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Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals

Tubes et raccords en plastiques thermodurcissables renforcés de verre (PRV) — Méthodes d'essai pour confirmer la conception des assemblages mâle-femelle verrouillés, y compris ceux à double emboîture avec joints d'étanchéité en élastomère

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 6, *Reinforced plastics pipes and fittings for all applications*.

This third edition cancels and replaces the second edition (ISO 7432:2018), which has been technically revised.

The main changes compared to the previous edition are as follows:

— addition of the bending test (Method A), which was already included in ISO 7432:2002.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

In a pipework system, pipes and fittings of different nominal pressures and nominal stiffnesses may be used. A joint may be made between pipes and/or fittings and should be designed such that its performance is equal to or better than the requirements for the pipeline, but not necessarily for the components being joined.

The requirements for the assembly of the joint are not included in this document, but they should be in accordance with the manufacturer's recommendations.

Material-dependent parameters and/or performance requirements are stated in the relevant standard.

Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of locked socket-and-spigot joints, including double-socket joints, with elastomeric seals

1 Scope

This document specifies methods of test for joints with a locked socket and spigot, including double-socket joints, and with elastomeric seals, for buried and above-ground glass-reinforced thermosetting plastics (GRP) piping systems.

It covers methods of testing for leaktightness and resistance to damage of the joint only, when subjected to specified combinations of angular movement, compression (deformation) perpendicular to the pipe axis and internal pressure. It assumes that the joint will be exposed to the effects of hydrostatic end thrust.

The tests detailed in 9.2, 9.3, 9.4 and 9.6 are applicable to joints with a locked socket and spigot, including double-socket joints, and with elastomeric seals intended to be used in buried or above-ground applications.

The bending tests detailed in 9.5 can be used to prove the design where joints are either intended to be used in buried applications or are intended to be used in particular above-ground situations, where the tests can be considered appropriate.

With the exception of the procedure detailed in 9.5, these test procedures are applicable to joints for pipes and fittings of all nominal sizes. The tests detailed in 9.5 are applicable to joints for pipes and fittings up to and including DN 600. The tests are applicable for evaluating joints intended for applications conveying liquids at temperatures specified in the referring standards.

The test procedures in this document are damaging to the test piece, which will not be suitable for reuse after these tests. The test procedure is intended for type testing purposes.

This document is applicable only to the joint and specifies methods of testing to prove its design.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
pressure
hydrostatic gauge pressure

Note 1 to entry: Expressed in bar.

3.2
bending
beam bending in the pipe and joint configuration as a result of a transverse force on the joint

3.3
deformation
pipe deformation in the coupling as a result of a vertical force on the pipe and a supported coupling causing a step between the two pipe spigots at the loading position

4 Principle

A test piece comprising two pieces of pipe jointed together, by incorporation of a socket or inclusion of a double-socket coupler, is subjected to specified load conditions, including combinations of bending and deformation. In each specified combination the test piece is subjected to a series of test pressures for specified periods of time, including an internal sub-atmospheric test pressure. This also simulates an external positive pressure.

The procedure includes prolonged static tests at elevated pressures and cyclic testing to prove the structural design of the joint.

A joint is subjected to a specified internal negative pressure. This also simulates an external positive pressure.

Two methods are specified for the arrangement in 9.5, Method A and Method B. Method A is the default method. Method B shall be applied on request by the purchaser.

When under pressure, the joint is monitored for leakage. After each test condition (see Table 1) the joint is inspected for signs of damage.

In addition, a test at elevated positive static pressure is conducted to prove the structural design of the joint (see Table 1 and 9.6).

NOTE The only reason for testing the joint for resistance to negative pressure is to ensure adequate safety against infiltration of pollutants through the joint into the fluid carried in the piping system. Under the test conditions used, pipes with low stiffness can require support to prevent buckling.

It is assumed that the following test parameters are set by the standard making reference to this document:

— the nominal size of the components to be connected by the joint;

— the pressure class of the components;

— the total effective length, L, of the test piece;

— the number of test pieces;

— if applicable, the conditioning to be applied;

— the test temperature;

— the sequence of testing, if appropriate;

— the test configuration;

— the deformation and bending forces, F_A or F_B;

— the permissible change in negative pressure.

In all of these arrangements, a joint of the same size and design shall be used. The same test piece may be used for more than one test procedure, providing it is undamaged and of sufficient size to enable the test conditions to be achieved.

5 Apparatus

5.1 End-sealing devices

The end sealing devices shall be of sizes and types appropriate to the components under test. The end-sealing devices shall be securely fixed to the pipes to transmit the end thrust loads to the pipes.

5.2 Supports

5.2.1 **Straps or cradles**, for use as follows:

a) a **support R** of sufficient width, typically 150 mm (item 6 in Figure 2), positioned at least 500 mm from the spigot end of the pipe at the point of balance to provide support during testing with deformation (see 9.3 and 9.4);

b) a **strap or cradle** (100 ± 5) mm wide (item 7 in Figure 2), supporting at least a 120° arc of the socket, as required for deformation testing (see 9.3 and 9.4);

c) a **strap or cradle** (100 ± 5) mm wide, supporting an arc up to 180° of the pipe barrel, positioned adjacent to the end of the joint being tested (item 5 in Figure 2) and through which the force F1 necessary for deformation testing (see 9.3 and 9.4) can be applied;

d) a **strap or cradle** (100 ± 5) mm wide, supporting an arc up to 180° of the pipe barrel, positioned in the middle of the joint being tested (item 6 in Figure 3, item 5 in Figure 4) and through which the force, F_A or F_B, necessary for the bending test (see 9.5) can be applied;

e) **supports** of sufficient width, typically 150 mm, to carry the pipe components of the test piece (item 3 in Figure 2) and designed in such a way that they allow deformation to occur.

The straps or cradles shall not have a detrimental effect on the test piece, e.g. by applying point loads.

5.2.2 Special supports

Special supports shall be used if necessary to prevent buckling of the pipe barrel during deformation (see 9.3 and 9.4) or negative pressure (9.2) testing. Such supports shall be positioned in such a way that they do not affect the force, F_1, applied to the joint or the joint's response to such a load.

5.3 Source of hydrostatic pressure

The source of hydrostatic pressure shall be capable of applying the required pressures including, as necessary, pressure cycle controls.

5.4 Pressure gauges

Pressure gauges shall be capable of measuring the positive and negative pressures. The gauges shall be calibrated to an accuracy of ±2 % of the value to be measured.

5.5 Vacuum pump

The vacuum pump shall be capable of producing the required negative gauge pressure (see 9.2).

5.6 Means of applying and measuring the required deformation and bending forces

The means of applying the required deformation forces F_1 (see 9.3 and 9.4) and bending forces F_A (see 9.5.2 and Annex A) or F_B (see 9.5.3 and Annex B) shall be calibrated to an accuracy of ±5 % of the value to be measured.

6 Test pieces

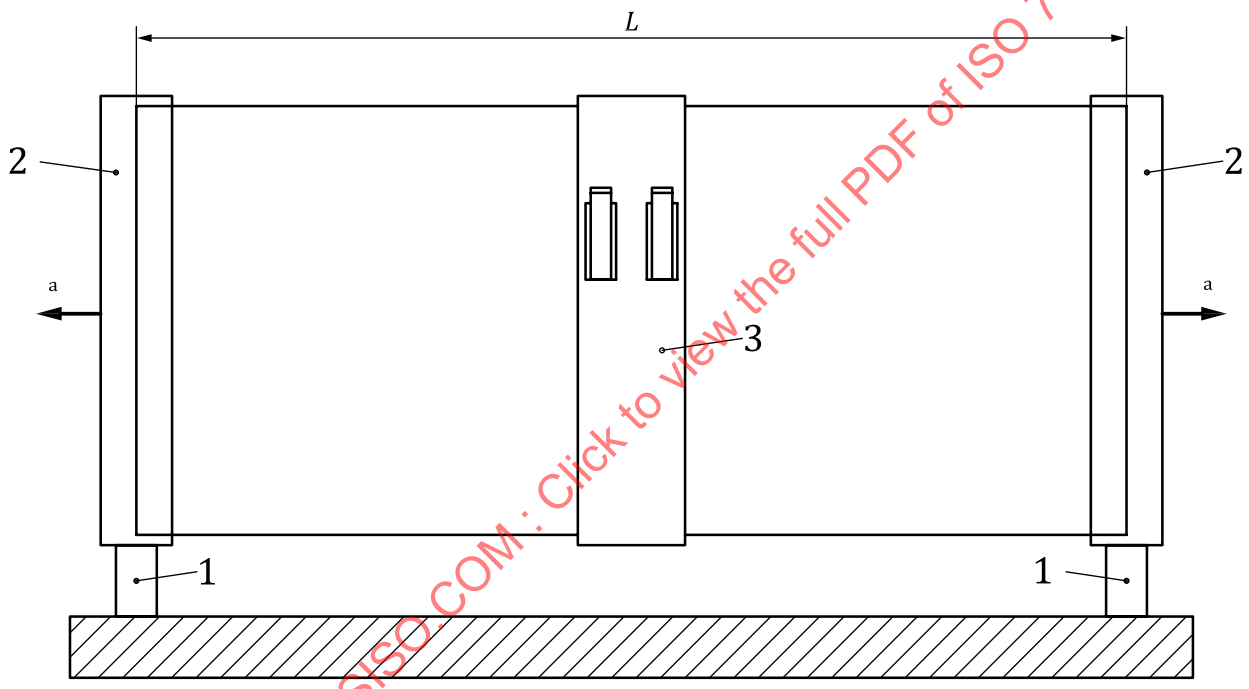
6.1 General

The test piece shall comprise an assembly of two pieces of pipe of the size and pressure class, as specified in the referring standard, between which the joint to be tested is located. In some cases, it can be desired to test a transition coupling capable of jointing two different nominal pipe sizes. In such a case both sides of the transition coupling shall satisfy the test requirements.

6.2 Test arrangement for tests detailed in 9.2 and 9.6

For the tests detailed in 9.2 and 9.6, the arrangement shall be as shown in Figure 1.

The total effective length, L, of the assembly shall be not less than specified in the referring specification for pressure test pieces and shall allow, if required, the joint under test to be located in the middle of the test arrangement.



Key

1 support (if required)
2 end-sealing device fixed to test piece
3 test joint
a Thrust transmitted to test piece (will be negative in leaktightness test specified in 9.2).
L total effective length

NOTE The arrangement can be used either horizontally (as shown) or vertically.

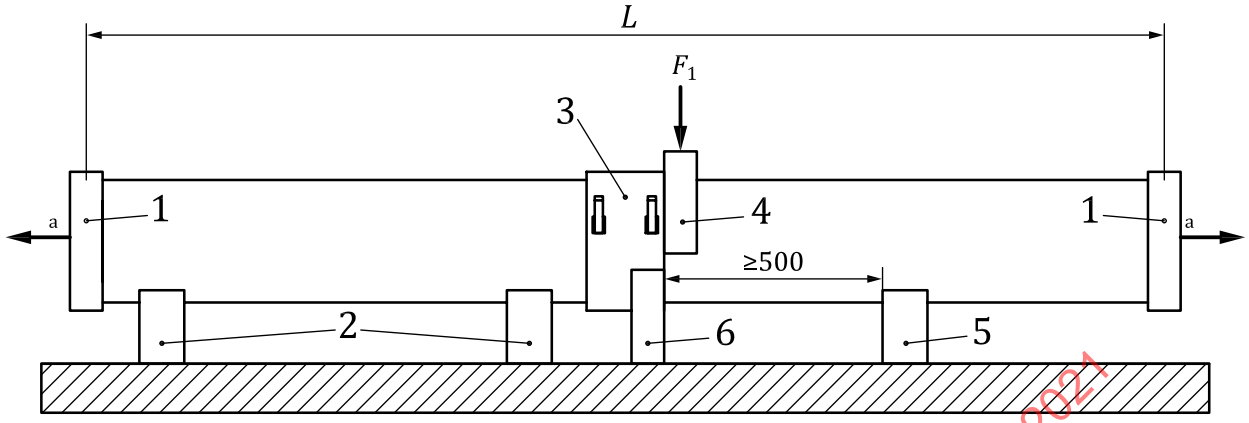
Figure 1 — Test arrangement for the tests detailed in 9.2 and 9.6

6.3 Test arrangement for tests detailed in 9.3 and 9.4

For the tests detailed in 9.3 and 9.4, the arrangement shall be as shown in Figure 2.

The total effective length, L, of the assembly shall be not less than specified in the referring specification for pressure test pieces and shall allow, if required, the joint under test to be located in the middle of the test arrangement.

Dimensions in millimetres



Key

1	end-sealing device fixed to test piece	6	strap or cradle [see item b) in 5.2.1]
2	support [see item e) in 5.2.1]	a	Thrust transmitted to test piece.
3	test joint	F_1	force to be applied
4	strap or cradle [see item c) in 5.2.1]	L	total effective length
5	support R [see item a) in 5.2.1]		

Figure 2 — Test arrangement for tests detailed in 9.3 and 9.4

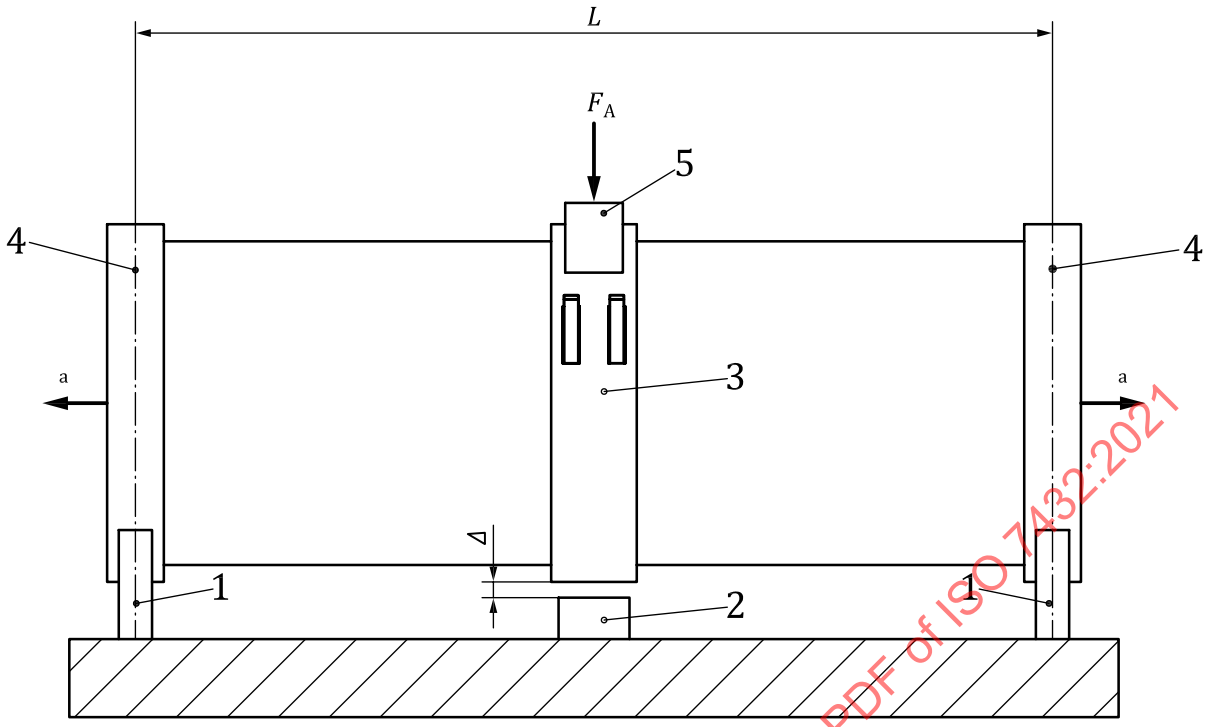
6.4 Test arrangement for tests detailed in 9.5

Two methods are provided for the arrangement in 9.5: Method A and Method B. Method A is the default method (see Clause 4).

The test arrangement for Method A and Method B are shown in Figure 3 and Figure 4 respectively. Details for Method A are given in Annex A, details for Method B are given in Annex B.

The joint shall be assembled in accordance with the manufacturer's recommendations.

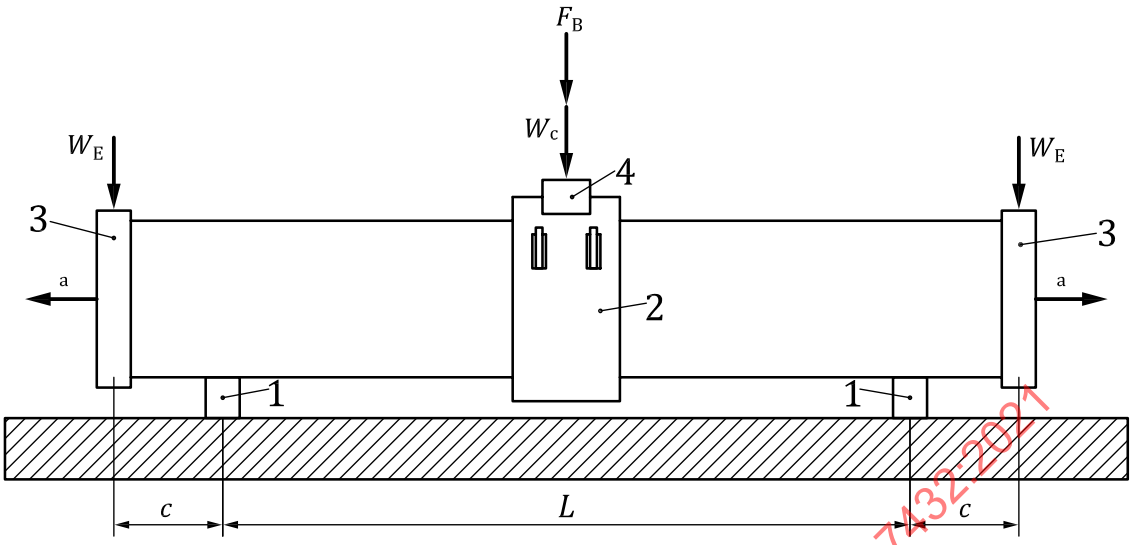
For the bending tests shown in Figure 3 and Figure 4, the length of pipe between the end closure and the joint, which is positioned in the middle, shall be maximum 8 m, but at least 3 times DN, with a minimum of 0,5 m.



Key

1	support	a	Thrust carried by test piece.
2	stop	L	support distance
3	test joint	F_A	additional force (if required)
4	end-sealing device fixed to test piece	Δ	limiting deflection at mid-span
5	support or cradle for the application of force F_A		

Figure 3 — Typical test arrangement for the test detailed in 9.5, Method A



Key

1	support	F_B	bending force to be applied
2	test joint	W_E	weight of the end sealing device
3	end sealing device	W_C	weight of the joint
4	strap or cradle for the application of force F_B [see item d) in 5.2.1]	L	distance between the centre of the supports
a	Thrust transmitted to the test piece.	c	distance between the centre of the support and the centre of the end sealing device

NOTE Dimensional requirements and limits for the test arrangements are detailed in 6.1.

Figure 4 — Typical test arrangement for the test detailed in 9.5, Method B

6.5 Number of test pieces

Unless otherwise specified, the number of test pieces shall be one.

7 Conditioning

Unless otherwise specified by the referring standard, following the assembly and filling, the filled test piece shall be conditioned by storing at the test temperature (see Clause 8) for at least 24 h prior to testing until the required temperature is reached (medium and sample).

NOTE Conditioning time is a function of pipe and joint wall thickness, water volume, temperature differential, the film heat transfer coefficient and whether an elevated temperature environment is applied to one or both sides of the specimen.

8 Test temperature

Conduct the procedure described in Clause 9 at the temperature specified in the referring standard.

9 Procedure

9.1 General

Subject a test piece (see 6.1) to the tests given in 9.2, 9.3, 9.4, 9.5, and 9.6. The pressure shall be measured at the top of the pipe. Each reference to hydrostatic pressure specifies an internal pressure, relative to

atmospheric pressure, expressed as multiples of the nominal pressure, PN, that is relevant to the joint under test.

A summary of test conditions for the evaluation of locked socket and spigot joints is shown in Table 1.

Table 1 — Summary of test conditions for evaluating locked socket and spigot joints

Subclause	Test	Pressure sequence	Minimum test pressure	Minimum duration
9.2	Negative pressure	Negative pressure[a]	−0,8 bar (−0,08 MPa)	1 h
9.3	Deformation with internal pressure and end thrust[b]	Initial pressure	1,5 × [PN]	15 min
		Positive static pressure	2 × [PN]	24 h
9.4	Deformation with cyclic pressure and end thrust[b]	Positive cyclic pressure	Atmospheric to 1,5 × [PN] to atmospheric	10 cycles of 1,5 min to 3 min each
9.5, Method A	Resistance to bending with pressure and end thrust	Initial pressure	1,5 × [PN]	15 min
		Positive static pressure	2 × [PN]	24 h
9.5, Method B	Resistance to bending with internal pressure and end thrust	Positive cyclic pressure	Atmospheric to 1,5 × [PN] to atmospheric	10 cycles of 1,5 min to 3 min each
9.6	Resistance to maintained internal pressure and end thrust	Positive static pressure, durability test	2,5 × PN	100 h

[a] Relative to atmospheric pressure, i.e. approximately 0,2 bar (0,02 MPa) absolute.

[b] The pipe deformation in the coupling is a result of a total vertical force, F_1, of 20 N/mm of the nominal size, expressed in millimetres, of the pipe.

NOTE The tests can be conducted in any sequence.

If a test is interrupted, record the fact in the test report and repeat the particular test before carrying on to the next in the series of tests. Failure at the end sealing devices shall not constitute failure of the joint. If the test conditions are invalidated thereby, repeat the affected test, after replacing the end sealing device as necessary.

The samples shall be inspected for damage and leakage (see Clause 9). Where a visual inspection is not possible for security reasons or when the test is performed at elevated temperatures and therefore in enclosed conditioning rooms, actions shall be taken so that leakage can be detected by different methods (e.g. camera inspection, or an electronic detection, colouring of test liquid, etc.).

WARNING — It is necessary to take account of the consequences of failure of the components under pressure and/or vacuum and to contain the test piece or apparatus accordingly. Care should be taken to provide suitable protection from flying objects resulting from catastrophic failure or movement of the test assembly.

9.2 Negative pressure

9.2.1 Assemble the test arrangement as shown in Figure 1, using supports (see 5.2) if appropriate.

9.2.2 Apply vacuum to a negative gauge pressure of at least −0,8 bar (−0,08 MPa) (i.e. absolute pressure of approximately 0,2 bar), seal and leave for at least 1 h.

9.2.3 Measure and record any change in pressure and compare the result with the requirement of the referring standard. Unless otherwise specified in the referring standard, the change in pressure shall not be greater than 0,08 bar/h (0,008 MPa/h).

9.2.4 Return the pressure to atmospheric pressure.

9.2.5 Inspect the joint for and record any observations of damage.

9.3 Deformation with internal pressure and end thrust

9.3.1 Assemble the test arrangement as shown in Figure 2, using supports if appropriate (see 5.2).

9.3.2 Connect the test piece (see 6.3) to the source of hydrostatic pressure (see 5.3) and fill with water, venting as necessary to remove any air.

9.3.3 Apply an internal pressure as specified in Table 1. Maintain this pressure equal to or above the specified pressure for the specified time.

9.3.4 Apply the force F_1, as specified in Table 1 or the referring standard, to the test piece as shown in Figure 2.

9.3.5 Inspect the joint for any signs of leakage or damage. If none are present, proceed in accordance with 9.3.6. Otherwise, record the observations in accordance with Clause 10.

9.3.6 Increase the pressure to the appropriate positive static pressure for the joint as specified in Table 1 and maintain that pressure for the time specified.

9.3.7 Inspect the joint for signs of leakage or damage and then depressurize. If there are no signs of leakage or damage, proceed in accordance with 9.4. Otherwise, record the observations in accordance with Clause 10.

9.4 Deformation with cyclic pressure and end thrust

9.4.1 Reduce the internal pressure to atmospheric pressure and maintain the test arrangement described in 9.3.1 with the force, F_1, as defined in 9.3.4.

9.4.2 In a period of 1,5 min to 3 min, raise the pressure to the level specified in Table 1 and lower it to atmospheric pressure.

NOTE Due to practical reasons (e.g. restriction of the test equipment such as pump capacities, etc.) the cycle time can be longer for larger DN and or higher PN.

9.4.3 Unless any leakage or damage is clearly apparent, repeat the cycle given in 9.4.2 a further nine times.

9.4.4 Inspect the joint for signs of leakage or damage. If neither are present, proceed in accordance with 9.5. Otherwise, record the observations in accordance with Clause 10.

9.5 Bending with cyclic pressure and end thrust

9.5.1 Introductory notes

Method A is the default method, whereas Method B is by agreement only (see Clause 4).

Note that for Method B, the joint is subjected to a bending load of such a magnitude that the axial tensile stress in the pipe is equal to that developed from a pressure of 0,5 times PN, see Formula (1).

$$\sigma_b = 0{,}5\frac{0{,}1\times PN\times(d_i + e)}{4e} \quad (1)$$

where

σ_b is the bending stress, in N/mm^2;

PN is the normal pressure of the joint, in bar;

d_i is the internal diameter of the pipe, in millimetres;

e is the wall thickness of the pipe, in millimetres.

In addition, the joint is then pressure tested at 1,5 times PN, which then results in a total axial stress (bending plus pressure), σ_{ax}, equivalent to 2 times PN, see Formula (2).

$$\sigma_{ax} = \frac{0{,}1\times PN\times(d_i + e)}{2e} \quad (2)$$

9.5.2 Method A

9.5.2.1 Assemble the test arrangement as shown in Figure 3 using a test piece conforming to 6.4 and having length, L, not exceeding 8 m. Determine the values of F_A and Δ in accordance with Annex A.

9.5.2.2 Connect the test piece (see Clause 6 and Figure 3) to the source of hydrostatic pressure and fill with water, venting as necessary to remove any air.

9.5.2.3 Position the stop at mid-span to ensure a deflection up to Δ can occur and condition the test piece in accordance with see Clause 6, Figure 3 and Annex A.

9.5.2.4 Apply the force, F_A, (see Annex A).

9.5.2.5 Apply and maintain for at least 15 min the initial pressure specified in Table 1. Inspect the joint for signs of leakage or damage. If neither are present, continue in accordance with 9.5.2.6. Otherwise, depressurize the test piece and record the observations in accordance with Clause 10.

9.5.2.6 Increase the hydrostatic pressure to the appropriate static pressure for the joint as specified in Table 1 and maintain it above or equal to that pressure for 24 h (see Table 1). Inspect the joint for signs of leakage or damage. If either has occurred, stop the test and depressurize the test piece and record the observations in accordance with Clause 10. Otherwise, continue with 9.5.2.7.

9.5.2.7 Reduce the pressure to atmospheric.

9.5.2.8 Inspect the joint and record any signs of damage. Record the observations in accordance with Clause 10.

9.5.3 Method B

9.5.3.1 Assemble the test arrangement as shown in Figure 4.

9.5.3.2 Apply the force F_B, as specified in Annex B (see B.3) or the referring standard, to the test piece as shown in Figure 4.

9.5.3.3 In a period of 1,5 min to 3 min, raise the pressure to the level specified in Table 1 and lower it to atmospheric pressure.

NOTE Due to practical reasons (e.g. restriction of the test equipment such as pump capacities) the cycle time can be longer for larger DN and or higher PN.

9.5.3.4 Unless any leakage or damage is clearly apparent, repeat the cycle given in 9.5.3.3 a further nine times.

9.5.3.5 Inspect the joint for signs of leakage or damage. If neither are present proceed in accordance with 9.6. Otherwise record the observations in accordance with Clause 10.

9.6 Internal pressure and end thrust

9.6.1 Assemble the test arrangement as shown in Figure 1.

9.6.2 Connect the test piece (see 6.2) to the source of hydrostatic pressure (see 5.4) and fill with water, venting as necessary to remove any air.

9.6.3 Increase the pressure to the appropriate positive static pressure as specified in Table 1. Maintain this pressure equal to or above the specified pressure for the specified time. During this time, the joint shall not fracture but leakage of the joint does not constitute a failure.

9.6.4 Reduce the pressure to atmospheric and empty the test piece.

9.6.5 Inspect the joint and record any signs of damage or fracture. Record the observations in accordance with Clause 10.

10 Test report

The test report for each test piece shall include the following information, as applicable:

a) reference to this document, i.e. ISO 7432:2021, and the referring standard;

b) full identification of the pipes and joint tested;

c) the nominal size, DN, and the nominal pressure class, PN, of the pipe(s) and joint tested;

d) details of the jointing procedures and, if applicable, the lubricant used;

e) details of any conditioning, if applicable (see Clause 7);

f) the temperatures during the test (see Clause 8);

g) the test conditions to which the test piece was subjected and their sequence;

h) details of interruptions, if any;

i) the deformation force F_1 applied;

j) the bending force F_A or F_B applied and length L (and distance c) used in the bending test;

k) the pressure applied at each stage;

l) observations on the leak tightness of the joint during each test;

m) observations of signs of damage to the joint components after each test;