TATA STEEL

TATA DUCTURA
Happiness Guaranteed

Technical Guide

Ductile Iron Pipes

CONTENTS

ABOUT THE COMPANY

Tata Steel Metaliks Division has its state-of-the-art manufacturing plant at Kharagpur, West Bengal, which produces the finest quality Pig Iron and Ductile Iron Pipes in India. With focus on Safety and Sustainability, TSMD has been consistently fulfilling its vision of ***Reaching Tomorrow First*** through innovative and superior quality products and service offerings.

Combining customer-centricity with technical effciency, Tata Steel Metaliks Division is the supplier of choice through its end-to-end product and service offerings for customers. It is also taking significant steps in its journey of digital transformation by rapidly adopting Industry 4.0 principles and becoming a 'Digital Factory' in line with its vision.

Aligned with its legacy of sustainable value creation, Tata Steel Metaliks Division is steadily working on its long-term Sustainability Strategy of becoming Net Zero by 2045. Its high-impact Corporate Social Responsibility interventions aim to uplift the lives of communities with a focus on Education, Essential Amenities and Skill Development.

'TATA Ductura' is the Ductile Iron Pipe brand of TSMD that promises the Tata Assurance of Quality for its technically superior products along with commitment of timely delivery, easy installation and ethical business practices.

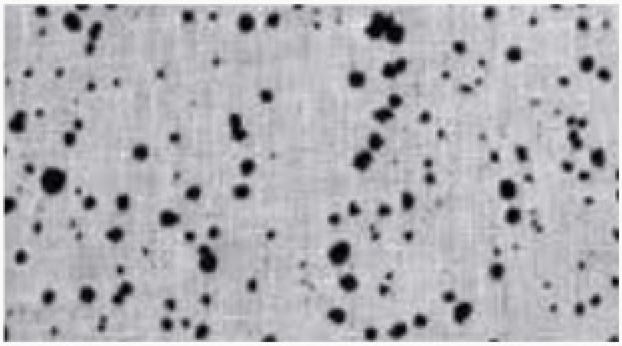
TSMD's energy efficient and environment friendly Pig Iron, marketed as 'Tata eFee' is a preferred raw material for manufacturing various kinds of castings by foundries due to its superior quality and customised specifications.

DUCTILE IRON'S SUPERIORITY

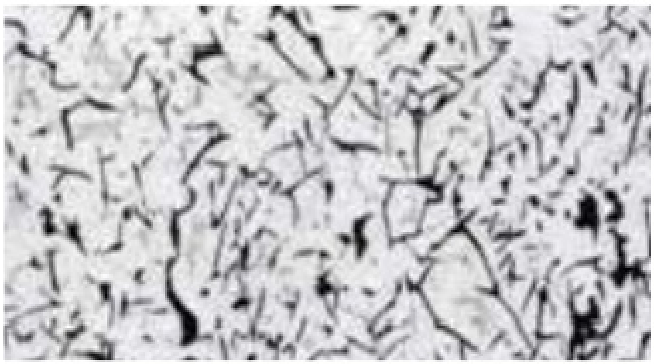
Ductile Iron is an improvement to the conventional Grey Cast Iron that have served the water industry with distinction through the centuries. The first Ductile Iron pipe was produced experimentally in 1948. Minor but significant changes in chemistries and processing result in physical differences at the micro-structure level that result in a vastly improved fracture toughness and ductility making Ductile Iron piping products substantially more resistant to damage from impact or concentrated stresses.

Ductile iron's superiority lies in its spheroid graphite microstructure. Since the graphite structure of grey cast iron is linear, under severe loading, stress builds up unevenly around the ends of particles and weakens the metal.

However, in ductile iron, since the graphite structure is spherical, similar stress distributes evenly, thereby-maintaining strength. Yet, the basic chemical composition of ductile iron is similar to that of grey cast iron, giving it the same excellent anticorrosive properties. Together, these features give ductile iron, excellent resistance to impact, pressure and corrosion.



Nodular Graphite in Ductile Iron



Flaky Graphite in Grey Cast Iron

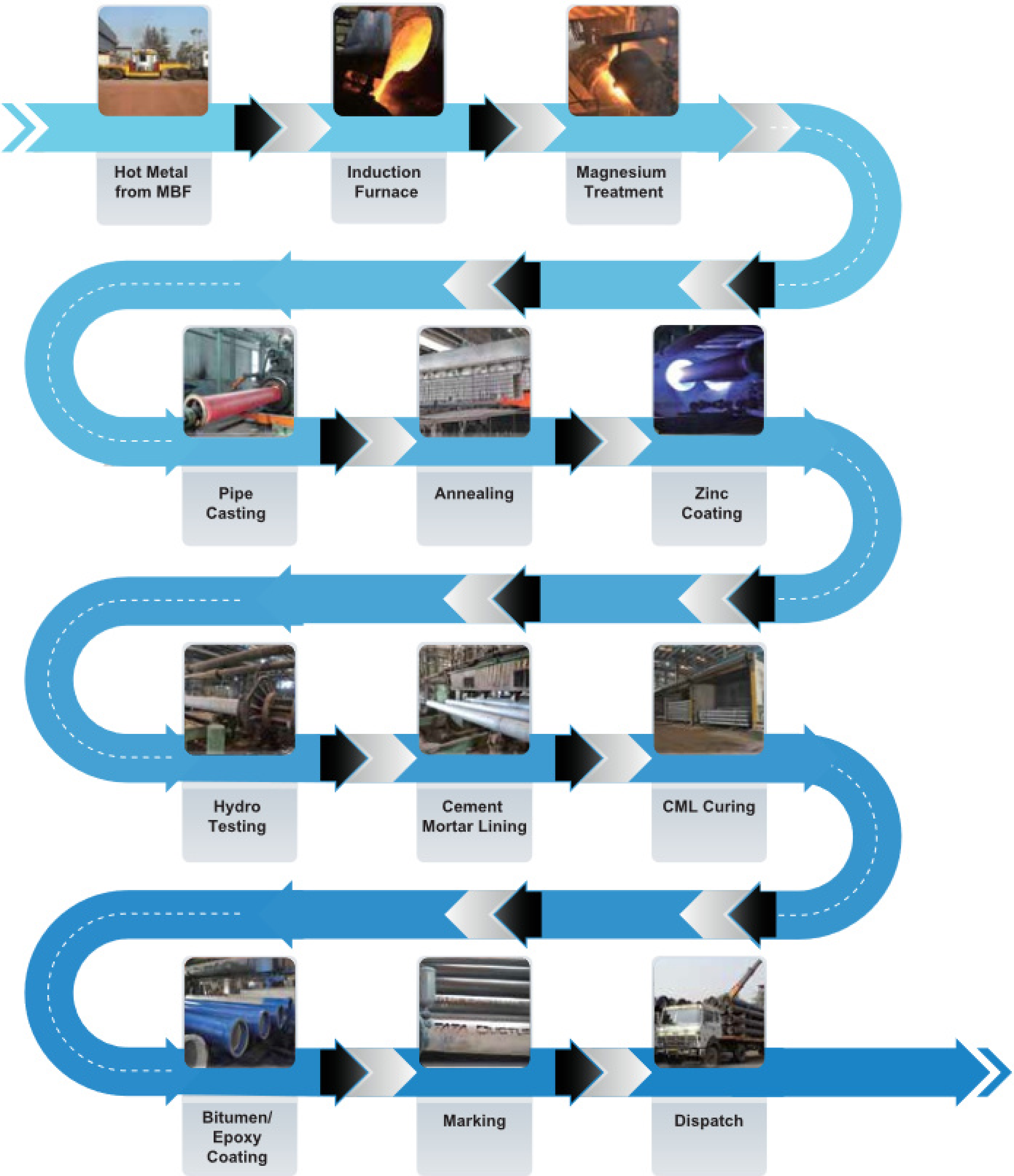
A Mechanical Properties of Ductile Iron Pipe

Tensile Strength	Min 420 MPa
Elongation (min) at Break	10% upto DN 1000 mm, 7% above DN 1000 mm
Modulus of Elasticity	1.5 to 1.7x105 N/mm^2
Hardness	Max.230 BHN
Poisson Ratio	0.28 to 0.29
Specific Weight	7.05
Linear Coefficient of expansion (1/^{o}C)	$1.0x10^{-5}$
Bursting Strength (min)	Factor of Safety against bursting is 8 to 10

B Advantages of Ductile Iron Pipe

- Very strong pipe with high tensile strength and impact resistance.
- Can withstand very high pressure and surge.
- Good resistance to handling/transportation damage.
- Easy to lay with simple push-on-type jointing system.
- Flexible joint offers considerable joint deflection.
- Back filling with special material not required.
- Low pumping cost due to lower frictional resistance.
- Reliable internal and external corrosion protection.
- Can accommodate ground movement and surge pressure.
- Long service life.
- Higher durability compared to other pipes.

MANUFACTURING PROCESS OF DUCTILE IRON PIPE



Properties	Ductile Iron Spun Pipes	Steel Pipes	Pre-Stressed Concrete Pipes	UPVC Pipes	Polyethylene Pipes	GRP Pipes
Resistance to tampering	Very Good	Good	Medium	Bad	Bad	Medium
Corrosion	In an aggressive soil, bitumen coating is only required. Corrosion rate is 0.005 mm/ year & hence practically corrosion free	Corrosion rate is 0.5 mm/year more than that of CI pipe. In absence of graphite in steel, oxidation expansion reaction takes place and failure is rapid in urban areas & salty weather & water condition	Corrosion of pre-tension wires is very common on account of attack by humic acid formed due to seepage of water through cracks. Failure of pipes common for this reason. Corrodes fast in sea weather & water condition	Non Corrosive but susceptible to decay in presence of organic contaminants	Non Corrosive but susceptible to decay in presence of organic contaminants	Non Corrosive but susceptible to decay in presence of high moisture or organic contaminants
Special Corrosion Protection i.e. Cathodic Protection	Due to Push-on Jointing electrical discontinuity is maintained	As the jointing is made by welding, electrical continuity persists	Chances of electrical continuity is negligible	Chances of electrical continuity is negligible	Chances of electrical continuity is negligible	Chances of electrical continuity is negligible
	Not required, as Graphite impedes progress of corrosion	Cathodic protection is compulsory if soil resistivity is found to be lower than 1000 Ohm-cm to prevent pitting corrosion due to difference in oxygen concentration in soil	No special protection is needed. However if the fluid is highly acidic, High Alumina cement lining is recommended	No special protection is needed	No special protection is needed	No special protection is needed
Resistance against Electrical Corrosion	High	Cathodic Protection required	Low, due to presence of prestressing wires	High	High	High
Design Friction Co-efficient	140	100 (in case of bare pipe) 110 (in case of in-situ cement lining) 140 (for Centrifugally cement lined pipes)	140	145	145	140
Flexibility of Pipe Joint in Alignment	2° - 5°	Joints are rigid	Up to ½°	Flexible Pipe	Flexible Pipe	Flexible Pipe

Properties	Ductile Iron Spun Pipes	Steel Pipes	Pre-Stressed Concrete Pipes	UPVC Pipes	Polyethylene Pipes	GRP Pipes
Type of fittings used	CI/DI	Steel	Steel	MS/CI/DI/PVC	MS/CI/DI/HDPE	MS/GRP
Availability of fittings	Readymade fittings widely available	Fittings are to be fabricated at site	Fittings are to be fabricated at site	Readymade fittings available	Readymade fittings available	Fittings are to be fabricated at site
Expected Salvage Value of Pipe after 30 years (in %)	18%	10%	Nil	Nil	Nil	Nil
Direct Tapping Facility	Directly by ferrule	Direct tapping is not recom-mended, saddle strap to be used. Possibility of bimetallic corrosion is there	Not recom-mended. Prestressing wire will snap	Direct tapping not possible. Saddle strap to be used	Direct tapping not possible. Saddle strap to be used	Direct tapping not possible. Saddle strap to be used
Bedding Requirement in Pipe Material	Not necessary	High compac-tion required if pipes unlined and uncoated	Sand bedding to be highly compacted	Sand bedding to be highly compacted	Sand bedding to be highly compacted	Sand bedding to be highly compacted
Damping Capacity	High specific damping capacity (15-40%) coupled with low notch sensitivity due to presence of graphite flakes is the unique feature	In welded steel, specific damping capacity is 2-3% only. Ductility of steel takes care of damping effect, but with the generation of internal stress	Good	Poor	Medium	Poor
Estimated "Design Useful Service Life"	DI pipes have useful life of over 50 years	Normal life is 25-30 years. Depends basically on soil conditions, location, character of water and kind of corrosion protection that is provided	Failure due to crack, disintegration, corrosion of prestressing wire and bad jointing is high. Optimistic life is around 20 years	Failure due to crack, impact and third party damage is high. Optimistic life is around 20 years	Failure due to crack, impact and third party damage is high. Optimistic life is around 20 years	Failure due to crack, impact and third party damage is high. Optimistic life is around 20 years

Properties	Ductile Iron Spun Pipes	Steel Pipes	Pre-Stressed Concrete Pipes	UPVC Pipes	Polyethylene Pipes	GRP Pipes
Advantages	1. Can withstand high surge pressure 2. Weight is 30 to 40% less than CI 3. Protected against internal & external corrosion 4. Can be cut, drilled or welded 5. Can withstand high impact load and traffick load 6. High deflection after jointing	1. Can withstand high working/ surge pressure 2. Easy to weld So easier to negotiate obstruction 3. Impermeable to organic contaminants	1. Being a customized pipe can be designed to suit different pressure rating 2. Good beam strength and rigidity 3. Can withstand high earth load	1. Corrosion resistant in most environment. 2. Rubber gasket type joints allows some deflection 3. Lightweight 4. Comparatively cheaper	1. Corrosion resistant in most environment 2. More resilient to impact damage 3. Flexible so less nos of bends etc required 4. Lightweight	1. Corrosion resistant in most conditions 2. Relatively lightweight 3. Coupling joints are easier to join 4. Can be customized depending on operating condition 5. Flexible joints tolerate some 6. Good rigidity
Limitation	1. May corrode in aggressive environment if laid without proper protection 2. For conveying aggressive fluid, which attacks cement, the lining should be replaced with epoxy	1. Tends to buckle under negative surge 2. Corrodes very fast if laid unprotected 3. Corrosion protection susceptible to impact and accidental damage 4. Being a flexible pipe requires sand bedding and good back-fill compaction 5. Requires skilled welder for jointing 6. Difficult to protect welded joints from inside 7. Expansion joints are required	1. Heavy 2. Joints are relatively rigid 3. Repair methods complex and time consuming 4. Susceptible to impact damage 5. Pipes cannot be cut in the field 6. Vulnerable to chemical attack by certain soils and waters 7. Difficult to take branching or to add connections after installation	1. Not suitable for pumping main or high pressure 2. Susceptible to impact damage 3. Proper compaction of backfill is must 4. Ultra-violet degradation on exposure to sunlight 5. Leakage detection/ underground pipe location difficult. 6. Strength deteriorates with time 7. Susceptible to permeation/ degradation by certain organic chemical 8. Risk of pipe floatation 9. Difficult to tap or take branching or to add connections after installation	1. Strength deteriorates with temperature rise 2. Susceptible to third party damage 3. Proper backfill compaction is must 4. Not at all suitable for over ground use 5. Leakage detection/ underground pipe location difficult 6. Susceptible to permeation/ degradation by certain organic chemical 7. Risk of pipe floatation 8. Difficult to tap or to add connections after installation	1. Strength deteriorates with time. 2. Susceptible to third party damage 3. Proper compaction of backfill is must 4. Ultra-violet degradation on exposure to sunlight 5. Leakage detection/ underground pipe location difficult. 6. Susceptible to permeation/ degradation by certain organic chemical 7. Risk of pipe floatation 8. Difficult to tap or to add connections after installation

Properties	Ductile Iron Spun Pipes	Steel Pipes	Pre-Stressed Concrete Pipes	UPVC Pipes	Polyethylene Pipes	GRP Pipes
Application	All application	Not recommended: • in aggressive soil/water • where ground movement and high impact load expected	Not recommended: • for pumping and tramsmission main • high pressure applications • in presence of high degree of organic contaminants • in over ground conditions as it may develop bending stress due to weight of pipe and water	Not recommended: • for pumping main • where there is ground movement and expected high impact load • for over-ground installation • in presence of high degree of organic contaminants	Not recommended: • for pumping main • for over- ground installation where there is high probability of third party damage • in presence of high degree of organic contaminants	Not recommended: • for pumping main • where there is ground movement and expected high impact load • for over-ground installation • in presence of high degree of organic contaminants
Nature & Frequency of Damage	Impact failure or bursting due to crack or water hammer is extremely rare. Frequency of damage- very low	Internal/external corrosion is the main reason of failure. Frequency of damage- Initially low, increases with age	Bursting due to cracks or impact damage is common. Failure due to corrosion of prestessing wire or joint failure is also common. Frequency of damage- High	Being notch sensitive, any crack leads premature failure. Impact failure or Failure due to material degradation is also common. Frequency of damage- High	Often damaged by third party interference. Failure due to material degradation is also common. Frequency of damage- Medium	Failure due star-crack propagation or water hammer happens. Joint failure and failure due to material degradation is also common. Frequency of damage- Medium

Source:
DIPRA
NEERI
Technical Literatures

PRODUCT PORTFOLIO

Tata Steel Metaliks Division is committed to exceed customers' expectations in product quality, supply and service. The Company manufactures Ductile Iron Pipes conforming to:

IS 8329:2000

Centrifugally cast (spun) ductile iron pressure pipes for water, gas and sewage application.

ISO 2531:2009

Ductile iron pipes, fittings accessories and their joints for water application.

ISO 7186:2011

Ductile iron product for sewage application.

EN 545:2010

Ductile iron pipes, fittings, accessories and their joints for water pipelines.

EN 598:2007 + A:2009

Ductile iron pipes, fittings, accessories and their joints for sewerage application.

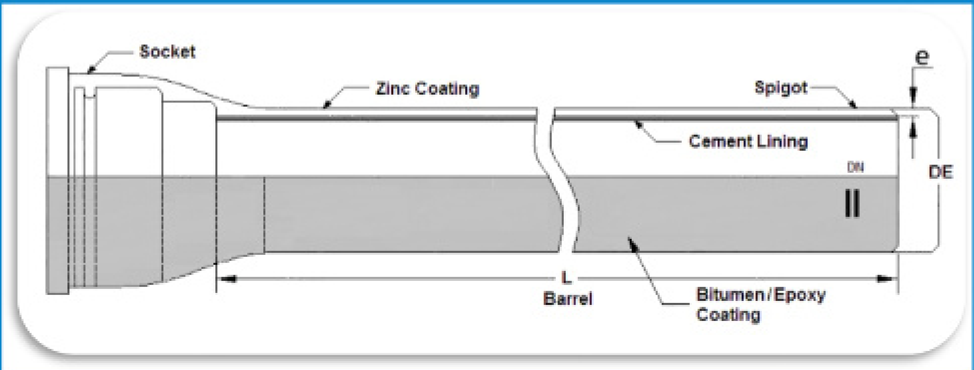
Product Range

Nominal Diameter (DN)	Class	Standard Length (Metre)
80, 100, 125, 150, 200, 250, 300, 350, 400, 450, 500, 600, 700, 750, 800, 900, 1000, 1100, 1200	K7, K9, K12	5.5
	C Classes as per latest BSEN-545 & ISO 2531	
	Pressure pipes as per latest BSEN-598:2007+A1:2009	

DUCTILE IRON PIPE DIMENSION

			Ductile Iron Pipe Dimension									
DN (mm)	DE (External diameter) (mm)	Nominal Pipe Wall Thickness, e (mm) Various Classes of Pipes										
	Nominal	Limit Deviations	C20	C25	C30	C40	C50	C64	C100	BSEN 598 As per (Pressure Pipe)	K7	K9
80	98	+1/-2.7				4.4	4.4	4.4	4.8	4.8	5.0	6.0
100	118	+1/-2.8				4.4	4.4	4.4	5.5	4.8	5.0	6.0
125	144	+1/-2.8				4.5	4.5	4.8	6.5	4.8	5.0	6.0
150	170	+1/-2.9				4.5	4.5	5.3	7.4	4.8	5.0	6.0
200	222	+1/-3.0				4.7	5.4	6.5	9.2	4.9	5.0	6.3
250	274	+1/-3.1				5.5	6.4	7.8	11.1	5.3	5.3	6.8
300	326	+1/-3.3			5.1	6.2	7.4	8.9	12.9	5.6	5.6	7.2
350	378	+1/-3.4		5.1	6.3	7.1	8.4	10.2	14.8	6.0	6.0	7.7
400	429	+1/-3.5		5.5	6.5	7.8	9.3	11.3	16.5	6.3	6.3	8.1
450	480	+1/-3.6		6.1	6.9	8.6	10.3	12.6	18.4	6.7	6.6	8.6
500	532	+1/-3.8		6.5	7.5	9.3	11.2	13.7	20.2	7.0	7.0	9.0
600	635	+1/-4.0		7.6	8.7	10.9	13.1	16.1	23.8	7.7	7.7	9.9
700	738	+1/-4.3	7.3	8.8	9.9	12.4	15.0	18.5	27.5	9.6	9.0	10.8
750	790	+1/-4.3									9.7	11.3
800	842	+1/-4.5	8.1	9.6	11.1	14.0	16.9	21.0		10.4	10.4	11.7
900	945	+1/-4.8	8.9	10.6	12.3	15.5	18.8	23.4		11.2	11.2	12.6
1000	1048	+1/-5.0	9.8	11.6	13.4	17.1	20.7			12.0	12.0	13.5
1100	1152	+1/-6.0	10.6	12.6	14.7	18.7	22.7			14.4	14.4	14.4
1200	1255	+1/-5.8	11.4	13.6	15.8	20.2				15.3	15.3	15.3

*All dimension are in mm



NOTES:

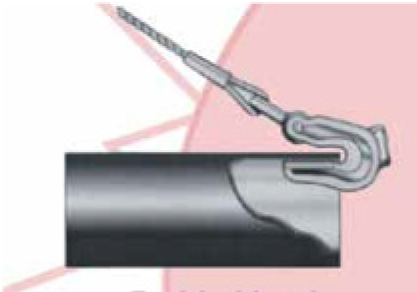
- The K-7 pipes of higher thickness as per the respective national standard may be supplied.
- The tolerance on pipe wall thickness is - (1.3+0.001 DN).
- For centrifugally cast pipes, minimum wall thickness shall not be less than 3.0 mm
- Source: Reference standards – ISO 2531, EN 545, EN 598

1. Handling (Loading and Unloading)

Use forklift, crane and overhead crane by belt or specific sling to handle Ductile Iron Pipes and Fittings gently.

Loading

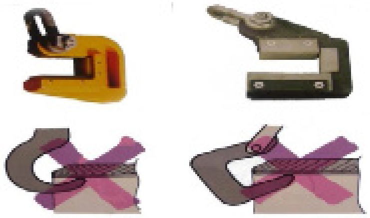
When loading the Ductile Iron Pipes by forklift, lift stably and slowly with protection on the contact face between the forklift and the pipe. Do not let the belt wind the pipe that may make the pipe revolve in mid-air. Do not knock the pipe with other hard objects. Suddenly lifting or stopping is prevented. When lift by crane or overhead crane, use specific lift hook with rubber protection around the steel hook or use nylon sling, steel cable with rubber protection to protect the external coating and internal lining of pipes.



Padded hook

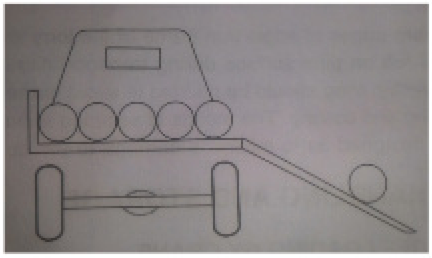
Unloading

It is requested to use belt and specific lift sling to unloading Ductile Iron Pipes. Do not lift by hooking directly the steel belt. Must make the belt through the bottom of the whole package (do not cross the package). Only hook the socket of pipes by using specific tools. One hook just for one package, must use specific tools when it's needed to lift several packages with one hook, in order to assure the package not be deformed or damaged. For single pipe, use specific hook or belt to lift one or several ones at one time. Pay attention to the center of gravity of pipes and the belt angle when using belt to lift pipes.



Unloading without Crane

Where a crane is not available and if the mass permits (normally up to DN 250) then individual pipes should be off-loaded by rolling them down a ramp made of timber skids extending from the vehicle side to the ground. Suitable steadying ropes should be used to prevent the pipes from rolling down at excessive speed and striking other pipes or objects on the ground.



Important - Never let the pipe fall on the floor, even if it is over tires or sand.

Stacking

The place for storage should be flat and firm. The wooden chock block should be tough. There are three ways of storage: square form, parallel form and pyramid form.

Square stacking

Put wooden chock block on the bottom, make the axial line of the near two layers to vertical. When the socket are to the same direction on one layer, use wooden wedge for every layer to avoid pipes rolling off. When on one layer the socket and spigot are in opposite direction, the wooden wedge may not be needed. Square stacking suitable for pipes up to and including DN 400.

Parallel stacking

Put wooden chock block on the bottom, make the axial line of the near one layers to vertical. When the socket are to the same direction on one layer and another layer the socket are to the same direction opposite site. Wooden wedge for every layer to avoid pipes rolling off. Parallel stacking suitable for pipes of all sizes.

Pyramid stacking

Put two parallel wooden sleepers on the bottom of pipes. Use wedge to fasten the sleepers. Put one sleeper 1m to the socket and the other 1m to the spigot. Pipes are parallel to each other without connection of socket and the floor. For each layer the socket are to one direction and two near layers are to opposite directions. Socket should be exceeded spigot end. Pyramid stacking suitable for pipes of all sizes.

Stacking Heights

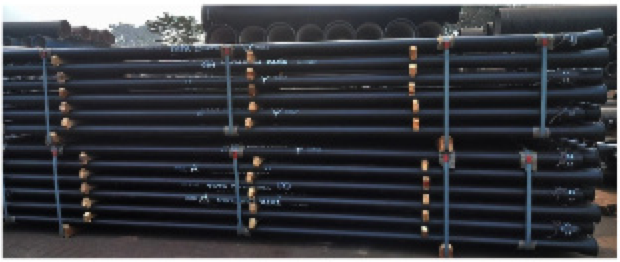
Diameter (mm)	80	100	125	150	200	250	300	350	400	450	500	600	700	750	800	900	1000	1100	1200
No. of Layers	27	23	22	20	16	13	12	10	9	8	7	6	5	4	4	3	3	2	2

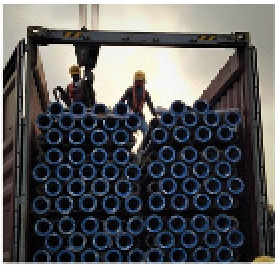
2. Loading of Pipes to Containers

Pipes are loaded in bundled form or loose depending upon nominal dia.

Bundled Pipe

Bundling is done for facilitating the loading of small size pipes (DN 80 to DN 150), in container shipment. The pattern of bundling may change on case to case basis depending on mode of shipment. Each bundle has two wooden battens placed parallel to each other at the bottom. Separator wooden battens are also provided between two rows/layers of pipes to provide stability to the bundle. The pipes are bundled such that the successive pipes have sockets in opposite direction, viewed vertically or horizontally. The pipes are strapped with adequate number of steel straps to ensure that the straps do not snap even during multiple handling.





Pipe Bundling and loading of bundles in container

Loose Pipes

Pipes of sizes DN 200 and above are normally shipped in loose condition. These pipes require careful handling to avoid damages. Loose pipes are loaded onto containers through Forklifts. Padded boom attachment should be used to ensure no damage to internal lining. A loading arrangement within container can be seen in. Suitable cushioning and separation is done to ensure the following :

a) No contact between pipe elements and metal surfaces.
b) No contact with trailer floor or trailer walls.
c) Adequate cushioning in between two layers of pipe.

Following are to be observed when loading pipes in loose condition :

(a) Pipes to be vanned in container, has to be spread in the designated place from where container to be loaded.
(b) Wooden bars to be used as a separator to maintain the layers of the pipes – spread for loose vanning of containers.
(c) Use wooden chocks for any rollover of pipes.
(d) In case of 40ft Normal & High Cube container wooden layer separator to be given between inside section and outside section.
(e) Wooden Chocking to be done to restrict side movement of pipes during transit and high sea.
(f) For loose vanning, turning radius of forklift / FX-150 with boom should be approx. 6 mtrs. It should be free from any obstacles so that during movement of forklift with pipes it should not hit any person or any pipe stacks.

Gaskets and Poly Ethylene Sleeves are packed in HDPE bags or Tissue Bags and placed within the container along with pipes. Cartons are used for packaging of Food grade lubricants.

Loading with forklifts using boom attachment

Packaging bag for Gaskets and PE Sleeves

3.Fumigation and Sealing Process

Fumigation is done after completion of vanning inside container and subsequently fumigation certificate issued by authorised Pest control service provider.
Sealing is done by attaching a unique numbered seal to the locking mechanism of the container. Intact seal bearing the same unique number indicates that container has not been opened since being loaded at Works.

4.Unloading, Stacking and Storage at Project Site

Unloading

Forklifts with specially padded booms are to be used for de-stuffing pipes from containers loaded in the truck.
Following are to be observed when using boom attachment in the forklift :

a) Lifting device i.e, Iron Boom (extra attachment) used for loose vanning of container should be in good condition. Iron Boom preferably should be rubber coated or should be properly rapped with hessian or mill cloth to avoid scr-atches on cement lining.
b) Specified boom should be used for lifting specific diameter of pipe.
c) Forklift with proper load capacity (load capacity determined on the maximum weight that a forklift is able to safely carry at a specified load centre).
d) Fx-150 crane with proper load capacity (load capacity determined on the maximum weight that a FX-150 crane is able to safely carry at a specified load centre).
e) Turning radius of forklift / FX-150 crane with boom attachment should be free from any obstacles so that during movement of the equipment with pipes, it should not hit any person or any pipe stacks and other objects.

Illustrating the usage for Boom Attachment

The use of wire ropes, chains, unpadded metal hooks or lifting hooks is absolutely prohibited as these come in direct contact with the Pipes. The basic Precautions to be followed while unloading are the following:

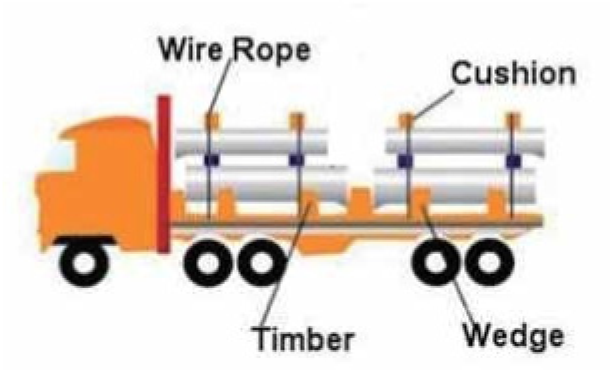
- The proper inspection of Forklift and the specially padded boom is necessary before starting the unloading procedure.
- Level ground to be used for Truck parking at the unloading station at site.
- Proper safety measures with display of caution messages should be present at the unloading site.
- After careful de-stuffing of Pipes the Pipes should not be dropped on old Tires or cushion.
- Other personnel should avoid staying near the truck while unloading.

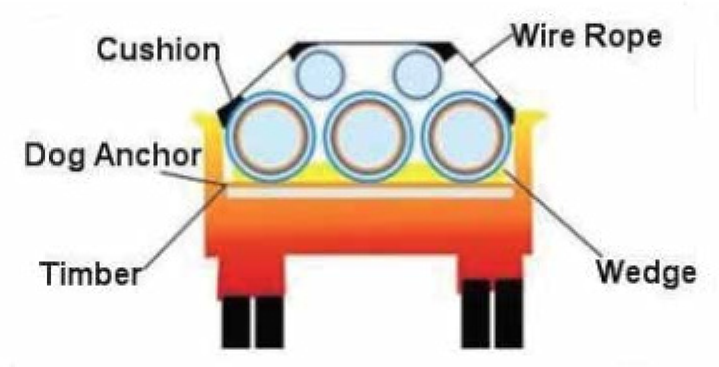
Transportation

Avoid making the pipes knock each other during transportation. Pipe socket and spigot of each layer should be put to opposite direction. It's requested strict operation according to protection and fasten requirement to avoid damage to pipes, fittings and their anti-corrosive coating.

Transportation vehicles: Use forklift or flat truck for short distance while truck or trailer for long distance. When truck or trailer is be used, the carriage should be cleaned, and should make a loading scheme according to the capacity of the vehicle.

When transport with trailer or truck, two blocks or more wood should be set up on the plate to avoid direct connecting between pipe socket and the plate. When transport with flat truck, put the pipe on the wood block and then fasten it. When there are more than one layer of pipes, each layer should have the socket and spigot to opposite direction with soft protection between each layer and fasten it with soft protective material, to avoid impact socket-spigot and socket-socket.





STORAGE OF RUBBER RING

For Water and Sewer Applications the TYTON JOINT is simple in itself. A single rubber sealing type joint that employs a circular rubber gasket assures a tight, permanent seal. This "push-on" type joint is simple to assemble and fast to install. The rubber gasket fits the inside contour of the bell which seats the gasket. The plain end of pipe is beveled to further ease assembly. It is particularly well suited for water or other liquid service.

Storage of Rubber ring

1. Don't take the rubber ring out of the package when not in use. It is not available exposure to the sun or stocking in the high temperature situation, meanwhile it is necessary to reduce stocking time as far as possible.
2. Storage temperature should be below 250C and preferably below 150C.
3. Elastomer rubber should be protected from light, direct sunlight & strong artificial light with a high ultraviolet content.
4. As ozone is particularly deleterious, storage room should not contain any equipment which is capable of generating ozone such as mercury vapor lamps, high voltage electrical equipment's electric motors or other equipment's which may cause electric sparks or salient electrical discharge.
5. If stocking for a long time, rubber ring should be put in the case packed with paper or plastic material, storage should be on the natural situation without any force and twisting.

Available standards for Rubber Ring are IS 5382 / ISO 4633 / BS EN 681-1. Normally two types of Rubber Ring are available:

- SBR: Styrene Butadiene Rubber.
- EPDM : Ethylene Propylene Diene Monomer.

Normally two types of Rubber Gasket are available.
SBR : Styrene Butadiene Rubber.
EPDM : Ethylene Propylene Diene Monomer.

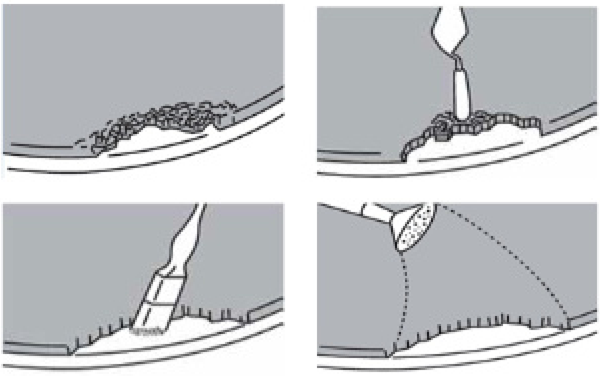
Bulb of Gasket
Shore Hardness 50 (± 5)

Repair of Damaged Cement Mortar Lining

Any damage of internal cement mortar lining caused accidentally during transportation, storage, laying or by rough handling can be repaired easily on site. When repairing damaged cement mortar linings, the following procedures should be used:

Preparation of repairing area

1. Identify the damaged area.
2. If possible position the pipe or fitting with the damaged area at invert level.
3. Carefully chip out the damaged lining.
4. Do not disturb surrounding lining.
5. Ensure edges are slightly undercut.
6. Brush off any loose mortar.
7. Thoroughly wet area to be repaired.



Materials required for repair of damaged CML

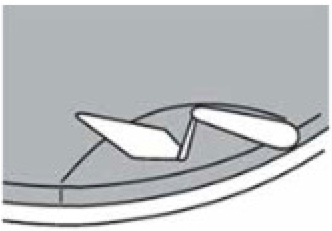
1. Potable water.
2. Cement – Compatible to original lining prepared with only the following:
   - Ordinary Portland cement (OPC).
   - Blast furnace slag cement (BFSC).
   - Sulphate Resistant cement (SRC).
   - High Alumina cement (HAC).
3. Sand – Having an average grain size 270 – 300 microns.

Composition of Repair Mix

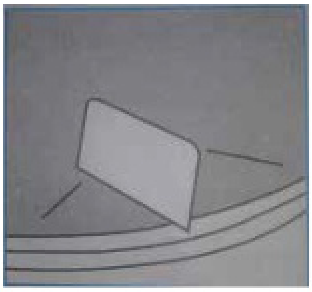
1. Mix sand and cement dry in proportion of 1:1 (ratio of cement and sand = 1:1).
2. Add sufficient potable water to form a thick paste which is workable.

CML repair procedure

1. Ensure repair area is wet.
2. Remove any areas of water accumulations.
3. Build up the thickness to above the original lining, and finally smooth down to the required thickness.



After repair

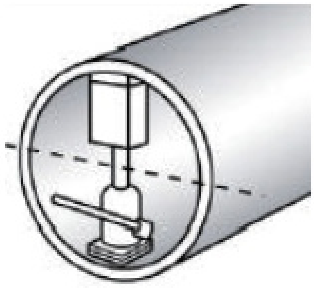


1. After 200 minutes of completing the repair, dampen the repair area.
2. Cover area with wet rags and leave to set in ambient temperature – must be above 40 °C.
3. In areas of high temperature and low humidity check periodically for 4 hours that rags are wet.

Transportation and bad handling is the main cause of pipe ovality. It is very difficult to make correct assembly of the pipe jointing with a oval pipe. In smaller diameter pipes (Less than DN300) ovality is generally negligible. Two methods are recommended for ovality correction.

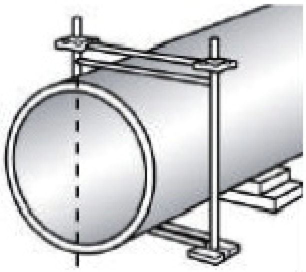
Method 1

The use of this recommended where it is possible to remove the tackle after ovality correction and subsequent jointing.



1. Position the timber strut and jack (approximately 5 ton capacity) into the spigot end at 90^0 to the major axis. Rubber / timber packing should be placed in position to prevent damage to the pipe lining.
2. Extend the jack until the ovality is within the allowable ovality level.
3. Complete the jointing operation with the major axis of the spigot in the vertical position.
4. After jointing remove the jack. When jointing with coupling it may be necessary to use two jacks in order to obtain a round profile.

Method 2



1. The use of this method is recommended where it is not possible to remove the tackle as described in method 1, after ovality correction and subsequent jointing.
2. Place the tackle around the spigot end of the pipe at a position 450 mm from end with the major axis of the spigot vertical. Where pipes are tape wrapped, rubber pads or similar should be placed between the re rounding tackle and the pipe for protection.
3. Tighten the two nuts evenly until the ovality is within the tolerance specified in table-1.
4. Complete the jointing operation with the major axis of the spigot in the vertical position.
5. After jointing remove the jack.

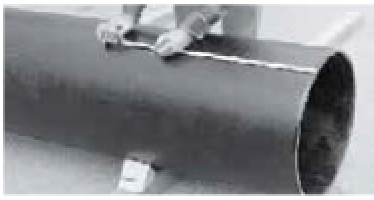
METHODS OF CUTTING OF DUCTILE IRON PIPE AT SITE

Ductile Iron pipe is easily cut in the field by several methods, the most common being as follows:

1. By manually operated cutter - Small diameter pipes can be cut by manually operated hacksaw.
2. By power driven abrasive wheel cutting machine – This is one of the most widely used methods for cutting Ductile Iron Pipe. This cutter is suitable for all sizes.

Procedure for field cutting

Measure the pipe diameter (or circumference) at the location of the cut to be made to ensure that the pipe diameter and circumference are within the tolerance.



Mark the pipe at sufficient intervals around the circumference (usually the spigot end) such that a square cut can be made.

Cut the pipe at the desired location. The outside of the cut end should be beveled smooth as per manufacturer's recommendation using a grinder or file to prevent damage to the gasket during assembly.

Edge Preparation (Chamfering)

Measure the pipe diameter (or circumference) at the location of the cut to be made to ensure that the pipe diameter and circumference are within the tolerance.

WELDING AT SITE

Ductile Iron Pipes can be welded at site as per requirement but following instruction should be maintained at the time of welding of Ductile Iron Pipe.

1. The surface which is to be welded should be free from any type of foreign material like rust, dirt, scale, paint or lubricant.
2. The welding of Ductile Iron can be done by direct or alternate current and the ampere range should be within 70 amps to 125 amps.
3. Special Fe-Ni alloy electrodes containing 40% to 50% Ni should be used for welding of Ductile Iron Pipe. Some widely used brands of electrode are XUPER 2240 (Eutectic) and XYRON 2230 (Eutectic). Other brand of same composition can also be used.
4. It is strongly advised that before welding of Ductile Iron Pipe, preheating of the surface which is to be welded is necessary at 400^0 C. preheating will prevent the formation of hard carbide at melted zone and heat affected zone. preheating can be done by oxy-acetylene flame.
5. Apply few tack welds first. Then the welding is completed in not less than two passes. Slag should be properly cleaned before applying the second pass.
6. After completion of welding, pipe should be allowed to slow cooling. Any kind of force cooling can damage the mechanical properties.

Surface coating removed at the place of welding

Pipe Welding

APPLICATION OF POLYETHYLENE (PE) SLEEVING

General Information

Polyethylene sleeving is a tubular film of low density polyethylene slipped over and snugly fitted to a pipe at the time of laying. It is used to supplement to the basic pipe coating (metallic zinc + bituminous paint) in certain cases of highly corrosive soils, or in presence of stray currents.

Material Characteristics

- The density of PE Sleeving is not less than 910 to 930kg/m^3.
- The nominal thickness of PE Sleeving shall not be less than 200μm and not more than 250 μm.
- Tensile strength shall not be less than 8.3 MPa.
- The elongation at fracture shall not be less than 300%.
- The Dielectric Strength of the film should be 31.5V/μm minimum.

Lay flat Width of Tubular Polyethylene Film for Various Sizes of Pipe	
Nominal Diameter of the Pipe (mm)	**For Use with Pipeline Incorporating Flexible Joints (mm)**
80	350
100	350
150	450
200	550
250	650
300	700
350	800
400	1100
450	1100
500	1350
600	1350
700	1750
750	1750
800	1750
900	2000
1000	2000
1100	2500
1200	2500

Installation of PE sleeving at site

STEP 1

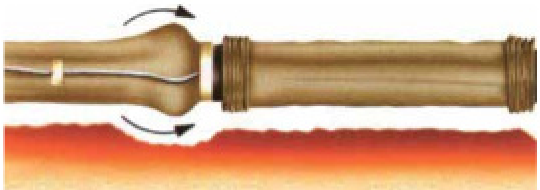
Clean all dirt, cinders, etc., from the surface of the pipe. Cut polyethylene two (2) feet longer than the pipe. Slip polyethylene over spigot end and bunch.

STEP 2

Dig bell holes at joint locations, lower pipe into trench and make up joint.

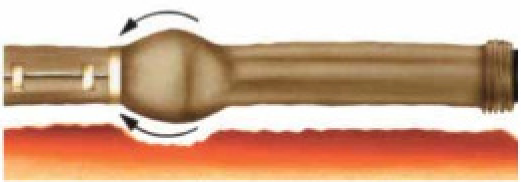
STEP 3

Move cable hoist to bell end of pipe and lift enough to slip polyethylene along pipe.



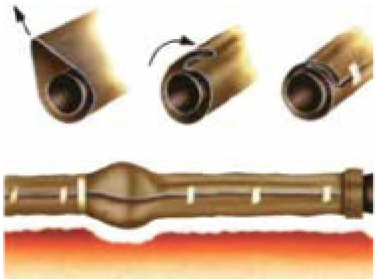
STEP 4

Pull polyethylene forward from previous joint over the bell and secure in place.



STEP 5

Pull polyethylene from new pipe over this same bell, providing a double layer of polyethylene and secure in place.

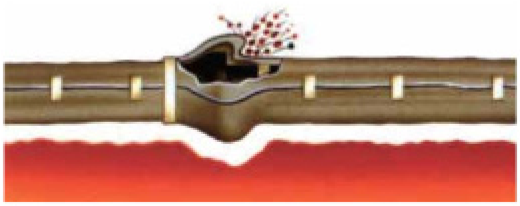


STEP 6

Take up slack in the tube along the pipe barrel, making a snug but not tight fit. Fold over on top of pipe and secure in place about every three (3) feet.

STEP 7

Make sure any tears in the polyethylene are repaired with tape or another piece of polyethylene secured over the damaged area.



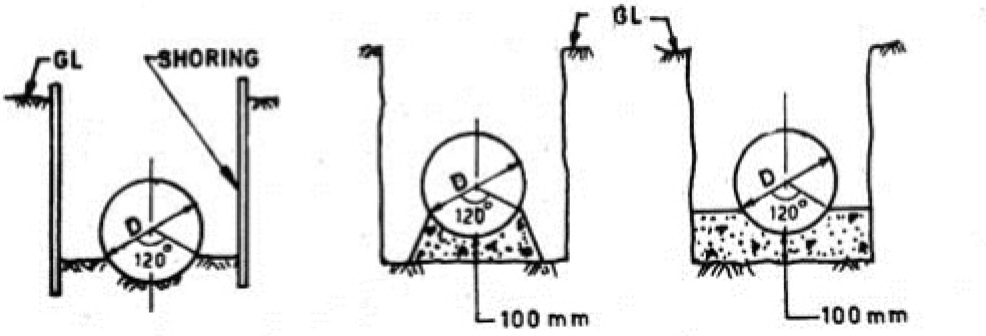
STEP 8

Backfill the trench according to specifications,being careful not to damage the polyethylene while tamp ing around pipe. Backfill should not contain materi al that might damage the polyethylene.

Underground Installation

Excavation and Preparation of Trenches for Laying Underground Pipeline

1. The width of the trench at bottom between the faces of sheeting shall be such as to provide not less than 200 mm clearance on either side of the pipe except where rock excavation is involved. Trenches shall be of such extra width, when required, as will permit the convenient placing of timber supports, strutting and planking and handling of specials.
2. In agricultural land, the depth should be sufficient to provide a cover of not less than 900 mm so that the pipeline will not interfere with the cultivation of the land.
3. In rocky ground, the trench should be excavated at least 100 mm deeper than normally required and then made up to the required level by the addition of well compacted selected bedding.
4. It may be necessary to increase the depth of Pipeline to avoid land drains or in the vicinity of crossings.
5. Where pipes are to be bedded directly on the bottom of the trench, it should be trimmed and levelled to permit even bedding of the pipeline and should be free from all extraneous matter which may damage the pipe or the pipe coating. Additional excavation should be made at the joints of the pipes so that the water main is supported along its entire length.



1A Trench in earth or Murum

1B Trench in Hard Rock with Cement Concrete Bedding

1C Trench in Hard Rock with Sand Bedding

Laying of Pipes into the Trench

1. Pipes should at all-times be handled with care. Pipe should be lowered into the trench with tackle suitable for the weight of pipes. For smaller size, up to 250 mm, the pipe may be lowered by the use of ropes but for heavier pipes, either a well design set of shear legs or mobile crane should be used. When lifting gear is used, the positioning of the the sling to ensure a proper balance, should be checked when the pipe is just clear of the ground. If sheathed pipes are being laid, suitable wide slings or nylon (zebra) Belts should be used.
2. All persons should vacate the section of the trench into which the pipe is being lowered.
3. When laying is not in progress, a temporary end closure should be fitted securely to the open end of the pipeline.

DUCTILE IRON PIPE DIMENSION

Step-1. Cleaning of socket and spigot

Thoroughly clean the groove and the bell socket of the pipe. All foreign metal in socket must be removed i.e mud, sand, cinders, gravel, peddles, trash etc and also clean the spigot end of the mating pipe. If the spigot end is not smoothly chamfered it may damage the gasket during insertion. Normally DI pipes are delivered with chamfered ends to facilitate easy jointing.

Step-2. Gasket inserting in socket groove

Check the condition of the gasket and using a gasket of the proper design for the joint to be assembled, make a small loop in the gasket and insert it in the socket groove. For pipe sizes larger than 500 mm it may be necessary to make two loops in the gasket (6 and 12 o'clock). Make sure the gasket faces the correct direction and that it is properly seated.

Step-3. Application of lubricant

Apply lubricant (such as soap solvent) to the exposed surface of the gasket and plain end of the pipe or fitting in accordance with the pipe manufacturers recommendations. Do not apply lubricant to the bell socket or the surface of the gasket in contact with the bell socket. Lubricants furnished in sterile containers and every effort should be made to keep it sterile.

Note: Petroleum based lubricant can harm the rubber gasket.

Step-4. Pipe alignment

Center the spigot in the socket and hold the pipe in a position so that the alignment is proper. Ensure that both the pipes are properly aligned and levelled. The pipe to be inserted should be lifted from the trench bottom to avoid excessive soil friction during insertion. It will also help to align the pipes properly.

Step-5. Pipe jointing / pushing

After alignment push the spigot into the socket. Push in the spigot until the first white mark disappears inside the socket. The second mark must be visible after assembly. Allows push spigot into the socket, if accidentally socket is pushed then the gasket may be displaced and concentricity of the spigot and socket may not be achieved.

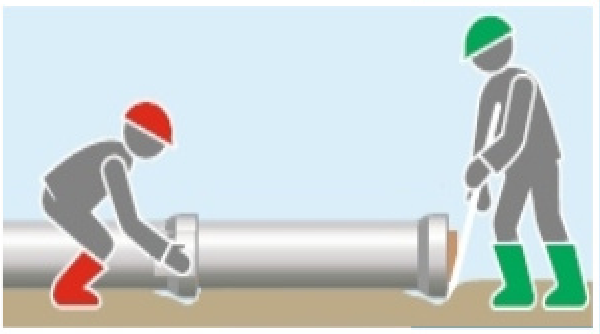
Step-6. Joint checking

After pipe jointing check that the gasket is correctly in position by inserting the end of a metal ruler through the annular spigot and socket gap until it touches the gasket. The ruler must penetrate to the same depth around the whole circu-mference.

Step-7. Joint deflection checking

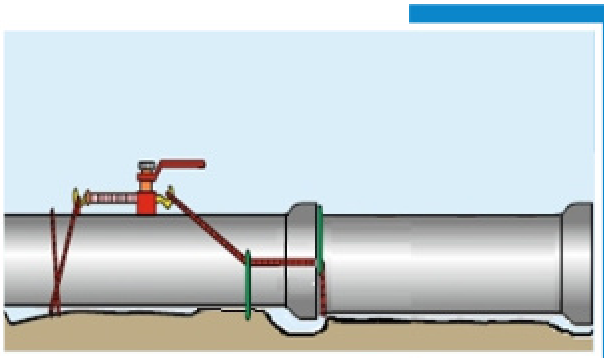
Jointing must be done with well aligned pipes. Make sure that the curvatures after assembly should not exceed the permissible angular deflection.

Various Method of Push-on Jointing System



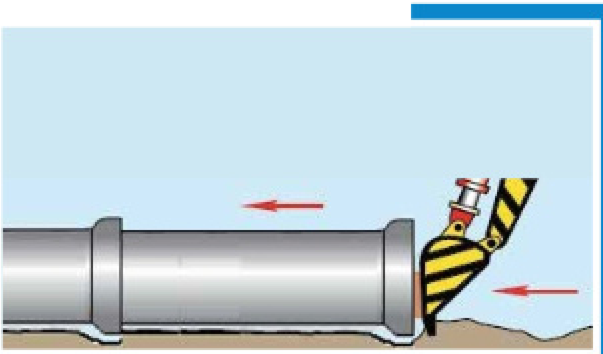
Crowbar Method (for DN 80 to DN 150)

The crowbar levers against the ground. The pipe socket face must be protected with a piece of hard wood. The jointing takes by the leverage of the crowbar.



Tirfor Method (Mechanical Winches)

• DN 150 to DN 300 :
Tirfor winch wire rope and protected hooks
• DN 350 to DN 600 :
Tirfor winch wire rope and protected hooks
• DN 750 & above :
2 nos Tirfor winches, diametrically opposite
2 nos wire rope and 2 nos protected hooks



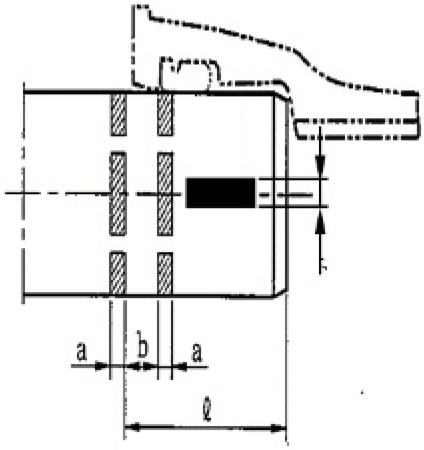
Pipe jointing using Digger bucket (for all diameter)

The hydraulic force of the arm and bucket of a mechanical digger to join pipes and straight fittings.

• Place a wooden batten between the pipe and digger bucket
• Push slowly and steadily, observing the rules for pipe joining

Markings of Major axis of Spigot and Lines for Checking of Assembled Joint

DN	Dimension (mm)					
	Lines for checking of assembled joint					
	a		b		c	
80	10	±1	13	±2	90	±2
100	10		13		92	
125	10		13		92	
150	10		13		95	
200	10		13		110	
250	10		13		115	
300	10		13		120	
350	10		13		135	
400	10		13		135	
450	10		13		135	
500	10		13		140	
600	10		13		145	
700	15		20		160	
750	15		20		160	
800	15		20		165	
900	15		20		180	
1000	15		20		183	
1100	20		25		199	
1200	20		25		207	



Back-Filling

- Backfilling is one of the most important phases of water main construction. The purpose of backfill is not only to fill the trench, but to protect the pipe and provide support along and under it. Backfilling operation should immediately do after the laying of pipes.

- Backfill material should be of good quality material and free from cinders, ashes, slag, refuse, rubbish, vegetable or organic material, lumpy or frozen material, boulders, rocks, or frozen material. Soil containing cobbles up to 8-inches in their greatest dimension may be used from 1-foot above the top of the pipe to the ground surface or pavement subgrade.

- For the purpose of back-filling, the depth of the trench shall be considered as divided into the following three zones from the bottom of the trench to its top:

  1) Zone A : From the bottom of the trench to the level of the center line of the pipe.

  2) Zone B : From the level of the center line of the pipe to a level 300 mm above the top the pipe.

  3) Zone C : From a level 300 mm above the top of the pipe to the top of the trench.

- Back-filling from the bottom of the trench to the level of the center line of the pipe, shall be done by hand with sand, fine gravel or other approved material placed in layers of 150 mm and compacted by tamping. The back-filling materi al shall be deposited in the trench for its full width of each side of the pipe.

- Back-filling from the level of the center line of the pipe to a level 300 mm above the top the pipe shall be done by hand or approved mechanical methods in layers injuring or moving the pipe.

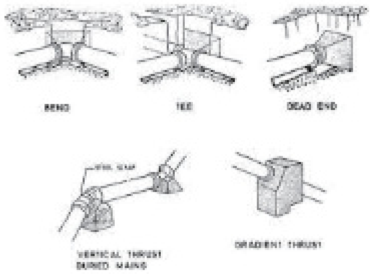
- Back-filling from a level 300 mm above the top of the pipe to the top of the trench shall be done by hand or approved mechanical method. The excavated material may be used for back-filling.

- If the joints are to be individually inspected during hydrostatic testing, it is not practicable to backfill the trench comp-letely and joints are to be left open.

- If pipes are greater than DN 600, special attention should be given to the compaction of the backfill material behind the socket of the pipe. Sand bag placed behind the socket is very helpful against socket movement at the time of testing.

- When pipes are laid under roads and pavement subjected to heavy traffic loads, the trenches may be covered with reinforced concrete slabs of suitable dimension.

Underground Pipeline Anchorage



All pipelines having unanchored flexible joints require anchorage at changes of direction and at dead ends to resist the static thrusts developed by internal pressure. Dynamic thrusts caused water act in the same direction as static thrusts. This thrust is of sufficient magnitude at high velocities to warrant safety consideration.

Anchorages to resist the thrust should be designed taking into account the maximum pressure the main is to carry in service or on test and the safe bearing pressure of the surrounding soil. Where possible, concrete anchor blocks should be of such a shape as to allow sufficient space for the remaking of the joints. The figuret shows typical anchorages using concrete anchor blocks.

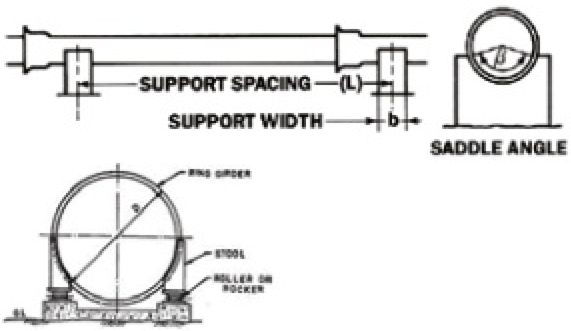
The dimensions of the anchor block are determined from the resultant thrust and the safe bearing pressure of the trench wall. Care is to be taken to ensure there is sufficient concrete curing time to withstand any thrust load and that the anchorage does not interfere with any other services. Pour the anchor block after excavation and make allowances for any joints to be pulled apart and pipes/fittings reinstalled. For both horizontal and vertical thrusts restraint ties are not generally used. The aim is to have the thrust distributed over the total bearing area so that the safe bearing pressure of the undisturbed part of the trench wall is not exceeded.

Above Ground Installation

Above ground, supported pipe is needed to carry the pipeline when there is a sudden ground depression, while crossing a natural/manmade obstacle, within treatment plants/buildings etc. where buried laying is not possible. Sometimes, unstable soil condition or other factors necessitate the installation of pipe on piers or pilings underground.

The socket & spigot pipes be provided with one support per pipe, the supports being positioned behind the socket of each pipe. Pipe should be fixed to the supports with mild steel straps so that axial movement due to expansion or contraction resulting from temperature fluctuation, is taken up at individual joints in the pipeline. Joint should be assembled with the spigot end withdrawn 5 to 10 mm from the bottom of the socket to accommodate these thermal movement.

Pipes supported in this way are capable of free deflection and axial movement at the joints which accommodate small movements of the pipe support. The most accepted formula for saddle supports, the minimum width (b) is determined by the following equation $b = \sqrt{2 D t_c}$.



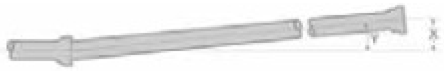
DEFLECTION OF PIPES AFTER JOINTING

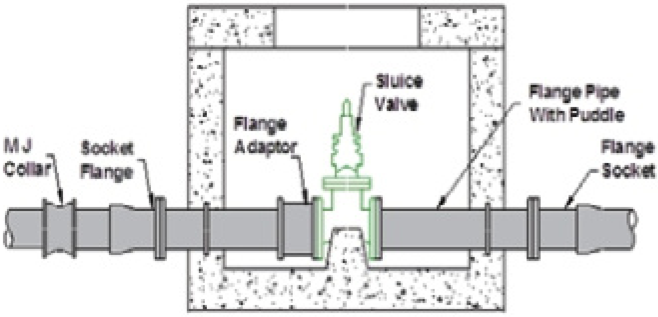
On long radius curves, the trench should be excavated wider than normalto allow for straight line assembly before deflection. Inserting the plain endof a full length of pipe into a socket under deflected conditions is not recommended and should be avoided if possible.

When deflection is necessary, pipe should be assembled in a straight line, both horizontally and vertically, before deflection is made. Ductile Iron Pipe push-on joints have a joint deflection of up to 5°depending upon the nominal diameter of pipe.

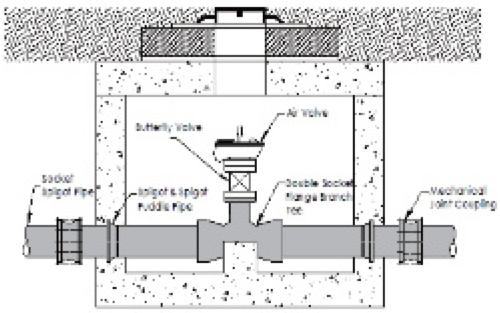
This deflection enables the pipeline to be diverted from a straight line when following the curvature of streets and roads or when avoiding obstacles.

Nominal diameter in mm	Permissible deflection in degree	Maximum Displacement in cm
100 - 150	5	52
200 – 300	4	42
350 – 600	3	32
700 – 800	2	25
800 – 1200	1.5	19

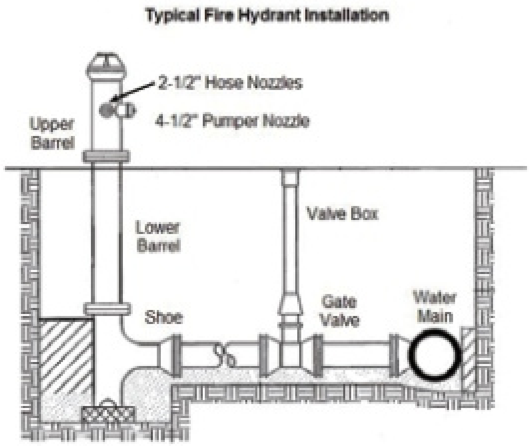




Sluice Valve Installation



Air Valve Installation



Fire Hydrant Installation

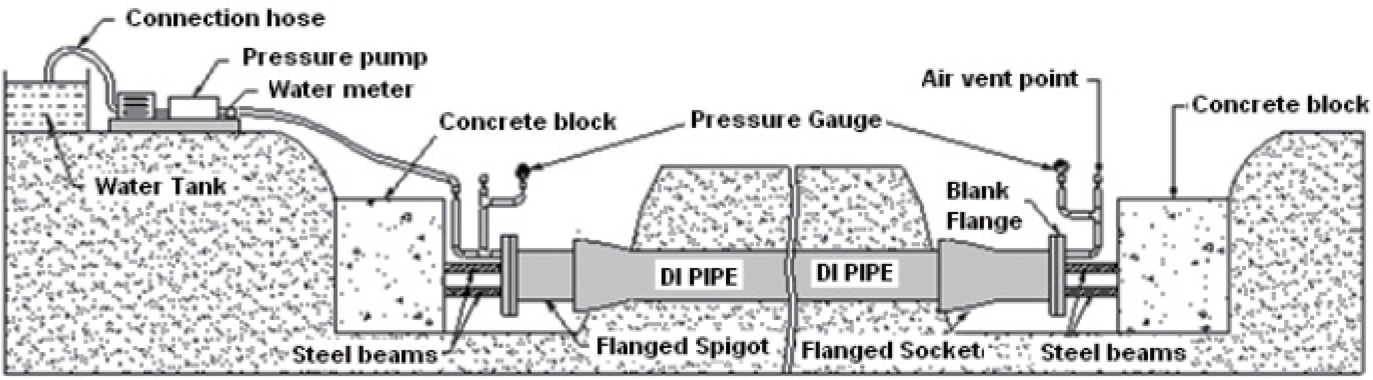
HYDROSTATIC PRESSURE TESTING OF INSTALLED PIPE

Newly installed pipelines are normally pressure tested to confirm proper installation of joints and fittings. When the new pipeline is initially filled, a calculation of a volume of make-up water is determined according to the size and length of the pipeline being tested. The make-up water allowance accounts for the absorption of water by the lining and the extension (lengthening) of pipe joints due to the thrust forces that occur when the pipeline is first pressurized. The allowance is not a measure of leakage through improperly installed joints. The pressure test is normally performed after backfilling. When unusual conditions require that pressure testing be accomplished before backfilling or with pipe joints accessible for examination, sufficient backfill material should be placed over the pipe barrel between the joints to prevent movement and consideration should be given to restraining thrust forces during the testing. At least 1.5 times the stated working pressure at the lowest elevation of the test section for a duration of two hours is recommended. The pipeline should be filled slowly and care should be taken to vent all high points and expel all air. Vents should remain open until water flows from them at a steady flow.

In addition, fittings and hydrants should be properly anchored and all valves should be completely closed before applying the test pressure. When using a valve for a closure piece of test section, the rated pressure of the valve should not be exceeded. After the air in the pipe has been expelled and the valve or valves segregating the part of the system under test have been closed, pressure is then applied with a hand pump or hydraulic-powered pump. The pipeline is then pressurized up to the full test pressure and the section under test completely closed off. The test should be maintained for a period of not less than 10 minutes to reveal any defects in the pipes, joint or anchorages.

The test pressure should be measured at the lowest point of the section under test or alternatively, an allowance should be made for the static head between the lowest point and the point of measurement to ensure that the required test pressure is not exceeded at the lowest point.

It is important to ensure that proper arrangements are made for the disposal of water from the pipeline after completion of hydrostatic testing.



PIPELINE COMMISSIONING

- If pipeline is intended to carry potable water, it should be thoroughly flushed with with clear water, where feasible.

- It should then be disinfected by contact for 24 hours with water containing at least 20 mg/l of free chlorine, then emptied and filled with potable water.

- After a further 24 hours, samples should be taken for bacteriological examination at several points along the pipeline.

- The pipeline should be not brought into service until the water at each sampling point, having stood in the pipeline for 24 hours, has maintained a satisfactory potable standard.

PROVIDING SERVICE CONNECTION

- Clean the exposed surface from where ferrule connection is sought.
- Chalk-mark a circle as per the required ferrule size on the cleaned pipe surface.
- Make drill hole by a manually operated ratchet drill to take out DI metal from the area inside the marked circle throughout the thickness of the pipe forming a hole.
- Normal tapping by the same ratchet arrangement giving the required threads for the ferrule to be connected.
- For larger connection (25 mm & above) strap-on saddles are to be used.

STANDARD REPAIRING PROCEDURE

- Clean the exposed surface from where ferrule connection is sought.
- Chalk-mark a circle as per the required ferrule size on the cleaned pipe surface.
- Make drill hole by a manually operated ratchet drill to take out DI metal from the area inside the marked circle throughout the thickness of the pipe forming a hole.
- Normal tapping by the same ratchet arrangement giving the required threads for the ferrule to be connected.
- For larger connection (25 mm & above) strap-on saddles are to be used.

UNIT CONVERSION

UNIT	CONVERSION
Acres	4047 m^2
Atmosphere	1.01 Bar
Bar	1.02 kg/cm^2
Bar	14.5 Pound/sq in
Centimetre	0.39 Inch
Cubic metre	264.17 Gallon
Cubic metre	1000 litre
Cubic feet	28.32 litre
Feet	30.48 cm
Gallon	4.545×10^{-3} cu m
Gallon	4.545 litre
Hectare	2.471 Acre
Horsepower	550 Ft-lbs/sec
Horsepower	0.7457 kW
Inch	25.4 mm
Inch/s	2.540×10^{-2} m/s
Kilogram	2.20 Pound
Kg/cm^2	14.22 Pound/sq inch (psi)
Kilometre	0.62 Mile
Kilowatt	14.33 kcal/min
Kilowatt	1.341 Horsepower
Litre	0.26 Gallon
Litre	0.03531 cu ft
Metre	3.3 ft
Mile	5280 ft
Mile/min	88 ft/s
MGD	4.545 MLD
Mega Pascal (Mpa)	10 kg/cm^2
Newton	0.1 kgf
Newton/mm2	1 Mpa
Ounce	28.35 g
Pound	16 ounce
Pound	4.45 Newton
Pound/sq foot	4.88 kg/m^2
Pound/sq inch	2.31 ft of water (at 620^0F)
Pound/sq inch	6.9 kPa
Tonne (metric)	1003 kg
Tonne (metric)	2205 Pound
Watt	0.74 ft-pound/s
Watt	1.34×10^{-3} Horsepower

Source:
DIPRA
NEERI
Technical Literatures
IS 12288:1987
ISO 21051:2020


Croatia
Lebanon
Morocco
Egypt
Nepal
Haiti
Jordan
Bhutan
Spain
Iraq
Kuwait
Bangladesh
Algeria
Turkey
Bahrain
Sri Lanka
Oman
Nicaragua
Seychelles
Senegal
Malawi
Singapore
Hongkong
UAE
Burkina Faso
Peru
Brazil
Qatar
Philippines
Cote d'Ivoire
Reunion
Island
Ethiopia
Vietnam
Switzerland
Tanzania
Mauritius
South Africa

TATA

TATA STEEL LIMITED

Metaliks Division Tata Centre 43 J L Nehru Road Kolkata 700 071 India Phone Number: 91 33 661 34200
Metaliks Division Vill Maheshpur PO Samraipur PS Kharagpur Local Distt. Paschim Medinipur Pin 721301 Phone Number: 9073331142
Registered Office Bombay House 24 Homi Mody Street Fort Mumbai 400 001 India Tel 91 22 66658282