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जलपूर्ति के लिए विद्युत वेल्डकृत इस्पात के पाईप डालने की रीति संहिता

(दूसरा पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR LAYING OF ELECTRICALLY WELDED STEEL PIPES FOR WATER SUPPLY

(Second Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 7

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Water Supply and Sanitation Sectional Committee had been approved by the Civil Engineering Division Council.

The selection of a pipeline for any particular application depends on the service and environmental conditions to be satisfied. With the development of new materials and jointing methods, changes in the application and in design can be expected, but it is the responsibility of every authority to ensure that the type of the pipeline selected is suitable and safe for the duty envisaged. The earlier disadvantages of steel pipelines (liability to deteriorate by corrosion) have been largely overcome in recent years due to development of protective coatings, and steel pipelines may now be safely used for carrying certain fluids. This standard was first published in 1970 and subsequently revised in 1986. The present revision incorporates the following major changes:

a) Inclusion of 168·3 mm outside diameter pipe,

b) Criteria for calculating the nominal thickness has been modified, and

c) Criteria for selecting protective coatings has been modified,

In the formulation of this code due weightage has been given to international co-ordination among standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country. This has been met by deriving assistance from the following standards:

BS CP 8010-1981 'Code of practice for pipelines' British Standards Institution.

BS CP 2010 (Part 2) 'Pipelines: Part 2 Design and construction of steel pipelines in land' British Standards Institution.

The Committee responsible for the preparation of this standard is given in Annex C.

Indian Standard

CODE OF PRACTICE FOR LAYING OF ELECTRICALLY WELDED STEEL PIPES FOR WATER SUPPLY

(Second Revision)

1 SCOPE

1.1 This code covers the methods of laying electrically welded mild steel pipes of outside diameters 168.3 mm to 2 032 mm (as covered in IS 3589 : 1991), laid either above ground or underground for water supply.

1.2 For the purpose of this code, electrically welded steel pipes shall conform to IS 3589 : 1991; mild steel plates to IS 2062 :1992 and welding electrodes to IS 814 : 1991.

2 REFERENCES

2.1 The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 CLEARING THE SITE

3.1 Preliminary work required to be done before pipe laying is started, includes pegging out, clearing and disposal of all shrub, grass, large and small bushes, trees, hedges, fences, gates, portions of old masonry and debris from the route.

3.2 Where trees have been felled, the resulting timber shall be stacked properly and disposed off, as directed by the authority. Tree roots within a distance of about half metre from the side of the pipeline shall be removed or killed.

3.3 All other serviceable materials, such as wood work, bricks and masonry, recovered during the operation of clearing the site shall be separately stacked and disposed off, as directed by the authority.

NOTE – For the purpose of this code, authority may be an individual, an official, a board, a department or an agency established and authorized by the Union or State Government or any statutory body created by law who undertakes to administer and enforce the provisions of this code as adopted or amended.

4 FORMATION

4.1 General

Before pipeline is laid, proper formation shall be prepared. For buried pipeline, suitable trenches should be excavated, pipeline above ground may be laid in cutting or on embankments or be supported by pillars as the case may be.

4.2 Excavation and Preparation of Trenches for Laying Underground Pipeline

The trench shall be so dug that the pipe may be laid to the required alignment and at required depth. When the pipeline is under a roadway, a minimum cover of 1.0 m is recommended, but it may be modified to suit local conditions by taking necessary precautions. The trench shall be shored, wherever necessary, and kept dry so that the workman may work therein safely, and efficiently. The discharge of the trench dewatering pumps shall be conveyed either to drainage channels or to natural drains, and shall not be allowed to be spread in the vicinity of the worksite.

4.2.1 *Trenching*

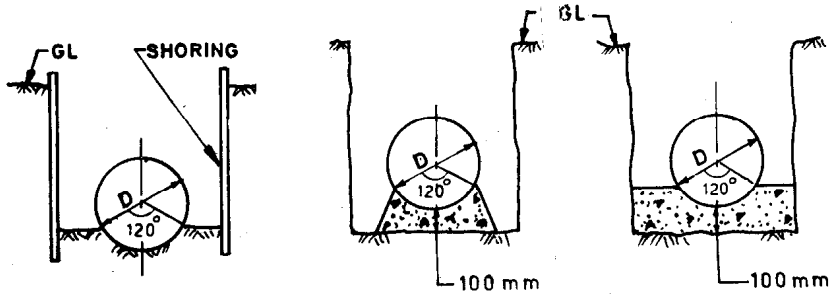
Trenching includes all excavation which is carried out by hand or by machine. The width of the trench shall be kept to a minimum consistent with the working space required. At the bottom between the faces, it shall be such as to provide not less than 200 mm clearance on either side of the pipe. Each case should, however, be considered on its merits, having regard to the safety of the trench, the method of laying and jointing the pipe and the need to avoid damage to pipe coating. The bottom of the trench shall be properly trimmed to permit even bedding of the pipeline. For pipes larger than 1 200 mm diameter in earth and murum the curvature of the bottom of the trench should match the curvature of the pipe as far as possible, subtending an angle of about 120° at the centre of the pipe, as shown in Fig. 1A. Where rock or boulders are encountered, the trench shall be trimmed to a depth of at least 100 mm below the level at which the bottom of the barrel of the pipe is to be laid and filled to a like depth with lean cement concrete or with non-compressible material like sand of adequate depth to give the curved seating, as shown in Fig. 1B and Fig. 1C.

4.2.2 *Pits for Joints*

When welding is to be carried out with the pipe in the trench, additional excavation of not more than 600 mm in depth and 900 mm in length should be provided all round the pipe at the position of the joints for facilities of welding.

4.2.3 *Special Foundations in Poor Soil*

Where the bottom of the trench at subgrade is found to consist of material which is unstable to such a degree that, in the opinion of the authority, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the pipe, consisting of piling, timbers or other materials, in accordance with plans prepared by the authority, shall be constructed.



1A Trench in earth or Murum

1B Trench in Hard Rock with Cement Concrete Bedding

1C Trench in Hard Rock with Sand Bedding

FIG. 1 TRENCHING FOR STEEL PIPES

4.2.4 *Rock Excavation*

The term 'rock', wherever used in this standard, shall have the same meaning as given in terminology in IS 1200 (Part 1) : 1992.

4.2.5 *Blasting*

Blasting for excavation shall be permitted only after securing the approval of the authority and only when proper precautions are taken for the protection of persons or property. The hours of blasting shall be fixed by the authority. The procedure of blasting shall conform to the requirements of local controlling authority (reference may also be made to IS 4081 : 1986).

4.2.6 *Braced and Sheeted Trenches*

Open-cut trenches shall be sheeted and braced as required by any governing state laws and municipal regulations and as may be necessary to protect life, property or the work. When close sheeting is required, it shall be so driven as to prevent adjacent soil from entering the trench either below or through such sheeting.

4.2.6.1 The authority shall have the right to order the sheeting to be driven to the full depth of the trench or to such additional depths as may be required for protection of the work. Where the soil in the lower limits of a trench has the necessary stability, the authority at its discretion may permit stopping of the driving of sheeting at some designated elevation above the trench bottom.

4.2.6.2 Sheeting and bracing which have been ordered to be left in place should be removed for a distance of 0.9 m below to established street level or the existing surface of the street, whichever is lower. Trench bracing, except that which should be left in place, may be removed when the backfilling has reached the respective levels of such bracing. Sheeting, except that which has been left in place may be removed after the backfilling has been completed or has been brought up to such an elevation as to permit its safe removal. Sheeting and bracing may be removed before filling the trench, but only in such a manner as will ensure adequate protection of the completed work and adequate structures.

4.2.7 *Care of Surface Material for Re-use*

All surface materials which, in the opinion of the authority, are suitable for re-use in restoring the surface shall be kept separate from the general excavation material as directed by the authority.

4.2.8 *Stacking Excavated Material*

All excavated material shall be stacked in such a manner that it does not endanger the work and avoids obstructing footpaths and roads. Hydrants under pressure, surface boxes, fire or other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clear or other satisfactory provisions made for street drainage and natural water-courses shall not be obstructed.

4.2.9 *Barricades, Guards and Safety Provisions*

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, torches, red lanterns and guards, as required, shall be placed and maintained during the progress of the construction work and until it is safe for traffic to use the roadway. All materials, piles, equipment and pipes which may serve as obstructions to traffic shall be enclosed by fences or barricades and shall be protected by proper lights when the visibility is poor. The rules and regulations of the local authorities regarding safety provisions shall be observed.

4.2.10 *Maintenance of Traffic and Closing of Streets*

The work shall be carried in such a manner that it causes the least interruption to traffic, and the road/street may

be closed in such a manner that it causes the least interruption to the traffic. Where it is necessary for traffic to cross open trenches, suitable bridges shall be provided.

4.2.10.1 Suitable signs indicating that a street is closed shall be placed and necessary detour signs for the proper maintenance of traffic shall be provided.

4.2.11 *Structure Protection*

Temporary support, adequate protection and maintenance of all underground and surface structures, drains, sewers and other obstruction encountered in the progress of the work shall be furnished under the direction of the authority. The structures which may have been disturbed shall be restored upon completion of the work.

4.2.12 *Protection of Property*

Tress, shrubbery fences, poles and all other property shall be protected unless their removal is shown on the drawings or authorized by the authority. When it is necessary to cut roots and tree branches; such cutting shall be done under the supervision and direction of the authority.

4.2.13 *Avoidance of the Existing Service*

As far as possible, the pipeline shall be laid below existing services, such as water and gas pipes, cables, cable ducts and drains but not below sewers, which are usually laid at great depth; if it is unavoidable pipeline should be suitably protected. A minimum clearance of 150 mm shall be provided between the pipeline and such other services. Where thrust or auger boring is used for laying pipeline across roads, railways or other utilities, larger clearance as required by the authority shall be provided. Adequate arrangements shall be made to protect and support the other services during laying operations. The pipeline shall be so laid as not to obstruct access to the other services for inspection, repair and replacement. When such utilities are met with during excavation, the authority concerned shall be intimated and arrangements made to support the utilities in consultation with them.

4.3 Preparation of Formation for Pipeline Above Ground

Formation should be prepared by cutting high grounds and filling in low areas. Care shall be taken while fixing the alignment and gradient of the pipeline, to balance the cutting and filling quantities, as far as possible, with minimum of lead. Care should also be taken to ensure that the pipe rests fully either on cutting or on bank.

4.3.1 *Cutting High Grounds*

Excavation for the formation in cutting should be done in such a manner as to obtain sufficient width at the bottom to accommodate the pipeline, its supports, a service passage and side drains. The sides of the cutting should generally have the following slopes:

a)	Earth MURUM and boulders	1 : 1
b)	Hard MURUM and soft rocks	1/2 : 1
c)	Hard rock	1/4 :1

All excavated material shall be the property of the authority and shall be stacked or disposed off as directed under **4.2** above. Typical sections in cuttings are shown in Fig. 2 and 3.

4.3.2 *Preparation of Embankment*

Material used for embankment shall be spread in horizontal layers not more than 300 mm thick. Each layer shall be consolidated by watering, ramming and rolling before the next layer is laid. Mechanical consolidation is recommended. The consolidation obtained shall not be less than 90 percent of the proctor density [*see* IS 2720 (Part 7) : 1980]. Any wash-outs during rains shall be replaced with suitable material. The embankment shall be finished to the correct dimensions and gradient prescribed by the authority. If banking is to be done on the sloping ground or on embankment, it shall be cut in steps of not less than 300 mm deep and 450 mm wide to give a proper bond. Side slopes of the embankment shall be steeper than 1 1/2 horizontal to 1 vertical. The slopes of embankment should be protected by pitching or any other method, if so required by the authority.

4.3.2.1 *Width of embankment*

The width of the embankment at top shall be such as to

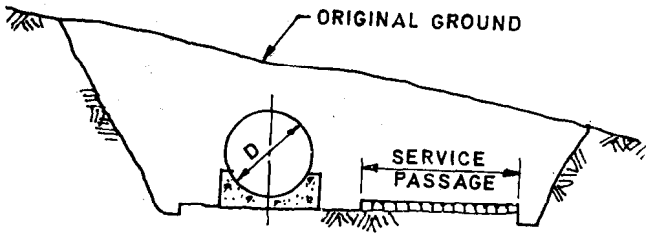


FIG. 2 SECTION IN CUTTING

accommodate the pipeline and the service passage. Typical section of the bank is shown in Fig. 4.

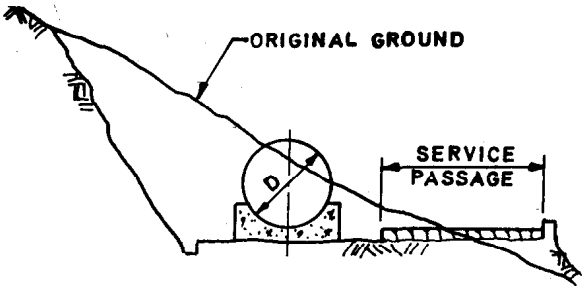


FIG. 3 SECTION IN PARTLY CUTTING AND EMBANKMENT

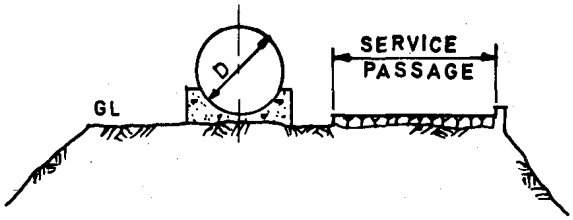


FIG. 4 SECTION IN EMBANKMENT

4.3.2.2 *Materials for embankment*

Materials used for embankment shall be such that it does not harm the pipeline. It shall not swell when moisture laden or shrink and crack when dry and shall have self-draining properties. Mud, clay, slush and decaying vegetable matter shall not be used. The material shall also be free from cinders, ashes, refuse, rubbish, organic material, frozen material or material which in the opinion of the authority is unsuitable or deleterious. All lumps and clods shall be broken to allow uniform subsidence of the earth work throughout the embankment.

4.3.2.3 *Stability of embankment*

Embankment shall rest on good foundation which shall be capable of taking load of the earth fill, the pipeline, service road, etc. When embankment is laid on soft ground, such as marshy clay or marine clay, such soft foundation shall be stabilized by providing sand piles or rubble piles. In the alternative, RCC or wooden piles should be driven to transfer load to harder substrata.

5 PIPE HANDLING AND INSPECTION

5.1 General

For the purpose of this code, it is presumed that the pipes, specials, expansion joints and appurtenances are available in the stockyard of the authority.

5.2 Preliminary Work Before Pipe Laying

Before the actual pipe laying operations are commenced, some preliminary work described in **5.2.1** to **5.2.5** shall be done.

5.2.1 *Bench Marks*

Reference bench marks, at least one per kilometre, shall be fixed before the work of laying the pipe line is started. These bench marks should be fixed a little away from the field of work and should be securely fixed in cement concrete.

5.2.2 *Transporting and Stacking of Pipes*

Delivery of the pipes and specials and appurtenances shall be taken from the stockyard of the authority and transported to the site of laying and stacked along the route on timber skids. Padding shall be provided between coated pipes and timber skids to avoid damage to the coating. Suitable gaps in the pipes stacked should be left at intervals to permit access from one side to the other.

5.2.3 *Pipe Inspection*

The pipes and specials shall be inspected and defects noticed, if any, such as protrusions, grooves, dents, notches, etc, shall be rectified. Care should be taken that the resulting wall thickness does not become less than the minimum specified. If the wall thickness becomes less than the minimum, the damaged portion should be cut out as a cylinder and replaced by an undamaged piece of pipe.

5.2.3.1 A dent is a depression producing a significant alteration of the curvature of the pipe shell. The depth of a dent is measured as a gap between the lowest point of the dent and the curvature of the pipeline. All dents exceeding 2 percent of the outer diameter of the pipe should be removed. Dents shall be removed by cutting out a cylindrical portion of the pipe and replacing the same with an undamaged piece of the pipe. Insert patching may be permitted by the authority if the diameter of the patch is less than 25 percent of the nominal diameter of the pipe. Repairs by hammering with or without heating shall not be permitted. Any damage to the coating shall also be carefully examined and rectified.

5.2.4 *Handling of Pipes and Specials*

It is essential to avoid damage to the pipes, fittings, specials, etc, at all stages during handling. The pipes and specials shall be handled in such a manner as not to distort their circularity or cause any damage to their outcoating. Pipes shall not be thrown down from the trucks nor shall they be dragged or rolled along hard surfaces. Slings of canvas on equally non-abrasive material of suitable width or special attachment shaped to fit the pipe ends shall be used to lift and lower coated pipes so as to eliminate the risk of damage to the coating.

5.2.5 *Preparing Pipe Faces for Welding*

Before aligning, assembling and welding, the pipe faces shall be cleaned by scraping by wire brushes or any other method specified by the authority.

6 WELDING

6.1 General

The welding of pipes in the field should comply with IS 816 : 1969. Electrodes used for welding should comply with IS 814 : 1991.

6.2 Testing of Welded Joints

The welded joints shall be tested in accordance with procedure laid down in IS 3600 (Part 1) : 1985. One test specimen taken from at least one field joint out of any 10 shall be subjected to test.

6.2.1 If the results of the tensile test do not conform to the requirements specified, retests of two additional specimen from the same section shall be made, each of which shall conform to the required specifications. In case of failure of one or two, extensive gouging (scooping out) and repairing shall be carried out as directed by the authority.

6.2.2 If internal pressures exceed 1.5 N/mm^2, special attention should be given to the assembly of the pipe and first run of weld. Non-destructive testing of the completed weld may be carried out on pipelines by radiographic (*see* IS 4853 : 1982) or ultrasonic method (*see* IS 4260 : 1986) as agreed upon between the user and the manufacturer.

6.3 Welding of Closure Gaps

Final welding of closure gaps should be carried out within a temperature range of average air temperature ± 8 °C. For buried pipelines final welding may best be done after intermediate pipes have been backfilled.

7 BLANK FLANGES

7.1 Blank flanges shall be used at all ends left unattended at the temporary closure of work. Blank flanges may also be necessary for commissioning a section of the pipeline or for testing the pipeline laid. For temporary closures, non-pressure blank flanges consisting of mild steel plates tack-welded at the pipe ends may be used. For pipes subjected to pressures, the blank flanges should be suitably designed. To prevent the floating of pipes, care should be taken to see that empty pipes with ends blank flanged should not be left in uncovered trenches, where water is likely to accumulate.

8 PIPE LAYING

8.1 Laying of Pipes Underground

8.1.1 *General*

The procedure for trenching as described in **4.2** and **4.2.1** shall be carefully followed. Before the pipe is lowered, the trench shall be carefully examined to determine that an even bedding is provided for the pipeline and that the pipe may be lowered into it without damaging the coating.

8.1.2 *Lowering and Assembling of Pipes and Specials*

The procedure for lowering varies with the method adopted for coating the pipeline. Where the coating is to be done in the trench, the pipe may be lowered in the trench on supports sufficiently high so as to facilitate out-coating. The pipe should be lowered progressively with the help of shear legs or cranes using wide belts or slings. In case of coated pipes, extra care shall be taken to preserve the coating while lowering. Slings may be removed progressively without the necessity of digging under the pipe. Where the trench is sheeted, the pipes shall be lowered into the trench by removing at a time, one or two struts only, care being taken to see that no part of the shoring is disturbed or damaged. If necessary, additional struts may be fixed during lowering. After the pipe is lowered, it shall be laid in correct line and level by use of levelling instruments, sight rails, theodolites, etc. Care shall be taken to see that the longitudinal joints of the consecutive pipes are staggered by at least 30° and should be kept in upper third of the pipeline, if there are two longitudinal joints they should be on the sides. While assembling, the pipe faces shall be brought close enough to leave a uniform gap not exceeding 3 mm. The spiders from inside and tightening rings from outside or other suitable equipment should be used to keep the two faces in shape and position till at least one run of welding is carried out.

8.1.2.1 The pipe faces shall first be tack-welded alternately at one or more diametrically opposite pairs of points. After completing tack-welding, full welding shall be carried out in suitable runs following a sequence of welding portions of segments diametrically opposite.

8.2 Backfilling

Backfilling should closely follow the welding of joints of the pipe so that the protective coating should not be subsequently damaged. Material harmful to the pipeline shall not be used for backfilling. Refilling shall be done in layers not exceeding 300 mm. Each layer shall be consolidated by watering and ramming, care being taken to prevent damage to the pipeline. The filling on the two sides of the pipeline should be carried out simultaneously.

8.2.1 The spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipeline to aid alignment, these shall be removed before backfilling. For further precautions and use of material in backfilling, reference should be made to IS 3114 : 1994.

8.3 Laying of Pipes Above Ground

8.3.1 *General*

The procedure for handling the pipes as described in **5** and for lowering and assembling the pipes underground as described in **8.1.2** should be followed for lifting and laying the pipes on supports or on ground. The pipeline may be allowed to rest on ground if the soil is non-aggressive. The ground should, however, be dressed to match the curvature of the pipe shell for an arch length subtending an angle of 120° at the centre of pipes. Alternatively, the pipeline should be laid either on saddle or roller and rocker supports as specified by

the authority. Figures 5 and 6 show supports generally adopted on steel pipelines.

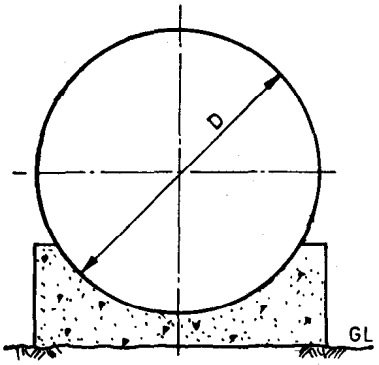


FIG. 5 SADDLE SUPPORT

8.3.2 *Expansion Joints*

For all pipelines laid above ground, provision for expansion and contraction on account of temperature variation should be made either by providing expansion joints at predetermined intervals or by providing loops where leakage through expansion joints cannot be permitted. Where expansion joints are provided, it is necessary to create restraining points on the pipeline to ensure proper functioning of these joints. The pipe laying work should preferably start from the restrained points on either side working towards centre where the expansion joint should be fitted last. Spacing of expansion joint depends on local conditions. Provision of expansion joint at intervals of 300 m on exposed steel pipeline is generally recommended. Expansion joints should always be provided between two fixed supports or anchorages (*see* **8.3.3**).

8.3.3 *Anchorages*

The pipe shall be anchored by concrete anchor blocks or other means to resist unbalanced water pressures and temperature stresses. Provision should be made to anchor the main during construction and in service where floatation could occur.

9 ROAD, RAIL AND RIVER CROSSING

9.1 The mode of laying the pipeline crossing, road, railway or a river shall be determined so as to satisfy the requirements of the authority concerned.

10 BRANCH CONNECTIONS, SPECIALS, ETC

10.1 Complicated specials, such as 'Y' pieces, composite bends and tapers, shall be fabricated in workshop. Small branches, single piece bends, etc, may be fabricated at site, care being taken to ensure that the fabricated fittings have at least the same strength as the pipeline to which these are to be joined.

10.2 Appurtenances

The spacing of the isolating sluice valves along a pipeline depends upon the type of terrain through which the pipeline passes and the operational flexibility required. Valves may be positioned as follows:

a) At the beginning and at the end of the pipeline;
b) To facilitate hydraulic testing of sections or the pipeline;
c) For long pipelines, isolating valves should be provided at intervals not exceeding 6 km; and
d) On either side of a major crossing.

Valves may be located either above ground or below ground, but should be easily accessible (*see* IS 780 : 1984 and IS 2906 : 1984).

10.2.1 Control valves should be provided on all branches. Similarly, air valves at all humps and scour valves at all dips are necessary. For inspection purposes, man-holes may be provided on either side of isolating valve and at other suitable places.

10.2.2 Protective devices, such as relief valves, surge or break pressure stations, may be provided to ensure that the internal pressure at any point in the pipeline does not exceed the design pressure.

10.2.3 Pressure indicating the flow recording instruments and burst alarms should also be provided at suitable places.

11 TESTING OF PIPELINE

11.1 General

Before putting it into commission, the welded pipeline shall be tested both for its strength and leakage.

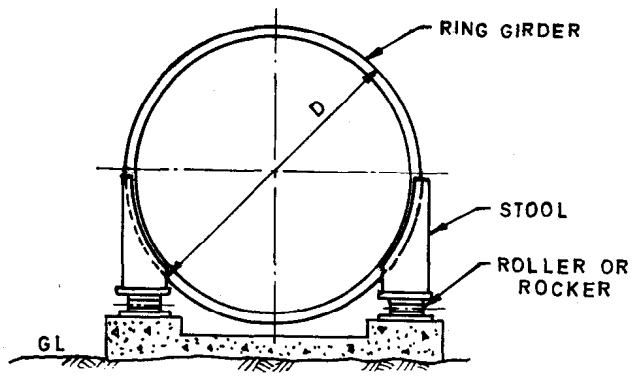


FIG. 6 ROLLER OR ROCKER SUPPORT

11.2 Procedure for Test

Each valved section of the pipe shall be slowly filled with clean water and all air shall be expelled from the pipeline through hydrants, air valves and blow-offs fixed on the pipeline. Before starting the pressure test, the expansion joints should be tightened.

11.2.1 *Pressure Test*

The field test pressure to be imposed should be not less than the greatest of the following:

a) 1 times the maximum sustained operating pressure,

b) 1 times the maximum pipeline static pressure, and

c) Sum of the maximum static pressure and surge pressure subject to the test pressure.

Where the field test pressure is less than two-thirds the test pressure, the period of test should be at least 24 hours. The test pressure shall be gradually raised at the rate of nearly 0.1 N/mm^2 per minute.

If the test pressure measurements are not made at the lowest point of the section, an allowance should be made for the static head between the lowest point and the point of measurement to ensure that the maximum pressure is not exceeded at the lowest point. If a drop in pressure occurs, the quantity of water added in order to re-establish the test pressure should be carefully measured. This should not exceed 0.1 litre per mm of pipe dia per km of pipeline per day for each 30 m head of pressure applied.

Where the pipeline is tested in sections, two or more welded joints at each gap may not get tested under pressure. Special care should be taken in making these welds and these joints should be kept under observation during the commissioning of the system.

11.2.2 *Pressurization*

Each valved section of pipe shall be filled with water slowly and the specified test pressure, based on the elevation of lowest point of the linear section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the authority.

11.2.3 *Examination Under Pressure*

Under the test pressure no leak or sweating shall be visible at all section of pipes, fittings, valves, hydrants and welded joints. Any defective pipes, fittings, valves or hydrants discovered in consequence of this pressure test shall be removed and replaced by sound material and the test shall be repeated until satisfactory to the Authority.

12 COATINGS

12.1 Buried Pipes

Buried steel pipelines are liable to external corrosion and should be protected by the use of suitable coatings and shall be in accordance with IS 10221 : 1982.

12.2 Above Ground Pipelines

Pipelines laid above ground are liable to atmospheric corrosion and should be adequately protected.

12.2.1 *Paints*

Paints should be applied as specified by the authority.

12.2.2 Where the pipeline is partly above ground and partly underground, the coating used on the buried portion should be continued well clear of the ground.

12.3 Internal Coating or Lining

Where water to be conveyed is aggressive in nature, the pipeline should be provided with an internal coating or lining, Such linings are usually of bitumen, coal tar, epoxy resin, concrete or cement mortar or plastic lining. Care should be taken to see that the material used for coating is non-toxic. The lining may be applied to the pipe before or after laying. In the former case, it should be made continuous at the joints after laying. Methods of applying internal lining vary according to the size of the pipe depending upon the working space inside the pipe. In case of large diameter pipelines, cement mortar lining preferably be carried out after the pipeline is laid in position and the backfill in the trenches is properly consolidated. This will prevent the lining from being damaged due to deformation of pipeline, due to self weight and also due to handling of pipes during laying operation.

12.4 Dry Film Thickness

Both for internal and external painting, the thickness of the dry paint film is very important from the point of view of determining the protective life. The minimum dry film thickness of the paint system should be specified and measurements to that effect be made by using instruments like elcometer or similar other reliable measuring devices.

13 FLUSHINGS AND DISINFECTION OF MAINS BEFORE COMMISSIONING

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

13.1.1 *Disinfection of New Mains*

Special care should be taken to ensure disinfection of new mains. Among possible sources of contamination are sewer drainage, contaminated soil in the trench, contamination from workmen or their equipment or both and unavoidable foreign material present in the trench during construction.

13.1.2 Education of crew members as to the need for avoiding contamination of the main during construction is fundamental. Contractors and workmen should be thoroughly familiar with all pertinent state and local requirements governing installation of mains. All sewers, water mains and other underground conduits should be located prior to construction and relocated, if necessary, to prevent contamination during construction. Pipe should be strung on high ground. At all times when construction is not actually in progress, watertight plugs should be installed in all pipe openings. Gunny sacks and rags are not adequate. Provision should be made to pump any other water that might collect in the trench. Special care should be taken to avoid contamination of valves, fittings, and pipe

interiors, both before and during construction each of them should be inspected and, if necessary, cleaned before installation.

13.1.3 After pressure testing the main, it should be flushed with water of sufficient velocity to remove all dirt and other foreign materials. When this process has been completed, disinfection (using liquid chlorine, sodium or calcium hypochlorite) should proceed by one of the recommended methods as described in **13.2** and **13.3**.

13.2 Continuous Feed

In this method, water from the distribution system or other approved source and the chlorine is fed at constant rate into the new main at a concentration of at least 20 mg/l. A properly adjusted hypochlorite solution injected into the main with a hypochlorinator, or liquid chlorine injected into the main through a solution-feed chlorinator and booster pump may be used. The chlorine residual should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. All valves, hydrants, etc, along the main should be operated to ensure their proper disinfection. The water should remain in the main for a minimum of 24 h. Following the 24 hours period no less than 10 mg/l chlorine residual should remain in the main.

13.3 Slug Method

In this method a continuous flow of water is fed with a constant dose of chlorine (as in the previous method) but with rates proportioned to give a chlorine concentration of at least 300 mg/1. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that contacts all interior surfaces of the main for a period of at least 3 h. As the slug passes tees, crosses, etc, proper valves shall be operated to ensure their disinfection. This method is used principally for large diameter mains where continuous feed is impractical.

13.4 Regardless of the method used, it is necessary to make certain that backflow of the strong chlorine solution into the supplying line does not occur. Following the prescribed contact period, the chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating that throughout the rest of the system. Bacteriological tests as prescribed by the authorities should be taken, and if the results fail to meet minimum standards, the disinfecting procedure should be repeated and the results again tested before placing the main in service.

14 COMMUNICATIONS

14.1 During all phases of cleaning, testing, disinfecting, flushing and commissioning, reliable communication system between both ends of the section of the pipeline being dealt with as well as between the field parties in between these sections should be established.

15 REMOVAL, RESTORATION AND MAINTENANCE OF PAVED FOOTPATHS, AFTER LAYING OF PIPE

15.1 Allowable Removal of Pavement

Pavement and road surfaces may be removed as a part of the trench excavation, and the amount removed shall depend upon the width of trench specified for the installation of the pipe and the width and length of the pavement area required to be removed for the installation of gate valves, specials, man-holes or other structures. The width of pavement removed along the normal trench for the installation of the pipe shall not exceed the width of the trench specified by more than 150 mm on each side of the trench. The width and lengths of the area of pavement removed for the installation of gate valves, specials, man-holes or other structures shall not exceed the maximum linear dimensions of such structures by more than 150 mm on each side. Wherever in the opinion of the authority, existing conditions make it necessary or advisable to remove additional pavement, it shall be removed as directed by the authority.

15.2 Replacement of Pavements and Structures

All pavements, paved footpaths, curbing, gutters, shrubbery, fences, poles, sods or other property and surface structures removed or disturbed as a part of the work shall be restored to a condition equal to that before the work began, furnishing all labour and materials incidental thereto. In restoring the pavement, sound granite blocks, sound brick or asphalt paving blocks may be re-used. No permanent pavement shall be restored unless and until in the opinion of the authority, the condition of the backfill is such as to properly support the pavement.

15.3 Cleaning-Up

All surplus water main materials and all tools and temporary structures shall be removed from the site as directed by the authority. All dirt, rubbish, and excess earth from the excavation shall be hauled to a dump and the construction site left clean to the satisfaction of the authority.

16 DESIGN REQUIREMENTS

16.1 General Design Requirements

General requirements for the design of steel pipes are given in Annex B for information.

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
780 : 1984	Specification for sluice valves for water works purposes (50 to 300 mm size) (*sixth revision*)
814 : 1991	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
816 : 1969	Code of practice for use of metal arc welding for general construction in mild steel (*first revision*)
1200 (Part 1): 1992	Methods of measurement of building and civil engineering works: Part 1 Earthwork (*fourth revision*)
2062 : 1992	Steel for general structural purposes (*fourth revision*)
2720 (Part 7): 1980	Methods of test for soils : Part 7 Determination of water content dry density relation using light compaction (*second revision*)
2906 : 1984	Specification for sluice valves for water works purposes (350 to 1 200 mm size) (*third revision*)
3114 : 1994	Code of practice for laying of cast iron pipes (*second revision*)
3589 : 1991	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 to 2 032 mm outside diameter) (*second revision*)
3600 (Part 1): 1985	Methods of testing fusion welded joints and weld metal in steel : Part 1 Cruciform fillet weld tensile test
4081 : 1986	Safety code for blasting and related drilling operations
4260 : 1986	Recommended practice for ultrasonic testing of butt welds in ferritic steel (*second revision*)
4853 : 1982	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes (*first revision*)
5330 : 1984	Criteria for design of anchor blocks for penstocks with expansion joints (*first revision*)
5555 : 1970	Code of procedure for conducting field studies on atmospheric corrosion of metals
7808 : 1975	Code of procedure for conducting studies on underground corrosion of metals
10221 : 1982	Code of practice for coating and wrapping of underground mild steel pipelines
12288 : 1987	Code of practice for use and laying of ductile iron pipes.

ANNEX B

(*Clause* 16.1)

GENERAL REQUIREMENTS FOR THE DESIGN OF STEEL PIPES

B-1 INTERNAL DESIGN PRESSURE

B-1.1 The internal design pressure shall not be less than the maximum pressure to which the pipeline is likely to be subjected including allowance for surge pressure, if any.

B-2 PROTECTIVE DEVICES

B-2.1 Protective devices, such as relief valves, pressure limiting stations and automatic shut-down equipment shall be provided to ensure that the internal pressure at any point in the pipe line system does not exceed the internal design pressure by more than 10 percent.

B-3 EXTERNAL PRESSURE

B-3.1 The pipe selected shall be strong enough to withstand the effect of partial vacuum corresponding to one-third the atmospheric pressure which may occur within the pipe and due to any pressure exerted by water or soil around it.

B-4 WORKING TEMPERATURE

B-4.1 Where working temperature lies between + 5°C and + 50°C no variation in the design stresses given in this section is necessary.

B-5 THERMAL MOVEMENT

B-5.1 Where substantial variation in the pipeline temperatures may occur within the range stipulated in **B-4.1**, allowance should be made for the effect of thermal expansion and contraction corresponding to the actual temperature variation expected to be met with at the site of work.

B-6 WEIGHT EFFECT

B-6.1 The weight of pipe, coatings, pipe components, liquid contents and any other weight sustained should be taken into account for pipe line that is not supported continuously. Weight effects should also include stresses caused due to floatation in any of section of the pipeline.

B-7 DYNAMIC EFFECT

B-7.1 Unusual loading, such as that may be caused by impact, wind, vibration and resonance, should be allowed for in accordance with the accepted engineering practice.

B-8 GRADE TAPERING

B-8.1 The reduction of the internal pressure in stages along the length of the pipeline to match the reduction in the maximum working pressure is permissible, provided that each stage is protected by pressure limitation device complying with **B-2.1**.

B-9 PRESSURE DESIGN OF PIPELINE COMPONENTS

B-9.1 Suitability of Components

Components of pipeline, including valves, flanges, specials, fittings, etc, shall be suitable to withstand internal design pressure and other loading.

B-9.2 Nominal Thickness

The nominal thickness of steel pipe is calculated as given below, plus the permitted manufacturing tolerance for reduction in thickness of steel plate plus thickness for corrosion allowance, if any:

$$t = \frac{P_{(i)}}{2a \times f \times e + P} \quad \text{or} \quad P = \frac{2.t \times a \times f \times e}{D - t}$$

where

t = thickness of shell in mm,

P = internal design pressure in N/mm^2,

D = outside diameter in mm,

a = design factor (0.6 for working pressure and 0.9 for test pressure inclusive of surge pressure),

f = specified minimum yield stress in N/mm^2, and

e = weld efficiency of the joint (0.9 for shop welding and 0.8 for field welding).

NOTE – The nominal thickness arrived at is subject to minimum thickness and manufacturing tolerances prescribed in IS 3589 : 1991.

B-9.2.1 External or internal coatings or lining of cement, plastics, or other material may be used on steel pipe in accordance with this code, but shall not be considered to add to the strength of such pipe.

B-9.3 Specified Minimum Yield Stress

The specified minimum yield stress used in the equation in **B-9.2** shall be appropriate value recommended for steel plates in IS 2062 : 1992.

B-9.4 Minimum Nominal Pipe Wall Thickness

The internal pressure is not the only criterion to be used in determining the wall thickness. Consideration should also be given to the other factors influencing the design of shell thickness, such as handling, ability to withstand stresses imposed during construction, deformation when not under pressure, external loads, mode of supporting the pipeline and the stresses accrued therefor, such as stresses due to beam action when the pipeline is supported at intervals, longitudinal stresses due to gravity component, hydrostatic head, tractive force of water, frictional forces resisting free expansion of pipe as in the case of pipeline provided with expansion joints or axial force due to temperature stresses as in the case of restrained pipeline and rim bending stress at the restraint joints.

B-9.4.1 Consideration of all longitudinal axial compressive stresses, bending stresses should be considered in relation to buckling.

B-9.4.2 Where unstiffened pipeline is supported on saddle support, care should be taken to account for local stresses both longitudinal and circumferential adjacent to the tip of the saddle. The maximum value of these localized stresses for a pipe fitting well in the saddle is given by the following expression:

$$s_{(Max)} = k \frac{P}{t^2} \log \left(\frac{R}{t} \right)$$

where

S = stress in N/mm^2,

K = coefficient given by the expression,

= 0.02 – 0.001 2 (β – 90) where β is support angle in degrees,

P = total load on support in N,

t = thickness in mm, and

R = radius of pipe shell in mm.

B-10 CORROSION ALLOWANCE

B-10.1 Where there is a possibility of internal or external corrosion taking place, a corrosion allowance should be made and which should be based upon a specialist investigation of the corrosion process involved in accordance with IS 5555 : 1990 or IS 7808 : 1975. This corrosion allowance should be further modified considering required life of the pipeline.

B-11 TEMPERATURE STRESSES

B-11.1 Expansion and Temperature Stresses

Above ground pipeline being exposed to direct

sunrays, undergoes variation in length as well as in diameters. The diametrical expansion or contraction of the pipe is generally small and it may be neglected for the purposes of design. The linear expansion in a pipe line is given by the expression:

$$dl = t \cdot \alpha \cdot L$$

where

dl = variation in length in mm,

t = temperature variation in °C,

α = linear coefficient of expansion in mm/mm/°C, and

L = length between fixed point and free end in mm.

B-11.1.1 Expansion joints are generally provided on the above ground pipeline which absorb the elongation or contraction of the pipe by telescopic movement of inner and outer gland of the expansion joint. Provision of expansion joint thus releases the pipeline of thermal stresses. The relief is not, however, complete as some amount of restraint on the free movement of the pipe line is always present due to frictional force developed within the expansion joint proper and at the supporting system of the pipeline, which depends upon the type of support adopted. The frictional force developed within the expansion joints is given by the expression.

$$F_e = m \times 3.14 \times d \times B \times p$$

(Skoctitch expression)

where

F_e = axial force in N,

m = coefficient of friction = 0.3,

d = diameter of pipe in mm,

B = width of packing in mm, and

p = internal pressure in N/mm^2.

OR

$$F_e = P \times F + A.p \text{ .....} \quad \text{(American practice)}$$

where

F_e = axial force in N,

P = $\pi \times \sigma$ = circumference of pipe shell in mm,

F = 7.43 N/mm of circumference,

A = cross-sectional area of shell in mm^2, and

p = internal pressure in N/mm^2.

B-11.2 Restrained Pipeline

In pipeline laid above ground where the movement due to temperature variation, cannot be accommodated either in expansion joints or loops, full provision for the longitudinal compression stress due to axial force caused by temperature rise should be made in accordance with the expression :

$$F_e = E \times L\,(t_2 - t_1) - m \cdot fh$$

where

E = modulus of elasticity in N/mm^2,

L = linear coefficient of expansion,

t_2 = maximum or minimum operating temperature in °C,

t_1 = temperature at the time of installation in °C,

m = Poisson's ratio, and

fh = hoop stress due to water in N/mm^2.

B-12 DESIGN REQUIREMENTS FOR FLEXIBILITY AND BENDING

B-12.1 The physical constants for the steel for pipeline shall be as follows:

a) *Coefficient of Expansion* – The linear coefficient of thermal expansion for mild steel may be taken as 12×10^{-6}/°C for temperature up to 120°C.

b) Modulus of elasticity as 0.2×10^6 N/mm^2, and

c) Poisson's ratio as 0.3 for steel.

B-13 PIPE SUPPORTS

B-13.1 General

The stresses transmitted to the connected equipment, like valves should be kept within safe limits.

B-13.2 Supports

Supports should be designed to support the pipeline without causing excessive local stresses. Due allowance shall be made for the weight of water, hydrostatic head, frictional resistance at the supports, etc. Proper bearing surface, such as flat base, roller and rocker, should be provided where controlled movements are required.

B-14 USE OF ANCHORS BLOCKS ON THE PIPELINE

B-14.1 Anchorages

Anchors are provided on the pipeline at the position of line valves or sectionalizing valves, at the blank flange, at the tapers and at the mid-point between two consecutive expansion joints, in the case of above ground pipeline. These anchors are generally of gravity type and should be designed to resist the axial forces due to maximum design hydraulic pressure, frictional resistance set up at the expansion joint, and at the supporting system, for their worst combination so that the pipe shell is completely relieved of stresses resulted from the above forces.

B-14.1.1 The anchors provided at the mid-point between the two consecutive expansion joints, fixity points may be frame type in which case all the axial forces acting on the pipeline are carried by the frame consisting of one or more pair of supports and the pipeline, by shear and bending.

B-14.2 Anchor Blocks

Anchor blocks shall be designed in accordance with IS 5330 : 1984.

ANNEX C
(*Foreword*)

COMMITTEE COMPOSITION
Water Supply and Sanitation Sectional Committee, CED 24

Chairman	*Representing*
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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all offices)

Regional Offices :	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002	331 01 31, 331 13 75
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola, CALCUTTA 700054	37 84 99, 37 85 61, 37 86 26, 37 86 62
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	53 38 43, 53 16 40, 53 23 84
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16, 235 04 42, 235 15 19, 235 23 15
Western : Manakalaya, E9 MIDC, Marol, Andheri (East), BOMBAY 400093	632 92 95, 632 78 58, 632 78 91, 632 78 92

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. PATNA. THIRUVANANTHAPURAM.

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