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Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of cemented or wrapped joints

Tubes et raccords en plastiques thermodurcissables renforcés de verre (PRV) — Méthodes d'essai pour confirmer la conception des assemblages scellés ou enrobés

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Contents

Page

Foreword ..... **iv**
Introduction ..... **v**
1 Scope **1**
2 Normative references **1**
3 Terms and definitions **1**
4 Principle **2**
5 Apparatus **2**
5.1 End sealing devices 2
5.1.1 General 2
5.1.2 Capable of applying the end loads 3
5.1.3 Not capable of applying the end loads 3
5.2 Supports 3
5.2.1 End thrust supports 3
5.2.2 Straps or cradles 3
5.2.3 Special supports 3
5.3 Source of hydrostatic pressure 3
5.4 Means of measuring the gauge pressure 3
5.5 Vacuum pump 3
5.6 Means for applying the required bending force 3
6 Test pieces **3**
6.1 Test arrangement for tests detailed in 9.2, 9.4 and 9.5 3
6.2 Test arrangement for tests detailed in 9.3 4
6.3 Number of test pieces 6
7 Conditioning **6**
8 Test temperature **6**
9 Procedure **6**
9.1 General 6
9.2 Negative pressure 7
9.3 Resistance to bending with pressure and end thrust 8
9.3.1 Method A 8
9.3.2 Method B 8
9.4 Resistance to internal cyclic pressure 9
9.5 Resistance to maintained internal pressure 10
9.6 Resistance to bolt-tightening torque 10
10 Test report **10**
Annex A (normative) **Calculation of the additional force F_A and limiting deflection Δ used in 9.3, Method A** **12**
Annex B (normative) **Calculation of the bending load F_B used in 9.3, Method B** **13**

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 on 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 the following URL: 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 second edition cancels and replaces the first edition ISO 8533:2003, which has been technically revised. It also incorporates the Amendment ISO 8533:2003/Amd1:2012. The main changes compared to the previous edition are as follows:

— changed the Scope to mention that the test procedure is a destructive test and that the bending test is limited up to DN 600;

— changed the Scope to cover the proof of structural design of cemented or wrapped joints;

— the Terms and definitions clause was added to this document;

— changed testing sequences from mandatory to recommended;

— modified test sequence for the proof of the design, Clause 9;

— changes in Table 1 with modified testing sequences for the proof of the design of cemented or wrapped joints;

— modification of bending test sequence;

— addition of an alternative bending test (Method B).

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 stiffness 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 of the pipeline, but not necessarily of 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.

The material-dependent parameters and/or performance requirements are stated in the referring standard.

Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Test methods to prove the design of cemented or wrapped joints

1 Scope

This document specifies methods of test for cemented or wrapped joints for buried and above ground glass-reinforced thermosetting plastics (GRP) piping systems. This document is only applicable to the joint and covers methods of test to prove its design. It assumes that the joint either is or is not intended to be subject to the effects of hydrostatic end thrust.

The tests detailed in 9.2, 9.4 to 9.6 inclusive are applicable to cemented or wrapped joints intended to be used in buried or above-ground applications. The bending tests detailed in 9.3 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 may be considered appropriate.

With the exception of procedure detailed in 9.3, these test procedures are applicable to joints for pipes and fittings of all nominal sizes. The tests detailed in 9.3 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 applied for type testing purposes only.

This document is applicable only to the joint and specifies methods of test 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 vertical force on the cemented or wrapped joint

4 Principle

A test piece comprising two pieces of pipe jointed together with a cemented or wrapped joint is subjected to a specified internal pressure. The procedure includes prolonged static tests at elevated pressures and cyclic testing to prove the structural design of the cemented or wrapped joint.

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

All tests except the bending tests in 9.3 shall be carried out with or without end thrust. The bending test in 9.3 is only applicable for joints intended to resist end thrust.

Two methods are specified for the arrangement in 9.3, Method A and Method B. Method A is the default method. Method B may be agreed between the purchaser and manufacturer.

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

NOTE 1 The only reason for testing the resistance to external pressure differential is to ensure adequate safety against infiltration of pollutants through the joint into the fluid carried in the piping system. Under these test conditions pipes with low stiffness may require support to prevent buckling.

NOTE 2 It is assumed that the following test parameters are set by the standard making reference to this document:

— whether GRP to GRP or GRP to metal flange tests are to be performed;

— 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 bending force F_A or F_B;

— the permissible change in negative pressure.

In all 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

5.1.1 General

The end-sealing devices shall be of sizes and type appropriate to the components under test.

5.1.2 Capable of applying the end loads

If the joint is to be tested with an end load, then the end-sealing devices shall be anchored to the pipes to transmit the end thrust loads.

5.1.3 Not capable of applying the end loads

If the joint is to be tested without the end load, then the end-sealing devices shall not be anchored to the pipes.

5.2 Supports

5.2.1 End thrust supports

End thrust supports, if required, comprising part of the rig, which shall be capable of supporting the end thrust induced by the internal pressure, but which shall not otherwise support the joint.

5.2.2 Straps or cradles

Straps or cradles for use as supports shall be of sufficient width for the pipe and joint components of the test piece (see Figure 1).

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

5.2.3 Special supports

Special supports shall be used if necessary to prevent buckling of the pipe barrel during external pressure differential testing (see 9.2).

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 Means of measuring the gauge pressure

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. The pressure shall be measured at the top of the pipe.

5.5 Vacuum pump

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

5.6 Means for applying the required bending force

The means of applying the required bending force F_A or F_B shall be calibrated to an accuracy of ±5 % of the value to be measured, (see 9.3, Annexes A and B).

6 Test pieces

6.1 Test arrangement for tests detailed in 9.2, 9.4 and 9.5

The test piece shall comprise an assembly of two pieces of pipe of the correct size and pressure class, as specified in the referring standard and the joint to be tested. The total effective length, L, of the

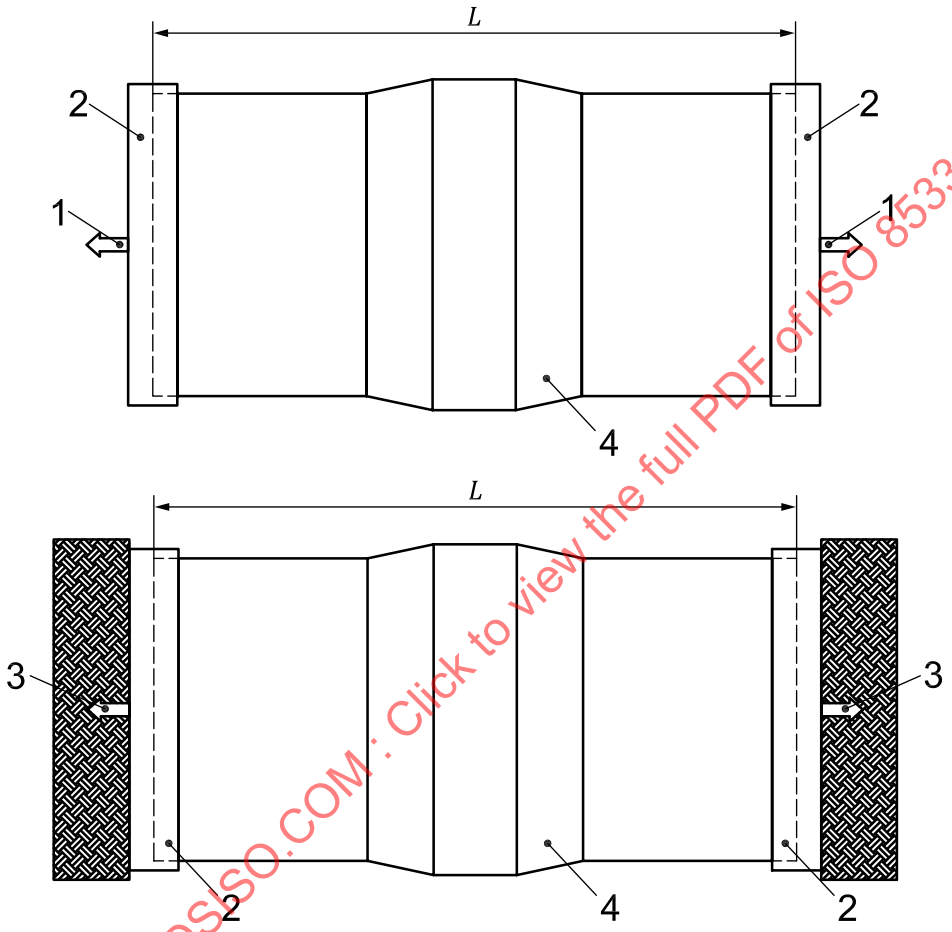
assembly shall be not less than that specified in the referring specification and shall allow, if required, the joint under test to be located in the middle of the test arrangement.

The test arrangement is shown in Figure 1.

The referring specification shall state which condition is to be used.

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

Conditioning, in accordance with Clause 7, shall commence immediately after assembly of a test joint.



Key

1 thrust carried by test piece
2 end sealing device
3 thrust carried by test rig
4 joint being tested
L length of the assembly

NOTE 1 The arrangement can be used either horizontally (as shown) or vertically.

NOTE 2 The upper Figure show the arrangement with end loads, the lower Figure show the arrangement without end loads.

Figure 1 — Typical test arrangements for the tests detailed in 9.2, 9.4 and 9.5

6.2 Test arrangement for tests detailed in 9.3

The test piece shall comprise an assembly of two pieces of pipe of the correct size and pressure class, as specified in the referring standard, between which the joint to be tested is located.

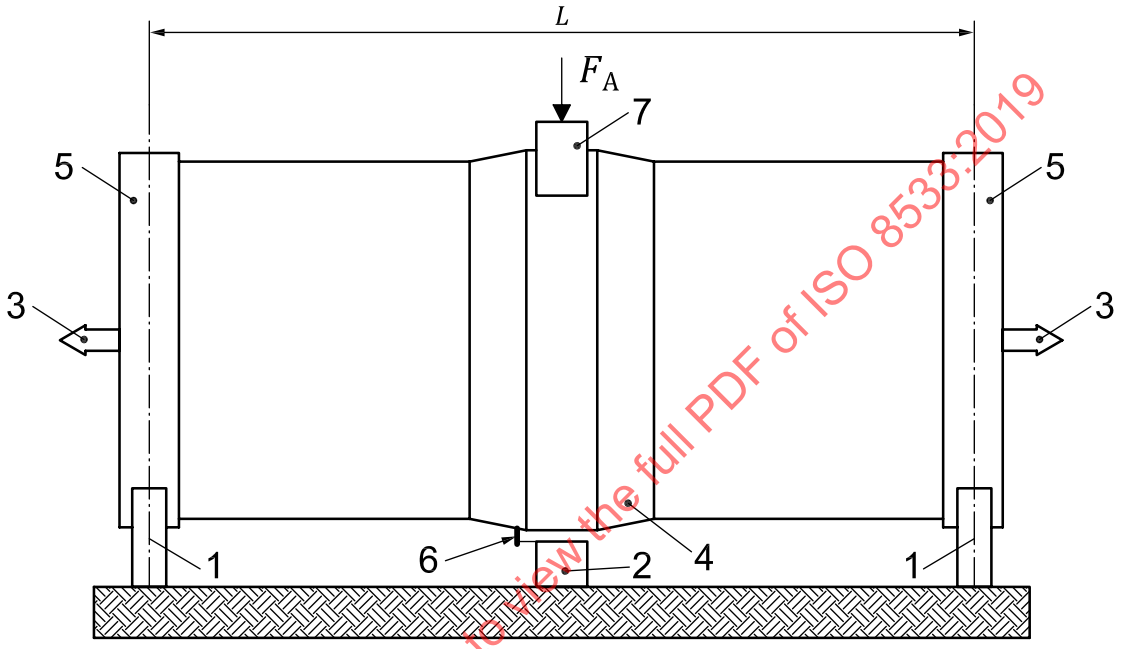
Two methods are provided for the arrangement in 9.3, Method A and Method B.

NOTE Method A is the default method (see Clause 4).

The test arrangement for Method A and Method B are shown in Figure 2 and Figure 3 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.

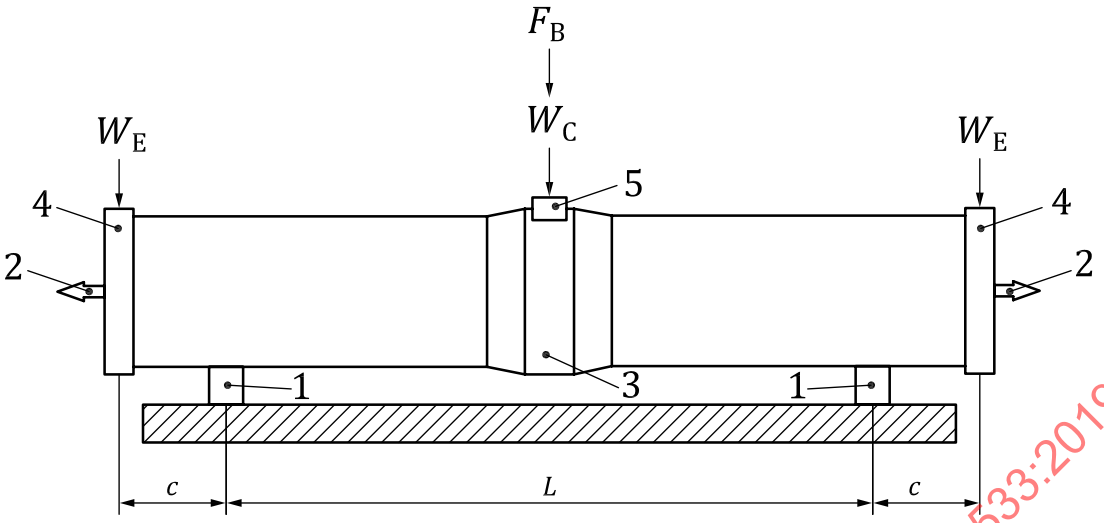
Conditioning, in accordance with Clause 7, shall commence immediately after assembly of a test joint.



Key

1 support
2 stop
3 thrust resisted by test piece
4 joint being tested
5 end sealing device connected to test piece
6 limiting deflection at mid-span, Δ
7 strap or cradle for application of force F_A
F_A additional force
L length not exceeding 8 m

Figure 2 — Typical test arrangement for tests detailed in 9.3, Method A



Key

1	support	4	end sealing device
2	thrust transmitted to the test piece	5	strap or cradle for the application of force F_B
3	test flange	W_E	weight of the end sealing device
F_B	bending force to be applied	W_C	weight of the joint
L	distance between the centre of the supports	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 3 — Typical test arrangement for tests detailed in 9.3, Method B

6.3 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 the elevated temperature environment is applied to one or both sides of the specimen.

8 Test temperature

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

9 Procedure

9.1 General

Subject a test piece according to Clause 6 to the tests given in 9.2 to 9.6, as appropriate. 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 cemented or wrapped is shown in Table 1.

Table 1 — Summary of test conditions for the evaluation of cemented or wrapped joints

Clause	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, Method A	Resistance to bending with pressure and end	Preliminary pressure	1,5 times PN	15 min
		Maintained pressure	2 times PN	24 h
9.3, Method B	Resistance to bending with internal pressure and end thrust[b]	Positive cyclic pressure	Atmospheric to 1,5 × [PN] and back to atmospheric	10 cycles of 1,5 min to 3 min each[c]
9.4	Resistance to internal cyclic pressure[d]	Positive cyclic pressure	Atmospheric to 1,5 × [PN] and back to atmospheric	10 cycles of 1,5 min to 3 min each[c]
9.5	Resistance to maintained internal pressure	Positive static pressure, durability test	2,5 × PN	100 h
9.6	Resistance to bolt-tightening torque	Not applicable	Not applicable	Not applicable

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

[b] This test is limited to diameters up to and including DN 600.

[c] 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.

[d] If 9.3 Method B is used, this test can be omitted.

NOTE The tests can be conducted in any sequence.

The tests may 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.

Carry out the procedures without any retightening of the bolts except as specified e.g. to replace a failed component, or to test in accordance with 9.6.

NOTE Each reference to hydrostatic pressure specifies a positive internal gauge pressure (i.e. relative to atmospheric pressure) and the nominal pressure is that relevant to the joint under test.

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).

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 pressure of at least –0,8 bar (–0,08 MPa) gauge pressure (i.e. approximately 0,2 bar absolute), seal and leave for not less than 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 in accordance with Clause 10.

9.3 Resistance to bending with pressure and end thrust

9.3.1 Method A

NOTE Method A is the default method, see Clause 4.

9.3.1.1 Assemble the test arrangement as shown in Figure 2 using a test piece conforming to 6.2 and having length L not exceeding 8 m. Determine the values of F_A and Δ in accordance with Annex A.

9.3.1.2 Connect the test piece (see Clause 6 and Figure 2) to the source of hydrostatic pressure and fill with water, venting as necessary to remove any air.

9.3.1.3 Position the stop at mid-span to ensure a deflection up to Δ can occur and condition the test piece in accordance with Clause 6, Figure 2 and Annex A.

9.3.1.4 Apply the force F_A (see Annex A).

9.3.1.5 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 9.3.1.6. Otherwise depressurize the test piece and record the observations in accordance with Clause 10.

9.3.1.6 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 9.3.1.7.

9.3.1.7 Reduce the pressure to atmospheric.

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

9.3.2 Method B

NOTE 1 Method B is by agreement only, see Clause 4.

NOTE 2 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).

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

where

σ_b is the bending stress, in N/mm^2;

PN is the value of the nominal pressure, PN, of the piping system for which the joint is designed, expressed in bars;

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

e is the declared wall thickness of the pipe for a nominal pressure, PN, 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).

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

9.3.2.1 Reduce the internal pressure to atmospheric pressure and assemble the test arrangement as shown in Figure 3.

9.3.2.2 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 3.

9.3.2.3 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.

9.3.2.4 Unless any leakage or damage is clearly apparent, repeat the cycle given in 9.3.2.3 for a further nine times.

9.3.2.5 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.

9.4 Resistance to internal cyclic pressure

NOTE This test can be omitted if Method B of 9.3 is chosen.

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

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

9.4.3 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.

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

9.4.5 Inspect the joint for signs of leakage or damage. If neither are present proceed in accordance with 9.5. Record the observations in accordance with Clause 10.

9.5 Resistance to maintained internal pressure

9.5.1 Assemble the test arrangement as shown in Figure 1.

9.5.2 Connect the test piece (see 6.1) to the source of hydrostatic pressure (see 5.3) and fill with water, venting as necessary to remove any air.

9.5.3 Increase the pressure to the appropriate positive static pressure as specified in Table 1. Maintain this pressure equal or above the specified pressure for the specified time.

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

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

9.6 Resistance to bolt-tightening torque

9.6.1 If required by the flange manufacturer lubricate the bolt and nut threads and their bearing surfaces. Record the chemical nature of the lubricant, e.g. graphite, molybdenum disulfide or petroleum-based grease.

9.6.2 Assemble the test flange to the metallic flange (see 6.3 and Figure 3), using the appropriate gasket and using the tightening sequence and torque recommended by the manufacturer of the flange under test.

9.6.3 Condition the test piece in accordance with Clause 7.

9.6.4 Using the same tightening sequence, increase the torque to 1,5 times the manufacturer's recommended value used in 9.6.2.

9.6.5 Using the reverse of the tightening sequence, decrease the torque in small stages and disassemble.

9.6.6 Following disassembly inspect the tested flange and record any visible damage, paying particular attention to the bearing surfaces.

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

NOTE Alternatively a test piece as detailed in Figure 1 can be used.

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 8533, and the referring standard;

b) full identification of the pipes and joints tested;

c) the nominal size, DN, and the nominal pressure class, PN, of the pipe(s) and joints 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 bending force F_A or F_B applied and effective test piece length L used in the bending test;

j) the pressure applied at each stage;

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

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

m) any factors which could have affected the results, such as any incidents or any operating details not specified in this document;

n) the dates of the test.