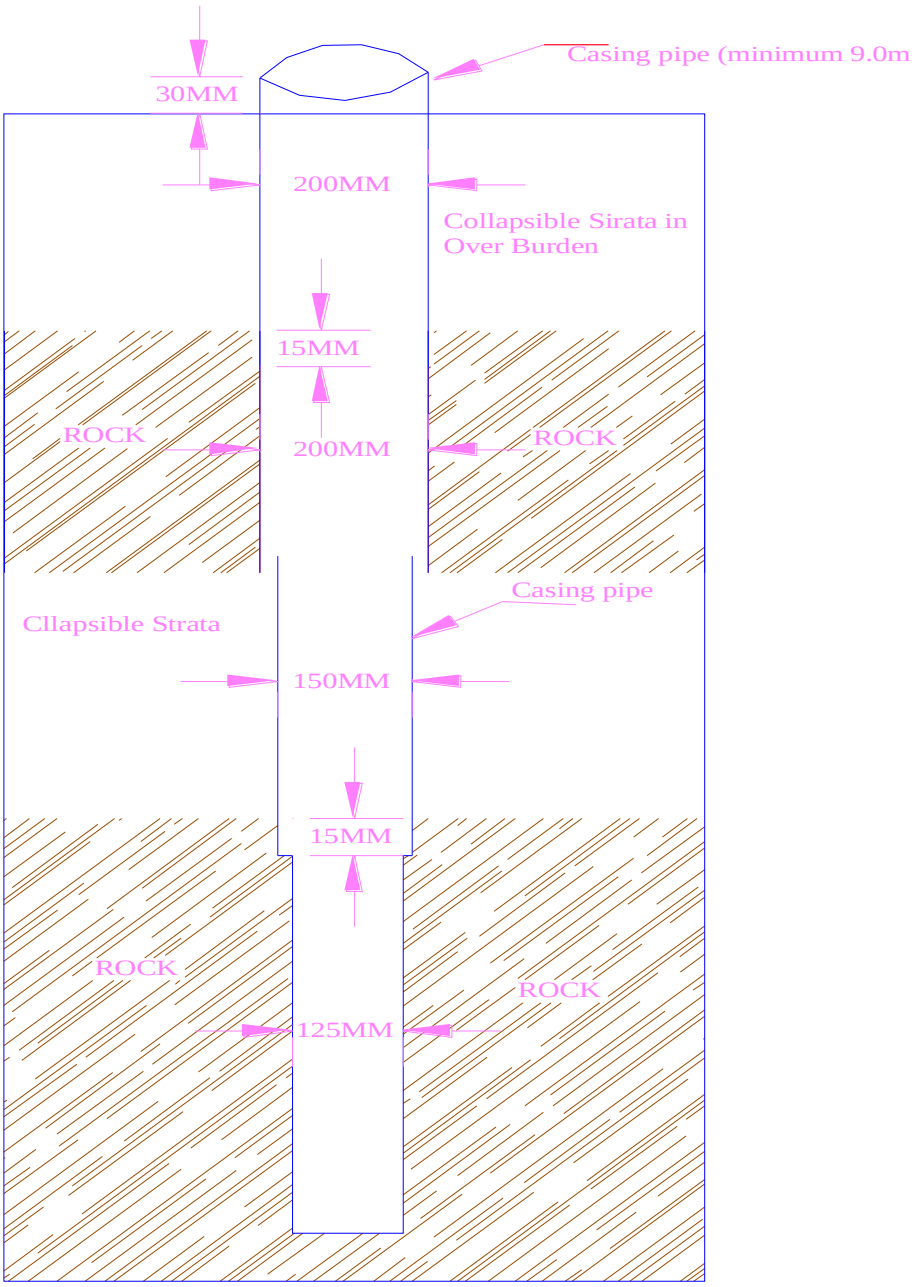
Signature of Assistant Engineer

GRAVEL PACKED TUBE WELLS

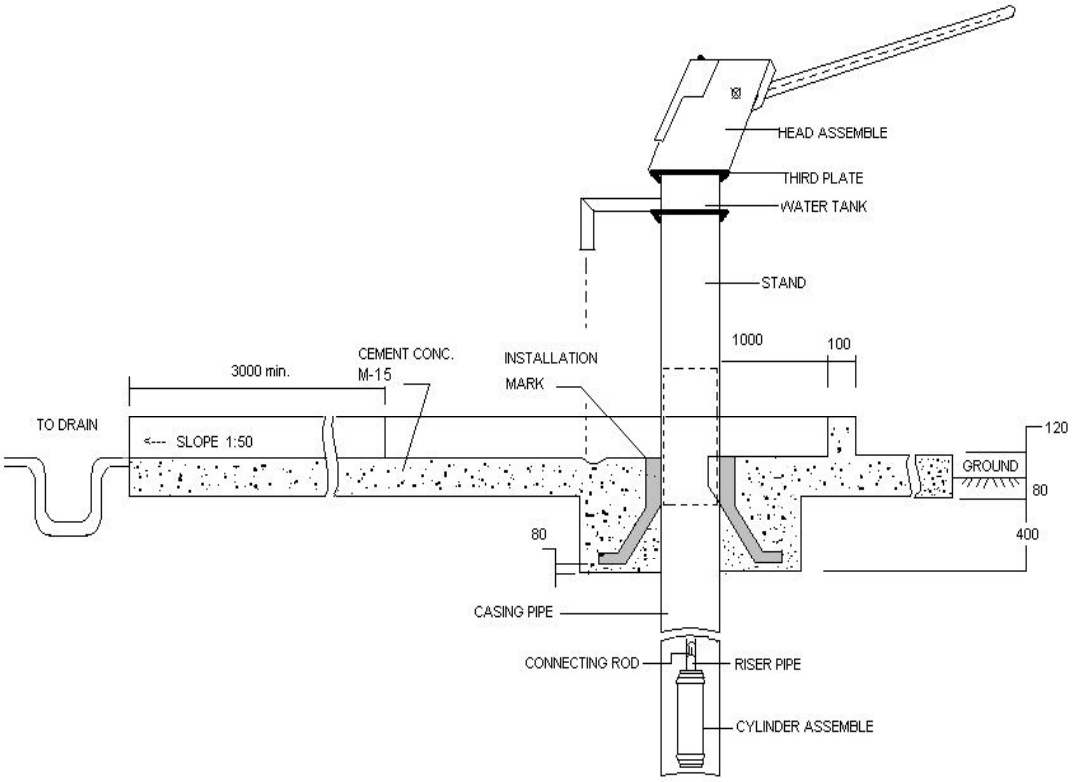


TELESCOPIC TUBE WELL

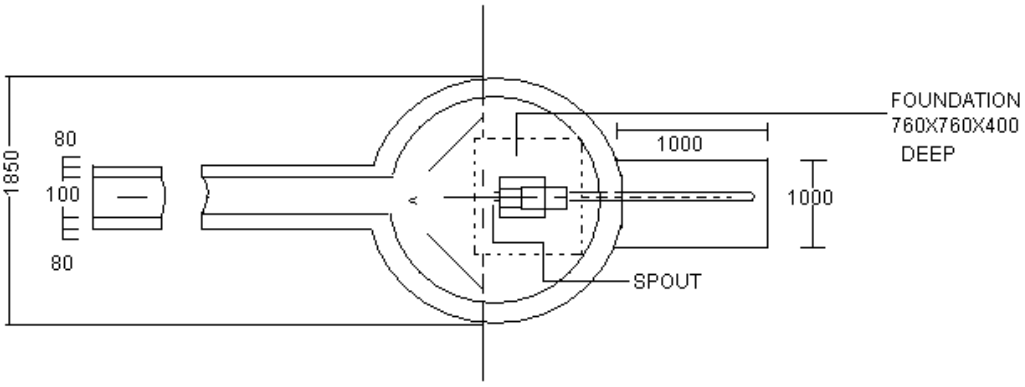
200/150/125mm dia



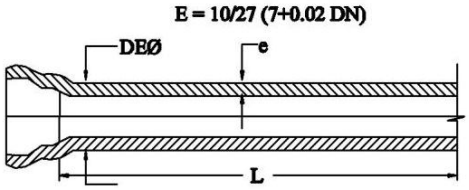
HAND PUMP PLATEFORM



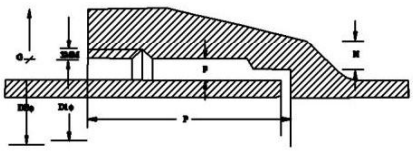
TYPICAL SET-UP FOR HANDPUMP



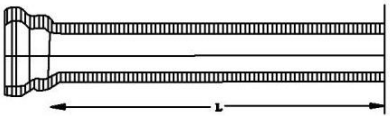
S & S and Flanged Pipes



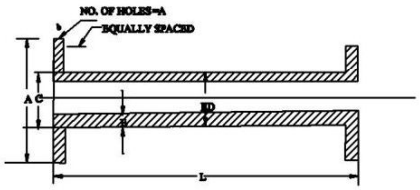
Cantrifugally Cast Socket & Spigot Pipe



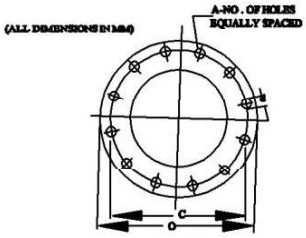
Dimensions of socket and spigot pipes (IS - 1536)

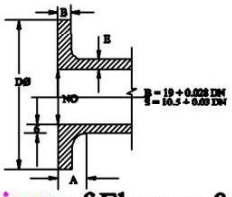


Socket & Spigot Vertical Cast Pipe



Flanged pipes - Vertlically Cast



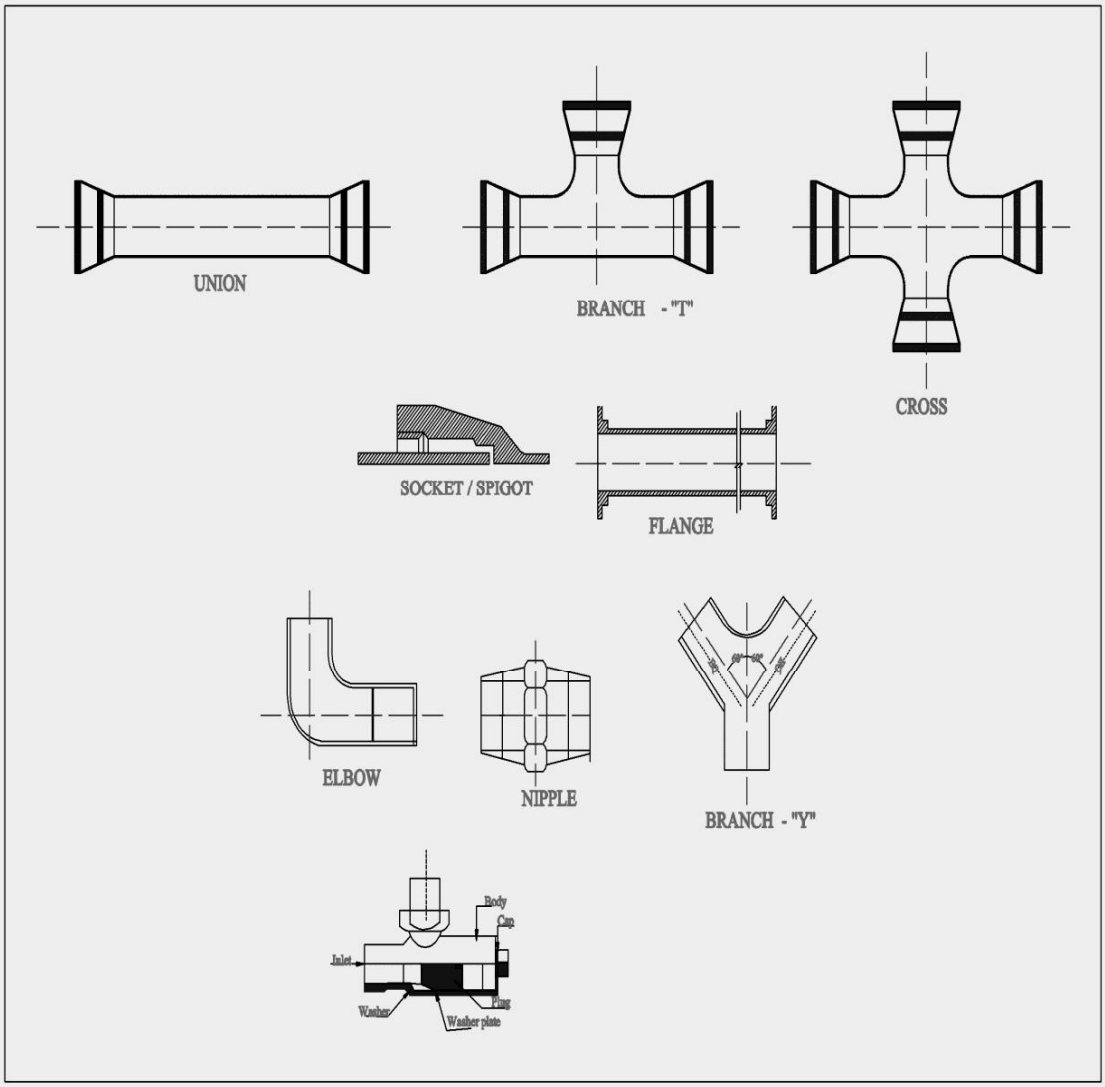


Dimensions of Flanges & Fittings

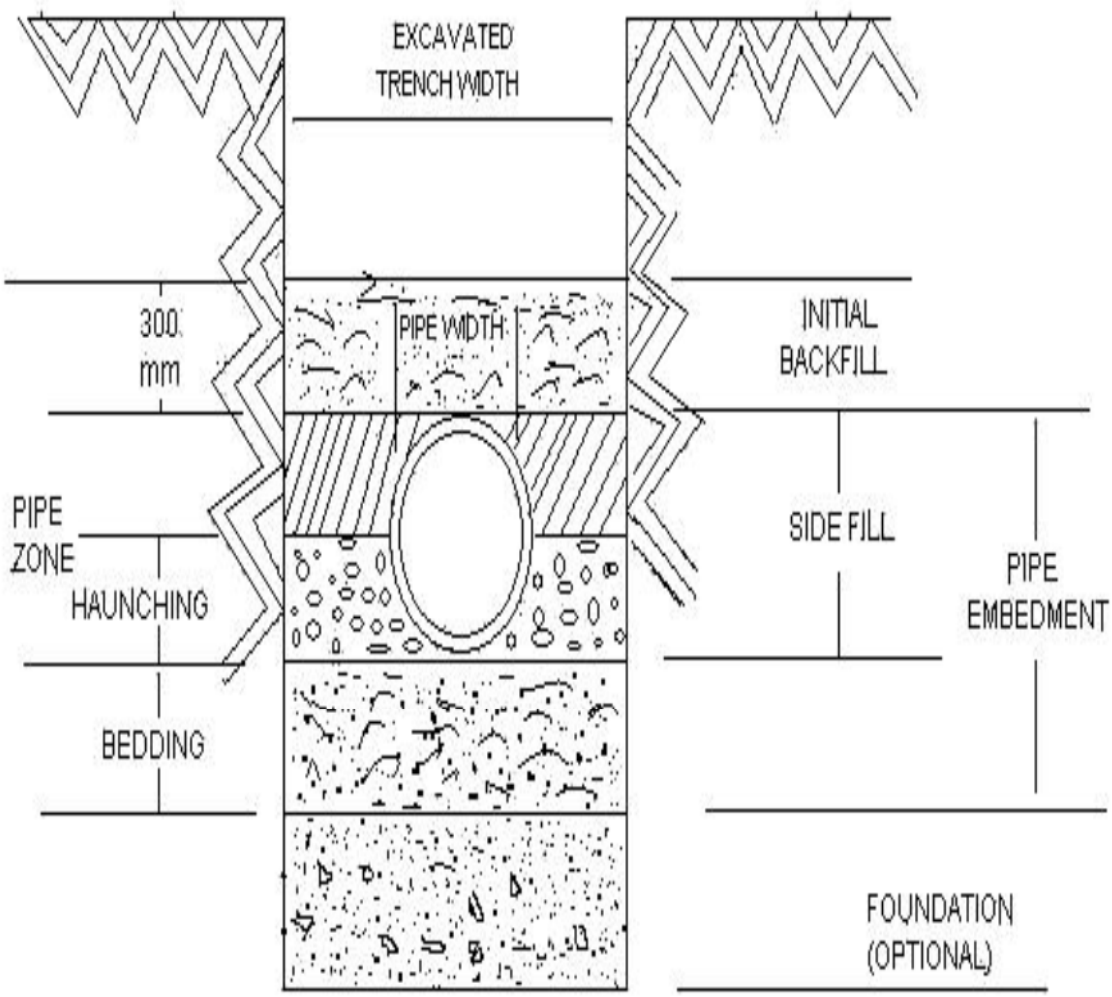
Standard Flange Drilling of Flanged pipe

Drawing No.-1

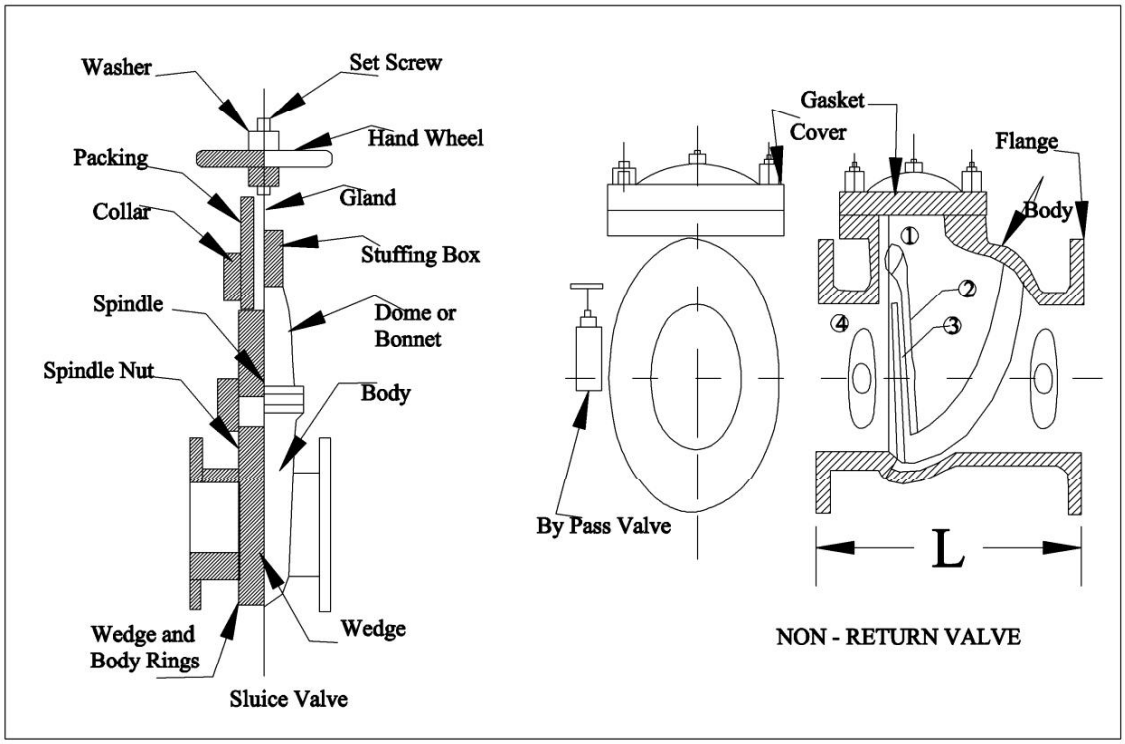
Fittings & Specials



Drawing No.-2

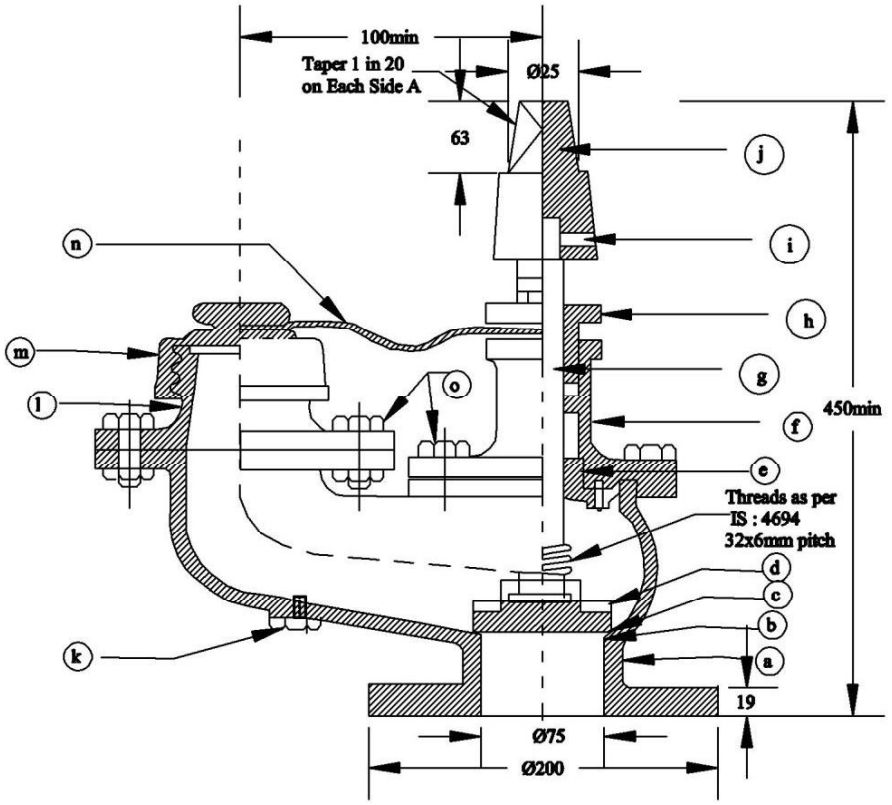

EXCAVATED
TRENCH WIDTH
300
mm
PIPE WIDTH
INITIAL
BACKFILL
PIPE
ZONE
HAUNCHING
SIDE FILL
PIPE
EMBEDMENT
BEDDING
FOUNDATION
(OPTIONAL)

Sluice Valve & Non - Return Valve



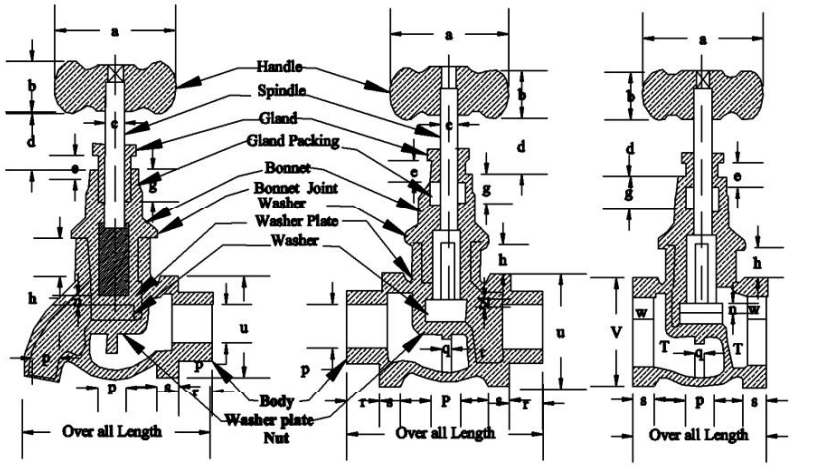
Drawing No.-4

Underground Fire Hydrant, Sluice Valve Gate



NO.	DESCRIPTION	MAT.	MAT. SPECIFICATION
a	Body	C.I.	IS 210-1972 FG -200
b	Valve seat	G.M.	IS 318-1981 LTB -2
c	Washer	Rubber	IS 937-1981
d	Valve	G.M.	IS 318- 1981 LTB - 2
e	Spindle nut	G.M.	IS 318 -1981 LTB - 2
f	Bonnet	C.I.	IS 210 - 1978 FG - 200
g	Spindle	Brass	IS 319 - 1989
h	Gland	C.I.	IS 210 - 1978 FG - 200
i	Grush screw (12mm)	M.S.	IS 6094 - 1981
j	Spindle cap	C.I.	IS 210 -1978 FG - 200
k	Drain bolt	M.S.	-
l	Outlet	G.M.	IS 318 - 1981 LTB -2
m	Cap	C.I.	IS 210 - 1978 FG - 200
n	Chain	Gal.MS.	-
o	Nut and Bolt	M.S.	-

Bib Taps & Stop Valves



BIB TAP | EXTERNALLY THREADED STOP VALVE | INTERNALLY THREADED STOP VALVE

ALL DIMENSIONS IN MILLIMETERS

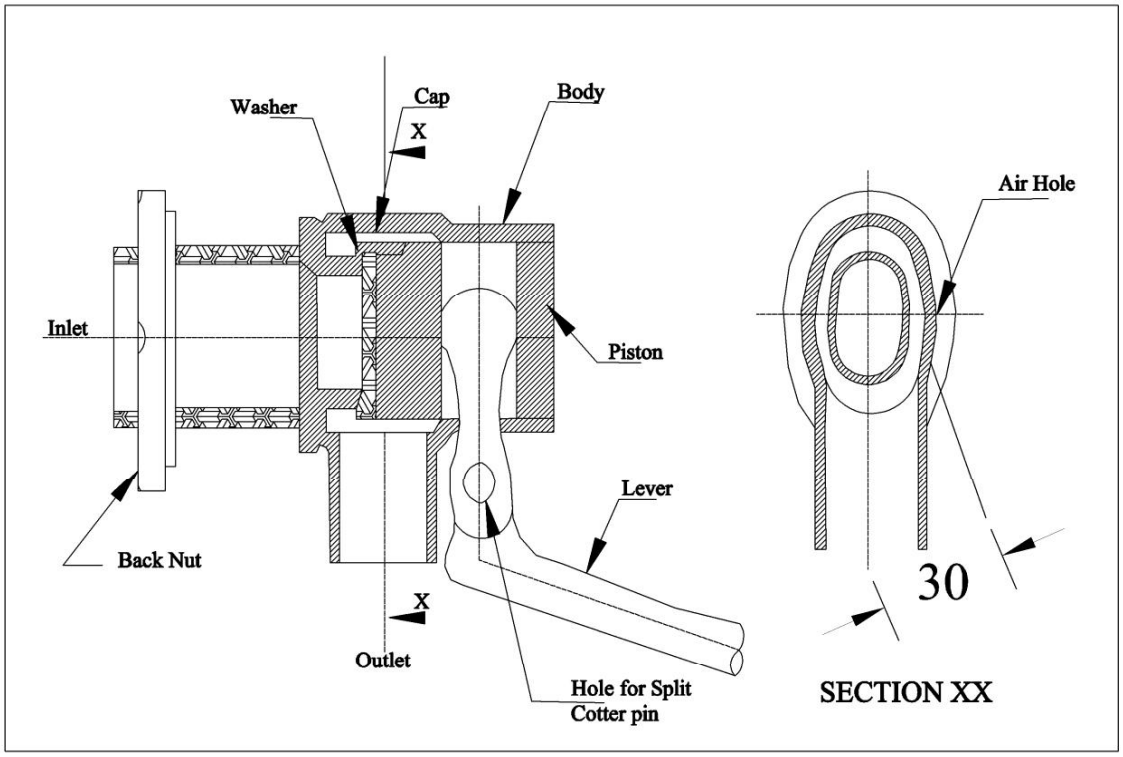
Nominal sizes	Dimensions. Min.																					Lift of washer plate (with washerin position.
	a	b	c	d	e	f	g	h	i	k	l	m	n	p +0.0 -0.5	q	r	s	t	u	v	w	
8	47.8	13.3	7.8	16.5	6.3	2.0	7.9	7.0	3.8	10.0	M20x1.5	14.3	2.8	6.5	2.4	11.0	4.7	1.6	15.2	19.5	7	3.5
10	54.0	14.0	9.4	18.7	7.5	2.0	9.5	9.5	4.7	11.5	M20x1.5	15.9	3.2	9.0	3.2	11.4	7.9	2.0	20.8	23.3	7	4
15	54.0	14.0	9.4	19.0	7.5	2.0	9.5	11.0	5.6	11.5	M24x1.5	19.0	3.2	13.0	4.1	15.0	9.5	2.0	25.6	28.3	9	4.6
20	60.4	15.7	10.9	20.1	8.9	2.5	11.1	12.5	6.4	13.5	M30x1.5	25.4	4.0	18.0	4.9	16.3	10.3	2.0	30.5	33.0	10.5	6
25	66.8	18.0	12.5	23.0	10.1	2.5	12.7	13.0	7.1	17.0	M39x1.5	33.3	4.0	23.0	4.9	19.1	11.0	2.8	37.6	42.4	11.5	7
32	74.6	20.5	14.1	30.9	11.4	2.5	14.3	16.0	7.8	19.0	M48x1.5	40.1	4.3	30	5.9	21.4	12.7	32	47.2	52.1	13.5	9.5
40	82.5	22.0	15.7	33.3	12.7	2.5	15.9	17.5	8.6	20.5	M56x1.5	47.7	5.5	36	6.6	21.4	14.3	3.2	56.4	58.5	13.5	11
50	95.0	25.3	17.3	35.9	14.0	2.5	17.4	17.5	12.5	26.0	M72x1.5	63.5	6.3	46	8.3	25.1	15.9	4.0	70.1	71.5	16.5	14.5

Note

1. Length of thread R includes cut back under hexagon, if any.
2. The values of K are for core diameter.
3. The diameter of U and V are for face to face.
4. The dimenison F is packing space.

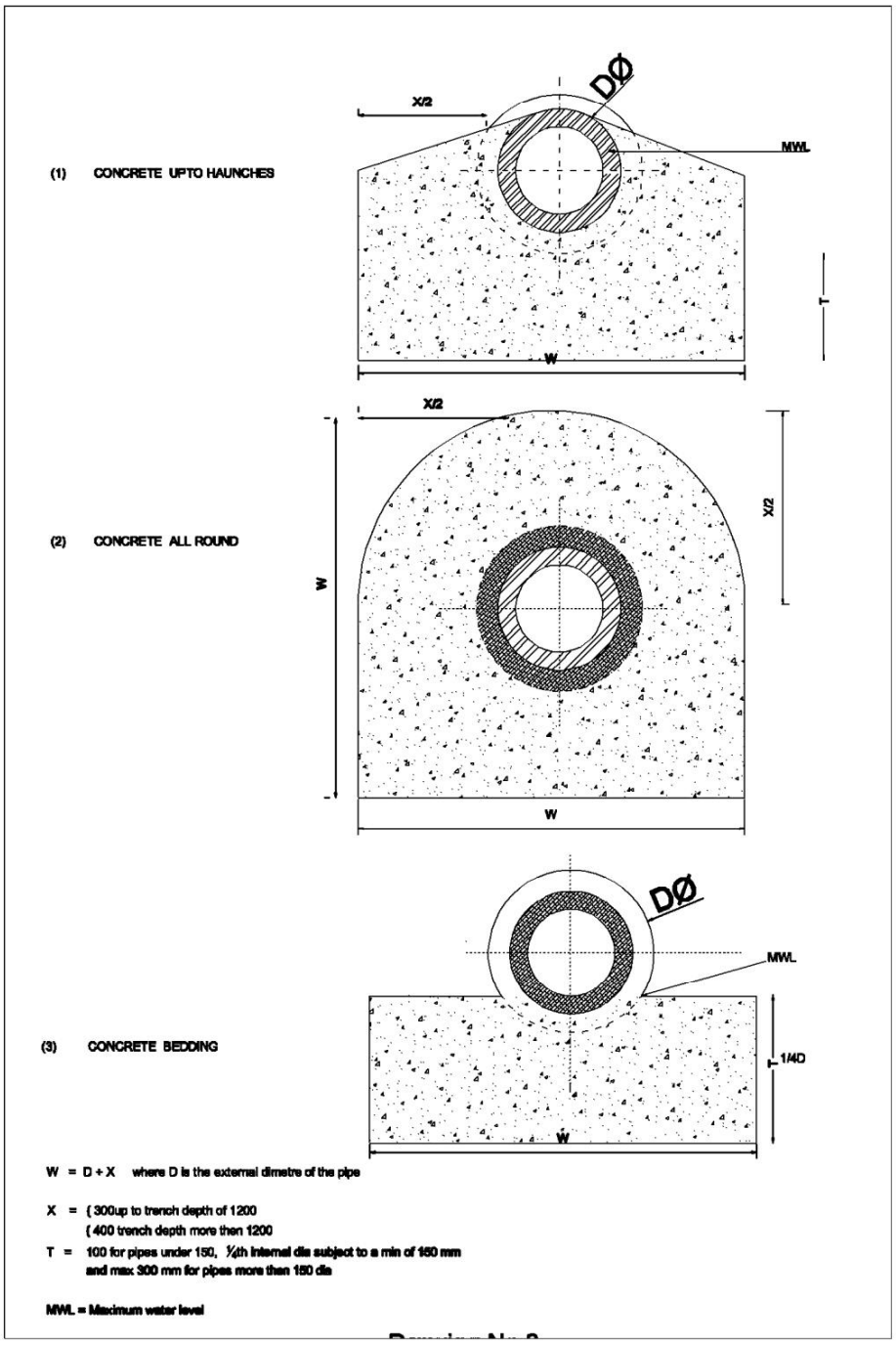
Drawing No.- 6

Ball Valves

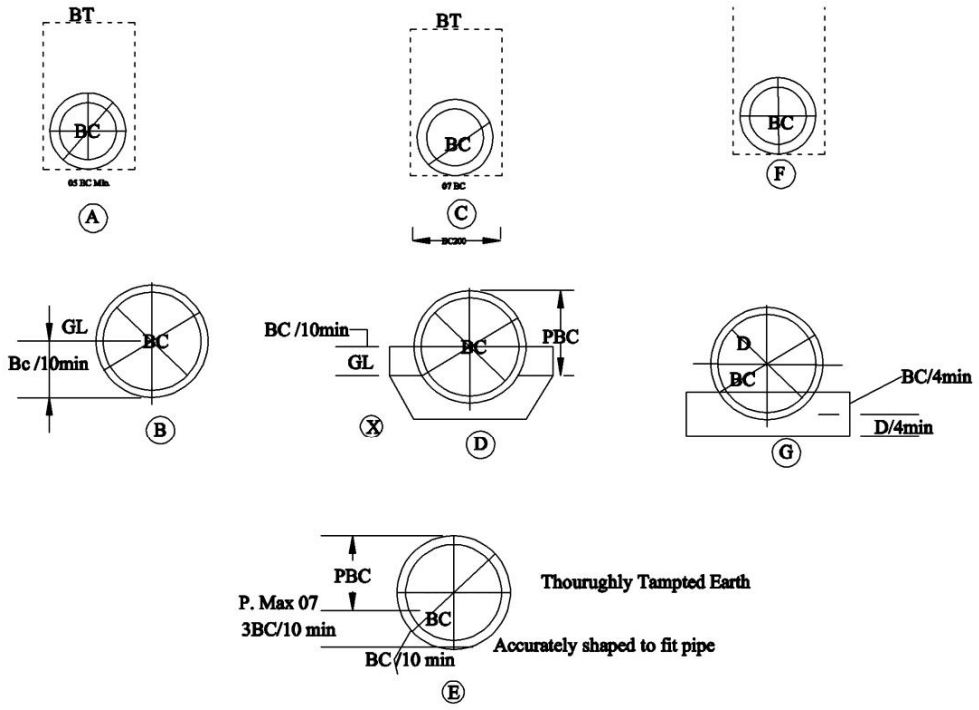


Drawing No.-7

Bedding / Encasing Stoneware Pipes



Bedding of Pipes

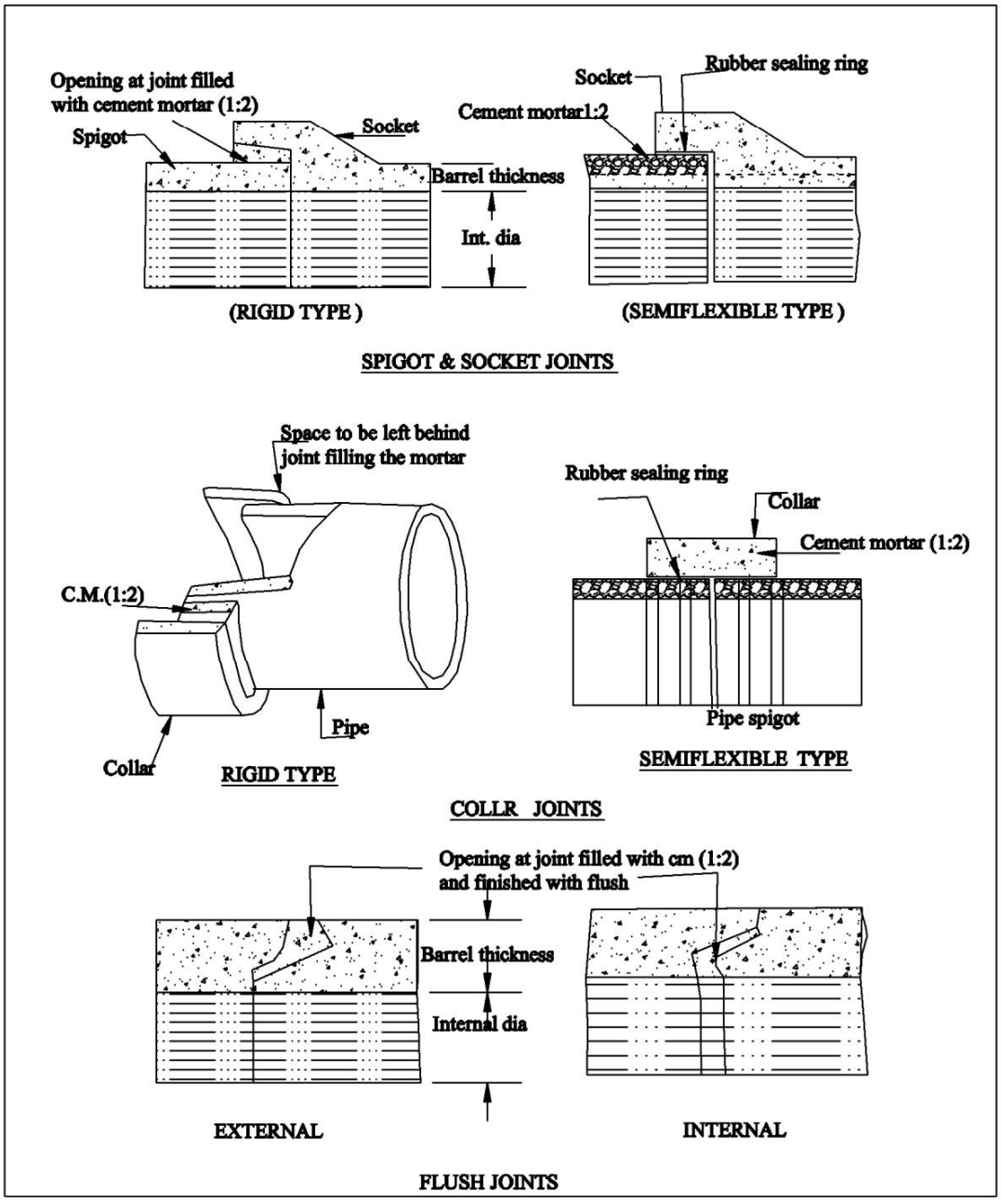


D = internal diameter
BC = horizontal breadth outside of the pipes in meters (i.e. external diameter in case of a circular pipe)
BT = horizontal width of trench immediately below the top of the pipe in meters
h = height of fill above top of pipe in meters
X = min 200 for 'H' <5000 when 'H'> 5000, 10 for every 250 of 'H'

FIG.	BEDDING	LOAD FACTOR
A	Ordinary	1.5
B	—DO—	—
C	First Class	1.9
D	—DO—	—
E	—DO—	—
F	Concrete Craddle	2.25 TO 3.4
G	—DO—	—

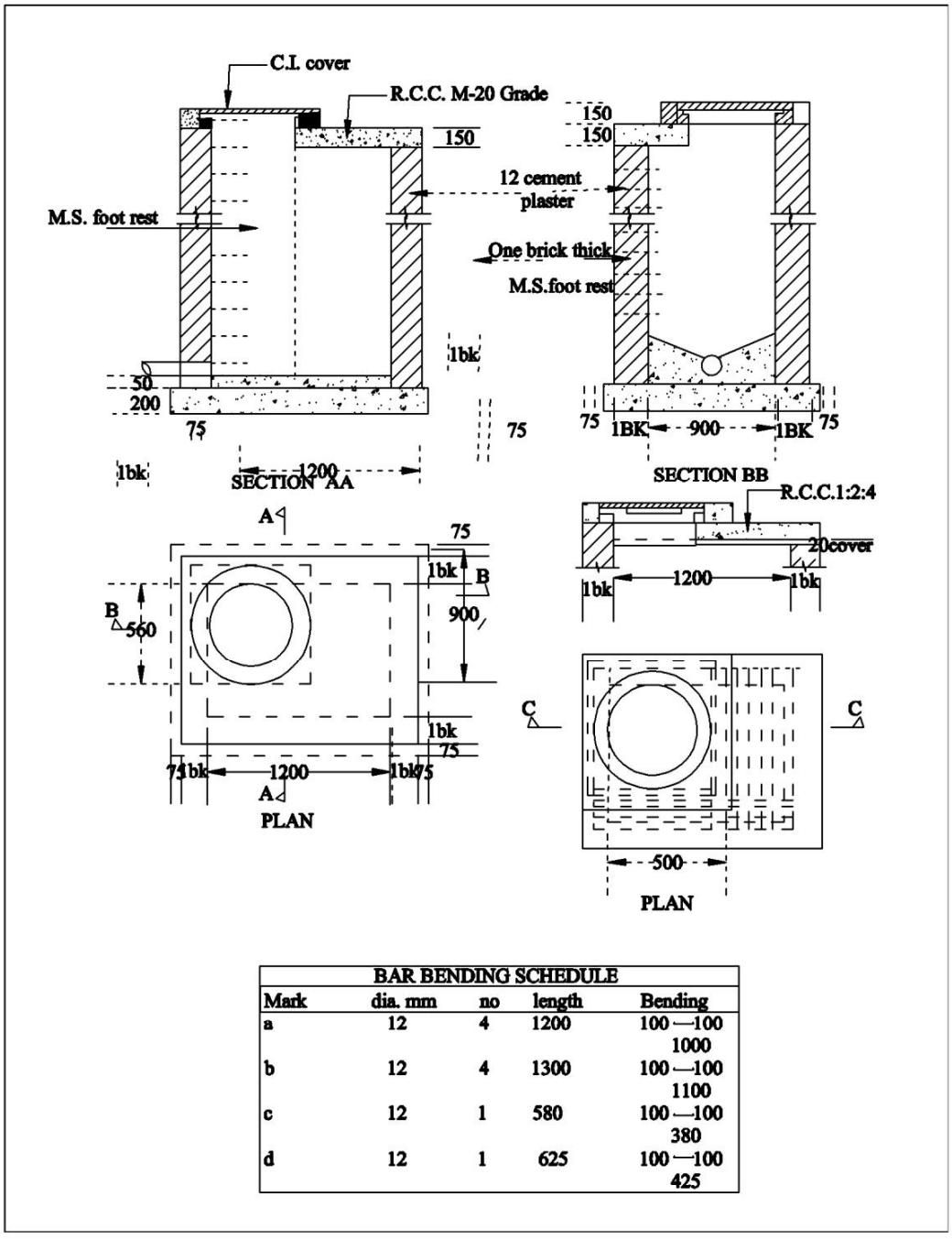
Drawing No.-9

Joints of Concrete Pipes



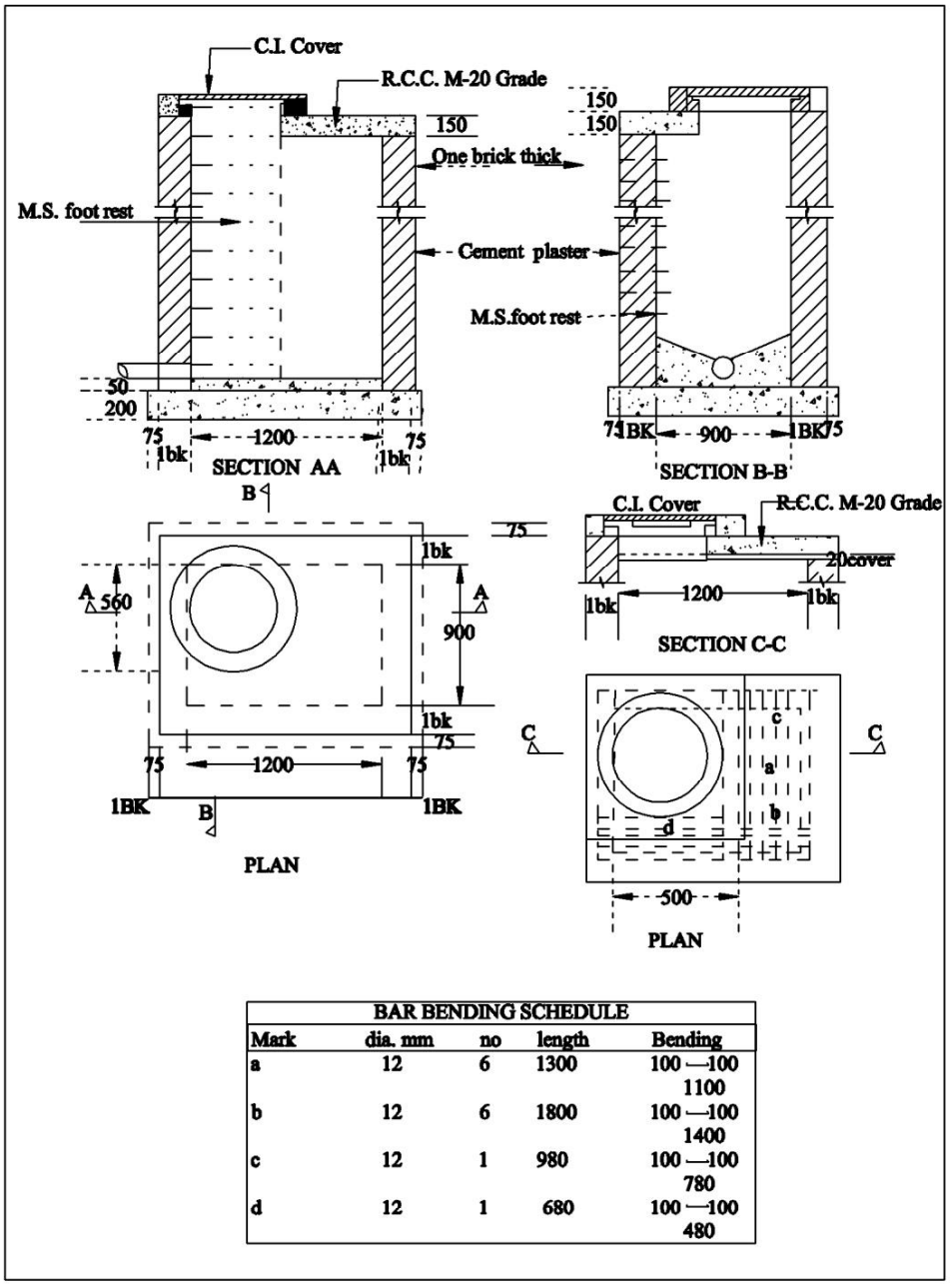
Drawing No.-10

MAN HOLE SIZE 1200 X 900 HEAVY DUTY COVER



BAR BENDING SCHEDULE				
Mark	dia. mm	no	length	Bending
a	12	4	1200	100 — 100 1000
b	12	4	1300	100 — 100 1100
c	12	1	580	100 — 100 380
d	12	1	625	100 — 100 425

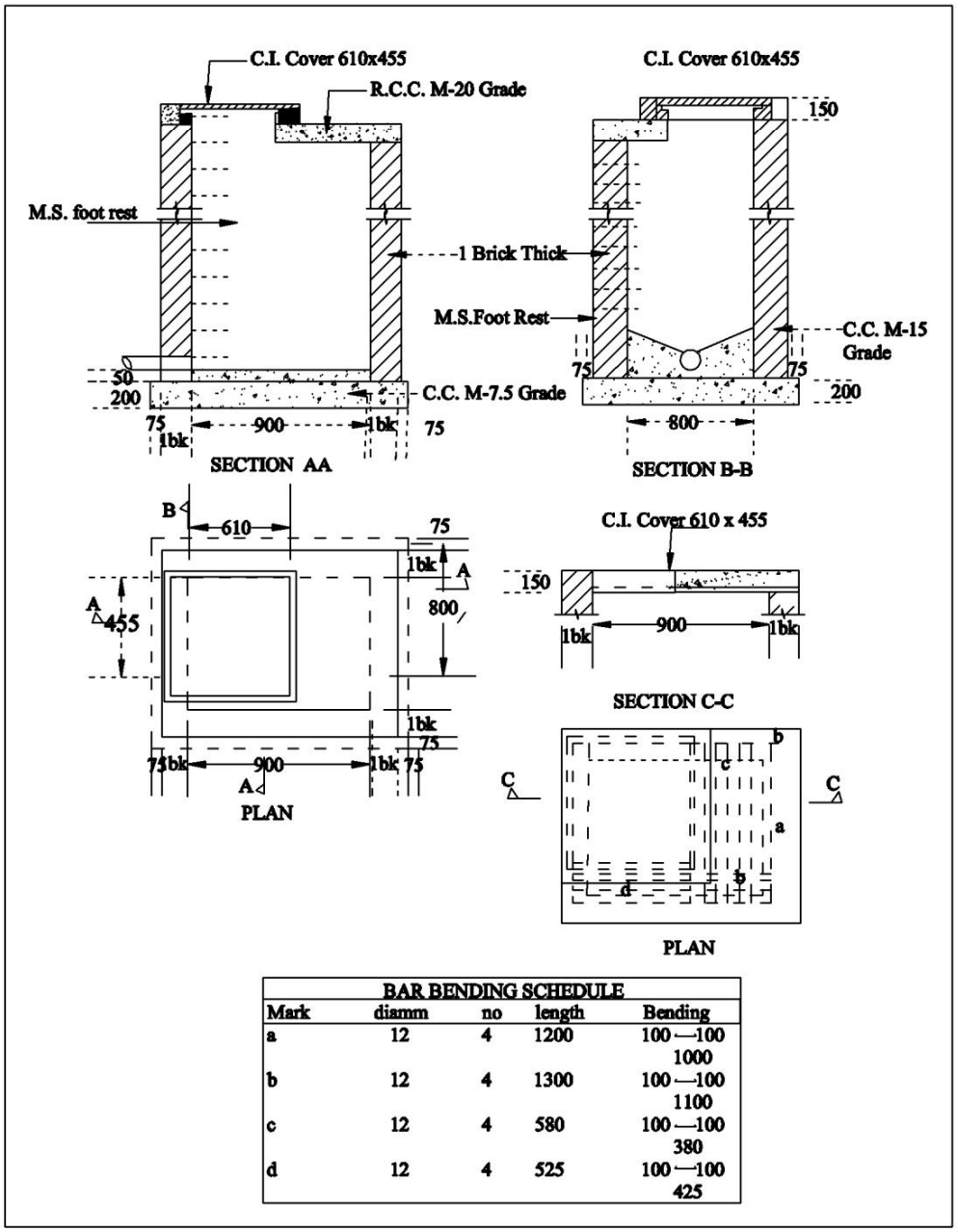
MAN HOLE SIZE OF 1200 X 900 WITH MEDIUM DUTY COVER



BAR BENDING SCHEDULE				
Mark	dia. mm	no	length	Bending
a	12	6	1300	100 — 100 1100
b	12	6	1800	100 — 100 1400
c	12	1	980	100 — 100 780
d	12	1	680	100 — 100 480

Drawing No.- 12

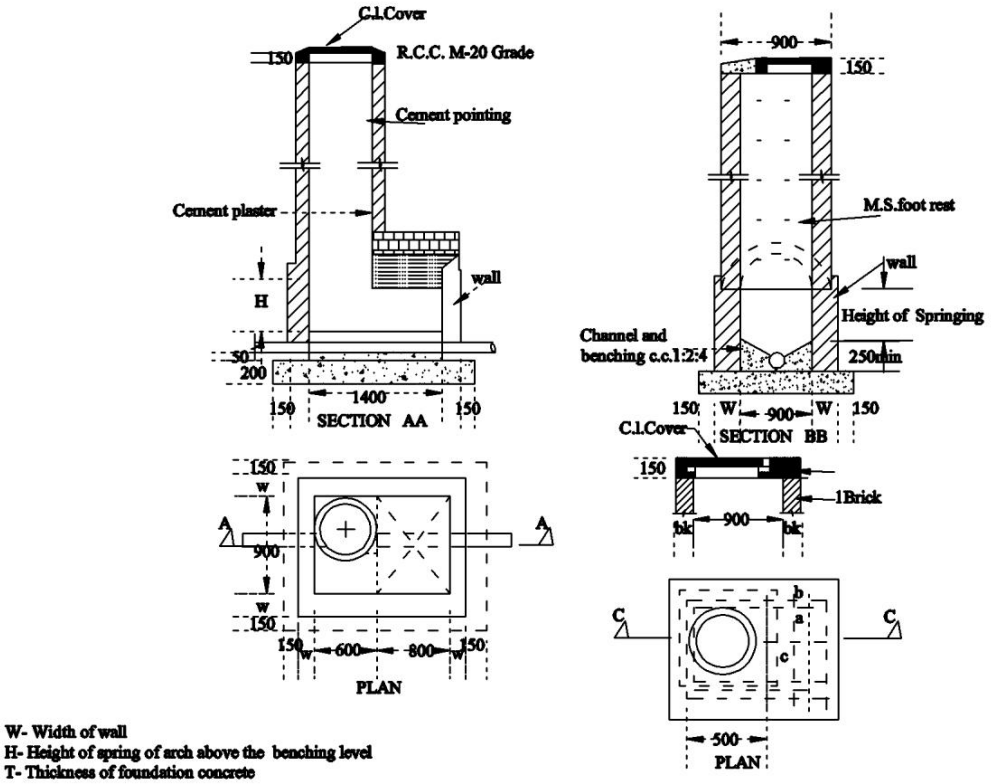
MAN HOLE SIZE 900 X 800 LIGHT DUTY COVER



BAR BENDING SCHEDULE				
Mark	diamm	no	length	Bending
a	12	4	1200	100 — 100 1000
b	12	4	1300	100 — 100 1100
c	12	4	580	100 — 100 380
d	12	4	525	100 — 100 425

Drawing No.-13

MAN HOLE ARCHED TYPE 1400X900



W- Width of wall
H- Height of spring of arch above the benching level
T- Thickness of foundation concrete

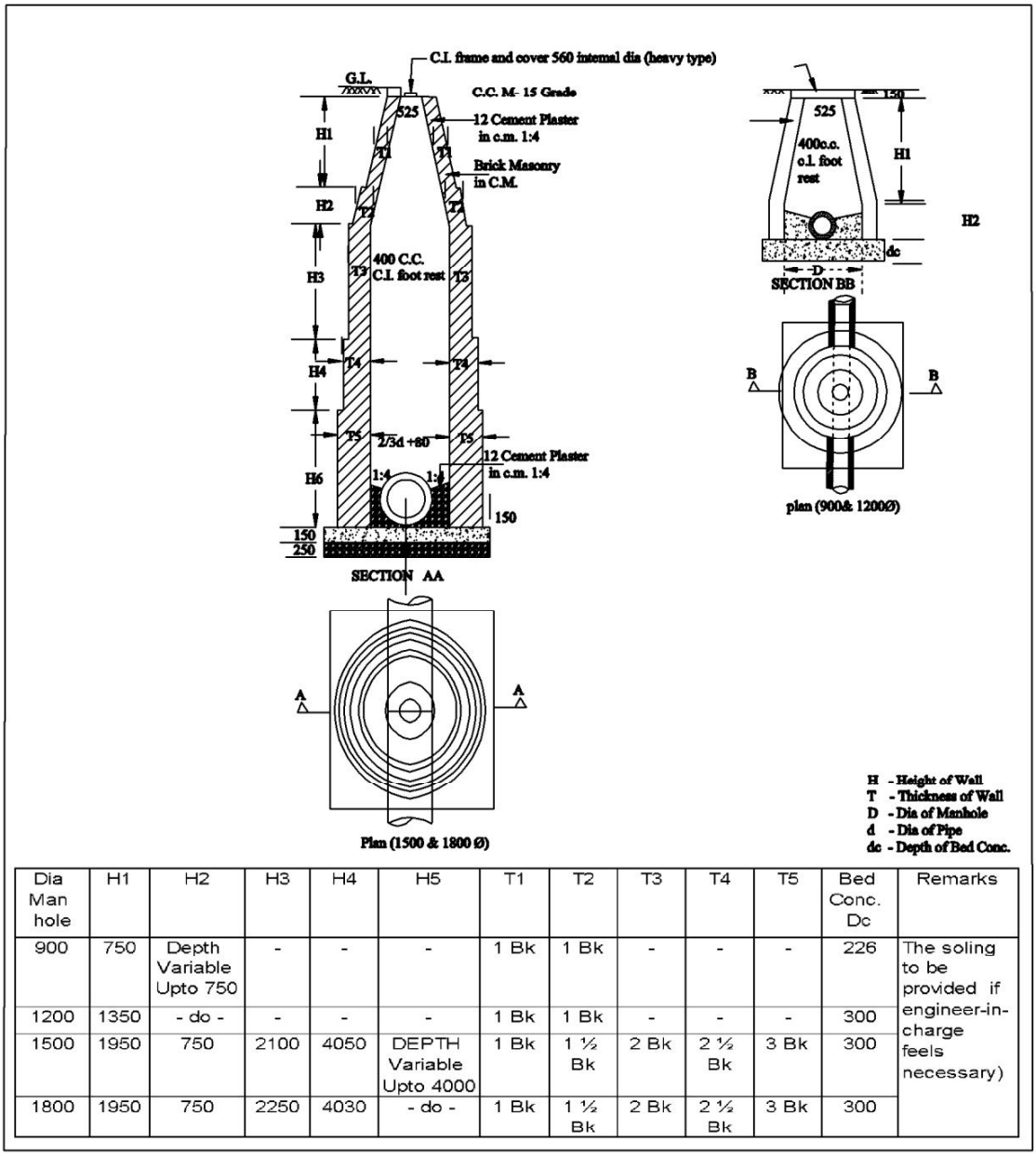
Depth of manhole from top of C.I. Cover	From top of 4250 (w)	From top of 4250 to 9750 from top (w)	Beyond 9750 from top (w)	H	T
2450 To 4250	1 Bk	----------	----------	900	200
More then 4250 upto 9750	1 Bk	1½ Bk	----------	1800	300
More then 9750	1 Bk	1½ Bk	2 Bk	1800	300

BAR BENDING SCHEDULE				
Mark	diam.	No	length	Bending
a	12	5	1000	100 — 100 800
b	12	3	1300	100 — 100 1100
c	12	1	680	100 — 100 480
a	12	5	1000	100 — 100 800
b	12	2	1300	100 — 100 1100
c	12	1	620	100 — 100 420

All Dimensions in mm

Drawing No.-14

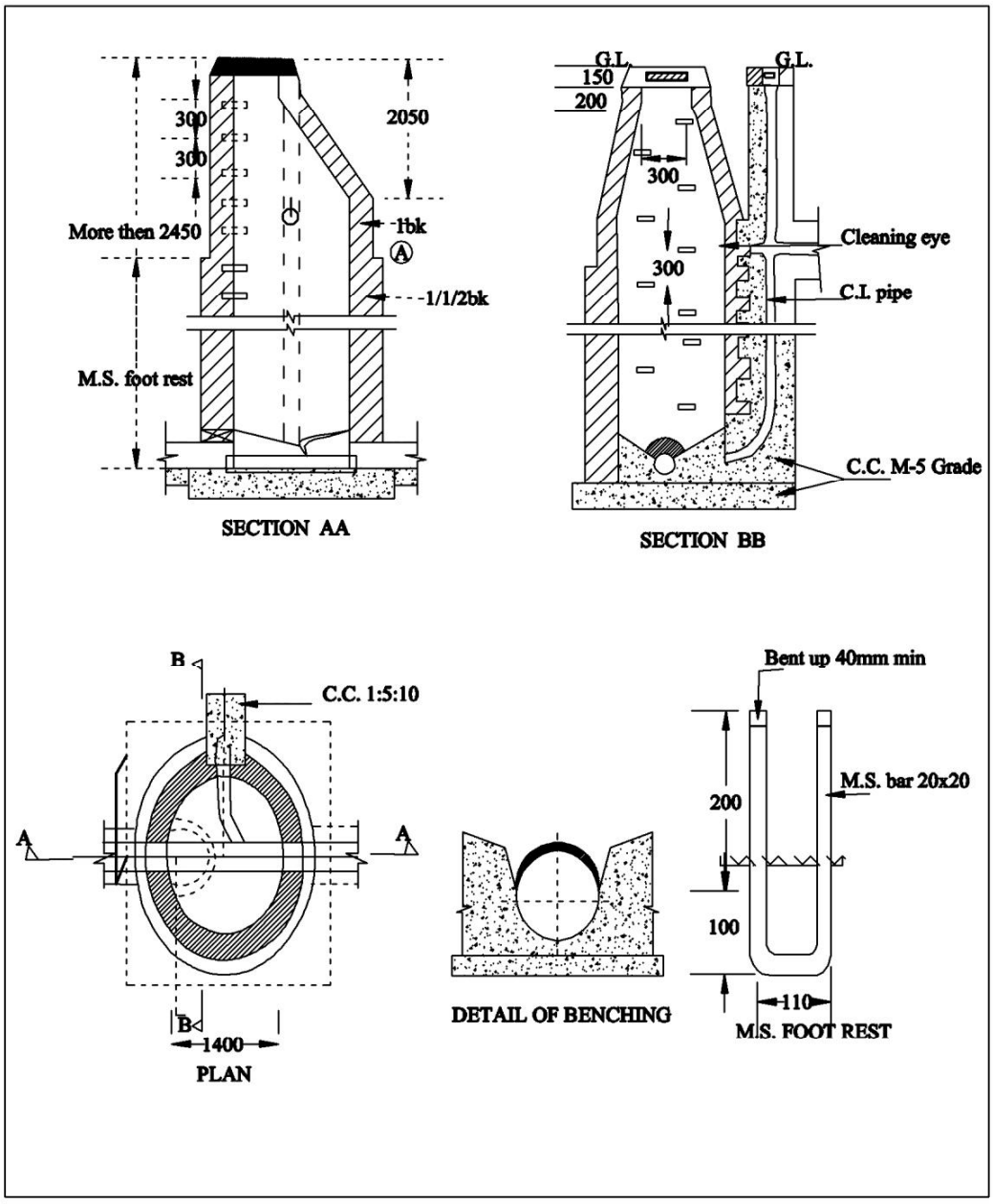
MAN HOLE



Dia Man hole	H1	H2	H3	H4	H5	T1	T2	T3	T4	T5	Bed Conc. Dc	Remarks
900	750	Depth Variable Upto 750	-	-	-	1 Bk	1 Bk	-	-	-	226	The soling to be provided if engineer-in-charge feels necessary)
1200	1350	- do -	-	-	-	1 Bk	1 Bk	-	-	-	300	
1500	1950	750	2100	4050	DEPTH Variable Upto 4000	1 Bk	1 ½ Bk	2 Bk	2 ½ Bk	3 Bk	300	
1800	1950	750	2250	4030	- do -	1 Bk	1 ½ Bk	2 Bk	2 ½ Bk	3 Bk	300	

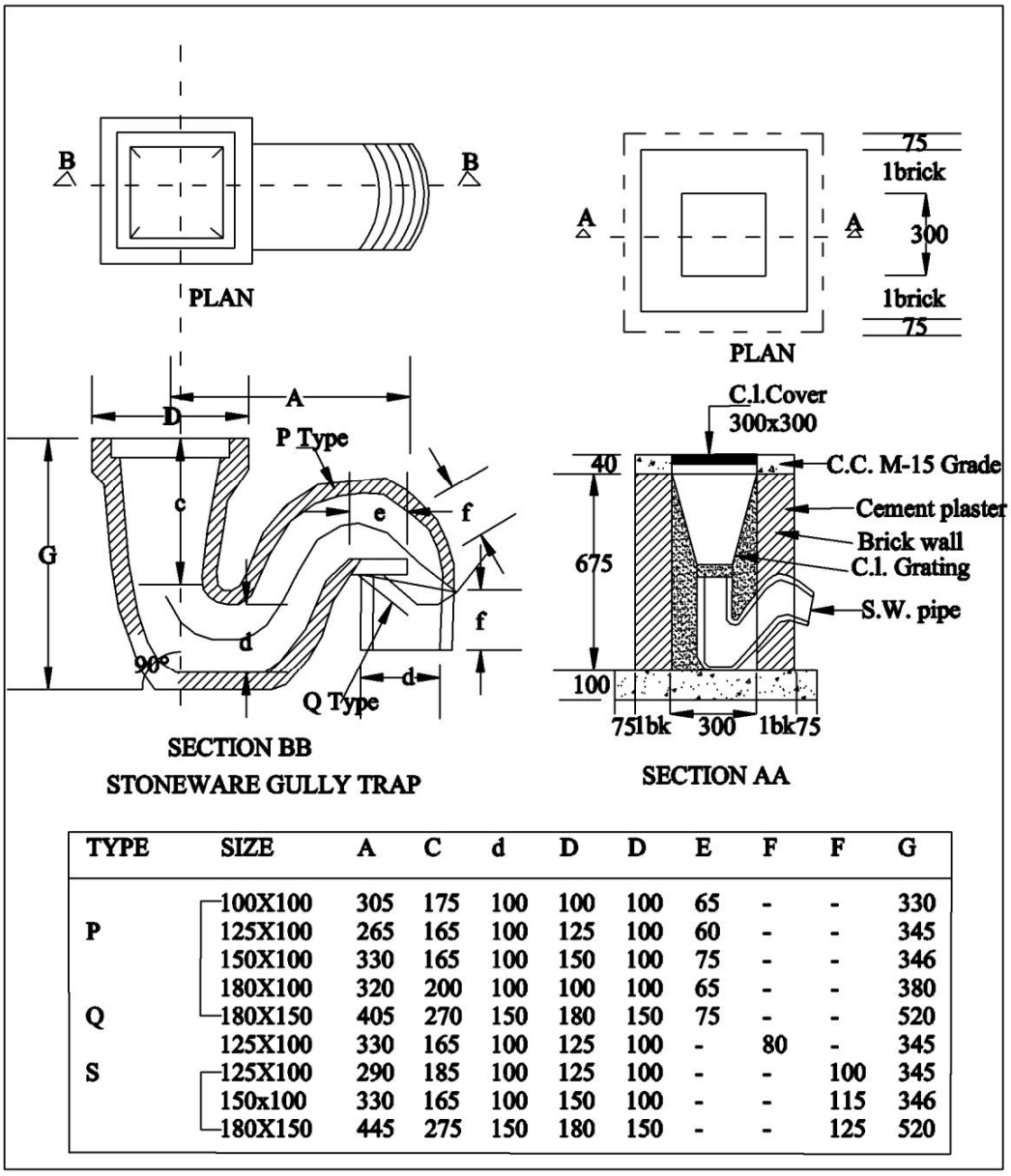
Drawing No.15

DROP MANHOLE



Drawing No.16

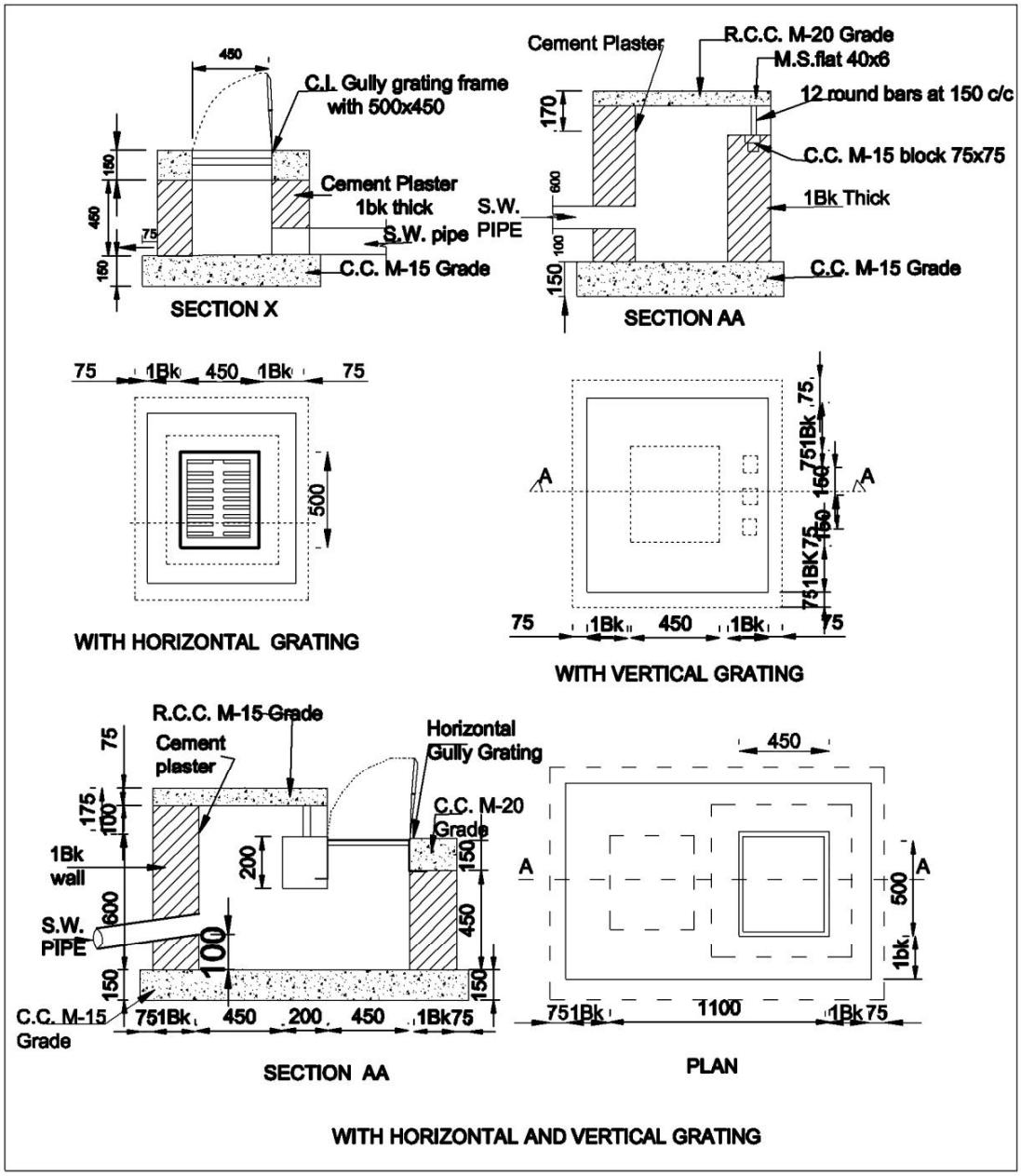
Gully Trap



TYPE	SIZE	A	C	d	D	D	E	F	F	G
P	100X100	305	175	100	100	100	65	-	-	330
	125X100	265	165	100	125	100	60	-	-	345
	150X100	330	165	100	150	100	75	-	-	346
	180X100	320	200	100	100	100	65	-	-	380
Q	180X150	405	270	150	180	150	75	-	-	520
S	125X100	330	165	100	125	100	-	80	-	345
	125X100	290	185	100	125	100	-	-	100	345
	150x100	330	165	100	150	100	-	-	115	346
	180X150	445	275	150	180	150	-	-	125	520

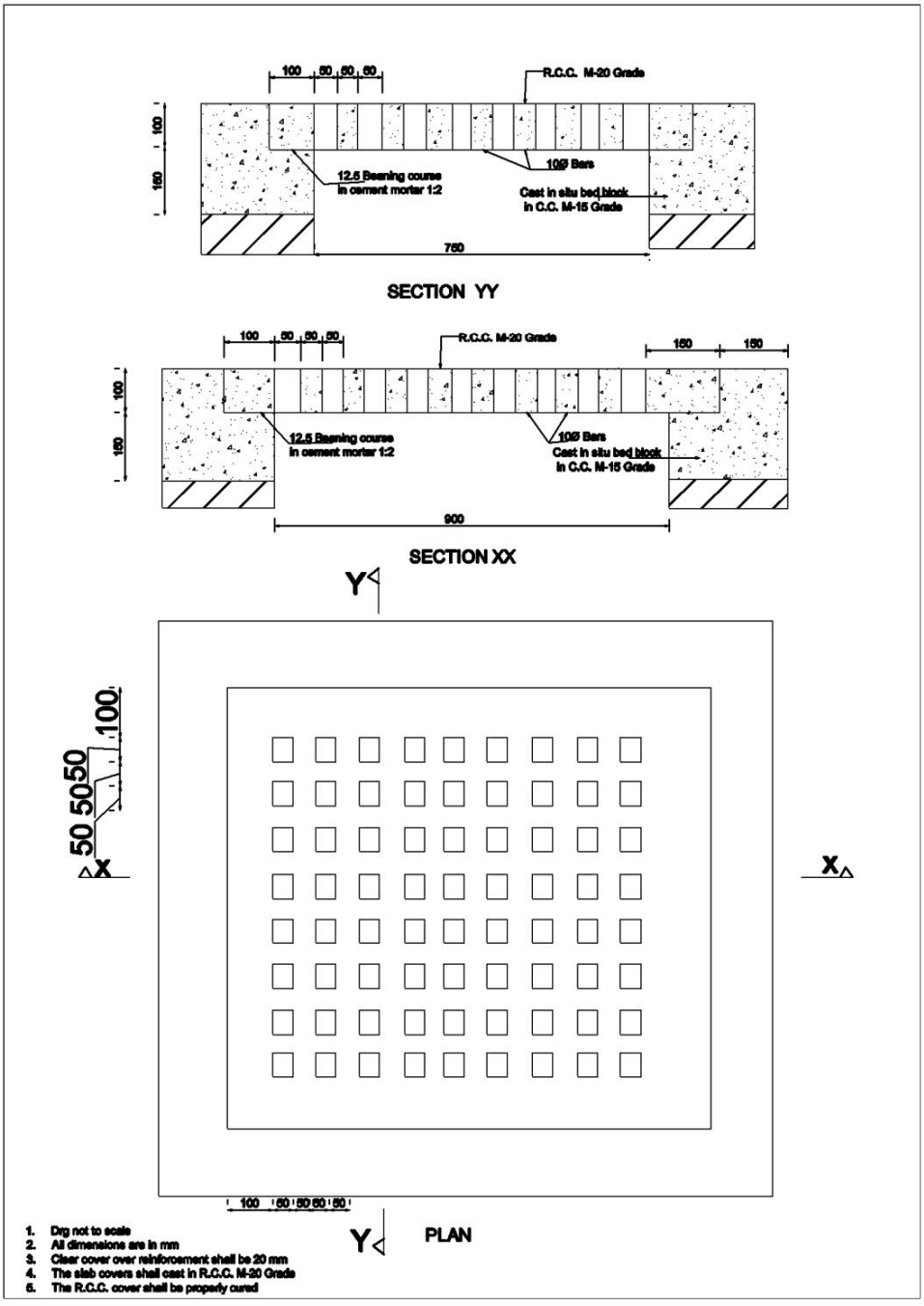
Drawing No.17

ROAD GULLY CHAMBER

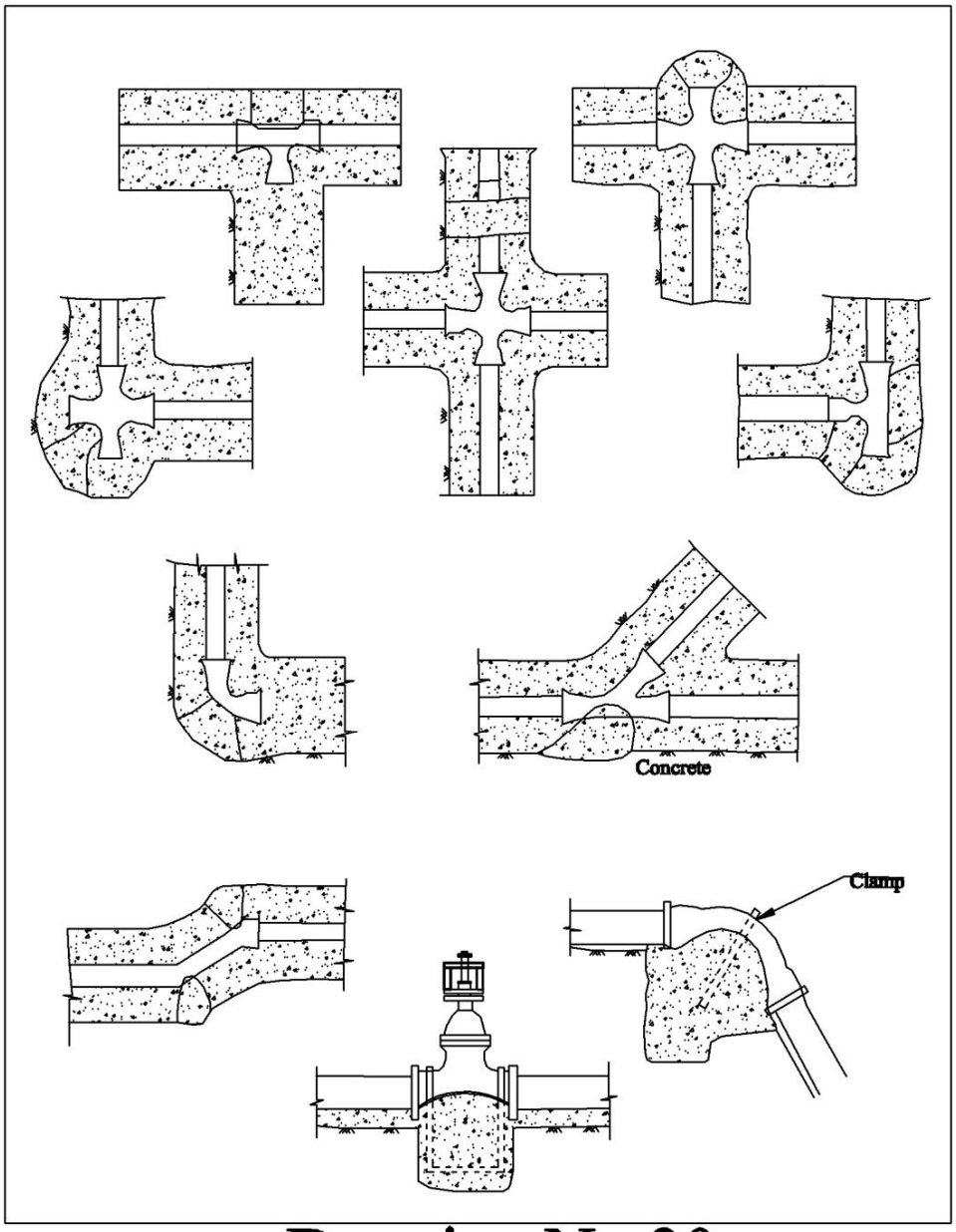


Drawing No.18

Road Gully Grating

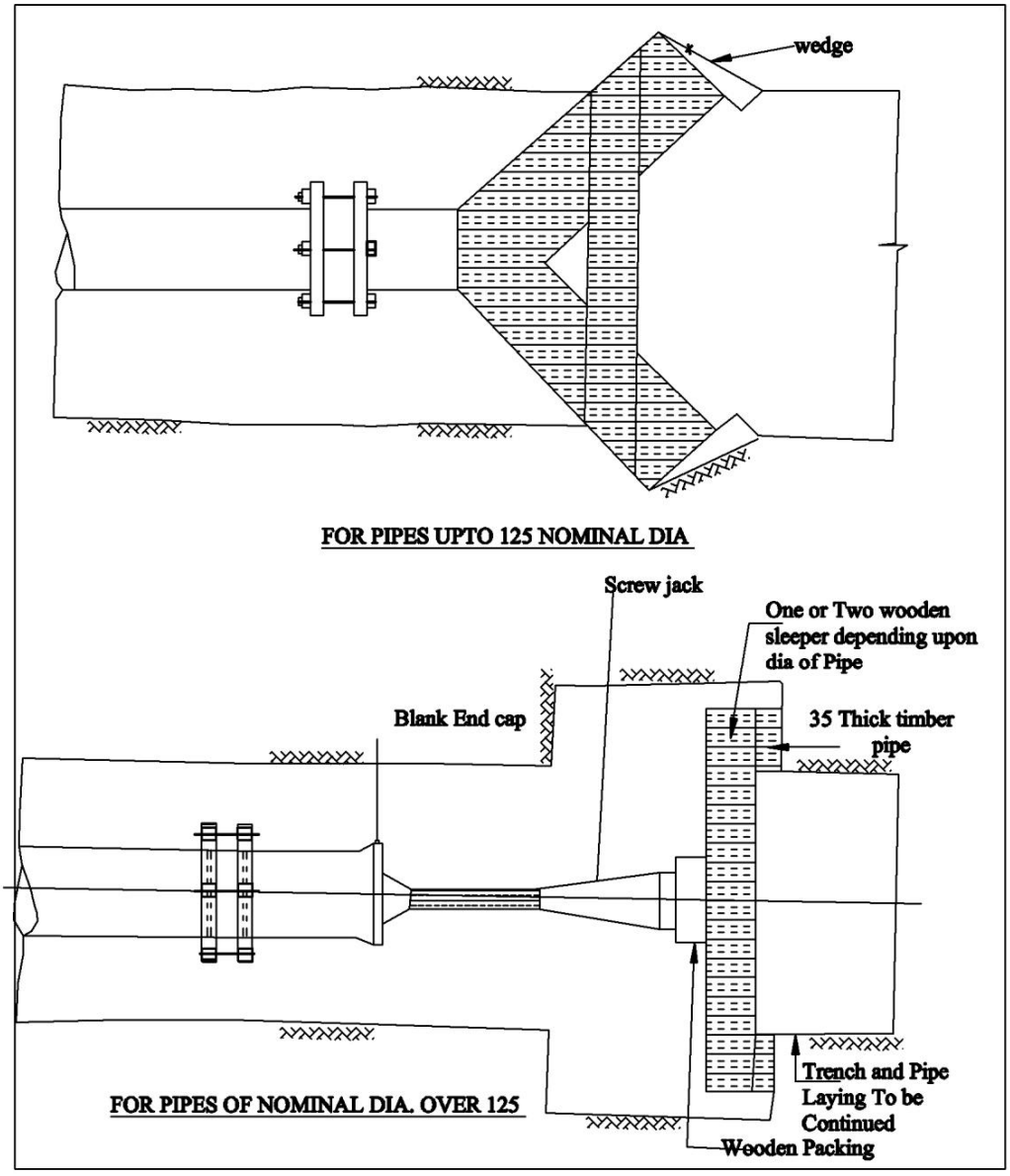


Thrust Blocks

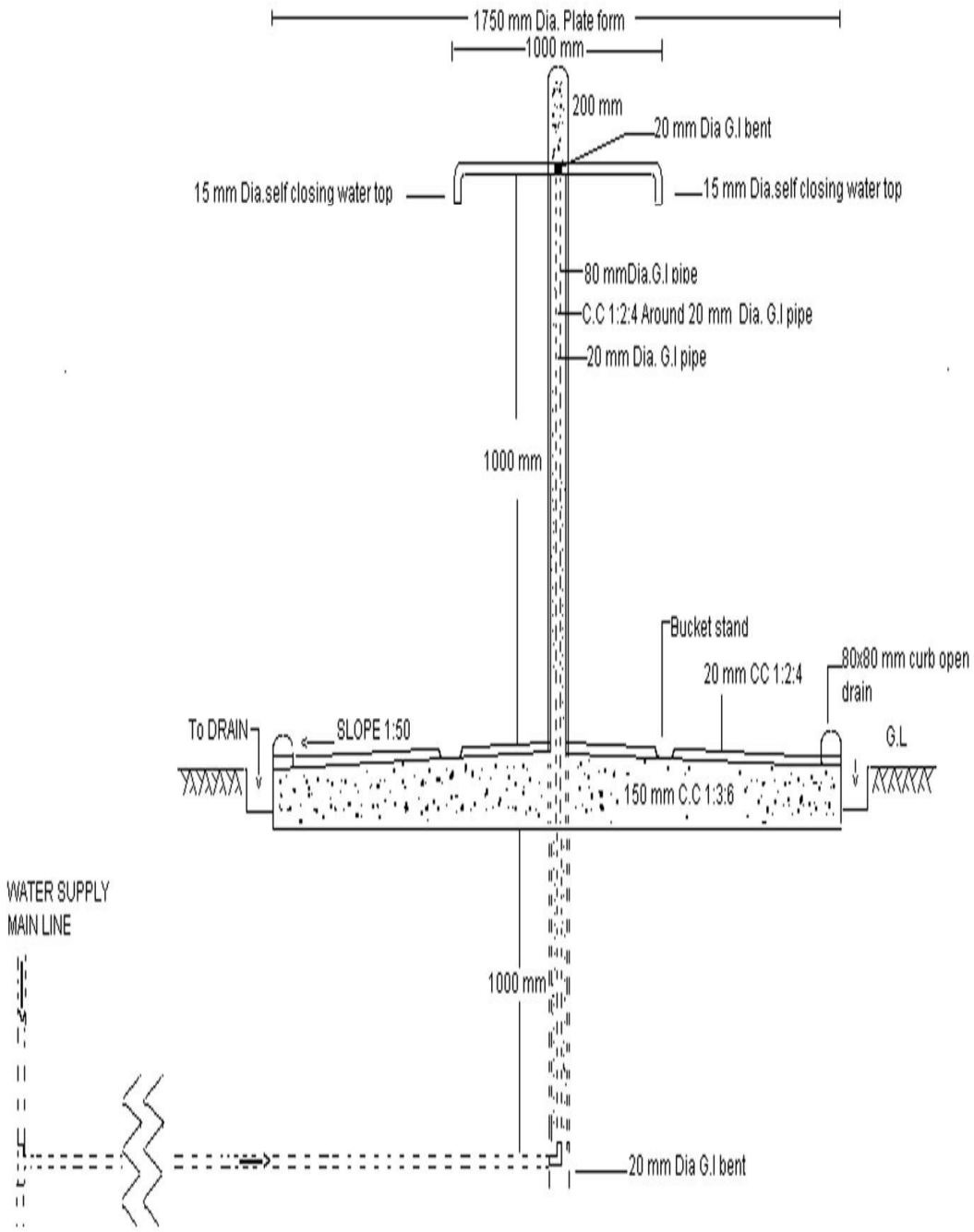


Drawing No.20

CLOSURE OF PIPES FOR HYDROSTATIC TEST



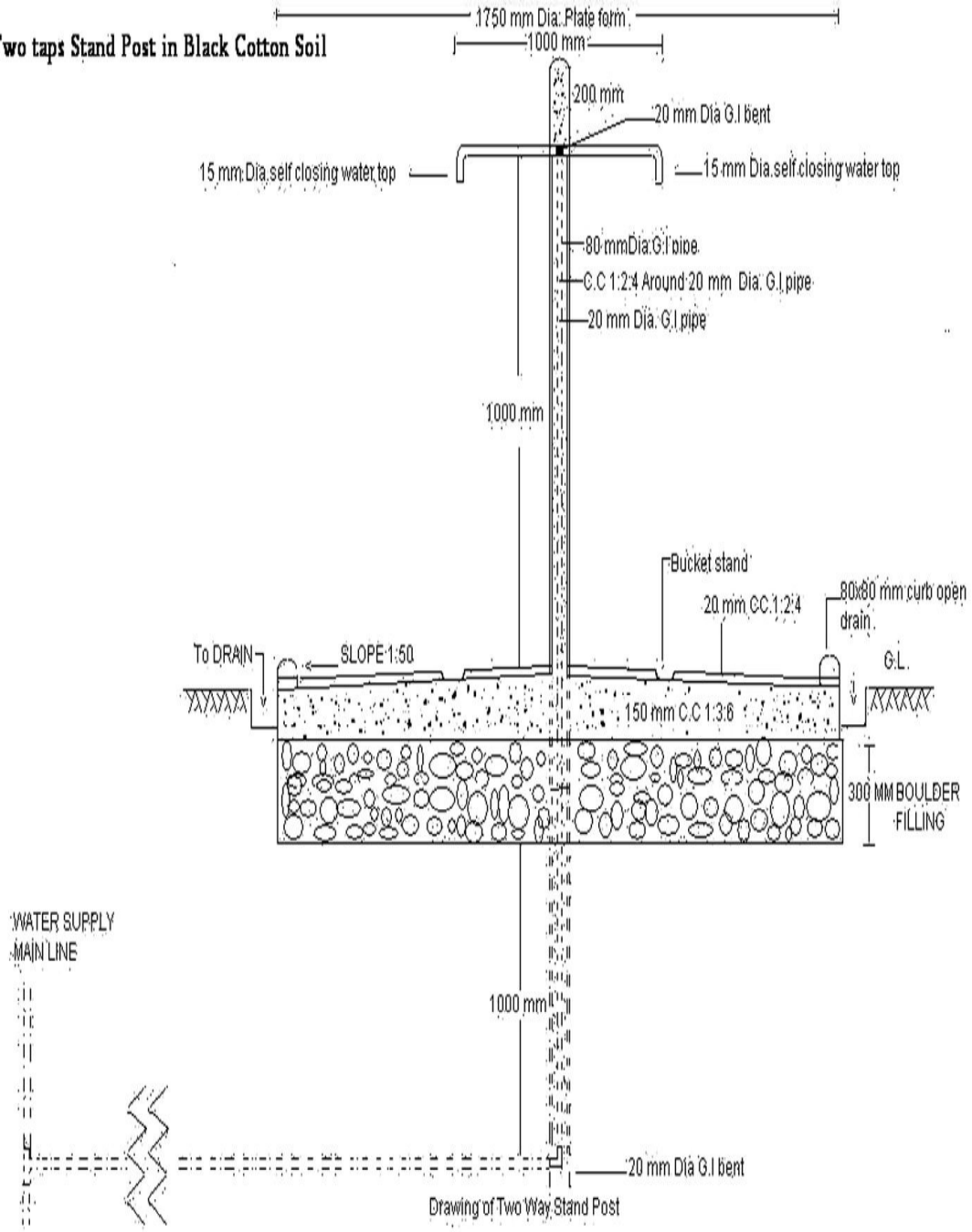
Drawing No .21



Drawing of Two Way Stand Post

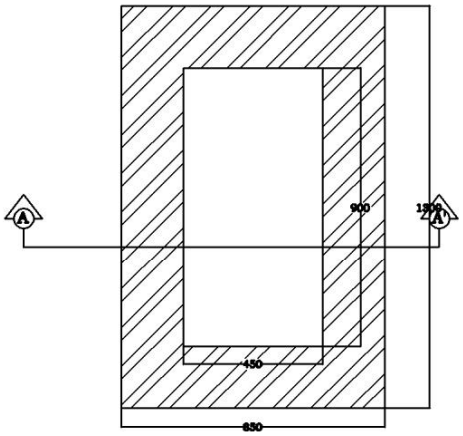
All dimensions are in milimeter

Two taps Stand Post in Black Cotton Soil

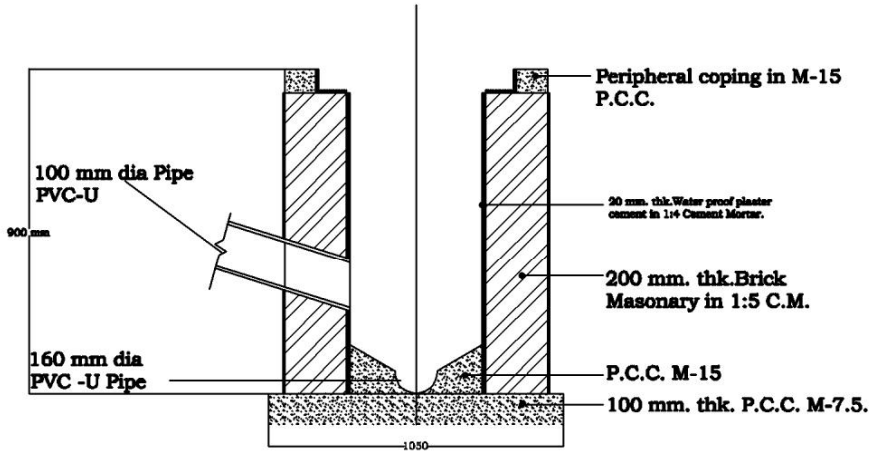


Drawing No. 23

MANHOLE CHAMBER 900MM X 450 MM



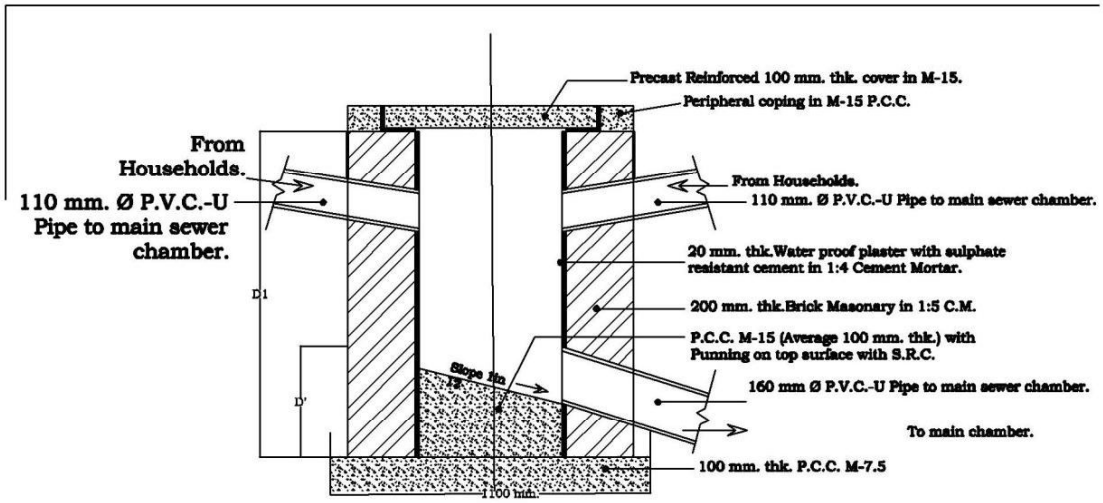
PLAN MAIN SEWER CHAMBER



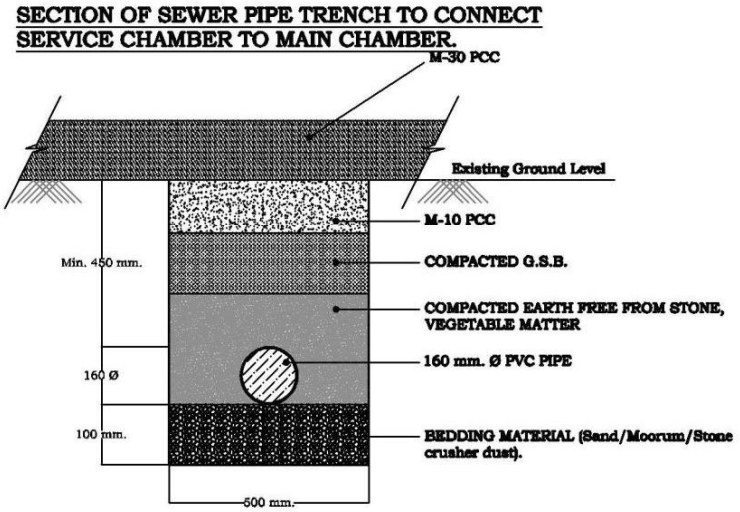
SECTION AT AA OF MAIN SEWER CHAMBER

* Note :- 1. D' depends as per site conditions.
2. D varies from 0.60 m. to 3.00 m.

HOUSE CHAMBER 450 X 600 MM



SERVICE CHAMBER



DRAWING NO.25