Ductile Iron Pipe Repair

Comprehensive pipe solutions

PAM
SAINT-GOBAIN

Ductile Iron Pipe Repair

This document is designed to provide a simple guide to the repair of damaged ductile iron pipe caused primarily by handling or transportation. It does not deal with all aspects repair and assumes a general level of knowledge of ductile iron piping systems of the reader. This document should not be the only source of information. Further information can be found in other SGP documentation or by referring to qualified engineers on the subject or SGP.

Third Edition May 2017

General Safety

Saint-Gobain PAM is a strong advocate of safety at home and in the workplace and extreme care must be taken whenever performing hazardous tasks.

This document is a general guide to the repair of damaged ductile iron pipes. There are numerous hazards and safety issues related to the handling, cutting, grinding and painting of these products which must be considered before performing repair tasks. This document highlights the main hazards present but cannot practically account for the actual task, the work site or environmental conditions.

All installers and contractors should be sufficiently trained to undertake the procedures highlighted in the document. A complete risk assessment must be undertaken before performing any repair task and control measures put in place to manage the risks following the Hazard Pyramid for control. PPE, while essential, must be seen as the last form of risk management.

1 Damage to Ductile Iron Pipe

Pipes may suffer damage during transport or handling.
Depending on the degree of damage, the pipes may be:
- rejected,
- repaired, or
- have the damaged section removed.

Damage is typically due to mechanical impact and can result in:
- denting of the ductile iron,
- severe scratching or scoring of the coating,
- fracture of the cement mortar lining,
- damage to internal lining.

Damage can also arise from extended rubbing contact of the pipe with the container walls, packing material or other pipes during transport. Damage of the cement mortar lining can also be caused by lifting hooks while rope, sling or chains can damage the pipe coating, particularly during hot weather. This later damage is usually more localised and of lesser severity.

Most damage can be repaired as described in this document.

2 Spigot Repair

The illustration in Figure 1 is of an assembled push-in joint highlighting the three zones on the pipe spigot:

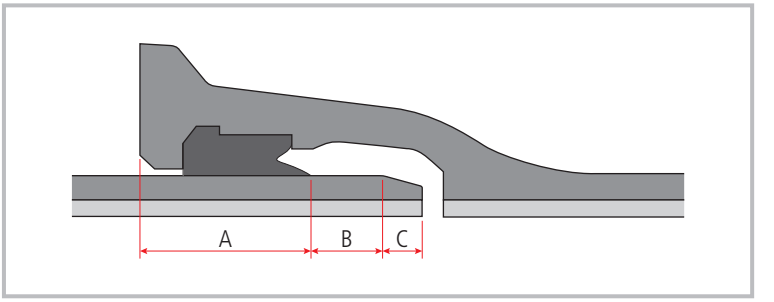
2.1 Spigot Zones

ZONE A: the sealing zone. This zone must not contain any defect.

ZONE B: corresponding with the portion of spigot inside the socket projecting beyond the sealing zone. There must be no metal damage in this area because of the risk of damage to the gasket during assembly, leading to joint leakage.

ZONE C: corresponding with the chamfer. This must not contain any roughness or burrs liable to damage the gasket during jointing.

Figure 1. Push-in joint highlighting the 3 zones.



Figures 2 & 3. Manual cutting tools

2.2 Spigot Zone Repair

If the metal on the spigot end is dented as a result of impact, the whole of the defective area must be cut off. The recommended cutting procedure is outlined below.

Any slight deformation outside sealing zone A can be tolerated, with no effect on the joint performance.

2.2.1 SAFETY

The use of power tools is required to cut and chamfer the pipes. Ensure personnel have all the required experience to handle power equipment. Ensure the area is well ventilated and personnel have the required PPE including hearing, eye and respiratory protection. Pipe must be held steady during cutting and not allowed to roll.

2.2.2 EQUIPMENT REQUIRED

- circumferential measuring tape
- marking pens (paint)
- power saw. Figures 2 & 3 for example.
- grinder. Figure 4 for example.

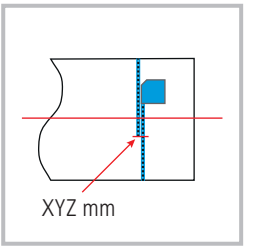
Figure 4. Chamfering tool

Figure 5. Automated cutting and chamfering equipment for large diameter pipes

2.2.3 PROCEDURE

STEP 1
CHECK THE OUTER DIAMETER

Before cutting, use a circumference tape to check that the OD measured is within the required dimensional tolerance.



▼ Table 1

ISO 2531 / EN 545 DIMENSIONED PIPES

Diameter must be less than OD+1mm, e.g., DN100 – OD<119mm.

DN : OD mm	DN : OD mm	DN : OD mm	DN : OD mm
60 : 77	250 : 274	600 : 635	1200 : 1255
80 : 98	300 : 326	700 : 738	1400 : 1462
100 : 118	350 : 378	800 : 842	1500 : 1565
125 : 144	400 : 429	900 : 945	1600 : 1668
150 : 170	450 : 480	1000 : 1048	1800 : 1857
200 : 222	500 : 532	1100 : 1151	2000 : 2082

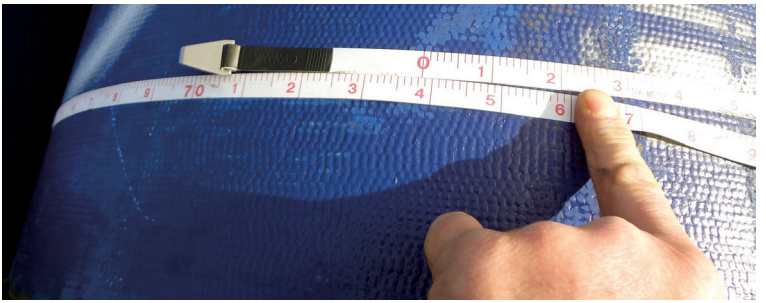
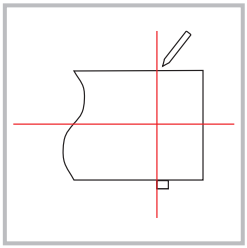


Table 2:

AS 2280 DIMENSIONED PIPE TOLERANCES

DN	OD mm	Tolerance mm
100	122	120-123
150	177	175-178
200	232	230-233
225	259	257-260
250	286	284-287
300	345	343-346
375	426	424-428
450	507	505-509
500	560	558-562
600	667	665-669
750	826	824-828

Notes. For DN≤300: preferably, cut at a distance of less than 3.5 metres from the spigot end. For DN>300: preferably, cut pipes identified as **calibrated** pipes. Generally any pipe can be cut at any position, provided it meets the dimensional tolerance.

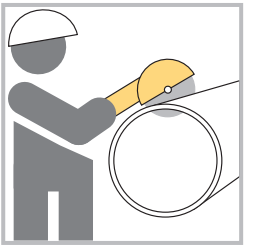


STEP 2
MARK THE CUTTING POSITION

Mark the cutting plane **perpendicular** to the pipe axis.

Use a marker that is clearly visible.

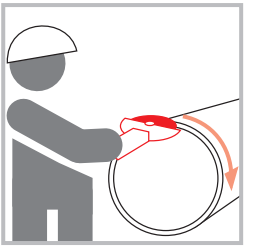
STEP 3
CUT THE PIPE



A hand held power saw can be used. Automated pneumatic crosscut saws should be used for larger diameters or when cutting larger numbers of pipes. Diamond or masonry blades are recommended.

If, during cutting, the cement mortar lining is damaged, follow the cement mortar lining repair procedure detailed in Section 5.2.

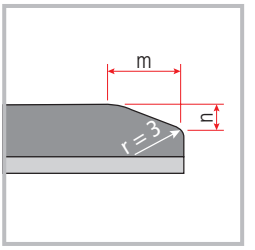
STEP 4
CHAMFER EDGE



After cutting, the pipe needs to be rechamfered to the dimensions shown below.

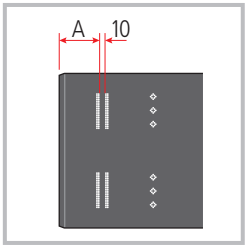
Table 3

DN	m mm	n mm
60-600	8	3
700-1200	15	5
1400-1600	20	7
1800-2000	23	8



Coating on chamfered edge can be reinstated if required, as detailed in section 4.

Figure 6. Cutting



STEP 5
INSERTION WITNESS MARK

Apply new insertion witness marks. Measure from the spigot to the apropriate depth indicated in the tables below and mark new lines.

Table 4. Mark at position A

FOR AS 2280 DIMENSIONED PIPES

DN	A mm
100	71
150	71
200	84
225	84
250	84

DN	A mm
300	84
375	102
450	102
500	102
600	110
750	130

Figure 7. Chamfering operation

Figure 8. Cut and chamfered spigot

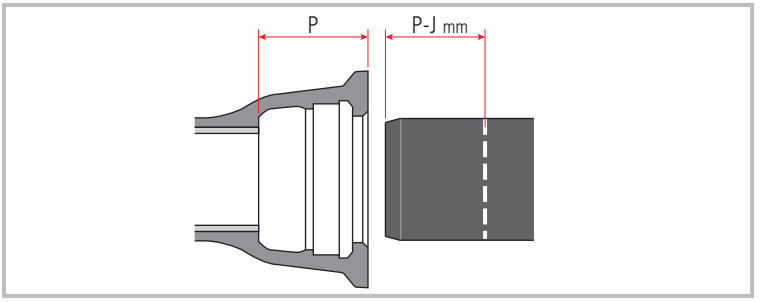


Table 5. Mark at P-J from spigot.

FOR ISO/EN DIMENSIONED PIPES

DN	P mm	J mm	P-J mm	DN	P mm	J mm	P-J mm
60	87	15	72	600	130	20	116
80	90	15	75	700	192	25	167
100	92	15	77	800	197	25	172
125	95	15	80	900	200	25	175
150	98	15	83	1000	203	30	173
200	104	15	89	1100	225	30	195
250	104	15	89	1200	235	30	205
300	105	15	90	1400	245	40	205
350	108	20	88	1500	265	40	225
400	110	20	90	1600	265	40	225
450	113	20	93	1800	275	40	235
500	115	20	95	2000	290	40	250

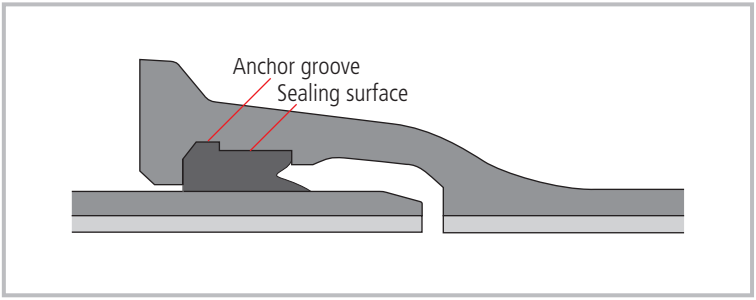
3 Socket Repair

During transportation or installation, dirt can collect in the socket grooves. In rare cases, manufacturing imperfections can also be found in the grooves.

3.1 3.1 Socket Zones

Figure 9 illustrates the most critical zone of the socket. The anchor groove into which the heal of the ring sits must be clean and free of debris to allow the ring to seat correctly. The sealing surface must also be clean and free of debris to allow for effective sealing.

Figure 9: Critical socket zone



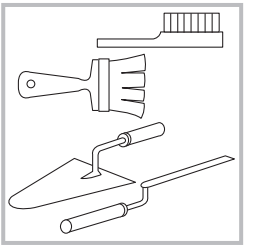
3.2 3.2 Socket Zone Repair

During transportation or installation, dirt can collect in the socket grooves. In rare cases, manufacturing imperfections can also be found in the grooves. This includes excess paint, remnant sand core, cement or metal. This material must be removed for effective sealing.

3.2.1 SAFETY

Depending on the repair required the safety equipment should be appropriate to the task. Hand tool repairs require glove and eye protection. If power tools are deployed, additional PPE shall be required.

3.2.2 EQUIPMENT REQUIRED



- wire brush
- spatula/file
- hammer/chisel
- power grinder
- touch up paint (possible)

3.2.3 PROCEDURE

STEP 1

Identify the material in the groove.

STEP 2

If the material is dirt or sand, remove with a wire bush or spatula.

If the material will not dislodge it may be necessary to use a hammer and chisel.

For excessive paint, a spatula is recommended.

If the material is metal, use of a grinder is required. Grind the metal until it matches the height of the surrounding metal

STEP 3

If bare metal is present recoat the surface following the procedures in Section 4 for zinc coated pipes or Section 6.2 for polyurethane coated pipes.

4 External Coating Repair

The following section provides details on when and how to repair damaged external coating. Special DI pipes can also be supplied with polyethylene or polyurethane coating, however repairs of these coatings is not covered in this document.

Please consult SAINT-GOBAIN PAM or local distributor in the case of more significant damage.

4.1 Coating Description

SAINT-GOBAIN PAM ductile iron pipes are plasma arc sprayed with zinc or zinc and aluminium alloy (referred to as ZINALIUM) over which a coating of synthetic resin or acrylic is applied to complete the corrosion protection system for the pipe.

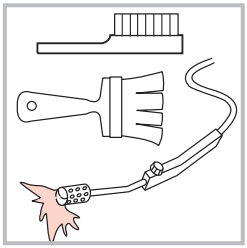
This coating system provides adequate protection to the pipe even if there is slight damage to the coating during transportation, however if there is more significant damage to the coating it must be repaired to provide optimal corrosion protection.

4.2 Repair Procedure

4.2.1 SAFETY

If applied in a confined space there must be sufficient ventilation for the paint film to dry and achieve its optimum properties.

Observe any precautions recommended by the paint supplier.

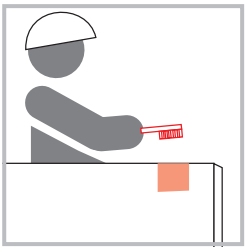


4.2.2 EQUIPMENT REQUIRED

- brush
- paint brushes
- roller
- gas torch
- Zn rich paint
- approprate top coat

4.2.3 PROCEDURE

STEP 1
PREPARE THE SURFACE

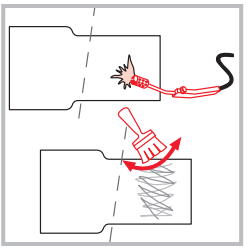


It is best to dry the area being recoated.

In cases of very low temperature, high humidity, or immediate use of the pipe, the pipe must be moderately heated with a gas burner or blowtorch (around 40°C, until just too hot to touch).

Remove dirt with a brush or cloth. Washing may be necessary.

STEP 2
APPLY THE COATING



Apply the product making strokes in different directions to ensure complete coverage.

FOR LIGHT DAMAGE TO EXTERNAL COATING

Definition: the zinc or ZINALIUM is not removed or the width of the damaged area is not greater than 3mm in width.

Apply 1 coat of top coat appropriate for the pipe being repaired.

FOR LARGER DAMAGE TO EXTERNAL COATING

Definition: the zinc or ZINALIUM is removed and the width of the damaged area is larger than 3mm but its surface area does not exceed 1m².

Apply one coat of zinc-rich paint.

- Wait around 30 minutes or until the paint is touch dry.
- Apply one coat of appropriate top coat or pore sealer.
- Wait until pipe is touch dry before proceeding.

5 Internal Coating Repair - CML

SAINT-GOBAIN PAM supplies ductile iron pipes with spun cement mortar linings and on occasions polyurethane (PUR) lining.

These pipes are inspected at works and are dispatched ready for laying, however the pipes may sustain some damage during handling and transport. As with external damage, the pipe can be repaired or rejected depending on the severity of the damage.

This booklet describes appropriate repair methods and defines the limits within which the damage is tolerable and can be considered as repairable. It covers the repair of:

- cement mortar linings: Portland, sulphate resisting, blast furnace and calcium aluminate cement mortar linings (CAC);
- polyurethane linings.

Please consult SAINT-GOBAIN PAM or local distributor in the case of significant damage.

5.1 Cement Mortar Lining

The cement mortar lining in ductile iron pipes is applied to the interior by spinning at the pipe plant. It is a solid lining which withstands the normal pipe handling and transport stresses.

Like all cement mortars, the lining undergoes reversible expansions and contractions, which arise from variations in the humidity and ambient temperature. Superficial crazing or cracking is inherent in this type of lining, as is some localised indications of poor adhesion. In these situations upon rehydration of the cement when the pipe is filled with water, the cement will swell up and reseal these cracks and voids. Further closure is effected by lime leaching from the cement and depositing in the cracks, this process is known as autogeneous healing.

Features in the cement lining which are considered "normal" and not needing repair are detailed in Australian Standard AS 2280, European Standard EN 545 and International standard ISO 4179. A summary of the relevant section of these standards is provided in Appendix A.

5.1.1 CEMENT MORTAR REPAIR CRITERIA

As opposed to the above inherent features in the cement lining which are considered acceptable (discussed in the previous section), some defects or damage may be repairable (Appendix A). Repairable damage of the cement lining can be the result of:

- damage as a result of rough handling of the pipes;
- more significant cement lining defects not repaired before shipping;

If damage or lining defect is detected the follow evaluation is made:

- to be repairable, the damage or defect must not exceed a set area and number per pipe as detailed in Table 6;
- if the lining is damaged or defective beyond the limits set in Table 6, and is contained within the spigot area, the damaged section of the spigot can be cut off as detailed in Section 2.2,
- if the damage is confined to the surface grey laitance layer (1-3mm), the area that can be repaired is double that detailed in Table 6.

Table 6. Maximum repair criteria for varying pipe diameters

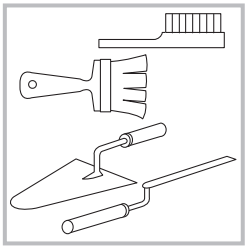
Pipe Diameter	Maximum Area per Repair cm^2	Maximum Number of Repairs per Pipe
DN 100 to DN 150	100	3
DN 200 to DN 300	150	3
DN 350 to DN 500	200	3
DN 600 to DN 900	250	3
DN 1000 to DN 2000	1000	4

5.2 Cement Mortar Repair Procedure

Cement mortar lining repairs must be performed during frost free periods.

5.2.1 SAFETY

Eye protection is required when removing cement lining. Follow manufacturer's recommendation for cement repair material.



5.2.2 EQUIPMENT REQUIRED

- wire brushes
- paint brushes
- trowel
- mortar board
- repair products

5.2.3 PROCEDURE

STEP 1
REMOVAL OF DAMAGED OR DEFECTIVE LINING

As far as possible, turn the specimen so that the area for repair is facing up.

Remove the damaged area, including one or two centimetres of sound coating, by means of a hammer and chisel.

The edges of the area removed must be perpendicular to the iron casting surface.

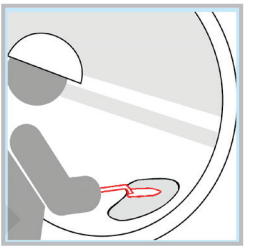
Clean area with a wire brush to remove all non-adherent material (cement, rust, etc).

REMOVAL OF LOOSE GREY LAITANCE LAYER

As far as possible, turn the specimen so that the area for repair is facing up.

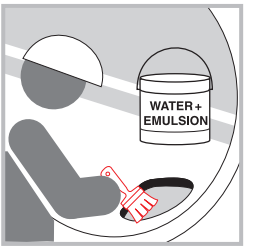
Remove any loose material that can be easily dislodged with a knife or blade.

Clean with a wire brush to remove all non-adherent material.



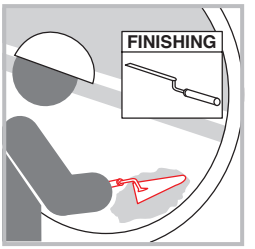
STEP 2
APPLICATION OF THE PATCH

Wet the area to be repaired with water and emulsion solution. Wet around the edges of the area to be repaired a few minutes before making repairs.



Prepare the mix ensuring correct mix ratios for cement. Recommended products include 'Eziline' or Ardex WMP 300.

Apply the mortar ensuring compaction.



Build up the thickness of cement until it matches the level of the original lining.

Smooth the repaired surface with a palette knife (or sleeker) so that it matches the surface finish of the surrounding surface. If required, smooth surface with sandpaper once cement is partially cured.

Cover with a damp cloth to enhance the curing.

6 Internal Coating Repair - PUR

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- cement mortar linings: Portland, sulphate resisting, blast furnace and calcium aluminate cement mortar linings (CAC);
- polyurethane linings.

Please consult SAINT-GOBAIN PAM or local distributor in the case of significant damage.

6.1 Polyurethane Lining

In more demanding water or sewerage applications, pipes internally coated with two part polyurethane (PUR or PH1) can be supplied. This lining is extremely durable and can withstand all types of water and sewage. Damage of this lining is rare, however it can occur on the spigot end. Repair of the lining is detailed in the procedure outlined in 6.2.

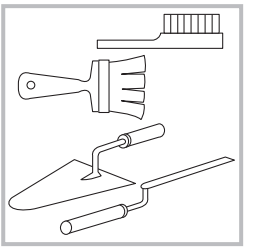
The repair paint is a two component system. It is important to follow the mixing ratios indicated by the manufacturer and stir until the paint is thoroughly mixed before application. Allow sufficient time for the paint to cure before using the pipe.

6.2 PUR Repair Procedure

6.2.1 SAFETY

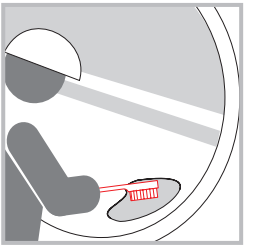
Follow safety requirements recommended by the coating supplier.

6.2.2 EQUIPMENT REQUIRED



- brush
- paint brushes
- spatula
- gas torch
- refer to pipe supplier for correct coating

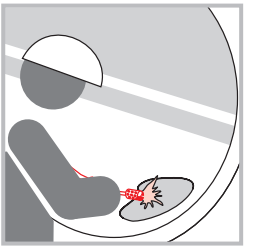
6.2.3 PROCEDURE



STEP 1
PREPARE THE AREA

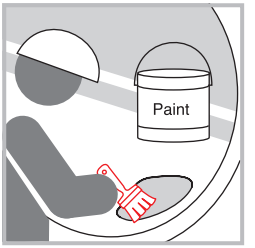
Eliminate any loose parts with a wire brush or spatula.

Clean thoroughly.



Dry the surface to be coated. Note that in case of low temperatures or high humidity, it may be necessary to dry with a gas torch.

STEP 2
APPLY THE COATING



Apply the epoxy paint with a paint brush or spatula.

Apply in two directions to achieve complete coverage.

Allow to dry completely before using.

A Appendix

FROM AS 2280 (Full extract can be found in Standard)
D8 - REPAIR OF DEFECTS

The standard defines the following as defects:
- Voids
- Sand and clay pockets
- Blisters

Areas that are thin or drummy, excessively cracked or not in contact with the surface of the pipe or fitting

Cracks are considered defects when a 0.8mm thick flat metal feeler gauge can be inserted into it to a depth greater than half the thickness of the lining. Superficial cracks and cracks less than 0.8mm are not defects but are a normal feature of cured cement (These cracks will seal by autogenous healing when the cement is rehydrated).

The defects should be repaired as soon as practicable and to the full thickness by removing the loose or defective material and applying cement.

FROM EN545 (Full extract can be found in Standard)

4.6.3.3 THICKNESS AND SURFACE CONDITION

Table 7 shows the nominal thickness and tolerance of the cement mortar lining when measured using the procedure detailed in Section 6.8 of this Standard.

While the surface of the cement mortar lining should be generally uniform and smooth, trowel marks, protrusion of sand grains and some surface texture is normal for cement linings and is acceptable. No defect can reduce the thickness of the cement to below the minimum value in Table 7.

The cement surface can contain fine crazing and hairline cracks which are associated with cement rich surfaces of dry linings. Shrinkage cracks may also develop which is normal for cement bound materials. After the cement has cured, the width of the crack should not exceed the amount shown in Table 7.

▼ Table 7. Thickness of cement mortar lining

DN	Thickness		Maximum crack width and radial displacement mm
	Nominal value mm	Limit deviation* mm	
40 to 300	4	-1.5	0.4
350 to 600	5	-2.0	0.5
700 to 1200	6	-2.5	0.6
1400 to 2000	9	3.0	0.8

*The lower limit only is given.

Note that if pipes are stored in a hot, dry environment it can cause metal expansion and mortar shrinkage which can result in the lining disbonding from the metal in areas and shrinkage cracks exceeding the width in Table 7. This is not a defect as when the lining is re-exposed to water, it will swell by absorption of moisture and the disbondment and cracks will close to conform to Table 7 and will eventually heal by an autogenous process.

EXTRACT FROM ISO 4179 (Full extract can be found in Standard)
SURFACE CONDITION OF HARDENED LINING

While the cement mortar lining should exhibit a generally smooth finish, however, due to the cement application process, some surface textures e.g. orange peel effects, are acceptable provided that they do not reduce the thickness of the lining to less than the minimum value specified in Table 8. Only firmly embedded sand grains are allowed to appear on the surface of the lining.

When the cement lining is applied centrifugally a thin laitance and cement rich layer, which is comprised of fine sand and cement, may be formed on the inner surface of the lining. It can extend up to a quarter of the total thickness of the lining.

Table 8. Thickness of cement mortar lining

DN Group	DN	Lining thickness		Maximum crack width and radial displacement (potable water)	Minimum crack width (partially filled sewerage pipelines)
		Nominal	Min at one point		
		mm	mm	mm	mm
I	40 to 300	3	2	0.8	0.6
II	350 to 600	5	3	0.8	0.7
III	700 to 1200	6	3.5	1	0.8
IV	1400 to 2000	9	6	1.2	0.8

Notes

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SGPREP1505.1