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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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Foreword

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Introduction

In a pipework system, pipes and fittings of different nominal pressures and 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 standard, but they should be in accordance with the manufacturer's recommendations.

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

1 Scope

This International Standard specifies methods of test for cemented or wrapped joints for plastics piping systems made of glass-reinforced thermosetting plastics (GRP) for buried and non-buried pipelines. This standard 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 7.1 to 7.6 inclusive are applicable to cemented or wrapped joints intended to be used in either buried or non-buried applications. The bending tests detailed in 7.4 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 7.4 these test procedures are applicable to joints between pipes and fittings of all nominal sizes. The tests detailed in 7.4 are applicable to joints between pipes and fittings up to and including DN 600. The tests are applicable to the evaluation of joints intended for the conveyance of liquids at temperatures specified in the referring standards (see Clause 2).

2 Principle

A joint is subjected to a specified internal pressure and, if applicable, longitudinal loading. The procedure includes prolonged static tests at elevated pressures and cyclic testing.

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

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.

A series of tests that are performed under bending is included.

At the end of each of the tests the joint is inspected for signs of leakage and damage and, unless otherwise specified, if either has occurred then the joint has failed.

If the joint is to be used in systems where the maximum operating temperature is higher than the value given in the referring standard the test conditions can be modified accordingly.

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

a) length, L, of the assembled test piece (see 4.1);

b) number of test pieces to be used (see 4.2);

c) if applicable, conditioning other than as given in Clause 5;

d) test temperature and its permissible deviations (see Clause 6);

e) nominal pressure relevant to the joint under test (see 4.1 and Clause 7, as well as the introduction to this standard);

f) if applicable, any criteria indicative of damage to the joint components [see Clause 7 and item j) of Clause 8];

g) whether the joint is or is not to be tested with end loads;

h) acceptable increase in pressure over 1 h for an external pressure differential test (see 7.2).

3 Apparatus

3.1 End-sealing devices

End-sealing devices shall be of a size and type appropriate to the joint system under test.

3.1.1 Capable of applying the end loads

If the joint is to be tested with the end load [see item g) of Note 2 of Clause 2] then the end-sealing devices shall be anchored to the pipes to transmit the end thrust loads.

3.1.2 Not capable of applying the end loads

If the joint is to be tested without the end load [see item g) of Note 2 of Clause 2 and 7.6] then the end-sealing devices shall not be anchored to the pipes.

3.2 Supports

3.2.1 End thrust supports

If required, the end thrust supports shall comprise part of the rig and shall be capable of supporting the end thrust induced by the internal pressure but shall not otherwise support the joint [see 7.6 and Figure 1b), item 3].

3.2.2 Straps and cradles

Straps or cradles for use as supports shall be of sufficient width for the pipe components of the test piece (see Figure 2) and shall not have a detrimental effect on the test piece, e.g. shall not apply point loads.

3.2.3 Special supports

Special supports may be used to prevent buckling of the pipe barrel during external pressure differential testing (see 7.2).

3.3 Source of hydrostatic pressure

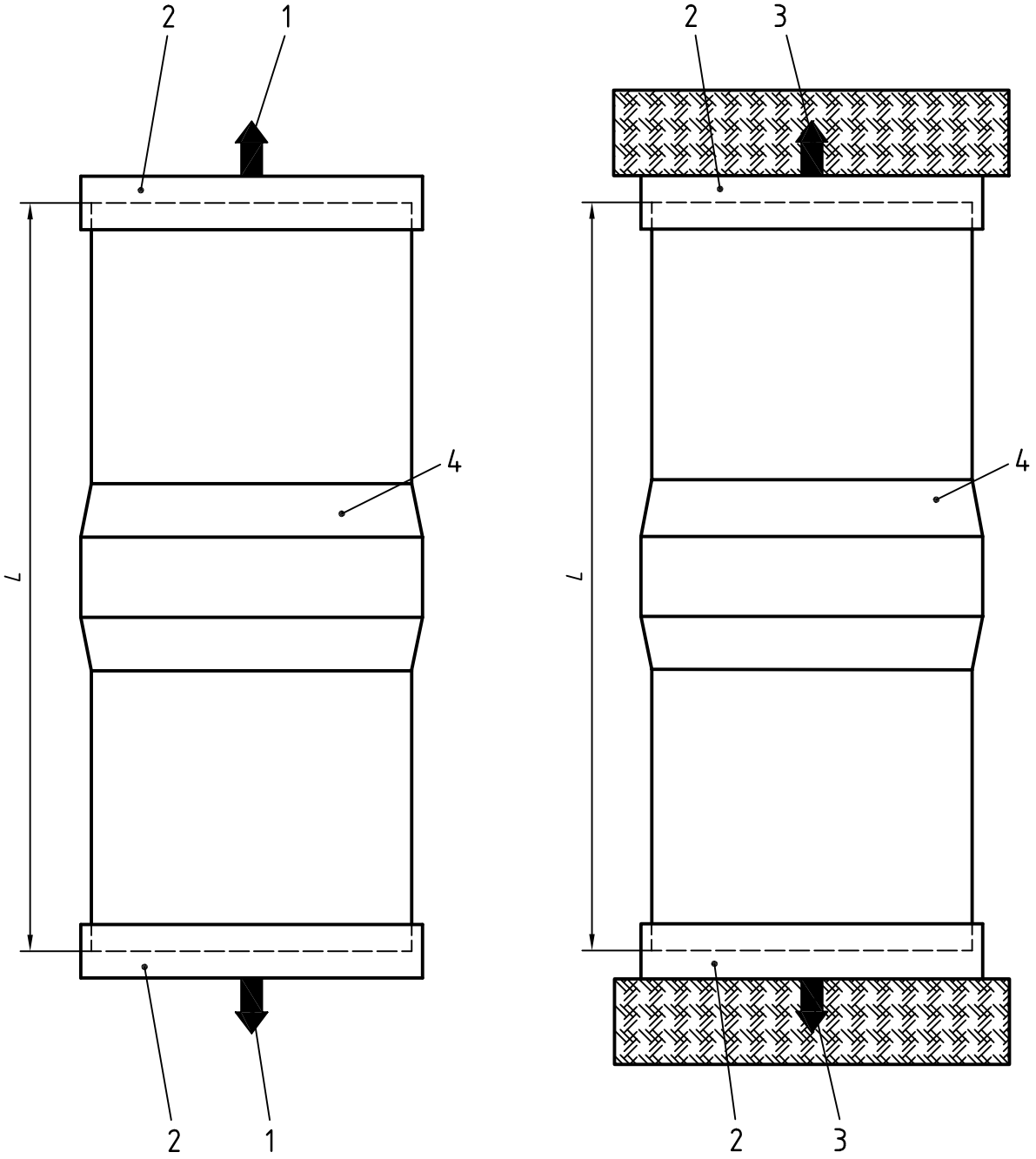
A source of hydrostatic pressure capable of meeting the needs of the test.

3.4 Means of measuring the gauge pressure

A means of measuring the gauge pressure at the top of the pipe to an accuracy within ± 1 % and checking conformity to the specified pressures (see 7.2, 7.3, 7.4 and 7.5).

3.5 Vacuum pump or equivalent

A vacuum pump or equivalent capable of applying the required negative gauge pressure (see 7.2).



a) Arrangement with end loads **b) Arrangement without end loads**

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

Figure 1 — Typical test arrangements for the tests detailed in 7.2, 7.3 and 7.5

4 Test pieces

4.1 Test arrangement

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 is located the joint to be tested.

For the tests detailed in 7.2, 7.3 and 7.5, the length of the assembly, L, 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. For the test detailed in 7.4 the length, L, of the assembly shall be not greater than 8 m and the joint under test shall be located in the middle of the test arrangement.

For the tests detailed in 7.2, 7.3 and 7.5, the arrangement shall be as shown in Figure 1. For the test detailed in 7.4, the arrangement shall be as shown in Figure 2. For the tests detailed in 7.4, see Annex A for details on determining the maximum deflection, Δ (see item 6 in Figure 2), at mid-span and the magnitude of the force F. 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.

The joint shall be assembled in accordance with the manufacturer's recommendations and the requirements of the referring standard.

4.2 Number of test pieces

The number of test pieces shall be as specified in the referring standard.

5 Conditioning

For any interval between assembly of the test piece in accordance with Clause 4 and conditioning performed in accordance with the following paragraph, store the test piece at a temperature which does not exceed the test temperature (see Clause 6).

Following assembly, unless otherwise specified in the referring standard, condition test pieces by storing at the test temperature (see Clause 6) for at least 24 h prior to testing.

6 Test temperature

Conduct the following procedures at the temperature specified in the referring standard.

7 Procedure

7.1 General

WARNING — When carrying out the procedures detailed in this clause, care should be taken to provide suitable protection from flying objects resulting from catastrophic failure.

Subject the test piece (see Clause 4) to either the tests in 7.2 to 7.5 summarized in Table 1, for joints intended to carry end thrust, or the tests detailed in 7.6 summarized in Table 1 for joints not intended to carry end thrust. In either case for the tests detailed in 7.4 the test piece shall have a length not exceeding 8 m and use a joint of the same size and design as that used for 7.2, 7.3 and 7.5.

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.

If a test is interrupted, record the details in the test report and repeat the particular test before carrying on to the next in the series of tests, if applicable. Failure at the end caps or of the pipe shall not constitute failure of the joint but, if the test conditions are invalidated thereby, repeat the particular test after replacing the failed component.

7.2 Leaktightness when subjected to an external pressure differential

7.2.1 Assemble the test arrangement as shown in Figure 1a) and condition as described in Clause 5.

7.2.2 Connect to the vacuum pump (see 3.5).

7.2.3 Reduce the pressure to at least 0,8 bar below atmospheric pressure (approximately 0,2 bar absolute). Record the pressure achieved.

7.2.4 Close the valve between the test piece and the vacuum pump and leave for 1 h.

7.2.5 After this time record any increase in pressure.

7.2.6 If an increase in pressure in excess of the acceptable level specified in the referring standard [see item h) of Note 2 to Clause 2] has occurred then inspect for sources of leakage other than the joint. If any such sources are found then return the test piece to atmospheric pressure, seal the source of the leaks and repeat the test in 7.2.2 to 7.2.5. Otherwise stop the test and record the observations.

7.2.7 If an increase in pressure in excess of the acceptable level specified in the referring standard [see item h) of Note 2 to Clause 2] has not occurred then restore atmospheric pressure and inspect for and record any signs of damage to the joint [see item f) of Note 2 to Clause 2] and proceed to the next test.

7.3 Initial leakage

7.3.1 Fill the test piece with water and vent to remove any air.

7.3.2 Apply an internal pressure of 1,5 times the nominal pressure of the joint, expressed in bars[1)], and maintain within $\pm$ 2 % for 15 min (see Table 1).

7.3.3 Inspect the joint for signs of leakage or damage. If neither are present proceed to the next test. Otherwise stop the test and record the observations.

7.4 Resistance of the joint to bending and pressure

7.4.1 Assemble the test arrangement as shown in Figure 2 using a test piece conforming to Clause 4 and having a length L not exceeding 8 m. Determine the values of F and Δ in accordance with Annex A.

7.4.2 Connect the end caps to the pipes in such a way that the full loads induced by the internal pressure will be transmitted along the pipes to the joint under test.

7.4.3 Position the stop at mid-span to ensure a deflection up to Δ can occur and condition the test piece in accordance with Clause 5.

7.4.4 Fill the test piece with water, taking care to avoid entrapping air.

7.4.5 Apply the force F.

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

7.4.6 Apply an initial hydrostatic pressure of 1,5 times the nominal pressure of the joint, expressed in bars, and maintain within ± 2 % for 15 min. Inspect the joint for signs of leakage or damage. If either has occurred stop the test and empty the test piece. Otherwise continue in accordance with 7.4.7.

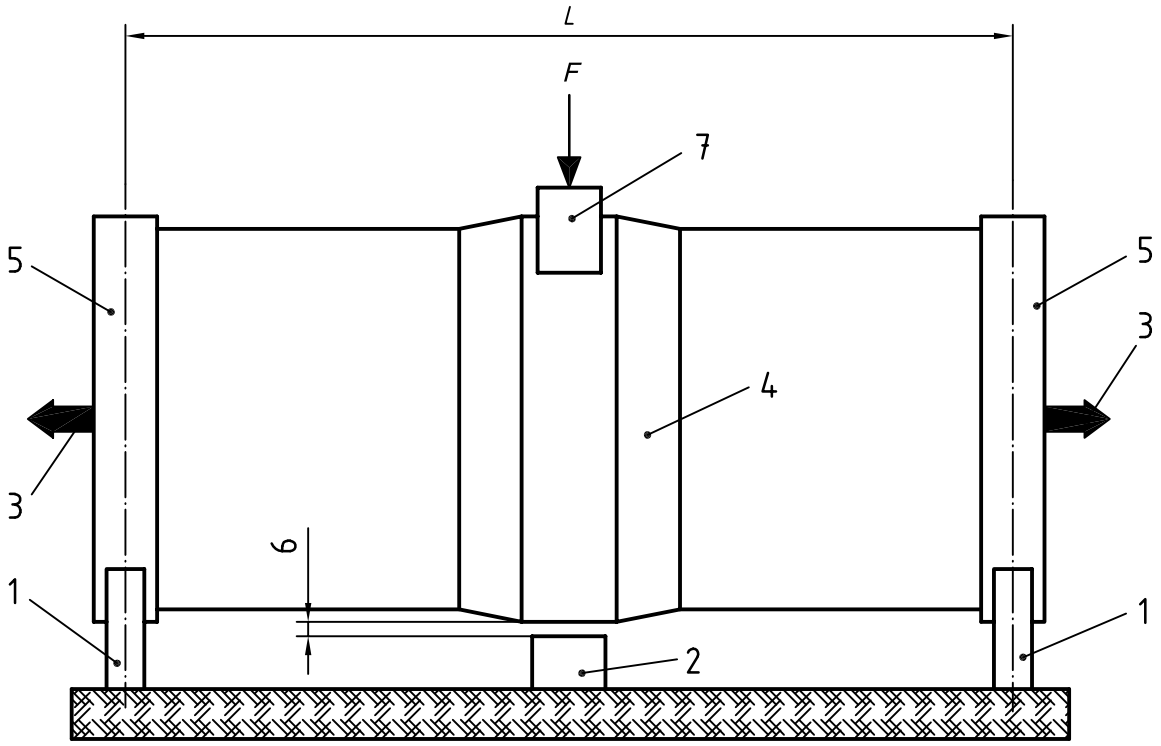
7.4.7 Maintain the hydrostatic pressure of 1,5 times the nominal pressure of the joint, expressed in bars, within ± 2 % for not less than 24 h.

7.4.8 Inspect the joint and record any signs of leakage or damage.

7.4.9 Check and record whether or not the joint is resting on the stop.

7.4.10 Remove the force F and reduce the pressure to atmospheric.

7.4.11 Inspect the joint and record any signs of damage.



Key

1	support	6	limiting deflection at mid-span, Δ
2	stop	7	strap or cradle for the application of force F
3	thrust carried by test piece	L	length not exceeding 8 m
4	joint being tested	F	additional force (if required)
5	end-sealing device fixed to test piece		

Figure 2 — Typical test arrangement for tests detailed in 7.4

7.5 Resistance to internal pressure

7.5.1 Maintain an internal pressure of 1,5 times the nominal pressure of the joint, expressed in bars, for 24 h (see Table 1).

7.5.2 Inspect the joint for signs of leakage or damage. If neither are present proceed in accordance with 7.5.3. Otherwise stop the test and record the observations.

7.5.3 Reduce the pressure to atmospheric.

7.5.4 Steadily raise the internal pressure to 1,5 times the nominal pressure of the joint, expressed in bars, and reduce again to atmospheric pressure so as to complete the cycle in between 1,5 min and 3 min.

7.5.5 Repeat this cycle a further nine times.

7.5.6 Inspect the joint for signs of leakage or damage. If neither are present proceed in accordance with 7.5.7. Otherwise stop the test and record the observations.

7.5.7 Raise the hydrostatic pressure so that a pressure equal to 3 times the nominal pressure of the joint, expressed in bars, is reached in not more than 8 min. Maintain this pressure within $\pm$ 2 % for 6 min. During this time the joint shall not fracture. Leakage of the joint does not constitute a failure, however.

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

7.5.9 Inspect the joint and record any signs of fracture.

7.6 Testing excluding hydrostatic end thrust (see 7.1)

Perform the procedures detailed in 7.2 to 7.5 and summarized in Table 1 except that the end-sealing devices shall not be connected to the pipe and the end thrust shall be carried by independent supports.

8 Test report

The test report shall include the following information:

a) a reference to this International Standard and to the referring standard;

b) whether the joint was tested with or without end thrust;

c) full identification of the pipes and joint tested;

d) the nominal pressure (PN) class(es) of the pipes and joint;

e) details of the jointing materials and procedures used;

f) the temperature range during the test;

g) a description of the tests to which the joint was subjected;

h) the positive and negative pressures applied, in bars;

i) any observations on the leaktightness of the joint during each test;

j) any observations on the condition of the joint after each test;

k) details of interruptions, if any, to the test sequence;

l) whether or not the test piece rested on the stop during the test;

m) any factors which may have influenced the results, such as any incidents or any operating details not specified in this International Standard;

n) the dates and times of the period of each test.

Table 1 — Summary of test requirements

Test	Pressure sequence	Test pressure	Duration	Subclause number
External pressure differential	Negative pressure	−0,8 bar (−0,08 MPa)	1 h	7.2 and Figure 1
Initial leakage	Initial pressure	1,5 times PN	15 min	7.3 and Figure 1
Resistance to bending	Preliminary pressure	1,5 times PN	15 min	7.4.1 to 7.4.6 and Figure 2
	Maintained pressure	1,5 times PN	24 h	7.4.7 to 7.4.11 and Figure 2
Resistance to internal pressure	Maintained pressure	1,5 times PN	24 h	7.5.1 to 7.5.3 and Figure 1
	Positive cyclic pressure	Atmospheric to 1,5 times PN and back to atmospheric	10 cycles of 1,5 min to 3,0 min each	7.5.4 to 7.5.6 and Figure 1 or Figure 2
	Maintained pressure	3,0 times PN	6 min	7.5.7 to 7.5.9 and Figure 1

NOTE 1 Nominal pressure (PN) is an alphanumeric designation of pressure related to the resistance of a component of a piping system to internal pressure. For the purposes of this table PN is expressed in bars.

NOTE 2 A test sequence different from that given in this table may be used.

Annex A
(normative)

Equations for calculating the additional force, F, and limiting deflection, Δ, for the bending test described in 7.4

The test arrangement for Subclause 7.4 is a simply supported pipe with a span, L, not exceeding 8 m. The load is provided by the weight of the pipe plus contents. The pipe is allowed to deflect before coming into contact with a stop that supports the pipe if it tries to deflect more than a limiting deflection, Δ.

The test is performed with the arrangement shown in Figure 2 with an additional force, F, determined in accordance with Equation A.1, applied at mid-span and the stop positioned at a distance Δ (see item 6 in Figure 2) below the joint, which is determined from Equation A.2.

$$\text{Additional force } F = \left(\frac{32}{L} - \frac{L}{2}\right) \times \left(m_{\mathrm{p}} + m_{\mathrm{w}}\right) + \left(\frac{8}{L} - 1\right) \times m_{\mathrm{j}} \qquad \text{(A.1)}$$

$$\text{Limiting deflection } \Delta = 5{,}75 \times L \qquad \text{(A.2)}$$

where

F is the additional force applied at mid-span, in kilonewtons;

Δ is the limiting deflection at mid-span, in millimetres;

L is the span, in metres;

m_{p} is the weight of the pipe empty, in kilonewtons per metre;

m_{w} is the weight of water in the pipe when full, in kilonewtons per metre;

m_{j} is the weight of the joint, in kilonewtons.

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