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Restrained joint systems for ductile iron pipelines — Design rules and type testing

Assemblages verrouillés pour canalisations en fonte ductile — Règles de conception et essais de type

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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.

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ISO 10804 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 2, *Cast iron pipes, fittings and their joints*.

This first edition of ISO 10804 cancels and replaces ISO 10804-1:1996, of which it constitutes a technical revision.

Restrained joint systems for ductile iron pipelines — Design rules and type testing

1 Scope

This International Standard specifies the design rules and type testing for restrained joint systems to be used on ductile iron pipelines complying with ISO 2531 and ISO 7186, in order to determine their mechanical properties and leaktightness.

2 Normative references

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, *Ductile iron pipes, fittings, accessories and their joints for water applications*

ISO 6708, *Pipework components — Definition and selection of DN (nominal size)*

ISO 7186, *Ductile iron products for sewage applications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6708 and the following apply.

3.1
restrained joint
joint in which a means is provided to prevent separation of the assembled joint

3.2
allowable operating pressure
PFA
maximum internal pressure, excluding surge, which a component can safely withstand in permanent service

3.3
allowable maximum operating pressure
PMA
maximum internal pressure, including surge, which a component can safely withstand in service

3.4
allowable site test pressure
PEA
maximum hydrostatic pressure that a newly installed component can withstand for a relatively short duration, when either fixed above ground level or laid and backfilled underground, in order to measure the integrity and tightness of the pipeline

NOTE This test pressure is different from the system test pressure, which is related to the design pressure of the pipeline.

3.5
type test
proof-of-design test which is performed once and repeated only after change of design

3.6
allowable angular deflection
angular deflection that a joint between two components can safely withstand in service under the allowable operating pressure (PFA)

4 Design rules

4.1 All restrained joints for ductile iron pipes, fittings and other components shall be designed in accordance with this clause. If the design of a restrained joint has been tested and successfully used for a minimum of ten years, a type test as described in Clause 5 is only required for a significant change in the design which could adversely affect the performance of the restrained joint.

4.2 The minimum thickness of the spigot for restrained joints shall be such as to allow any necessary welding or loading from attachments (e.g. gasket teeth). This may result in pipe thicker than the corresponding pressure class thickness of the pipe. The manufacturer shall declare the pipe thickness for his restrained joints.

4.3 The design safety factors with respect to failure against axial forces due to internal pressure shall be such that the joints shall withstand a type test of 1,5 times the allowable operating pressure (PFA) plus 5 bar (5×10^5 Pa)[1)].

4.4 The joints shall be type tested to a negative pressure of 0,9 bar (9×10^4 Pa) below atmospheric pressure [approximately 0,1 bar (10^4 Pa) absolute pressure]. When the restraining mechanism and sealing component of a restrained joint are independent, such a joint does not need to be subjected to a negative internal pressure test if the unrestrained version of the joint has passed this test (see ISO 2531).

4.5 The joints shall be type tested to a cyclic internal hydraulic pressure as follows:

a) 24 000 cycles;

b) test pressure of between PMA and PMA less 5 bar.

4.6 Ductile iron pipelines and the restrained joints defined in this International Standard are well suited for use in seismic zones. However, certain locations such as fault crossings, liquefaction zones and connections to structures require specialized designs. The pipe manufacturer or a competent earthquake engineer should be consulted.

4.7 For joint restraint components, the protection against aggressive soils shall be at least as good as that of the pipes and/or fittings. It may be achieved by means of works-applied coatings and/or site-applied protection systems.

5 Type testing

5.1 General

Each restrained joint design shall be tested in order to demonstrate its mechanical strength and its leaktightness under the most unfavourable condition of casting tolerances and joint movements.

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1) 1 bar = 10^5 Pa = 0,1 MPa = 0,1 N/mm^2 = 10^5 N/m^2.

The type tests shall be carried out in the configuration of maximum design radial gap between the components to be jointed (smallest spigot together with largest socket). In addition, the spigot thickness shall be the minimum casting thickness $^{+10}_{0}$ %. The length of the minimum thickness of the spigot for the type test shall be such as to include any welding and/or attachments for that joint. It is permissible to machine the spigot end of the test pipe in the bore to achieve the required thickness.

In the type tests, the maximum gap shall not be less than the corresponding maximum design radial gap by more than 5 % or 0,5 mm (whichever is the smaller). The internal socket diameter may be machined to achieve this.

5.2 Test conditions

There shall be a type test for at least one DN in each of the groupings given in Table 1, normally using the preferred DN. One DN is representative of a grouping when the performances are based on the same design parameters throughout the size range.

Table 1 — DN groupings for type tests

DN grouping	40 to 250	300 to 600	700 to 1000	1100 to 2000	> 2000
Preferred DN	200	400	800	1600	2400

If a grouping covers products of different design and/or manufactured by different processes, the grouping shall be subdivided. If, for a certain manufacturer, a grouping contains only one DN, this DN may be considered part of the adjacent grouping provided it is of identical design and manufactured by the same process.

Each diameter tested shall be subjected to the following conditions:

a) joint assembled in the aligned position, then deflected to the allowable angular deflection indicated in the manufacturer's instructions, and tested while maintained in the deflected position;

b) joint assembled in the aligned position, then subjected to a load giving a resultant shear force across the joint of not less than 30 times DN (expressed in newtons), and tested under shear.

Joint assemblies shall exhibit no visible leakage and no mechanical instability after 2 h under the following pressures:

— hydrostatic pressure according to 4.3;

— negative internal pressure according to 4.4;

— cyclic internal hydraulic pressure according to 4.5.

In addition, any axial movement that may occur at the joint shall reach a constant value within the 2 h.

5.3 Test method for positive internal pressure

The test apparatus shall be capable of providing suitable end closure whether or not the joint is in the aligned position, deflected or subjected to a shear load. The apparatus shall be equipped with a pressure gauge with an accuracy of ±3 %.

Testing shall be carried out on an assembled joint comprising two pipe sections, each at least 1 m long.

For the test according to 5.2 b), the shear load shall be applied to the spigot end by means of a V-shaped block with an angle of 120°, located at approximately 0,5 × DN, in millimetres, or 200 mm from the socket face (whichever is the larger); the socket shall bear on a flat support.

The test assembly shall be filled with water and suitably vented. The test pressure shall be raised at a rate not exceeding 1 bar/s (10^5 Pa/s).

The test pressure shall be kept constant to ±0,5 bar (5×10^4 Pa) for at least 2 h, during which the joint is to be thoroughly inspected and its axial movement measured every 15 min.

5.4 Test method for negative internal pressure

The test assembly and apparatus shall be as given in 5.3, with the pipe sections axially restrained to prevent them moving towards each other.

The test assembly shall be empty of water and shall be evacuated in accordance with 4.4 and isolated from the vacuum pump. The test assembly shall be left under vacuum for at least 2 h, during which the pressure shall not have changed by more than 0,09 bar (9×10^3 Pa). The test shall begin at a temperature between 5 °C and 40 °C. The temperature of the test assembly shall not vary by more than 10 °C for the duration of the test.

5.5 Test method for dynamic (cyclic) internal pressure

The test assembly and apparatus shall be as given in 5.3. The test assembly shall be filled with water and suitably vented of air.

The pressure shall be steadily increased up to PMA, the allowable maximum operating pressure of the joint, and then automatically monitored according to the following pressure cycle:

a) steady pressure reduction to PMA less 5 bar;

b) maintain PMA less 5 bar for at least 5 s;

c) steady pressure increase to PMA;

d) maintain PMA for at least 5 s.

The number of cycles shall be recorded and the test stopped automatically in the occurrence of a failure of the joint. Any axial movement at the spigot shall be measured at the end of the test.

All necessary safety precautions should be taken for the duration of the pressure test.

5.6 Test report

The test report shall contain at least the following:

a) type of joint;

b) size range covered by the test;

c) DN tested;

d) class of pipe tested;

e) allowable operating pressure;

f) maximum allowable operating pressure;

g) allowable test pressure;

h) allowable angular deflection;

i) result of test;

j) date of test.