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Ductile iron pipes and fittings for pressure and non-pressure pipelines — Cement mortar lining

Tuyaux et raccords en fonte ductile pour canalisations avec et sans pression — Revêtement interne de mortier de ciment

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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 4179 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

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This third edition cancels and replaces the second edition (ISO 4179:1985), which has been technically revised.

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Ductile iron pipes and fittings for pressure and non-pressure pipelines — Cement mortar lining

1 Scope

This International Standard specifies the nature, the method of application, the surface condition and the minimum thickness of internal linings of cement mortar for ductile iron pipes and fittings for pressure and non-pressure pipelines as defined in ISO 2531 and ISO 7186.

It covers cement mortar linings which are used to improve the hydraulic properties of pipes and fittings compared to un-lined pipes and fittings and/or to prevent corrosion damage and includes special requirements for linings of gravity sewers operating partially filled.

It also covers linings used for the conveyance of particularly aggressive fluids, where the following solutions may be used either separately or in combination:

a) an increase in the thickness of the lining;

b) a change of the type of cement;

c) a coating over the lining.

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2 Normative references

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The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2531:1998, *Ductile iron pipes, fittings, accessories and their joints for water or gas applications*

ISO 7186:1996, *Ductile iron products for sewage applications*

ISO 16132, *Ductile iron pipes and fittings — Seal coats for cement mortar linings*

3 Materials

3.1 Cement

The cement used for the lining shall comply with the cement standard(s) in application in the country of pipe manufacture.

Unless otherwise specified, the type of cement shall be selected by the manufacturer in order to be suitable for the nature of the fluid to be transported, with due consideration to ISO 2531:1998, Annex B, and ISO 7186:1996, Annex B.

3.2 Sand

The sand used shall have a controlled granulometric distribution from fine to coarser elements; it shall be clean and shall be composed of inert, hard, strong and stable granular particles. The granulometric curve for the sand shall be appropriate to the lining method, the lining thickness and the surface conditions required in Clause 6.

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Sampling shall be carried out in accordance with national standards for the testing of construction materials.

The cleanliness of the sand shall be evaluated in terms of organic impurities and clay-bearing substances according to the methods described below.

The test for organic impurities shall be carried out by a colorimetric method in accordance with the standards in force in the producing country; the sand shall not produce any coloration darker than that of the reference solution.

The determination of the content of clay-bearing substances in the sand (having dimensions less than 63 μm to 90 μm depending on the country) shall be carried out in accordance with the standards in force in the producing country; it shall not exceed 2 % by mass.

3.3 Mixing water

The water used for the preparation of the mortar shall be either potable water or water free from substances deleterious either to the mortar or to the water to be transported in the pipeline. The presence of solid mineral particles is, however, admissible provided that these requirements are still fulfilled. Existing national hygienic requirements have to be complied with.

3.4 Mortar

The fresh mortar of the lining shall be composed of cement, sand and water complying with 3.1, 3.2 and 3.3 respectively.

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Additives may be used, provided that

— they do not prejudice the quality of the lining and that of the transported water,

— the lining remains in accordance with all the requirements of this International Standard, and

— they comply with the hygienic requirements of the country where the pipes and fittings are to be installed.

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The mortar shall contain at least one part of cement to 3,5 parts of sand by mass (i.e. S/C ⩽ 3,5 by mass in the mortar).

The respective proportions of sand and water to cement (S/C and W/C) shall be selected and controlled by the manufacturer in order to achieve compliance with this standard. The methods of determination of the ratios S/C and W/C shall be specified by the manufacturer.

4 Application of lining

4.1 Condition of interior surface of pipe before application of lining

All foreign bodies, loose scale or any other material which could be detrimental to good adhesion between the metal and the lining shall be removed from the surface to which the lining shall be applied.

The inner surface of the pipe and fitting shall also be free of any metal projections likely to protrude beyond 50 % of the thickness of the lining.

4.2 Method of application

The mortar shall be thoroughly mixed in order to achieve the appropriate consistency and homogeneity.

For pipes, the mortar is centrifugally cast inside the pipes or projected onto the wall by means of a rotating projection head or using a combination of both methods depending on the manufacturer's decision. For fittings, the mortar is projected onto the wall by means of a rotating projection head, or may be placed by hand using appropriate trowels.

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Apart from the inner surface of the socket, the parts of the pipe or fitting coming in contact with the transported water shall be entirely covered with mortar.

The consistency of the mortar, the time and the speed of centrifugation, and the speeds of rotation and translation of the projection head shall be controlled so as to achieve a dense and continuous lining. The mortar shall be free of any cavities or visible air bubbles, so that minimum thickness and optimum density are ensured at all points.

4.3 Curing

The fresh lining shall be cured at temperatures greater than 0 °C. Any loss of water from the mortar by evaporation shall be sufficiently slow that hardening is not impeded. This may be achieved, for example, by means of controlled atmosphere, closed pipe ends or by application of a seal coat to the still moist lining.

The curing conditions shall be such as to achieve sufficient hardening of the lining and compliance with the requirements of Clause 6.

4.4 Seal coat

Unless otherwise specified, the manufacturer has the option of providing or not providing a seal coat. The seal coat shall not affect adversely the quality of the transported water. For water intended for human consumption, national hygienic requirements in force in the country where the pipes and fittings are to be installed shall be fulfilled.

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When a seal coat is supplied, it shall be in accordance with ISO 16132.

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4.5 Repairs

Repairs to damaged or defective areas are allowed. They should be carried out according to the manufacturer's instructions. The damaged mortar shall first be removed from these areas. Then the defective part shall be repaired by using, for example, a trowel with fresh mortar so that a continuous lining having a constant thickness is again obtained.

For the repair operation, the mortar shall have a suitable consistency; if necessary, additives may be included to obtain good adhesion against the side of the existing undamaged mortar.

Sufficient curing shall be provided to the repaired areas.

5 Thickness of lining

5.1 Thickness requirements

The nominal thickness of the lining and the minimum thickness at one point are given in Table 1. The lining thickness measured at any one point in the pipe shall not be smaller than the minimum value given in Table 1.

For partially filled sewage pipelines, by agreement between manufacturer and purchaser, the lining thickness may be increased, and/or high alumina cement mortar, polymer-modified mortar or suitably coated mortar may be used.

At the pipe ends, the lining may be reduced to values below the minimum thickness. The length of the chamfer shall be as small as possible but, in any case, shall be less than 50 mm.

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Table 1 — Thickness of cement mortar lining

DN group	Nominal size DN	Lining thickness nom.	Lining thickness min. at one point	Maximum crack width and radial displacement (potable water)	Maximum crack width (partially filled sewage pipelines)
		mm	mm	mm	mm
I	40	3	2	0,8	0,6
	50				
	60				
	65				
	80				
	100				
	125				
	150				
	200				
	250				
	300				
II	350	5	3	0,8	0,7
	400				
	450				
	500				
	600				
III	700	6	3,5	1	0,8
	800				
	900				
	1 000				
	1 100				
	1 200				
IV	1 400	9	6	1,2	0,8
	1 500				
	1 600				
	1 800				
	2 000				
V	2 200	12	7	1,5	0,8
	2 400				
	2 600				

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5.2 Determination of lining thickness

The thickness of the lining is checked on the freshly applied mortar by the insertion of a steel pin, or on the hardened mortar by means of a non-destructive method of measurement.

The thickness of the lining shall be measured at both ends of the pipe in at least one section perpendicular to the pipe axis.

In each section, which shall be at least 200 mm from the pipe end, measurements shall be taken at four points spaced at 90° intervals.

The values for the thickness of the lining shall be reported to the nearest 0,1 mm.

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6 Surface condition of hardened lining

The cement mortar lining shall exhibit a generally smooth finish on its entire surface. However, the structure of the lining and its surface finish are related to the lining process; surface textures inherent in the method of manufacture (e.g. orange peel effects) shall be acceptable provided that they do not reduce the thickness of the lining to less than the minimum value at one point as specified in Table 1. Only firmly embedded sand grains are allowed to appear on the surface of the lining.

For centrifugally applied linings, a thin laitance and cement rich layer, comprising fine sand and cement, may be formed on the inner surface of the lining. It may extend up to approximately one-quarter of the total thickness of the mortar.

Due to the complex internal shape of the fittings and to the application process (rotating projection head), the lining of fittings may show a corrugated surface provided that it does not reduce the thickness of the lining to less than the minimum value at one point as specified in Table 1.

NOTE 1 It is known that the surface condition has very little effect on the hydraulic characteristics, the main factors being the effective internal diameter of the pipes and the shape of the fittings.

On contraction of the lining, the formation of cracks and radial displacements cannot be avoided (see Figure 1). These cracks and radial displacements, together with other isolated cracks which may result from manufacture or may develop during transportation, are acceptable if their width does not exceed the values in Table 1. Cracks shall not be detrimental to the mechanical stability of the lining.

NOTE 2 It is known that these cracks and radial displacements will close and heal when the lining comes into contact with water due to re-swelling of the lining and continued hydration of the cement.

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For partially filled pipelines, crack widths and radial displacements shall not exceed the values given in Table 1, column “partially filled sewage pipelines”.

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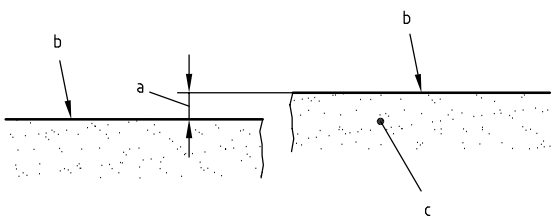
Hollow areas, which are detectable by acoustic means (knocking), are related to the shrinkage of the lining in hot and dry climates and are acceptable.

NOTE 3 It is known that these hollow areas will disappear when the lining comes into contact with water.



[a] Radial displacement.

[b] Bore of lining.

[c] Cement mortar lining.

Figure 1 — Radial displacement caused by cracking of cement mortar lining

7 Test conditions

7.1 General

The various checks specified in this International Standard shall be carried out according to the manufacturer's quality plan, taking account of the following conditions.

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