IS 7634-2 (2012): Plastics Pipes Selection, Handling, Storage and Installation for Potable Water Supplies - Code of Practice, Part 2: Laying and jointing of polyethylene (PE) pipes [CED 50: Plastic Piping System]

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भारतीय मानक

पेयजल पूर्ति के लिए प्लास्टिक के पाइपों का चुनाव, प्रहस्तन, भण्डारण और संस्थापन — रीति संहिता

भाग 2 पोलीइथाईलीन पाइपों को बिछाना एवं जोड़ना

(पहला पुनरीक्षण)

Indian Standard

PLASTICS PIPES SELECTION, HANDLING, STORAGE AND INSTALLATION FOR POTABLE WATER SUPPLIES — CODE OF PRACTICE

PART 2 LAYING AND JOINTING OF POLYETHYLENE (PE) PIPES

(First Revision)

ICS 83.140.3;91.140.60

B U R E A U O F I N D I A N S T A N D A R D S
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

June 2012 **Price Group 8**

Plastic Piping Systems Sectional Committee, CED 50

FOREWORD

This Indian Standard (Part 2) (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastic Piping Systems Sectional Committee had been approved by the Civil Engineering Division Council.

This standard covers laying, jointing and installation of polyethylene (PE) pipes. This standard is published in three parts. Other parts in the series are:

Part 1 Choice of materials and general recommendations
Part 3 Laying and jointing of PVC-U pipes

This standard was first published in 1975. In this revision following major modifications have been made:

a) Provisions regarding screwed joints (threaded joints) have been deleted as these joints are not being used for polyethylene pipes,
b) Fusion type of joints have been classified into butt fusion, socket fusion and electro fusion,
c) Telescopic joints have been re-named as spigot and socket joints,
d) Installation guidelines for laying the pipes under water have been given,
e) Provisions related to house service connections have been given, and
f) Other necessary modifications as per current practices prevailing in the country have been made.

The composition of the Committee responsible for the formulation of this standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the results of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

PLASTICS PIPES SELECTION, HANDLING, STORAGE AND INSTALLATION FOR POTABLE WATER SUPPLIES — CODE OF PRACTICE

PART 2 LAYING AND JOINTING OF POLYETHYLENE (PE) PIPES

(First Revision)

1 SCOPE

1.1 This standard (Part 2) gives guidance for the recommended methods of laying, jointing and testing of polyethylene (PE) pipes for the potable water supplies (pumping and distribution mains and service lines buried under ground and for the conveyance of water above ground for the both outside and inside buildings).

1.2 This standard is applicable for the water supplies up to and including 45°C water temperatures.

1.3 This standard does not purport to give guidelines for designing and dimensioning of pipe lines.

1.4 Local bye-laws shall be observed, whenever used for municipal water distribution.

2 REFERENCES

The standards given in Annex A contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards given in Annex A.

3 JOINTING TECHNIQUES

3.1 General

Polyethylene pipes are made by continuous extrusion process and are generally available in factory cut lengths and in form of coils. PE pipes conforming to IS 4984, as they are UV protected (due to carbon black content in the pipe), may be stored either in open or covered.

3.1.1 The commonly used joints are as follows:

a) Fusion welding:
   1) Butt fusion welding;
   2) Socket fusion welding; and
   3) Electro fusion welding;
b) Insert type joints;
c) Compression fittings/push fit joints;
d) Flanged joints; and
e) Spigot and socket joints.

3.2 Fusion Welded Joints

The principle of fusion welding is to heat the two pipe surfaces to a designated temperature and then fuse them together by application of sufficient force. This force causes the melted materials to flow and mix, there by resulting in fusion.

Fusion welding of PE pipes must be carried out with welding equipment having temperature and pressure (where applicable) display arrangements. PE pipes and PE fittings, to be joined by face-to-face (butt fusion) welding must be of the same wall thickness and the ends must be cut square. However, in some cases of fusion, where face-to-face contact is not involved the jointing pipes/fittings wall thicknesses need not be same. The integrity of the fusion joint is dependent on the cleanliness, temperature control and designated equipment that has been properly maintained.

The pipe ends shall be dry and free of dust. Mating surfaces shall be planed/scraped before fusion to remove surface material as polyethylene (PE) oxidizes on exposure to air. These prepared (scraped) surfaces should not be touched, as there is a risk of contamination of the surface, which may affect the weld efficiency. The site conditions must be protected against bad weather influences such as moisture and temperatures below 5°C.

The fusion welding procedure described here is suitable for welding polyethylene pipes and fittings falling in melt flow rate (MFR) range of 0.1–1.2 g/10 min at 190°C with nominal load of 5 kgf.

3.2.1 *Butt Fusion Welding* (see *Fig.* 1)

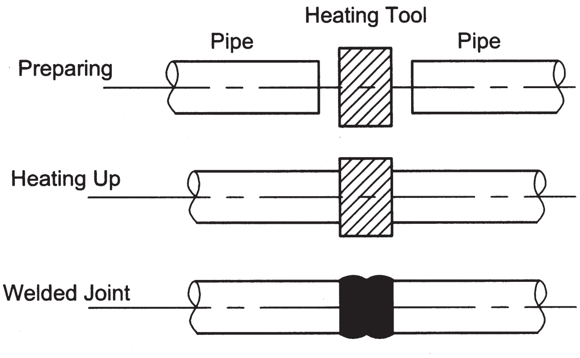


FIG. 1 BUTT WELDING PROCEDURE OF PE PIPES

3.2.1.1 *Butt fusion equipment*

Basic welding machine shall be self-supporting such as guides and clamps to suit the stability of the basic machine and with sleeves as per the size requirement along with the following accessories:

a) Non-stick coated with poly tetra flouro ethylene (PTFE), heating plate with thermostat and temperature indicator,
b) Chamfering (Planing) tool — electrical/ manual as appropriate, and
c) Electro-hydraulic power pack (for sizes greater than 125 mm) unit with pressure indicator, by-pass arrangement and accumulator.

The butt fusion equipment shall incorporate a facility for supporting the heating plate and planing tool (necessary to square cut the pipe end) when in use. The machine shall be robust enough to withstand normal field use.

Butt welding machines can be manual (for diameters up to 125 mm), hydraulic or pneumatic. However, a locking system to hold the fusion force is to be ensured in all the systems, and the equipment shall be protected against exerting over-pressure on the pipe. It shall be able to maintain the required interface force on the pipe or fittings end as long as necessary.

3.2.1.2 *Butt welding procedure* (see *Fig.* 1)

a) Clamp the pipes/fitting in the butt fusion machine.
b) Wipe the ends to be welded, inside and out, with a clean cloth to remove water, dirt, mud, etc.
c) Welding ends should be squared. In case of pipe, plane both ends by a planer (mechanical/ electrical for pipe diameters greater than 160 mm) until they are perfectly square. Fittings' ends can be re-cut square, where necessary.
d) Remove the plastic shavings from the vicinity of the ends without touching the prepared surface as any contamination will be detrimental to the welding process. Re-clean the surface with proper solvent.
e) Bring together the two ends and ensure they are aligned.
f) Check the hot plate (mirror) temperature (range 200-230°C) and make certain the plate surfaces are clean. It is good practice to make 'dummy' welds daily, prior to welding sessions as a means of cleaning the mirror. That is, the weld procedure should be taken to the heat soak stage, when the process can be aborted. The hot plate surface must not be touched with hand, metal implements or tools. A damaged or dirty hot plate will result in a poor joint. Heating mirror is nothing but a metallic plate heated up to the required temperature by electrical coil embedded inside. The word 'mirror' has come into vogue because the heating plate radiates heat.
g) Prior to heating, levelling of the pipes/fittings is essential to ensure square plane face over the heat surface [*see* **3.2.1.2** (c)].
h) Move the pipe/fitting ends into contact with hot plate and a steady pressure of 0.15 ± 0.01 MPa shall be applied while a uniform bead forms around the circumference of the both ends. This procedure is to ensure that the entire face of the weldable portion heats uniformly through the surface contact with the mirror.
j) After the bead height is formed as per Table 1 relieve the pressure but maintain contact pressure between the plate and the ends of the heated surfaces as per pressure build up time mentioned in Table 1.
k) Push back the pipe/fitting ends away from the mirror after the above operation. When removing the mirror, make sure it is not brushed across the molten pipe ends.
m) Bring the molten ends together and follow the recommended pressure as per the requirement of the pipe/fitting wall thickness (*see* Table 1). This pressure should be applied by building up gradually to avoid squeezing out too much of the melt. Do not disturb the joint during the required cooling time. Follow the pressure-time diagram as given in Fig. 2.
n) Relax the pressure and carefully remove the clamps only after ensuring that cooling time has elapsed.

p) Inside or outside bead removal after the weld joint cools, shall have no affect on the weld performance.

3.2.1.3 *Caution*

It is essential to ensure the pressure-temperature chart and the corresponding timing table is followed.

While jointing, the pressure should be maintained as mentioned in Table 1. After the pressure is relieved, the joint is allowed to cool to ambient temperature. Under no circumstance the weld should be forcibly cooled (no quenching).

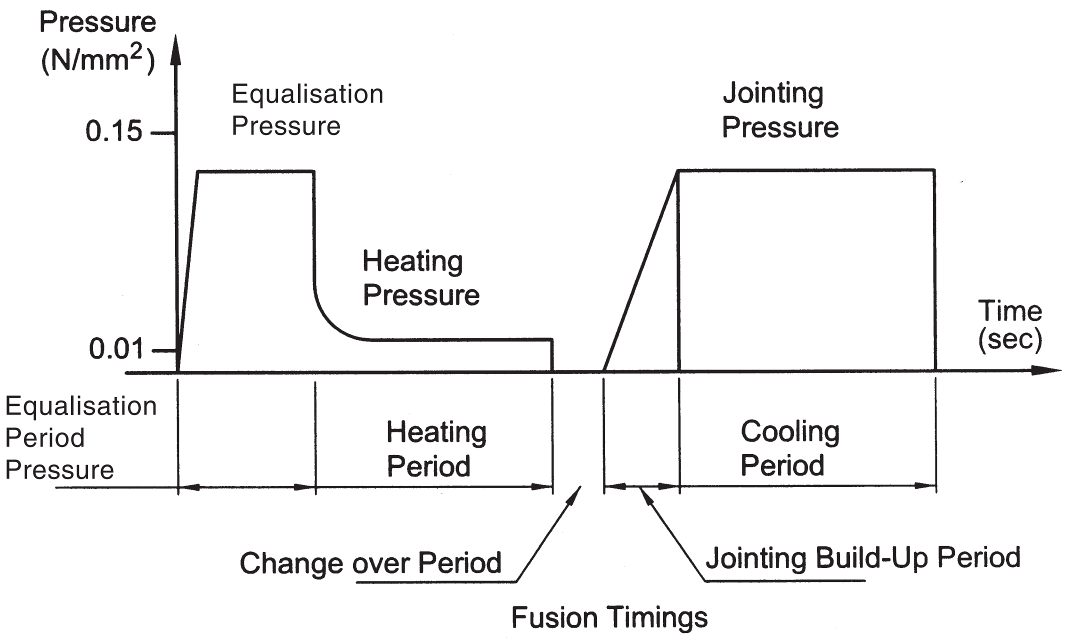


FIG. 2 PRESSURE-TIME DIAGRAM

Table 1 Values of the Recommended Bead Width and Timing for Butt Fusion Welding
(*Clauses* 3.2.1.2 *and* 3.2.1.3)

Sl No.	Nominal Wall Thickness	Bead Height on the Heated Tool	Heating Up	Change Over	Jointing and Cooling		
					Pressure Build-up Time	Cooling Time Under Pressure	Cooling Time During Pressure Relaxation
	mm	mm	s	s	s	s	S
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Up to 4.5	0.5	45	5	5	6	300
ii)	4.5-7	1.0	45-70	5-6	5-6	6-10	600
iii)	7-12	1.5	70-120	6-8	6-8	10-16	900
iv)	12-19	2.0	120-190	8-10	8-11	16-24	1 200
v)	19-26	2.5	190-260	10-12	11-14	24-32	1 500
vi)	26-37	3.0	260-370	12-16	14-19	32-45	1 800
vii)	37-50	3.5	370-500	16-20	19-25	45-60	2 100
viii)	50-70	4.0	500-700	20-25	25-35	60-80	2 700

NOTE — Bend strap testing is suggested on a test sample to verify fusion joint integrity and to qualify the welding technicians. The specimen shall be made by the cutting the pipe longitudinally into strips of 1 or 1.5 times the wall thickness wide and by about 300 mm or 30 times the wall thickness in length with the fusion centred strip (*see* Fig. 3). The fusion sample should be bent till the ends meet and visually inspected. The sample should be free of cracks and breaks and shall have seamless joint surface. Testing shall be done on the each size of the pipe being used at the site, to qualify various machines and the technicians that are likely to be employed at the site.

FIG. 3 BEND STRAP TEST — WELDED PIPE PORTION CUT LONGITUDINALLY AND BENT

3.2.2 *Socket Fusion* (see *Fig*. 4)

This technique consists of simultaneously heating the external surface of the pipe and the internal surface of the socket fitting until the material reaches fusion temperature; inspecting the melt pattern; inserting the pipe end into the socket; and holding it in place until the joints cools.

3.2.2.1 *Socket fusion procedure*

a) Prepare the pipe — cut at right angles and trim;
b) Chamfer pipe end. Remove burrs and chips from inside pipe ends;
c) Utilize proper depth gauge to ensure correct insertion depth and pipe roundness;
d) Clean pipe and fitting with cloth to remove all the contaminants;
e) Verify proper heater plate temperature. Temperature should be 200-230°C;
f) Force fitting and pipe onto a heater surface. Be sure to insert pipe completely into female socket and the fitting completely onto the male socket;
g) Apply the heat on the surface of the pipe;
h) Remove the pipe and fitting from the heater. Care should be taken for not to apply torque or twist the pipe or fitting;
j) Quickly insert heated portion of the pipe into the heated socket of the fitting and ensure co-axial alignment of the pipe and fitting;
k) Allow joint to cool for proper cooling time. Be sure to maintain pressure while cooling;
m) Allow joint to cool to room temperature before moving the joint; and
n) Inspect joint for weld integrity.

3.2.3 *Electro Fusion* (see *Fig*. 5)

Electro fusion is a heat fusion process where a coupling or fitting containing an integral heating source (resistance wire) is used to join the pipes and fittings. The jointing areas, that meets the pipe surface and the inside the fittings are overlapped and the resistance wires inside the fitting are heated by electric current. During heating, fitting and pipe materials melt, expand and fuse together. Heating and cooling cycles are automatically controlled by the bar code arrangement on the fittings and machinery used.

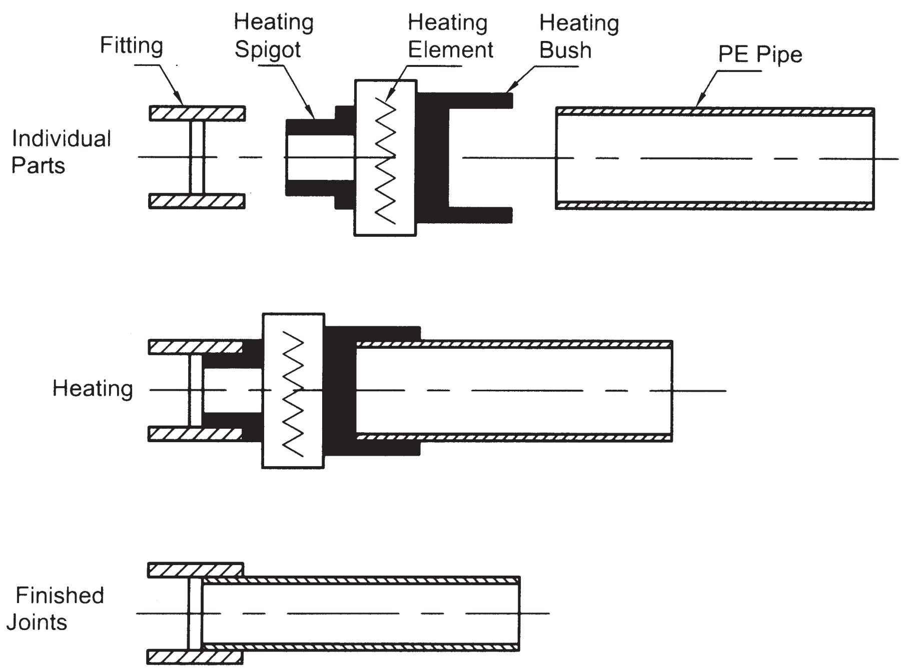


FIG. 4 SOCKET FUSION JOINTING PROCEDURE

The welding equipment or its accessory shall be able to supply the required voltage for the electro fusion joint. The device must switch off as soon as the necessary heat has been fed to the welding zone. The welding machine must be calibrated and timing adjusted to the electro fusion fitting's bar code data (the fitting and machinery manufacturer recommendations shall be followed).

Electro fusion is the only heat fusion procedure that does not require longitudinal movement of the joinable surfaces. It is frequently used where both pipes lengths are constrained, such as for repairs or tie-in joints in the trench. Joints between dissimilar polyethylene grades and different wall thicknesses can also be made using electro fusion, as the procedure readily accommodates polyethylene grades with different melt flow rates and is independent of the pipe wall thickness.

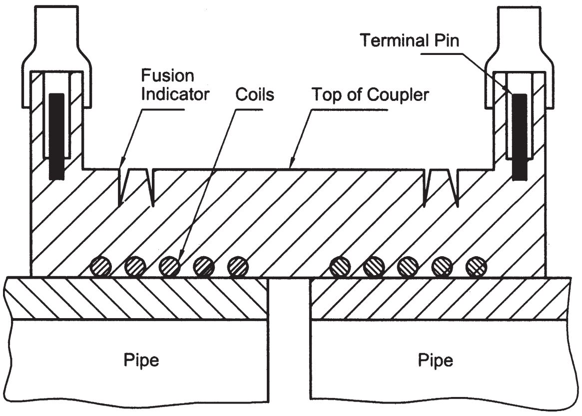


FIG. 5 ELECTRO FUSION PROCESS

3.2.3.1 *Electro fusion welding procedure*

a) Prepare the pipe — Cut at right angles and trim;
b) Remove the outer film of pipes using scraper;
c) Clean pipe surfaces with cleaner (as recommended by the electro fusion fittings supplier);
d) Mark the insertion depth on the pipe;
e) Remove the fittings from the packaging without touching the fusion surface;
f) Firmly push-in the pipe until the centre stop or marking;
g) Mount and fix assembly attachment;
h) Slide in the second pipe up into the fitting to centre stop or marking;
j) Firmly fasten the integrated clamp to ensure no movement while welding;
k) Follow operating instructions of the machine and fitting manufacturer or read the bar code;
m) Check the fusion indicator on the fittings and then remove cable; and
n) Wait for cooling to remove the assembly (follow the fusion guidelines of the fusion fittings supplier or what is given in the bar code data).

3.2.4 *Insert Type Joint* (see *Fig.* 6)

3.2.4.1 Insert type of fittings are available in both plastic and metal for use with PE pipes. These are commonly used for the delivery pipe connections of bore/tube well pumps.

3.2.4.2 In corrosive locations plastic/stainless steel insert fittings are preferred. In less corrosion conditions gunmetal fittings may be used and in normal or slightly corrosive environments, brass fittings may be employed. The insert moulding plastic fittings with metallic inserts are also available. The outer serrations of PE/metal insert type fittings — slightly over sized — lock into the pipes to prevent their coming out under sudden pressure surge. The pipe bore is expanded by immersion in oil bath (130°C) where the heat of the oil bath would soften the pipe to enable insertion of fitting.

3.2.4.3 The insertion of these fittings into the bore of the pipe is done with by hand pressure only. A worm driven type clip while the surface of the pipe is relatively warm should be tightened over the pipe to ensure the grip. Bolting or riveting the inserted fitting onto the pipe wall is also recommended for carrying heavy weight, such as submersible pump.

3.2.4.4 This type of jointing is used normally for diameter pipes up to 110 mm and internal pressure below 0.4 MPa. Load carrying capacity of this assembly depends on the pull force applied by the weight of the total assembly including the weight of the hung item (say a submersible pump) and media weight inside the pipe. The pipe manufacturers' recommendations are to be followed for allowable total pull force on a given pipe with insert type connection. The elongation of PE pipe is very high (over 600 percent), hence these recommendations attain significance. More so, if the load on to the assembly is very high such as in the case of submersible pump lowered with PE pipe as a delivery pipe with this type of connection.

3.2.5 *Compression Fittings* (see *Fig.* 7 *and Fig.* 8)

3.2.5.1 Compression fittings are detachable joints and are made of metal or plastics [polypropylene (PP)] or a combination of both. Compression fittings form a tight seal by applying a compressive force to the pipe and pipe fitting. The fitting is compressed against the pipe with a force sufficient to eliminate all space remaining in the joint, thus preventing the fluid from leaking.

3.2.5.2 It is critically important to the integrity of the fitting that excessive force is avoided in tightening the nut. If the fitting is over tightened, the gripper (clip ring) will deform and cause leaks. Over tightening is the most common cause of leaks in compression fittings. As a general rule, a compression fitting should be 'finger tight' and then tightened one turn with a wrench. The fitting should then be tested, and if slight weeping is observed, the fitting should be slowly tightened a bit more until the weeping stops.

3.2.5.3 Compression fittings are also available as metal fitting such as the type of fitting commonly used for copper tubes. In this type of joint the dimensions of the pipe are generally not altered. The joint is affected by an internal liner and a compression ring or sleeve which shrinks and therefore compresses the pipe wall on the liner, thus gripping to the wall of the pipe. The liner and compression sleeve may also be an integral unit.

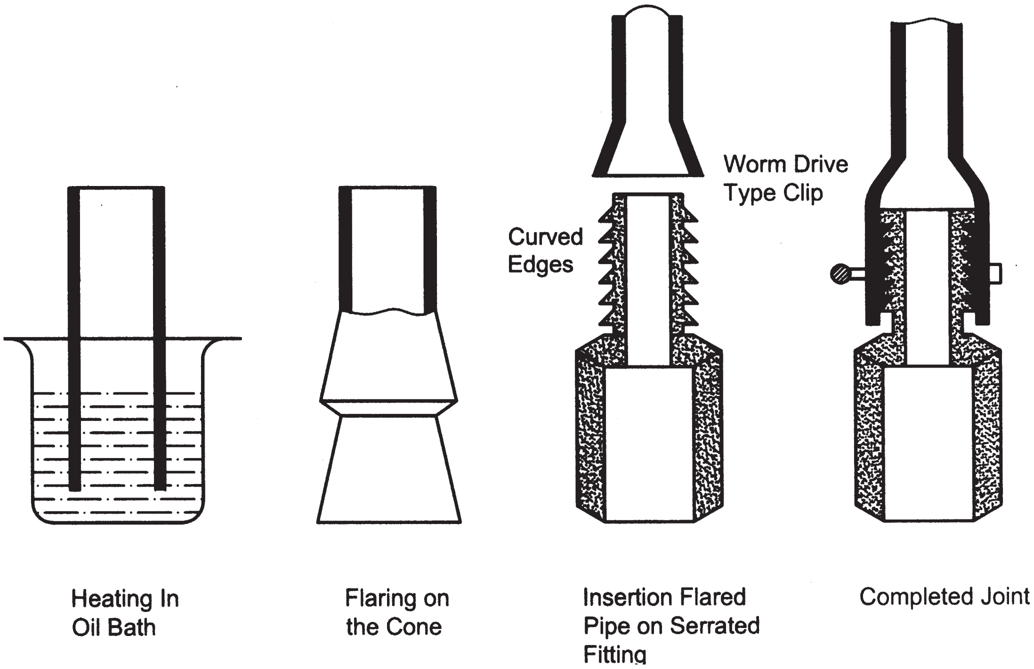


FIG. 6 TYPICAL ILLUSTRATION OF MAKING INSERT TYPE JOINTS FOR PE PIPES

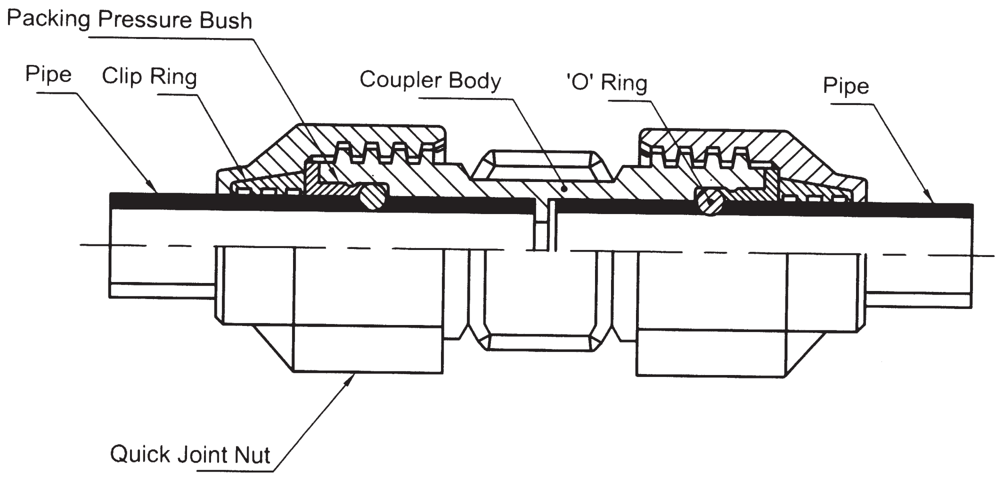


FIG. 7 POLYPROPYLENE COMPRESSION COUPLER (SOCKET)

3.2.5.4 *Compression fittings with collar/pipe ends and flat gaskets*

Aluminum alloy or brass fitting with male and female coupling parts may also be used for jointing with metallic fittings. The male and female ends of the coupling are welded face to face on two 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 the detachable type of jointing and is practicable up to 50 mm diameter pipes (*see* Fig. 8).

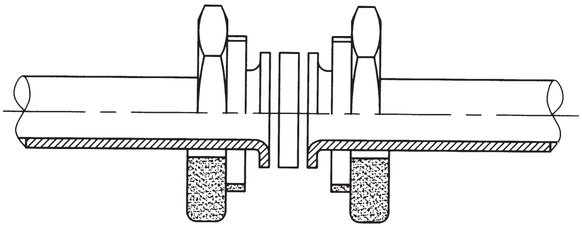


FIG. 8 METALLIC COMPRESSION FITTING

3.2.5.5 Compression fittings do not require fusion. They work at higher pressures and even with toxic media. Compression fittings are especially useful in installations that may require occasional disassembly or partial removal for maintenance, etc, since these joints can be detached and re-joined without affecting the integrity of the joint. They are also used in situations where a heat source, in particular a heating plate, is prohibited and inside bead formation by butt fusion is not preferred.

3.2.5.6 For coiled polyethylene pipes, of small diameters (<110 mm) where the working pressure do not exceed 1.6 MPa, jointing by polypropylene (PP) compression fittings is generally recommended over fusion jointing.

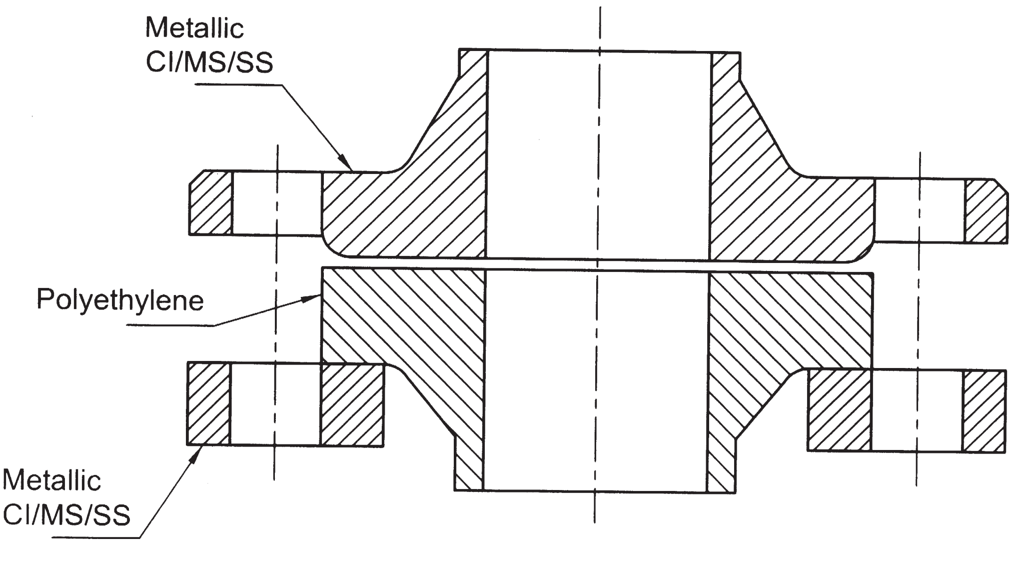
3.2.5.7 Various varieties of PP compression fittings such as couplers, bends, tees, reducers and threaded/flanged adapters to connect to valves /tanks/ non-PE pipes are available.

3.2.5.8 Polypropylene compression fittings are easy to fit requiring no special skills, have no possibility of infiltration (seepage) from outside or leaks from inside and therefore, are most ideal for domestic service connections enabling easy threaded connections to the ductile/cast iron/PVC-U/PE pipe ferrules/saddles of the main lines.

3.2.6 *Flanged Joints* (see *Fig*. 9)

3.2.6.1 These are used for jointing the PE pipes particularly of larger size to valves and vessels and large size metal pipes, and where non-PE pipes are to be joined with PE pipes.

3.2.6.2 It contains slip-on metallic/polyethylene flanges with collar/stub ends. The collar/stub end is welded by butt, socket or electro fusion, as per procedures (*see* **3.2.1.2**, **3.2.2.1** and **3.2.3.1**) to the pipe. In case polyethylene flanges are used a suitable metallic backing plates shall be used to support the polyethylene flanges so that the bolt force does not deform the plastic flange. Injection moulded polyethylene flanges without backing flanges conforming to IS 8008



NOTE — Dimensions and bolt tightening torque shall be as per manufacturers' recommendations.

FIG. 9 TYPICAL FLANGED JOINT

(Part 7) may also be used. Sealing is improved by incorporating a natural or synthetic rubber gasket between flanges.

3.2.7 *Spigot and Socket Joint* (see *Fig*. 10)

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

3.2.7.2 The socket (bell) could be an integral part of the pipe at one end or a special coupler, into which the free ends (spigot ends) of the pipes are pushed to achieve a water tight joint. Various types of 'O' rings are available in the market and the user may check with the manufacturer about the suitability of the same as per site conditions.

3.2.7.3 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. 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 to prevent loosening because of longitudinal pull. Special type of rubber gasket (for water tightness) to prevent any slipping out of the free end of the pipe shall be used.

3.2.7.4 This type of joint is best used for non-pressure applications, such as gravity lines and for encasing cables or smaller diameter pipes.

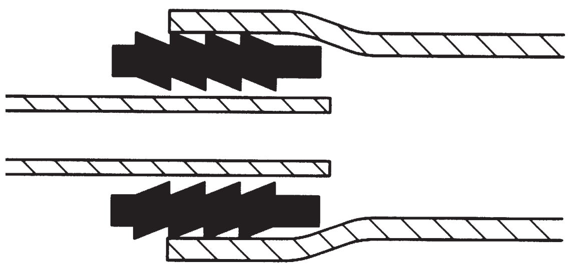


FIG. 10 SPIGOT AND SOCKET JOINT

4 BENDING

4.1 Cold Bending (*see* Fig. 11)

Polyethylene pipes have a degree of flexibility such that a substantial radius may be set up within a length of pipe itself without heating and causing residual stress. This enables gradual curves to be negotiated without the need for special bends or flexible couplings. However the radius of the bend shall be as per Table 2. Cold bending should only be used on pipes at ambient temperature.

Table 2 Allowable Bend Radius for Various SDRs
(*Clause* 4.1)

Sl No.	Pipe SDR	Minimum Bending Radius *R*
(1)	(2)	(3)
i)	SDR ≤ 9	10 times diameter
ii)	9 < SDR ≤ 13.6	13 times diameter
iii)	13.6 < SDR ≤ 21	17 times diameter
iv)	SDR > 21	20 times diameter

NOTE — SDR (Standard Dimension Ratio) is defined as:

$$\text{SDR} = \frac{\text{Outside diameter, mm}}{\text{Minimum wallthickness, mm}}$$

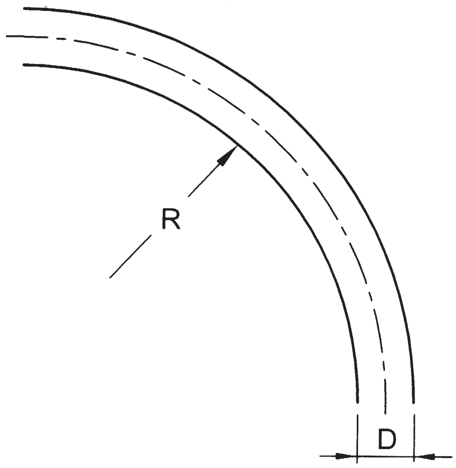


FIG. 11 BEND RADIUS

4.2 Hot Bending

4.2.1 Forming of small radius bend may easily be done by the application of heat either by hot air oven or by immersion in a suitable liquid at an appropriate temperature. For lower density polyethylene pipe, the temperature range is 100 to 110°C and suitable liquids are water, glycerol or a solution of calcium chloride. Higher density polyethylene pipe should be heated in an inert liquid, such as glycerol at a temperature of 130°C. Electrical heating coils or plates may be used only by experienced technicians.

4.2.2 In preheating operations, the low thermal conductivity of PE should be kept in mind. Over heating can usually be recognized by surface discolouration and distortion. On the other hand bending operations should not be performed at too low a temperature.

4.2.3 At higher temperature, the bore of the pipe tends to collapse and therefore requires support during the bending operation. Internal support should be affected before heating by packing the bore of the pipe with warm fine dry sand or by inserting rubber pressure hose, rubber rod or a flexible spring. After the pipe is uniformity heated it should be bent around a sample jig and held in the correct position until the form is cooled.

4.2.4 It is recommended that radius of the bend for pipe up to 50 mm size should not be less than three times the outside diameter of the pipe for lower density PE and five times the outside diameter for higher density PE. Pipes of large diameter will require an increase in radius. General recommendations of the bend radius given in Table 2 are to be followed. The pressure compatibility of the bend is to be tested before using the same in the field.

5 PIPE LAYING

5.1 The pipe line may be laid along side of the trench and jointed there. There after the jointed pipeline shall be lowered into the trench carefully without causing undue bending. The pipeline shall be laid inside the trench with a slack of up to 2 m/100 m of pipe line.

5.2 Polyethylene pipes conforming to IS 4984, being black in colour, when subjected to direct sunlight or warm ambient temperature may become warmer than the ground temperature. When placed inside the trench, the pipe will contract in length as it cools to the surrounding soil temperature. If the pipe is connected to sub-surface structures (such as preset valve, etc) before it is cooled sufficiently, excessive pull forces could develop. Allow the pipe to cool to ambient temperature prior to making a connection to an anchored joint.

5.3 Polyethylene pressure piping systems jointed by butt welding, electro fusion and flanges do not require external joint restraints or thrust block joint anchors.

5.4 Polyethylene pipes are non-metallic, so once buried, metal detector type locators are ineffective. To facilitate locating a buried PE pipe, metallic locating tapes or copper wires can be placed alongside the pipe. Locating tapes/wires are placed slightly above the crown of the above before the final back fill.

5.5 Because of high integrity of properly made fusion joints, PE pipes can be used with special installation techniques such as horizontal directional drilling, pipe bursting, micro tunnelling methods of trench less technologies.

6 EARTH WORK AND PIPE SUPPORT (TRENCHING)

6.1 Trench width and depth shall be as per Fig. 12 and Table 3.

Table 3 Trench Dimensions
(*Clauses* 6.1 *and* 6.4.1)

All dimensions in millimetres.

Sl No. (1)	Size of Pipe mm (2)	Width (3)	Initial Back Fill (4)	Range of Depth of Cover (5)
i)	20-110	300	150	900-1 100
ii)	125	425	150	900-1 100
iii)	140	440	150	900-1 100
iv)	160	460	150	900-1 100
v)	180	480	150	900-1 100
vi)	200	500	150	900-1 100
vii)	225	525	150	900-1 100
viii)	250	550	150	900-1 100
ix)	315	615	150	900-1 100
x)	355	655	150	900-1 100
xi)	400	700	150	900-1 100
xii)	450	750	150	900-1 100
xiii)	500	800	150	900-1 100
xiv)	560	860	150	900-1 100
xv)	630	930	150	900-1 100
xvi)	710	1 010	150	900-1 100
xvii)	800	1 100	150	900-1 100
xviii)	900	1 200	150	900-1 100
xix)	1 000	1 300	150	900-1 100

NOTES
1 Width may be increased where jointing inside the trench becomes necessary because of site conditions.
2 Under national/state highways, a concrete/hume pipe shall be covered over the pipe.
3 Depth is to be measured over the crown of the pipe.
4 In case of mole-plough technique of pushing the coils of diameters 20-100 mm in am narrow trench the width of 300 mm is not mandatory.
5 Initial back fill material shall be as per this standard.
6 For gravity lines SDR more than 22, manufacturers should be consulted for allowable deformation calculations under dynamic traffic load.

6.2 Flexibility

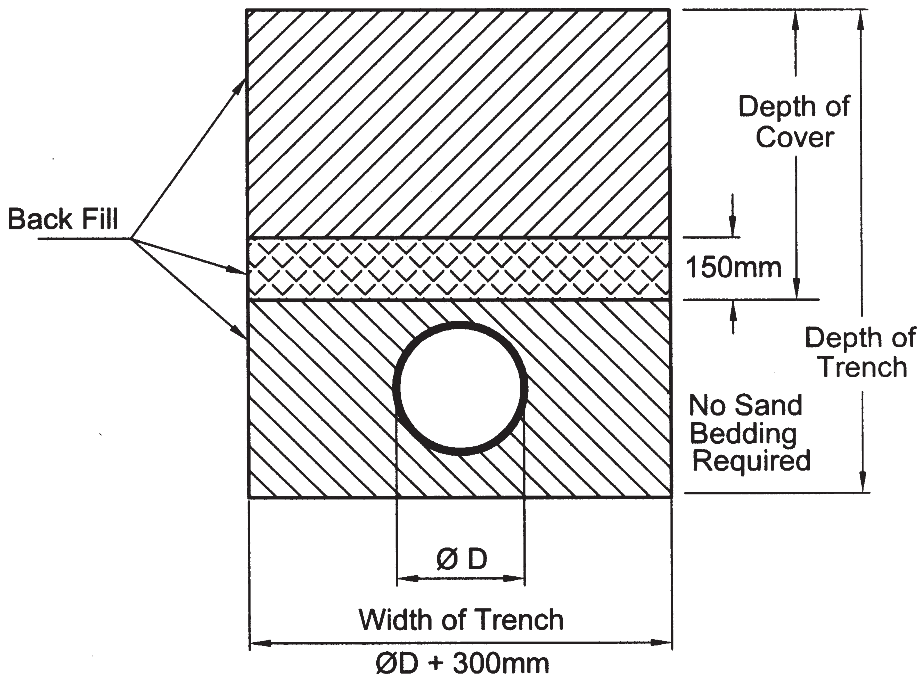
For rigid pipes such as concrete, etc, the pipe alone has to take the main vertical forces acting on the pipe, while flexible PE pipe makes use of the horizontally acting soil support accumulating as a result of the deflection of the pipe. This aspect improves the load bearing capacity of PE pipe especially useful property in gravity pipe design where there is no internal pressure to ensure the pipe circularity.

6.3 Trench Bedding

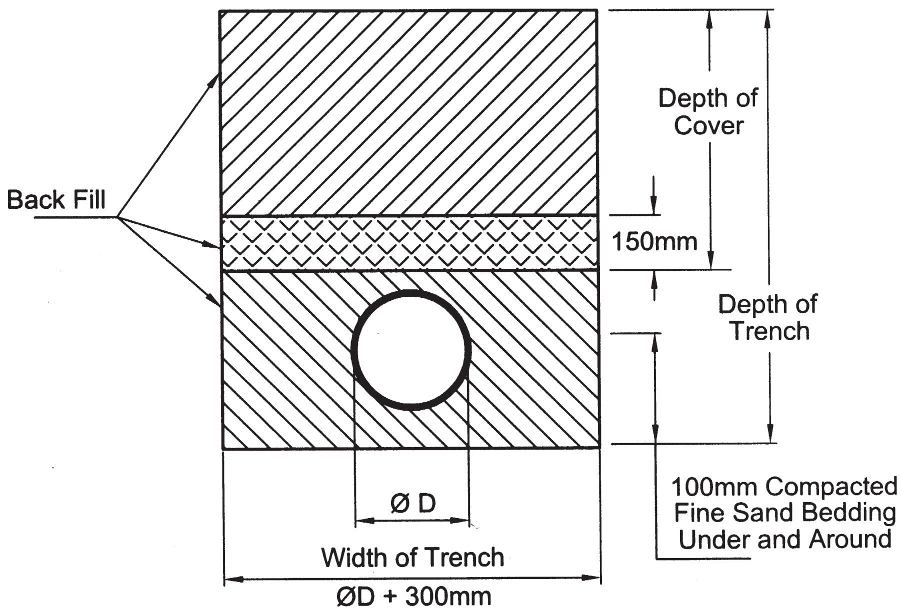
Polyethylene pipe requires no special bed preparation for laying the pipe underground, except that there shall be no sharp objects around the pipe. However, while laying in rocky areas suitable sand bedding should be provided around the pipe and compacted.

6.4 Trench Depth

6.4.1 The trench depth shall be as per Table 3. The initial back fill up to 150 mm above the crown of the pipe should be compacted with screened excavated material free of sharp stones or objects or with fine sand where no such material is available.



12A For Soil having no Rocks and Natural Aggregate Comprised Primarily of Rounded Particles Created by Mechanical Erosion



12B For Soil having Sharp Rocks and Unconsolidated Material that are Made Up of Rocks Fragments > 20 mm Diameter

FIG. 12 TRENCH LAYOUT

6.4.2 The excavated soil from the trenches should be placed such that it shall not interfere with stringing and jointing of the pipes.

6.4.3 In all cases, 150 mm above the top of the crown of the pipe is to be compacted either by mechanical or manual means. Wherever road crossing with heavy traffic is likely to be encountered — a concrete pipe encasing is recommended.

6.4.4 Polyethylene pipes can be jointed inside or outside the trench, as per site conditions. However, in case of jointing inside the trench, the width of the trench may be suitably increased to ensure work space.

6.5 Water in the Trench (*see* Fig. 13)

The pipe shall be laid on a stable foundation. Where water is present or where the trench bottom is unstable, excess water should be removed before laying the pipe. In case there is a chance of floatation because of likely flood, the pipe shall be encased with concrete weights as per the buoyancy calculations.

6.6 Under Water Installations (*see* Fig. 14)

Polyethylene pipes are frequently used for carrying potable water across rivers/canals/lakes. Even water filled PE pipe is lighter than water. Thus the pipe can be aligned along the recommended route over the water surface and then submerged with suitable weights (*see* Fig.13). Submerged installations require permanent concrete ballast rings attached around the pipe to ensure submergence and stable system once it is submerged. Concrete block design depends on type of installation, tidal flows and wave actions.

6.7 Service Connection (*see* Fig. 15A and Fig. 15B)

6.7.1 New service connections can be made on PE pipes with mechanical saddles or electro fusion saddles. Mechanical saddles are similar to those available for PVC-U and ductile iron.

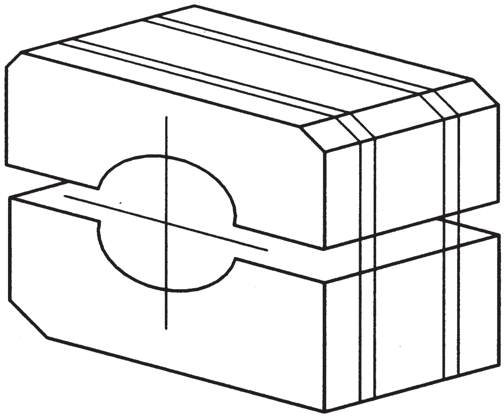


FIG. 13 TYPICAL ANTI-BUOYANCY WEIGHT — CONCRETE BLOCK

6.7.2 Installation of mechanical saddle is similar to techniques used to install saddles on other piping materials, however care has to be taken as excessive tightening of the side bolts may make the pipe oval. Mechanical saddles should have wide straps to distribute compressive forces and must be installed as per manufacturer's recommendations.

6.7.3 Installation of electro fusion saddle shall be as per the electro fusion jointing procedure detailed in **3.2.3.1**.

6.7.4 Mechanical saddles can also be used for PE to metal connection as a transition tapping.

7 INSTALLATION

7.1 Lowering

7.1.1 When jointed outside of the trench the jointed pipeline shall be lowered into the trench (for underground installations) carefully (preferably with mechanical handling equipment for sizes greater than 160 mm) without causing undue bending that can cause kinking. The pipeline shall be laid inside the trench

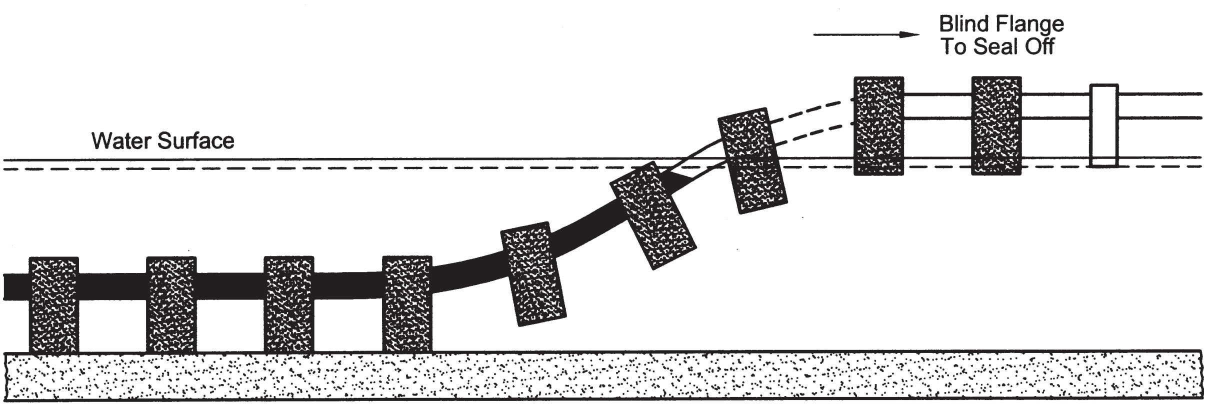
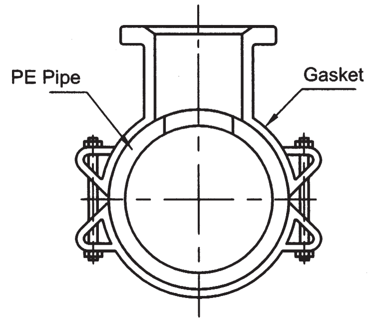
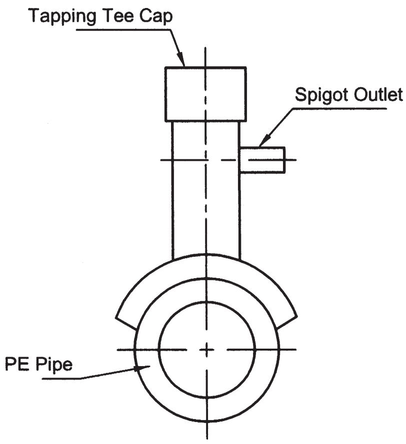


FIG. 14 UNDER WATER INSTALLATION



15A Typical Mechanical Saddle Tappings



15B Typical Electro Fusion Saddle Tappings

FIG. 15 TYPICAL SADDLE TAPINGS

with a slack of up to 2 m/100 m of the pipeline (pipe line to be laid in a sinuous alignment).

7.1.2 Bending of pipe inside the trench involves excavating the trench to the desired bend radius. Exposed black PE pipe to ambient temperature greater than 30°C will have very high surface temperature that makes it difficult to handle. Proper precautions shall be taken to ensure safety at work site.

7.2 Thermal Expansion

7.2.1 For exposed PE pipes, provisions shall be made for the effects of thermal movement. The support anchors for exposed PE pipes should not grip or distort the pipe (*see* Fig. 16), but should allow free movement of the pipe due to temperature variation.

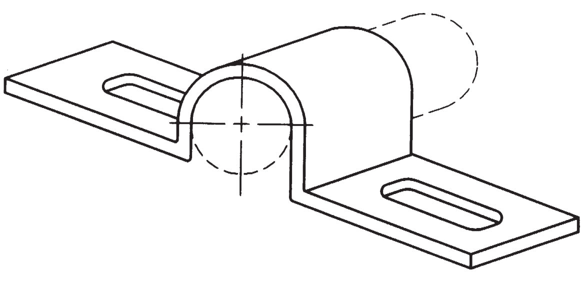


FIG. 16 TYPICAL PIPE CLAMP

7.2.2 Plastics pipe clamps may be used to support the pipe. Standard pipe clips may also be used but care shall be taken not to over tighten and cause the clips to bite into the pipe. Pipe clips should be correctly aligned and should provide a smooth flat surface for contact with pipe. Sharp edged supports should be avoided.

7.3 Painting

Plastics pipes in general need not be painted. Painting may disguise its character. Hazard might occur by mistaking this pipe for metal one in using it for load bearing support, or for electrical grounding.

Precaution — Polyethylene pipes shall not be installed near hot water pipes or near any other heat sources.

7.4 Valve Anchoring (*see* Fig. 17)

All types of manual controls and valves in particular should be anchored firmly so as to avoid the turning torque imparted by the operation of the hand wheel of the valve onto the pipe. In short the valve should not be 'hung' on the pipe, as is normally done for metallic pipes.

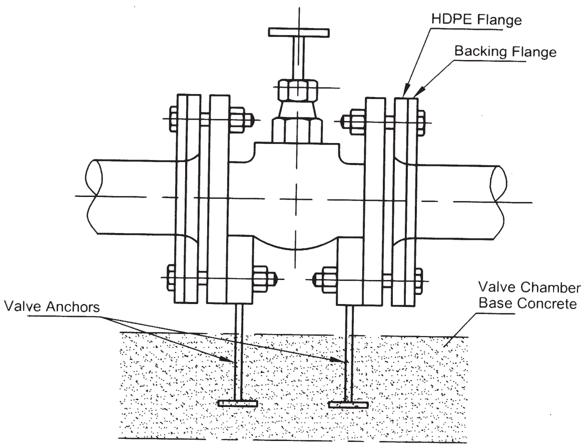


FIG. 17 VALVE ANCHORS

7.5 Support Spacing

Suitable supports as agreed to between the buyer and the supplier for horizontal over ground run of PE pipe with pipe clamps/brackets should be used. At >40ºC, continuous support is recommended, if the pipe is carrying heavier liquids.

7.6 Effect of Temperature

7.6.1 *Expansion and Contraction*

The co-efficient of expansion is about fourteen times than that for expansion experienced with metal pipes. This also holds good for contraction due to fall in temperature.

7.6.1.1 In underground pipe the normal changes in the direction of the pipe provide an adequate means of accommodating expansion/contraction.

7.6.1.2 In the continuous straight runs of exposed pipe it is necessary to insert units to absorb the expansion. Expansion loops, bellows or sliding gland expansion joints may be used.

7.6.1.3 Care should be taken in, to account for the high increase in surface temperatures of these pipes in cases of exposed laying or laying in the close proximity of artificial heat sources.

7.7 PE Fittings

Polyethylene pipe fittings conforming to IS 8008 (Parts 1 to 9) and IS 8360 (Parts 1 to 3) may be used for connecting the pipes and other system appurtenances. These fittings can also be used for connecting to metallic valves (sluice, scour and air), tanks, pipes and other mechanical equipment (pumps, etc). However, where there is a likely hood of vibrations and turning torques in such connections, the fitting wall thickness shall be minimum one rating higher than the corresponding pipe.

7.8 Concrete Encasement

Polyethylene pipes may be encased in concrete, wherever necessary. Compressible padding material at least 3 mm thick and at approximately 150 mm from the face of concrete shall be provided around pipes at the entry and exit points to eliminate any potential sharp edges from rubbing against the pipe wall. Pipeline shall not be filled with water until the concrete has developed sufficient strength.

8 LAYING THE PIPE IN TRENCHES

8.1 Trench Filling

8.1.1 On completion of the pipe laying operations up to a length of about 1 000 m while further laying work is still in progress, refilling of trenches of this stretch shall be carried out up to 300 mm above pipeline. Pipe laying shall follow closely the progress of trench excavation. Only soft earth and gravel of good quality free from boulders, roots vegetable matter, etc, shall be used first. If sufficient quantity of suitable (sharp edge stone free) excavated earth is not available, the trench shall be filled by borrowed gravel or material up to 300 mm above top of the pipe.

8.1.2 Care shall be taken during back filling for not to damage the pipe or joints. Filling has to be carried out simultaneously on the both sides of the pipes so that unequal pressure does not occur. Load on the buried pipeline shall not be permitted unless the trench has been filled to the height of at least 300 mm over the top of the pipe. Filling shall be done in layers of 150 mm, with the first layer watered and compacted by stamping or by mechanical means. The trench shall be refilled so as to build up the original ground level, keeping due allowance for subsequent settlement likely to take place.

9 FIELD TESTING OF PIPELINE

The pipeline to be tested shall be filled with water slowly allowing for splurging the entrapped air. Air valves at high points should be open to allow air to escape while water is being filled. Before pressure is applied, the pipeline section under test shall be restrained against movement.

The following procedure is recommended for PE pipe testing:

a) Polyethylene pipelines shall be pressure tested at ambient temperature. After filling with water the pipeline shall be left to stabilize for a period of 1 h.
b) Fusion joints may be covered during testing. Flanged joints shall be kept open for visual inspection. The pipeline shall be filled with water and pressure tested from the lowest point.
c) During the test period, make-up water is continuously added to maintain the pressure.
d) The test pressure shall be 1.5 times the rated pressure of pipes or of the proposed maximum design pressure of the section. Apply the pressure by continuously pumping at a constant rate.
e) Under no circumstance, air is to be used instead of water for testing.
f) Tests should be performed on reasonable lengths of pipelines. Long lengths more than 2 000 m may make leak detection more difficult.
g) *Acceptance criteria* — If the pressure remains steady (within 5 percent of the target value) for 1½ h, leakage is not indicated. Flanged connections shall be visually inspected.
h) If the test is not complete because of leakage or equipment failures, the test section shall be depressurized and allowed to relax for at least 8 h, before starting the next testing sequence.
j) Testing outside the trench is to be avoided, as pipe rupture may involve safety issues.

10 REPAIR AND MAINTENANCE (*see* Fig. 18)

10.1 A perfectly welded fusion jointed PE pipes is totally leak proof. A good compression fitting also ensures total integrity of the system. However, there may be external conditions that necessitate repairs and maintenance of the system. Various methods may be employed for repairing leakages or damage to sections of PE pipes.

10.2 In general, the best way is to cut the damaged portion and to replace it by a new pipe or pre-fabricated flanged replacement section. The connections of new pipe to either ends of the old pipe may also be done by insert type of fittings (subject to their pressure limitations) and by electro fusion fittings. Butt fusion inside the trench for repairs is not recommended as the movement of the pipe for attaining the required facial pressure for good weld integrity may not be possible. When failure or damage occurs in a welded joint, the original weld shall be removed entirely before re-welding. No patch work is recommended.

11 GENERAL GUIDANCE

11.1 Freezing

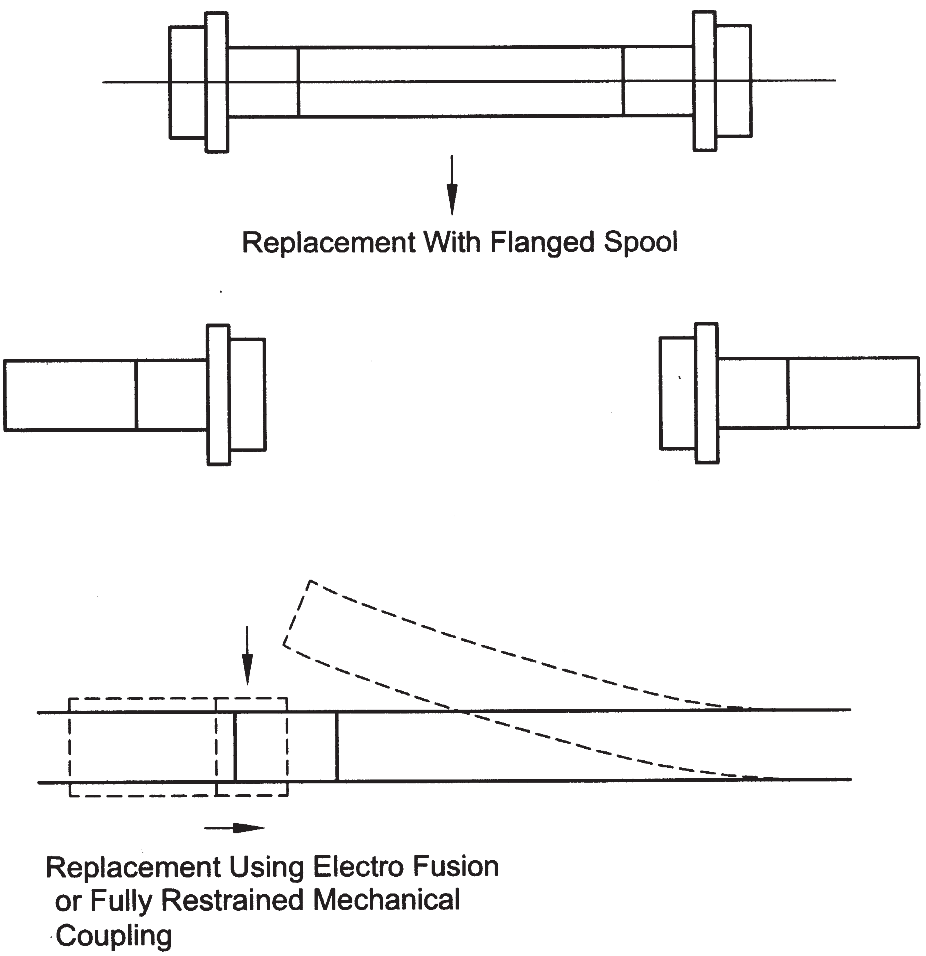
Freezing of water inside the PE pipes does not fracture it, as the pipe expands to allow the extra volume. However, direct application of intense heat, such as a torch or open flames should not be used to de-freeze.

11.2 Pressure Check

In any application where polyethylene pipe is attached to a pressure source, which is greater than the pressure rating of the polyethylene pipe being installed, adequate pressure reduction devices shall be installed. Whenever, such devices are installed a regular check of such devices should be made to ensure their continued proper functioning as a protection to the PE pipe.

11.3 Surge Pressure

Polyethylene pipes, by their visco-elastic nature and creep properties, can withstand much higher short term loads, that is, 2.3 times the working pressures. This property enables PE pipe to be able to withstand repetitive water hammer surges of pumping mains, without any need for any extra correction factor. However, for velocities higher than 1.5 m/s a surge check is necessary.



NOTE — The saddles shown in Fig. 15A and Fig. 15B can also be used as repair sleeves.

Fig. 18 Repairing PE Pipe

11.4 Slack in Laying

When PE pipes are laid inside the trench, up to 2 percent slack is permitted.

12 SUPPLY, PACKAGING, HANDLING, STORAGE AND TRANSPORTATION OF POLYETHYLENE PIPES

12.1 Supply

12.1.1 The polyethylene pipes shall be supplied in straight lengths either independent or bundle together, or as self supporting coils as agreed to between the supplier and the purchaser.

12.1.2 Their ends shall be clearly cut square and protected against shocks. Coils shall be protected for the ingress of foreign bodies by appropriate end caps.

12.2 Packing

Generally, PE pipes are tough and do not require any special packing. However, where necessary (during long distance transportation) the pipes shall be bundled to eliminate scratches. Coils may be wrapped in jute cloth.

12.3 Handling

Polyethylene is a tough resilient material which may be handled easily. However, because it is softer than metals, it is prone to damage by abrasion and by objects with a cutting edge. Such practices as dragging pipes over rough ground should therefore be avoided. If handling equipment is not used, techniques, which are not likely to damage the pipe are to be chosen.

12.3.1 *Coils*

Individual coils must not be rolled off the edge of the loading platforms or trailers. These coils should be slung individually when off-loading with a crane. Uncoiling the pipe at site requires trained personnel. The manufacturer need to be consulted, as unloading of the coils may involve safety concerns of the workmen involved.

If, due to improper storage or handling, a pipe is damaged or kinked the damaged portion should be cut out completely.

12.3.2 *Straight Pipe*

Handling and storage of straight polyethylene pipes should be such so as to avoid penetration by sharp objects. When loading, unloading or handling of large outer diameter (>160 mm), it is preferable to use mechanical equipments. Safety precautions should be followed while unloading the pipes at site. Unloading of the large outer diameter pipes from trucks and trailers shall be with the help of properly set-up platforms and the same shall be rolled smoothly and not dumped from a high ground.

12.4 Transportation

12.4.1 When transporting straight polyethylene pipes, use flat bedded vehicles. The bed shall be free from nails and other projections. The polyethylene pipes shall rest uniformly in the vehicle over their long length.

12.4.2 The vehicle shall have side supports approximately spaced 2 m apart, and the pipes shall be secured effectively during the transportation. All posts shall be flat with no sharp edges. Strapping the pipe bundles during transit may be required to avoid excessive movement in the truck.

12.4.3 Polyethylene pipes shall not be transported with other metallic items in the same vehicle.

12.4.4 Coiled pipe with outer diameter < 63 mm may be supplied on pallets. The coils should be firmly strapped to the pallets, which in turn be firmly secured to the vehicle. Coiled pipe with outer diameter ≥ 63 mm should be supplied individually.

12.4.5 There should be facilities to ensure that each coil is securely fastened throughout transit and the un-loading process.

12.4.6 To save on transport cost nesting of coils/ straight lengths can be considered, if agreed to between the purchaser and the supplier.

12.5 Storing

12.5.1 Polyethylene pipes conforming to IS 4984 may be stored either under cover or in the open as the pipes are suitably protected from ageing due to sun light by the addition of the appropriate quantity and the type of carbon black. Other non-black polyethylene pipes, however, should be stored under cover and protected from direct sunlight (*see* Fig. 19).

12.5.2 Polyethylene pipes shall be stored in the manner to prevent damage from elevated temperature, contact with harmful chemicals (such as solvents). Prolonged exposure to direct sunlight shall not alter the pipe performance, but the pipe may bend because of the heat during summer months. Precautions are to be taken accordingly.

12.5.3 Non-ventilated covering of the polyethylene may sometimes create excessive heat, which may be cumbersome for pipe handling.

12.5.4 Storage of pipes in hot areas should be avoided.

While storing the pipes at temperatures above 45°C continuous support may be provided by leveled sand layer or other suitable methods.

12.5.5 The polyethylene pipes shall be stacked on a reasonably flat surface, free from sharp objects, stones or projections likely to deform or damage them.

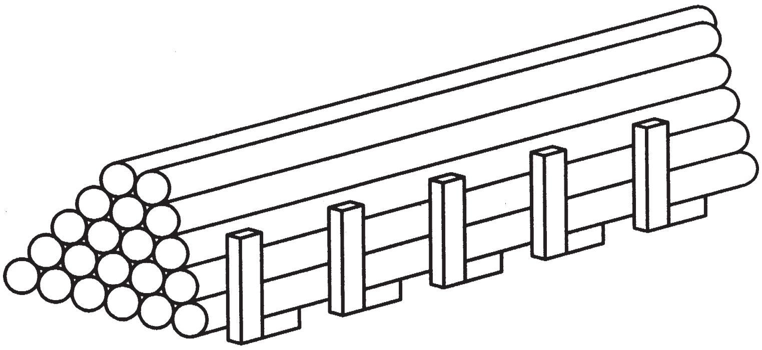


FIG. 19 STORING OF PIPES

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
4984 : 1995	Specification for high density polyethylene pipes for potable water supplies (*fourth revision*)
5382 : 1985	Specification for rubber sealing rings for gas mains, water mains and sewers (*first revision*)
8008	Injection moulded/machined high density polyethylene (HDPE) fittings for potable water supplies — Specification:
(Part 1) : 2003	General requirements for fitting (*first revision*)
(Part 2) : 2003	Specific requirements for 90º bend (*first revision*)
(Part 3) : 2003	Specific requirements for 90º tee (*first revision*)
(Part 4) : 2003	Specific requirements for reducers (*first revision*)
(Part 5) : 2003	Specific requirements for ferrule reducers (*first revision*)
(Part 6) : 2003	Specific requirements for pipe ends (*first revision*)
(Part 7) : 2003	Specific requirements for sandwich flanges (*first revision*)
(Part 8) : 2003	Specific requirements for reducing tees (*first revision*)
(Part 9) : 2003	Specific requirements for ends caps (*first revision*)
8360	Specification for fabricated high density polyethylene (HDPE) fittings for potable water supplies:
(Part 1) : 1977	General
(Part 2) : 1977	Specific requirements for 90º tees
(Part 3) : 1977	Specific requirements for 90º bends

ANNEX B
(*Foreword*)

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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