INTERNATIONAL STANDARD

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Second edition
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Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the apparent initial circumferential tensile strength

Systèmes de canalisations en matières plastiques — Tubes en plastiques thermodurcissables renforcés de verre (PRV) — Méthodes d'essai pour la détermination de la résistance en traction circonférencielle initiale apparente

Reference number
ISO 8521:2009(E)

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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 8521 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 8521:1998), of which it constitutes a technical revision.

Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Test methods for the determination of the apparent initial circumferential tensile strength

1 Scope

This International Standard specifies six test methods for the determination of the initial circumferential tensile wall strength per unit of length of glass-reinforced thermosetting plastics (GRP) pipes.

NOTE Another commonly used term for "circumferential tensile strength" is "hoop tensile strength" and the two expressions can be used interchangeably.

The burst test (method A) is suitable for all types and sizes of pipes. It is considered the reference method. However, all the methods in this International Standard have equal validity. If correlation of any of the methods B to F can be established by a comparative test programme, then that method can be considered as the reference method.

The split disc test (method B) might not be suitable for pipes with helically wound reinforcing layers.

The strip test (method C), the modified strip test (method D) and the restrained strip test (method E) are suitable for pipes with a nominal size of DN 500 and greater.

The notched plate test (method F) is primarily intended for use with helically wound pipes of nominal size greater than DN 500 with a winding angle other than approximately 90°.

Results from one method are not necessarily equal to the results derived from any of the alternative methods.

If required, the initial circumferential tensile modulus can be determined by method A.

2 Terms and definitions

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

2.1
initial circumferential tensile wall strength
σ_{cA}^*, σ_{cB}^*, σ_{cC}^*, σ_{cD}^*, σ_{cE}^*, σ_{cF}^*
ultimate circumferential tensile force per unit length in the circumferential direction (the upper-case subscripts denote the method of test used)

NOTE It is expressed in newtons per millimetre of circumference.

2.2
burst pressure
p_{ult}
internal pressure at bursting

NOTE It is expressed in bars [1] or megapascals.

2.3
bursting
failure by rupture of the pipe wall

2.4
ultimate tensile force
F_{ult}
tensile force at failure

NOTE It is expressed in newtons.

2.5
width
b
width of the test piece in the notched area

NOTE It is expressed in millimetres.

2.6
winding angle
θ
angle between the direction of the continuous reinforcement and the longitudinal axis of the pipe

NOTE It is expressed in degrees.

2.7
helical wound
cross wound
filament wound pipes made with a balanced winding angle

3 Principle

3.1 General

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

a) for method A, the length between end sealing devices (see 5.1);

b) for methods B, C, D and E, the width of the test piece (see 5.2, 5.3, 5.4 and 5.5);

c) for methods C and E, the total width of the test piece (see 5.3 and 5.5);

d) for method F, the dimensions of the plate to be tested (see 5.6);

e) the number of test pieces (see 5.7);

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

f) the requirements for conditioning (see Clause 6);

g) the test temperature (see Clause 7).

3.2 Method A

The initial circumferential tensile wall strength, $\sigma_{cA}{}^{*}$, is determined by an internal pressure test.

Cut lengths of pipe are subjected to an increasing internal pressure which, within a specified time, causes bursting (see 2.3). The test conditions are such that a mainly uniaxial circumferential stress is obtained.

3.3 Method B

The initial circumferential tensile wall strength, $\sigma_{cB}{}^{*}$, is determined by a split disc test.

Rings cut from the pipe are subjected to an increasing tensile force, by means of a split disc positioned within the ring, until rupture occurs within a specified time.

3.4 Methods C, D and E

The initial circumferential wall strength, $\sigma_{cC}{}^{*}$ or $\sigma_{cD}{}^{*}$ or $\sigma_{cE}{}^{*}$, is determined by a strip test.

Strips cut from the pipe wall in the circumferential direction, and if necessary, shaped to incorporate notches at defined locations, are subjected to an increasing tensile force until rupture occurs within a specified time.

3.5 Method F

The apparent initial circumferential wall strength, $\sigma_{cF}{}^{*}$, is determined by a notched plate test.

Plates cut from the pipe wall are subjected to an increasing tensile force until rupture occurs within a specified time.

4 Apparatus

4.1 For method A

4.1.1 Hydrostatic pressurizing system, capable, for pipes up to DN 500, of causing failure of the test piece between 1 min and 3 min after commencing the pressurization.

For some nominal sizes greater than DN 500, the duration of the test will, for practical equipment reasons, need to be increased. Where increasing the testing time results in lower burst pressures, this shall be evaluated by comparing results of different test durations.

The pressurizing system shall prevent air from entering the test piece during pressurization to failure.

4.1.2 Pressure measuring device, capable of measuring the applied internal pressure to an accuracy of ± 2,0 %.

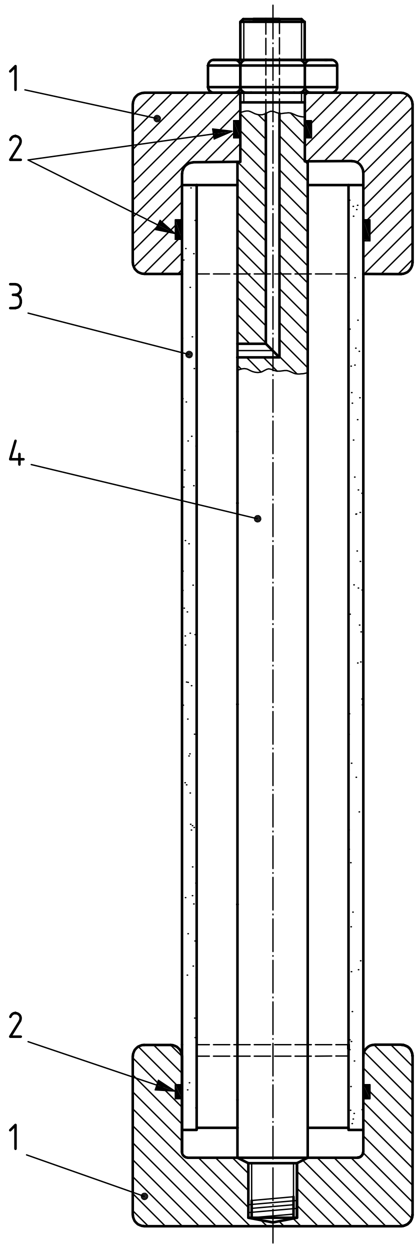
4.1.3 End sealing devices for the test pieces, capable of inducing in the test piece, during the test, a mainly uniaxial state of stress in the circumferential direction in the test piece (see Figure 1).

4.1.4 Dimension measurement devices, capable of measuring the necessary dimensions of the test piece to an accuracy of ± 0,1 mm.

4.1.5 Test piece support, if needed, to minimize deformation due to the weight of the test piece and its contents.

4.1.6 Strain measurement, if circumferential tensile modulus of the pipe wall is to be determined, strain gauges of the foil type, single element suitable for the anticipated strain level and of a length appropriate for the pipe diameter.

4.1.7 Flexible membrane (if used as a barrier system to prevent weeping), which does not reduce the stress in the pipe wall by more than 1 %. The flexible membrane may be of a different material from the pipe, e.g. elastomeric or thermoplastic sheet or a flexible coating.



Key

1 end sealing device

2 elastomeric seal

3 test piece

4 tie bar for carrying end thrust

Figure 1 — Typical arrangement for pressure testing pipes (method A)

4.2 For method B

4.2.1 Test machine, of the type capable of producing a progressive separation of the split disc and incorporating the following components:

a) a fixed or virtually fixed part;

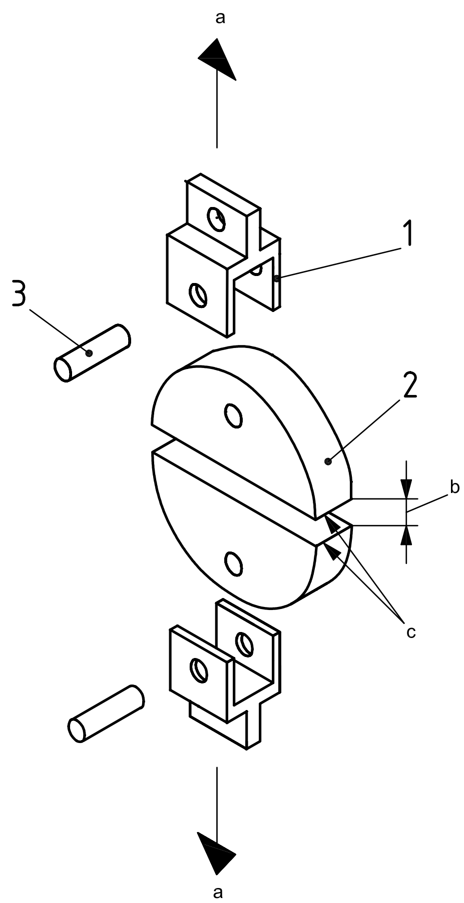
b) a moveable part;

c) a drive mechanism, capable of imparting a constant speed to the moving part so that rupture can be reached between 1 min and 3 min after initial loading;

d) a load indicator, capable of measuring the force applied. This shall be virtually free from inertia at the specified rate of testing and shall indicate the force to an accuracy of within 1 % of the measured value.

4.2.2 Rigid split discs, as shown in Figure 2, capable of making even contact with the internal diameter of the test piece. The diameter of the two segments of the split disc shall be not less than 98 % of the internal diameter of the pipe with which they are intended to be used.

4.2.3 Dimension measuring devices, capable of measuring the necessary dimensions of the test piece to an accuracy of ± 0,1 mm.



Key

1 toggle

2 saddle

3 shear pin

a Direction of loading.

b Separation.

c Rounded edges.

Figure 2 — Typical arrangement for the split disc test (method B)

4.3 For method C

4.3.1 Test machine, of the type with constant separating speed, incorporating the following components:

a) a fixed, or virtually fixed, part with a grip to hold one end of a test piece;

b) a moveable part, incorporating a second grip to hold the other end of the test piece. The grips holding the ends of the test piece shall do so as far as possible without slipping and/or crushing;

NOTE Grips that tighten automatically can be used.

c) the fixed and moving parts and their associated grips shall enable the test piece to be aligned when a force is applied, so that the axis of the test piece is coincident with that of the force;

d) a drive mechanism capable of imparting a constant speed to the moving part, so that failure can be reached between 1 min and 3 min after initial loading;

e) a load indicator capable of measuring the force applied. The mechanism shall be virtually free from inertia lag at the specified rate of testing and shall indicate the force to an accuracy of within 1 % of the measured value.

4.3.2 Dimension measuring device(s), capable of measuring the necessary dimensions of the test piece to an accuracy of ± 0,1 mm.

4.4 For method D

4.4.1 Test machine, conforming to 4.3.1 (see also Figure 6).

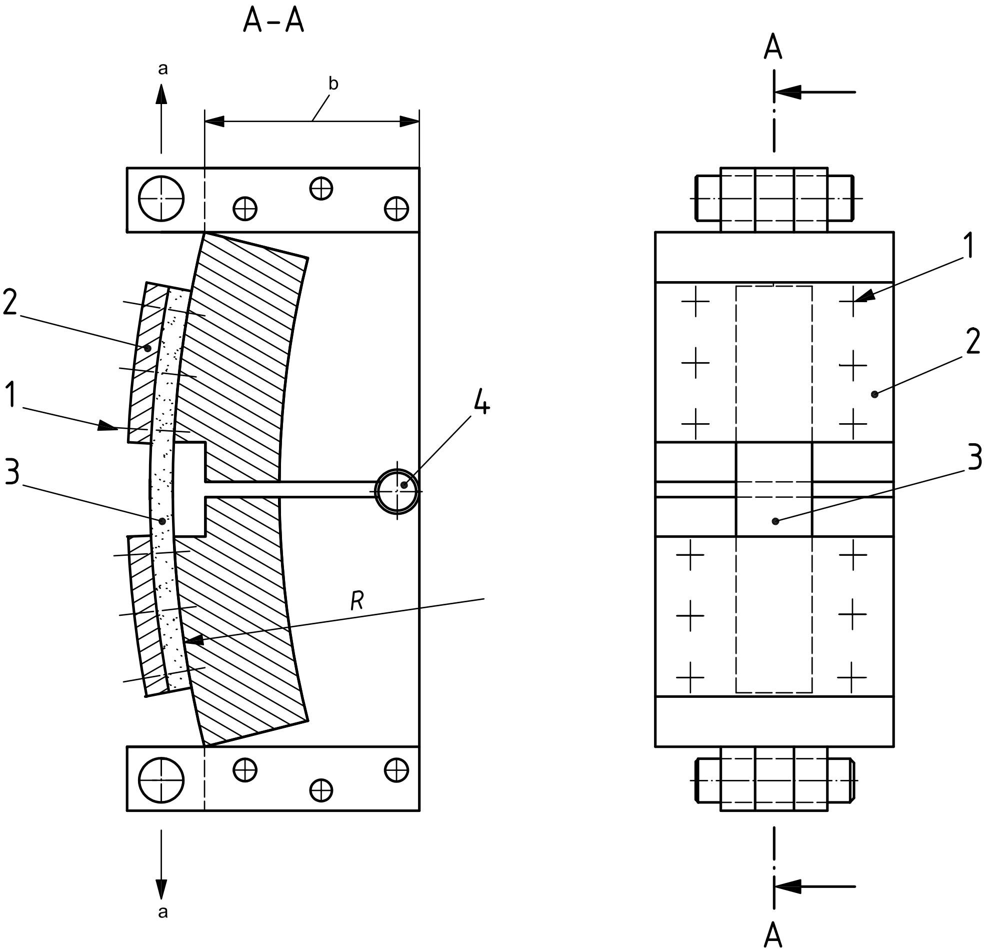
4.4.2 Dimension measuring device(s), capable of measuring the necessary dimensions of the test piece to an accuracy of ± 0,1 mm.

4.5 For method E

4.5.1 Test machine, conforming to 4.3.1 (see also Figure 3).

4.5.2 Dimension measuring device(s), capable of measuring the necessary dimensions of the test piece to an accuracy of ± 0,1 mm.

4.5.3 Restraining fixture, capable of preventing the test piece from bending. The radius of curvature of the support plate shall be half the nominal size, DN, expressed in millimetres, ± 5 %. An example of such a fixture is shown in Figure 3.



Key

1 bolt

2 clamping plate

3 test piece

4 pivot

R = 0,5 × d_i

a Direction of loading.

b Adjustable distance.

Figure 3 — Typical arrangement for restrained-strip test with a split support (method E)

4.6 For method F

4.6.1 Test machine, conforming to 4.3.1.

4.6.2 Load indicator, capable of indicating the force applied to the test piece to an accuracy of ± 1 % of the indicated value.

4.6.3 Means of measuring the necessary dimensions of the test piece to an accuracy of ± 0,1 mm and the winding angle, θ, to an accuracy of ± 1°.

5 Test pieces

5.1 For method A

The test piece shall be a cut length of pipe whose length between the end sealing devices shall be as specified in the referring standard.

5.2 For method B

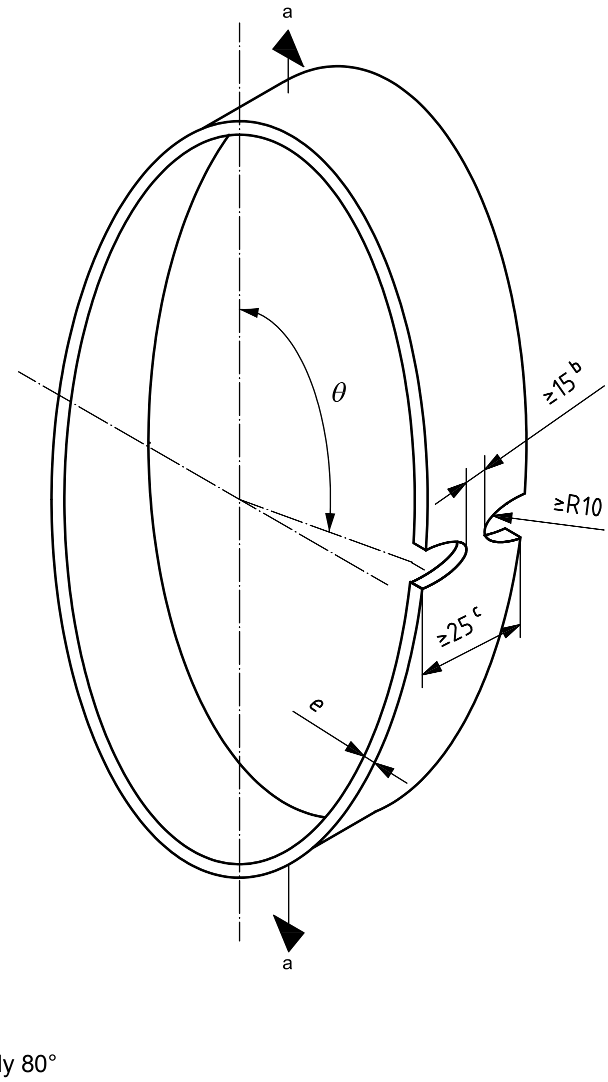
The test piece shall be a ring cut from a pipe; see Figure 4.

The width of the test piece shall not exceed the width of the split disc. The width of the test section, b, shall be a minimum of 15 mm.

NOTE For larger diameter and/or higher pressure pipes, the width of the test section might, for practical equipment reasons, need to be reduced.

The ends of the ring shall be smooth and perpendicular to the longitudinal axis of the pipe.

Dimensions in millimetres



Key

e test piece wall thickness

θ angle equal to approximately 80°

a Direction of loading.

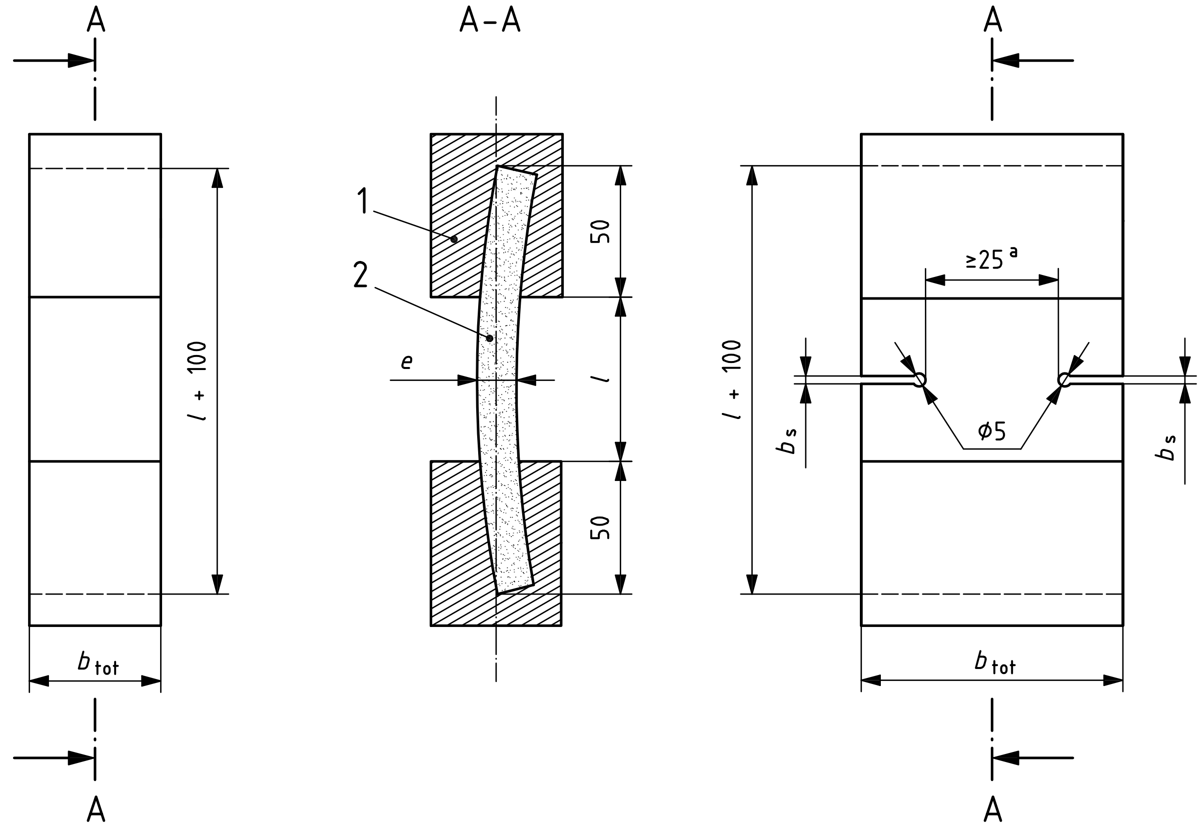
b Width of test section, b.

c Test piece width.

Figure 4 — Test piece for split-disc test (method B)

5.3 For method C

The test pieces (see Figure 5) shall be cut out of the pipe in the circumferential direction.



a) Case 1 - no helically wound layers

b) Case 2 - helically wound layers

Key

1 cast-resin end

2 test piece

b_s free slot width (between 5 mm and 1 mm)

b_{tot} total width

e wall thickness

l length of test piece (between $4e$ and $5e$)

a Width of test piece.

Figure 5 — Test piece for strip test (method C)

The test piece conforming to case 1 (see Figure 5) shall be used when helically wound reinforcing layers are not present or are present with a winding angle of $\theta > 70°$. The test piece conforming to case 2 (see Figure 5) shall be used when helically wound reinforcing layers with a winding angle of $\theta \leqslant 70°$ are present.

The ends shall be smooth and perpendicular to the longitudinal axis of the pipe.

For case 1, the total width, b_{tot}, shall be as specified in the referring standard, but at least (25 ± 0,5) mm.

For case 2, the total width, b_{tot}, shall be as specified in the referring standard, but at least $2b$ ($b \geqslant 25$ mm) to prevent shear failure. Failures not occurring in the notched area shall not be taken into account.

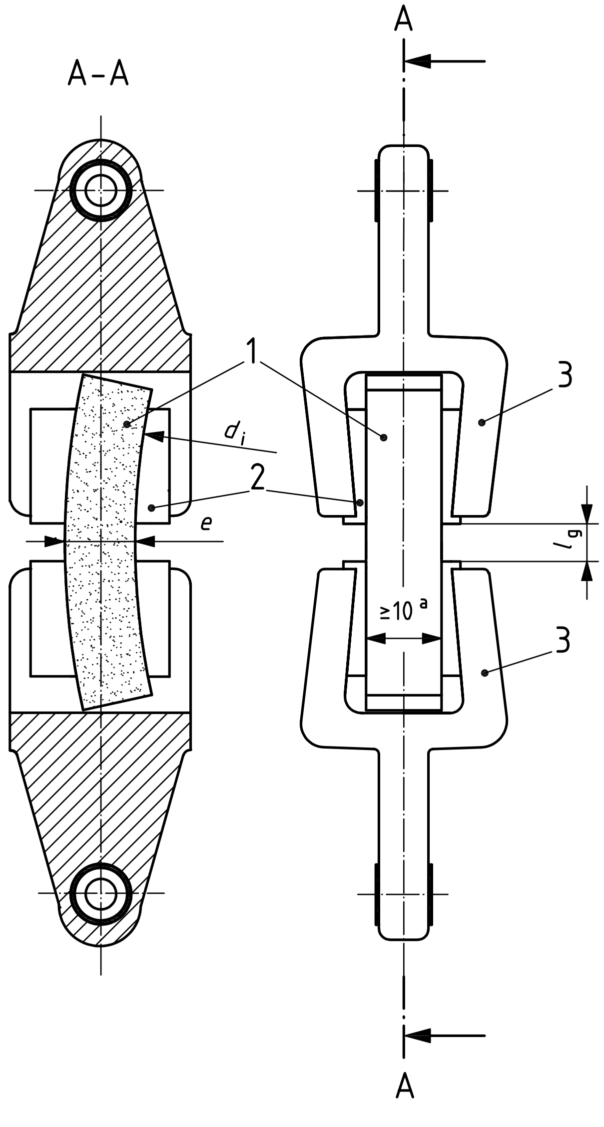
NOTE For larger diameter and/or higher pressure pipes, the width of the test piece might, for practical equipment reasons, need to be reduced.

The ends of the strip shall be encased in thermosetting resin as shown in Figure 5.

5.4 For method D

When it is required only to determine conformity to a minimum strength requirement, the test piece shall be cut out of the pipe in the circumferential direction and shaped to the dimensions shown in Figure 6. If, when using parallel-sided strips, the test piece fails before the minimum force is applied, the test shall be repeated using a test piece containing a notch conforming to the notch configurations shown in Figure 7.

Dimensions in millimetres



Key

1 test piece

2 tapered clamp

3 grip

d_i inside diameter

e test piece wall thickness

l_g distance between grips (15 ± 5) mm

a Width of test piece.

Figure 6 — Typical test arrangement for modified strip test (method D)

The faces of the test piece in contact with the clamp shall be smooth and perpendicular to the axis of the pipe.

The width, b, shall be as specified in the referring standard but not less than 10 mm.

NOTE For larger diameter and/or higher pressure pipes, the width of the test piece might, for practical equipment reasons, need to be reduced.

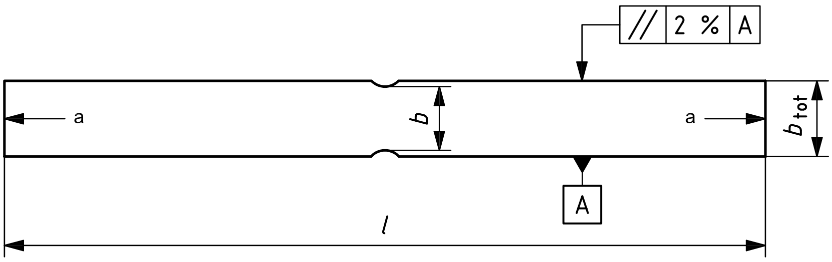
In order to prevent shear failure, the distance between the grips, l_g, shall be (15 ± 5) mm.

The total length of the test piece shall be adjusted to suit the grip arrangement.

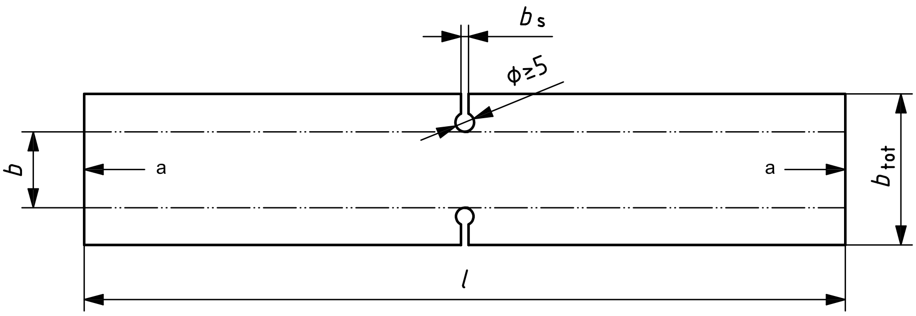
5.5 For method E

The test piece shall be cut out of the pipe in the circumferential direction and shaped to the dimensions shown in Figure 7, where the long sides are parallel to within 2 %. Alternatively, when it is required only to determine conformity to a minimum strength requirement, parallel-sided wide strips may be used. If, when using parallel-sided strips, the test piece fails before the minimum force is applied, the test shall be repeated using a test piece conforming to Figure 7.

Dimensions in millimetres



a) Case 1 - applies when helically wound layers are not present in the test piece



b) Case 2 - applies when helically wound layers are present in the test piece

Key

b test width (between 24 mm and 26 mm min.)

b_s free slot width (between 1 mm and 5 mm)

b_{tot} total width, case 1

b_{tot} total width (48 mm min. to prevent shear failure), case 2

l length of test piece (between 250 mm and 350 mm)

a Circumferential direction.

Figure 7 — Test piece for restrained strip test (method E)

The test piece conforming to case 1 (see Figure 7) shall be used when helically wound reinforcing layers are not present or are present with a winding angle of $\theta > 70°$. The test piece conforming to case 2 (see Figure 7) shall be used when helically wound reinforcing layers with a winding angle of $\theta \leqslant 70°$ are present.

The test width, b, shall be as specified in the referring standard, but not less than 10 mm.

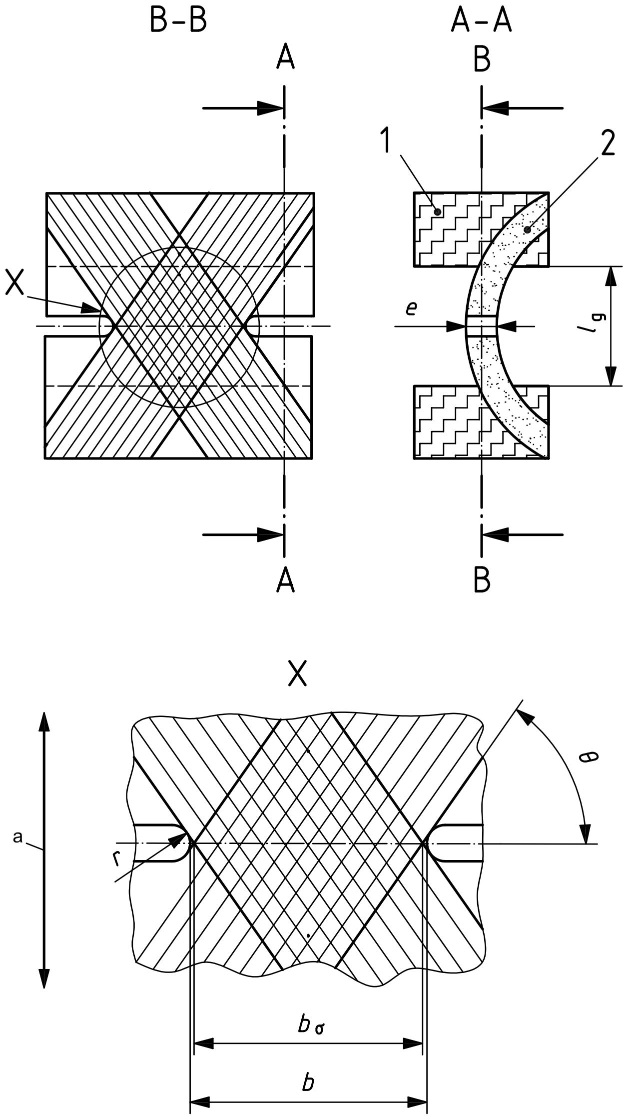
NOTE For larger diameter and/or higher pressure pipe, the test width, b, might, for practical equipment reasons, need to be reduced.

For case 2, the total width, b_{tot}, shall be as specified in the referring standard, but at least $2b$ to prevent shear failure.

5.6 For method F

The test piece shall be cut approximately square from the pipe, taking care that the reinforcement is properly oriented. The dimensions of the test piece shall be as specified in the referring standard, but sufficiently large to ensure that failure occurs across the neck of the test piece (see Figure 8).

The test piece ends shall be built up with thermosetting resin with or without reinforcement. When cured, machine the built-up ends flat and parallel and ensure that the centroid of the gauge length cross-section (see Figures 8 and 9) will lie on the loading centreline of the test machine when gripped.



Key

1 thermosetting resin

2 pipe section test piece

θ winding angle, of glass fibres

b width of neck, is equal to (min. 25 mm; max. $5e$)

b_σ stressed width, $b + 2r\,(1-1/\sin\theta)$

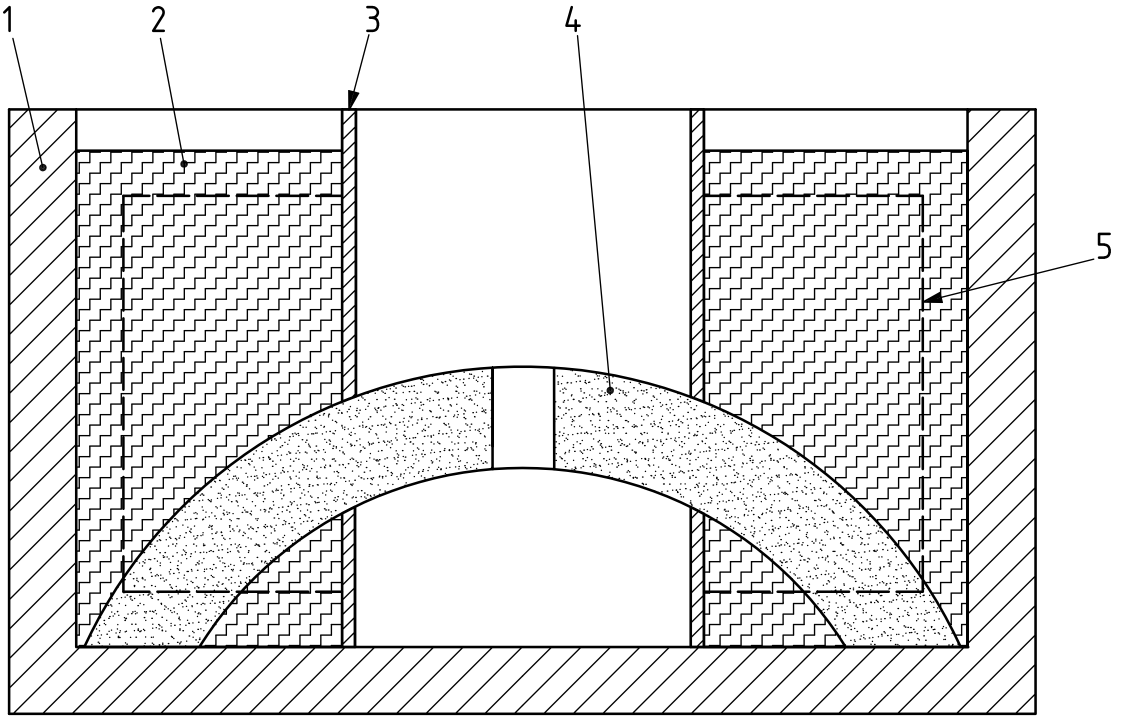
e pipe wall thickness

l_g distance between grips ($4 \times e$ min.)

r radius within neck of test piece

a Circumferential direction.

Figure 8 — Test piece for method F



Key

1 outer mould

2 thermosetting resin

3 inner void former

4 pipe section test piece

5 profile of ends after trimming

Figure 9 — Mould for resin application to test piece for method F

Any flash shall be removed, and the test piece shall be machined to the following dimensions (see Figure 8):

— distance between the grips, l_g:

$l_g \geqslant 4e$;

— radius within the neck of the test piece, r:

$0{,}2e \leqslant r \leqslant 0{,}5e$;

— width, b, of the neck:

$25\ \text{mm} \leqslant b \leqslant 5e$.

5.7 Number of test pieces

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

6 Conditioning

Unless otherwise specified by the referring standard, store test pieces at the test temperature (see Clause 7) for at least 0,5 h prior to testing.

7 Test temperature

The test shall be conducted at the temperature specified in the referring standard.

8 Procedure

8.1 For method A

8.1.1 Determine the internal diameter, d_i, to an accuracy of ± 1 %.

8.1.2 Attach the end sealing devices to the test piece and fill the assembly with water. Attach the assembly to the pressurizing system, taking care to avoid entrapment of air.

8.1.3 Pressurize at a rate such that failure occurs between 1 min and 3 min after starting to apply pressure. Record the maximum pressure reached, in bar, and the time to failure. For some nominal sizes greater than DN 500, the duration of the test will, for practical equipment reasons, need to be increased. Where increasing the testing time results in lower burst pressures, this shall be evaluated by comparing results of different test durations.

Because of the very high stresses (strains) generated by the pressures used to develop this ultimate strength, the discontinuity effects of the end closures can significantly influence the test results. Where the failure can clearly be determined to have occurred in a zone of

$$3{,}3\ (\mathrm{DN}e)^{0{,}5}$$

where

DN is the nominal size of the pipe, in millimetres, and

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

from the end closure, the results of the test may be disregarded and an additional sample tested.

8.1.4 If the modulus is to be measured, mark a circumferential line around a pipe sample at approximately the longitudinal centre of the sample and measure to an accuracy of 0,1 mm the average wall thickness of the pipe. Install three strain gauges, equally spaced on the marked line.

Attach the end sealing devices to the test piece and fill the assembly with water. Attach the assembly to the pressurizing system, taking care to avoid entrapment of air. Pressurize the sample to a level of 1,5 PN while measuring the strain for the calculation of the modulus.

After completion of the strain measurements, depressurize the sample. Then test the sample for circumferential tensile wall strength according to 8.1.3.

8.2 For method B

8.2.1 Measure to an accuracy of ± 0,1 mm the width, b, of the test piece as the average of two measurements, one of which shall be taken at the inside surface of the ring in the notched area and the other at the outside surface of the ring in the notched area.

8.2.2 Mount the test piece on the outside periphery of the split disc with the expected failure zone (i.e. notched area) located on the surface of the split discs away from the separation of the two discs.

8.2.3 Apply a constant separating speed to the split disc such that failure occurs between 1 min and 3 min. Record the maximum force and the time to failure. Failures not occurring in the notched area shall be disregarded.

8.3 For method C

8.3.1 Measure the width, b, of the test piece to an accuracy of ± 0,1 mm.

8.3.2 Fix the test piece in the grips so that the load will be applied through the centreline of the test piece (see Figure 5).

8.3.3 Apply a constant separating speed to the grips so that failure occurs between 1 min and 3 min. Record the maximum force and the time to failure. When using test pieces in accordance with case 2, failures not occurring in the notched area shall be disregarded.

8.4 For method D

8.4.1 Measure the width, b, of the test piece to an accuracy of ± 0,1 mm.

8.4.2 Fix the test piece in the grips (see Figure 6) so that the force is applied through the centreline of the test piece. When fixing the test piece in the grips, take care to ensure that the midpoint of the test piece is located at approximately the midpoint of l_g.

8.4.3 Apply a constant separating speed to the grips so that failure occurs between 1 min and 3 min. Record the maximum force and the time to failure. When using notched test pieces, failures occurring outside the notched area shall be disregarded.

8.5 For method E

8.5.1 Measure the width, b, of the test piece to an accuracy of ± 0,1 mm.

8.5.2 Fix the test piece in the grips and align the restraining fixture so that no bending occurs in the test piece. Position the test piece so that its centreline is coincident with the loading axis of the machine.

8.5.3 Apply a constant separating speed to the grips so that failure occurs between 1 min and 3 min. Record the maximum force and the time to failure. When using test pieces in accordance with case 2, failures not occurring in the notched area shall be disregarded.

8.6 For method F

8.6.1 Measure the width, b, of the test piece to an accuracy of ± 0,1 mm and the winding angle, θ, to an accuracy of ± 1°. Determine by measurement and/or calculation the radius, r.

8.6.2 Position the test piece so that its centreline is coincident with the loading axis of the machine.

8.6.3 Apply a constant separating speed to the grips so that failure occurs between 1 min and 3 min. Record the maximum force and the time to failure.

Disregard the result of any test piece that does not break across the neck.

9 Calculation

9.1 For method A

NOTE The subscript "n" used in Clauses 9 and 10 is the number of the test piece.

For each test piece, calculate the initial circumferential tensile wall strength, $\sigma_{\text{cA},n}{}^*$, in newtons per millimetre of length, using Equation (1):

$$\sigma_{\text{cA},n}{}^* = 0{,}05 \times p_{\text{ult}} \times d_{\text{i}} \tag{1}$$

where

p_{ult} is the internal pressure at burst, in bar;

d_{i} is the internal diameter of the pipe, in millimetres.

Calculate the average initial circumferential tensile wall strength, $\overline{\sigma_{\text{cA}}{}^*}$, of the test pieces and, if applicable, the standard deviation.

When the circumferential tensile strain is measured, calculate the modulus, E, in N/mm^2 using Equation (2):

$$E = \frac{10^5 \times \Delta P \times d_{\text{i}}}{2 \times \Delta \varepsilon \times e} \tag{2}$$

where

E is the circumferential tensile modulus, in newtons per square millimetre;

ΔP is the change in pressure, in bar;

d_{i} is the internal diameter, in millimetres;

e is the wall thickness, in millimetres;

$\Delta \varepsilon$ is the change in strain corresponding to ΔP.

9.2 For method B

For each test piece, calculate the initial circumferential tensile wall strength, $\sigma_{\text{cB},n}{}^*$, in newtons per millimetre of length, using Equation (3):

$$\sigma_{\text{cB},n}{}^* = \frac{F_{\text{ult}}}{2 \times b} \tag{3}$$

where

F_{ult} is the ultimate force, in newtons;

b is the width of the test piece in the notched area (see 8.2.1), in millimetres (see Figure 4).

Calculate the average initial circumferential tensile wall strength, $\overline{\sigma_{\text{cB}}{}^*}$, of the test pieces and, if applicable, the standard deviation.

9.3 For methods C, D and E

For each test piece, calculate the initial circumferential tensile wall strength, $\sigma_{cC,n}^*$, $\sigma_{cD,n}^*$ or $\sigma_{cE,n}^*$, in newtons per millimetre of length, using Equation (4), (5) or (6):

$$\sigma_{cC,n}^* = \frac{F_{ult}}{b} \tag{4}$$

$$\sigma_{cD,n}^* = \frac{F_{ult}}{b} \tag{5}$$

$$\sigma_{cE,n}^* = \frac{F_{ult}}{b} \tag{6}$$

where

F_{ult} is the ultimate force, in newtons;

b is the width of the test piece, in millimetres.

Calculate the average initial circumferential tensile wall strength, $\overline{\sigma_{cC,n}}^*$, $\overline{\sigma_{cD,n}}^*$ or $\overline{\sigma_{cE,n}}^*$, of the test pieces and, if applicable, the standard deviation.

9.4 For method F

For each test piece, calculate the initial circumferential tensile wall strength, $\sigma_{cF,n}^*$, in newtons per millimetre of length, using Equation (7):

$$\sigma_{cF,n}^* = \frac{F_{ult}}{b + 2r(1\text{-}1/\sin\theta)} \tag{7}$$

where

F_{ult} is the ultimate load, in newtons;

b is the width of the neck of the test piece, in millimetres;

r is the notch radius, in millimetres;

θ is the winding angle of the reinforcement (see also Figure 8), in degrees. If the circumferential reinforcement is provided wholly by non-continuous fibre, take θ to be 90°. If two or more winding angles are used for continuous fibre, take θ as the largest angle used.

Calculate the average initial circumferential tensile wall strength, $\overline{\sigma_{cF,n}}^*$, of the test pieces and, if applicable, the standard deviation.

10 Test report

The test report shall include the following information:

a) a reference to this International Standard, i.e. ISO 8521:2009, and the referring standard;

b) all details necessary for full identification of the pipe tested;

c) the test method used (i.e. A, B, C, D, E or F);

d) for method A, the internal diameter, d_i, and the modulus, E, if measured;

e) for methods B, C, D, E and F, the width, b, of the test piece;

f) for method F, the notch radius, r;

g) for method F, the winding angle, θ, if applicable;

h) the number of test pieces;

i) the position in the pipe from which the test pieces were obtained;

j) the temperature during testing;

k) the individual values of the initial circumferential tensile wall strength, $\sigma_{c,x}^*$;

l) the average value of the initial circumferential tensile wall strength and the standard deviation, if applicable;

m) a description of the test pieces after testing;

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

o) the date of testing.

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