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

Systèmes de canalisations en matières plastiques — Tubes en plastiques thermodurcissables renforcés de verre (PRV) — Détermination de la résistance en traction circonférencielle initiale apparente

Reference numbe
(E)

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.

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.

International Standard 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,* in collaboration with CEN/TC 155, *Plastics piping systems and ducting systems.*

This standard is one of a series of standards on test methods which support standards for plastics piping systems and ducting systems.

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

1 Scope

This standard specifies six test methods for the determination of the apparent initial tensile strength in the circumferential direction per unit length of glass-reinforced thermosetting plastics (GRP) pipes.

The burst test (method A) is suitable for all types and sizes of pipes. It is the reference method.

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

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

The restrained strip test (method E) is suitable for all types of pipes with a nominal size greater than DN 500.

The notched plate test (method F) is primarily intended for use for 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.

2 Definitions

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).

It is expressed in newtons per millimetre of circumference.

2.2 burst pressure (p_{ult}): The internal pressure at bursting.

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}): The tensile force at failure.

It is expressed in newtons.

2.5 width (b): The width of the test piece in the notched area.

It is expressed in millimetres.

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

For the purposes of this standard, the following definitions apply:

2.1 apparent initial circumferential strength (

2.6 winding angle (θ): The angle between the direction of the reinforcement and the longitudinal axis of the pipe.

It is expressed in degrees.

3 Principle

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

a) for method A the length between the 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 (5.7);

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

g) the test temperature (see clause 7).

3.1 Method A

The apparent initial circumferential strength, σ_{cA}*, is determined by a burst 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.

3.2 Method B

The apparent initial circumferential strength, σ_{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 within the ring until rupture occurs, within a specified time.

3.3 Methods C, D and E

The apparent initial circumferential strength, σ_{cC}*, σ_{cD}*, σ_{cE}*, is determined by a strip test.

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

3.4 Method F

The apparent initial circumferential strength, σ_{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

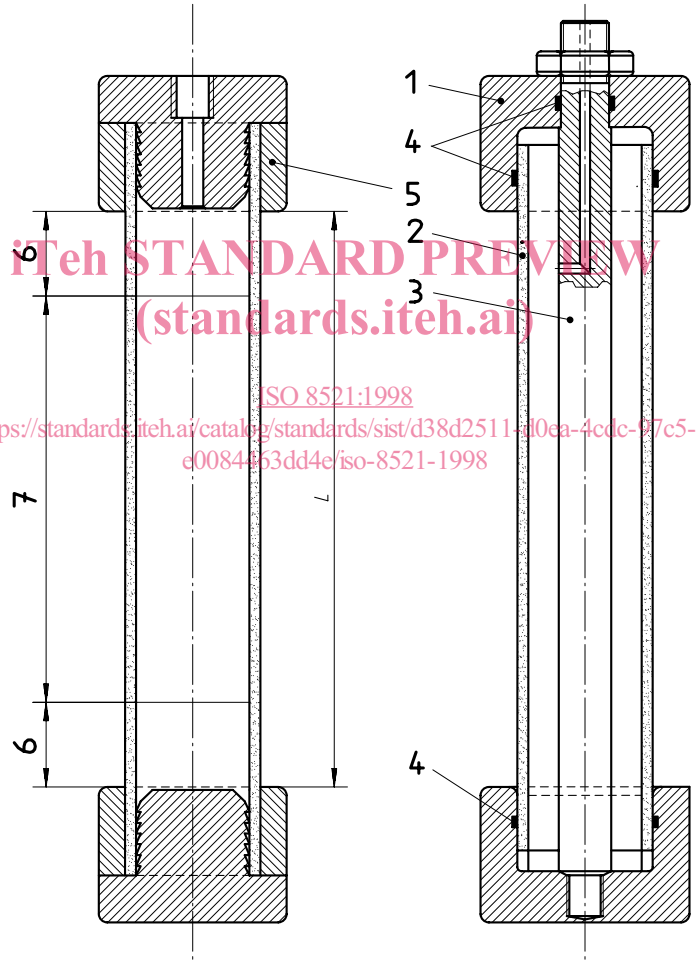
4.1.1 Hydrostatic pressurizing system, for pipes of up to DN 500, capable of causing failure of the test piece between 1 min and 3 min after commencing the pressurization. For nominal sizes greater than DN 500 the duration of the test may have to be increased.

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

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

4.1.3 End sealing devices for the test pieces, such that a mainly uniaxial state of stress in the circumferential direction will be induced (i.e. type 1 or type 2 in figure 1).

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



Key

1	End cap	5	End cap
2	Test piece	6	See 8.1.3 for this dimension
3	Tie bar carrying end thrust	7	Valid failure zone
4	Elastomeric seal	L	Length of test piece

Type 1: Testing with end thrust (external seals)

Type 2: Testing without end thrust (internal seals)

Figure 1 — Typical arrangement for pressure testing of pipes

4.1.5 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.

4.2 For method B

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

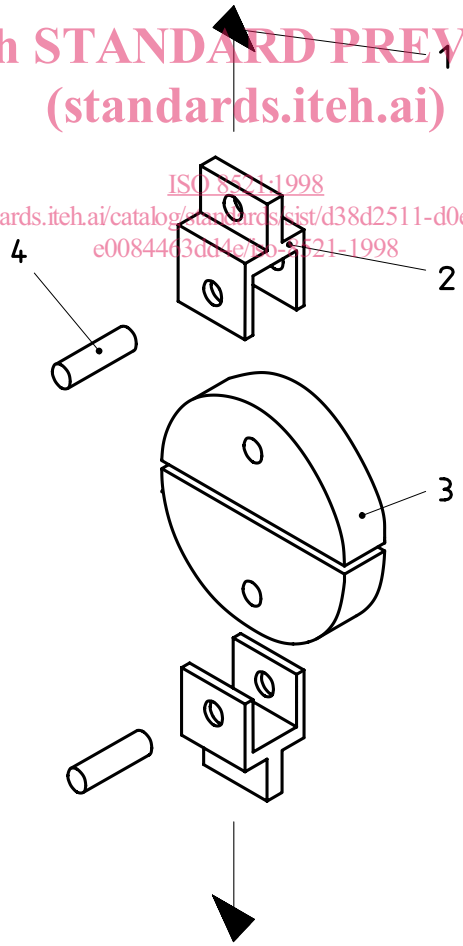
a) a fixed or virtually fixed part;

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.



Key

1 Direction of loading
2 Toggle
3 Saddle
4 Shear pins

Figure 2 — Typical arrangement for the split disc

4.2.3 Dimension measurement devices, capable of measuring the necessary dimensions of the test piece (e.g. length, wall thickness) to an accuracy of half the accuracy required in clause 8 measurements, e.g. measuring accuracy ± 0,1 mm requires a device accuracy of ± 0,05 mm.

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 which tighten automatically may be used.

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.

c) 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.

d) 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 with an accuracy of within 1 % of the measured value.

4.3.2 Dimension measuring device(s), for measuring the widths, b and b_{tot}, and the free length, l, of the test piece (see figure 5) to an accuracy of ± 0,1 mm.

4.4 For method D

4.4.1 Test machine, conforming to 4.3.1.

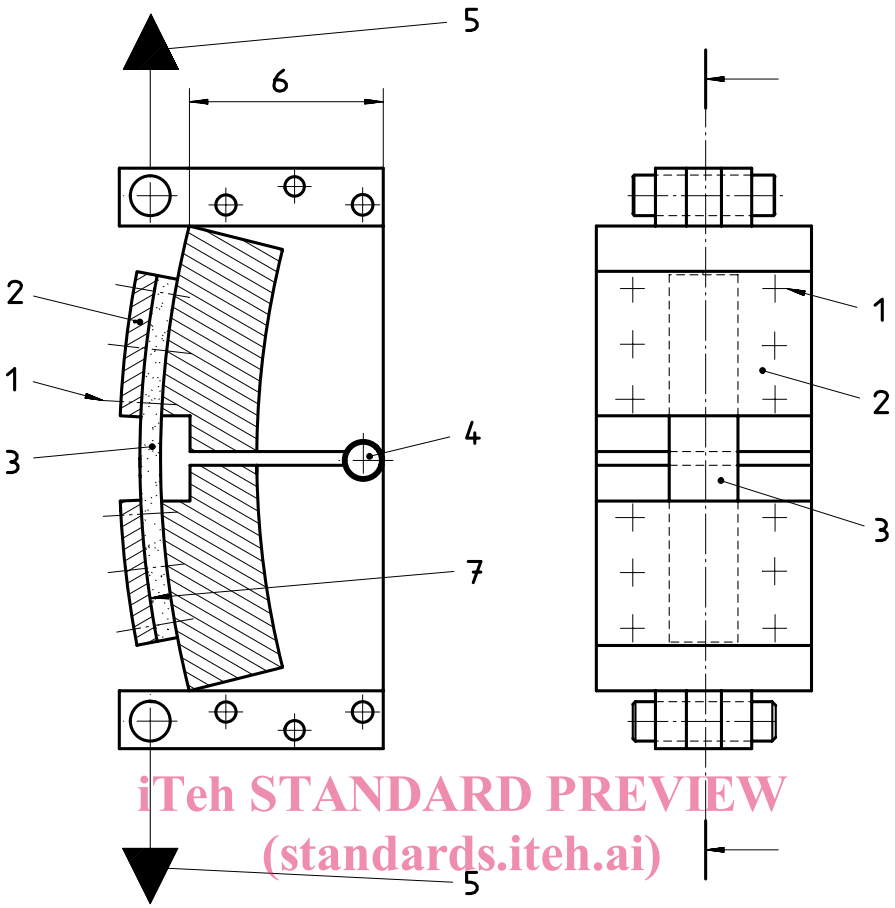
4.4.2 Dimension measuring device(s), capable of measuring the width, b and the thickness, e, of the test piece (see figure 6) to an accuracy of ± 0,1 mm.

4.5 For method E

4.5.1 Test machine, conforming to 4.3.1.

4.5.2 Dimension measuring device(s), capable of measuring the widths, b and b_{tot}, and the length, l, of the test piece (see figure 7) to an accuracy of ± 0,1 mm.

4.5.3 Restraining fixture, that prevents the test piece 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
5 Direction of loading
6 Adjustable distance
7 Radius = 0,5 × external diameter

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 width, b, (see figure 8) of the neck of the test piece to an accuracy of ± 0,1 mm **and the winding angle**, θ, to an accuracy of ± 1°.

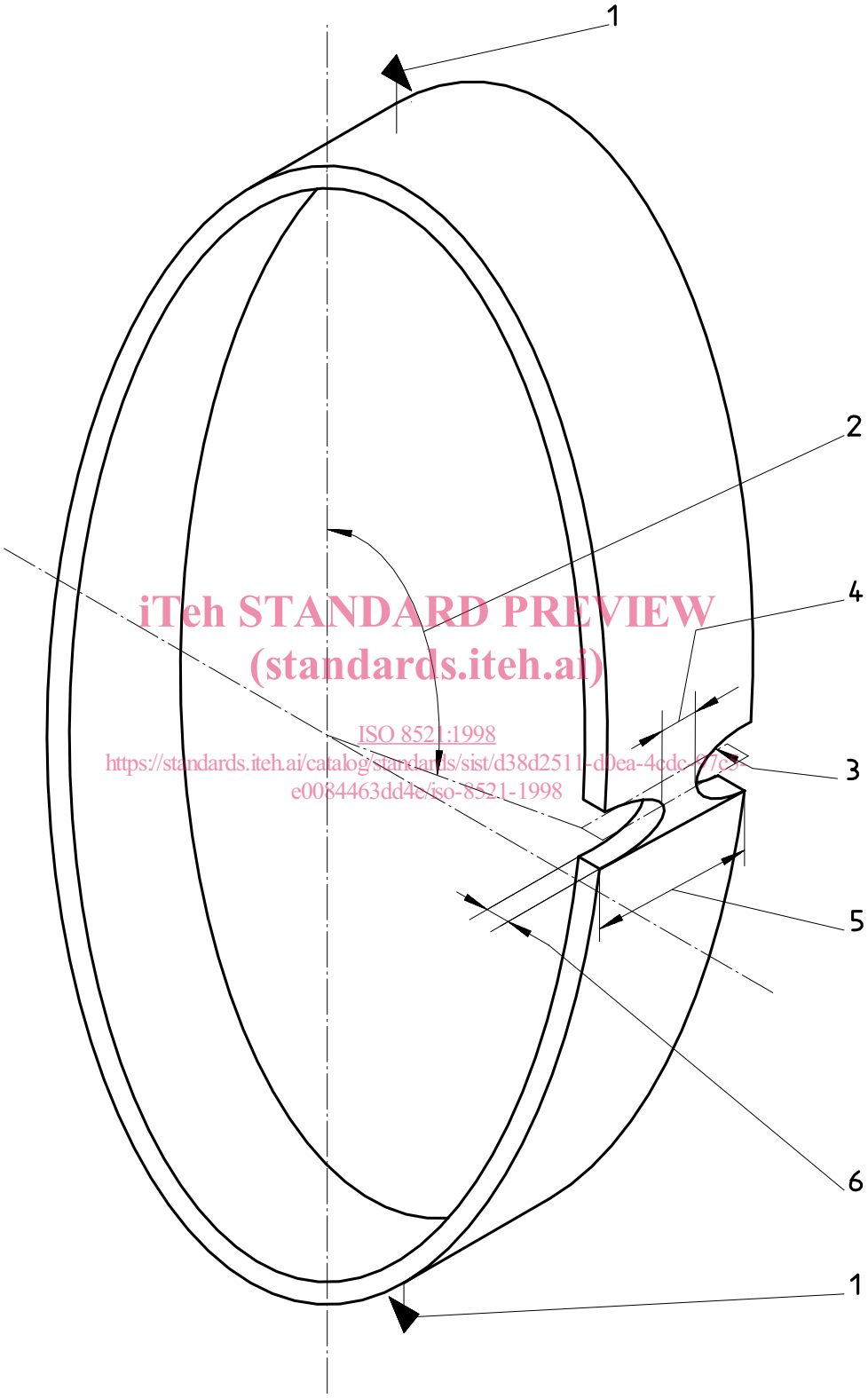
5 Test pieces

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 and its dimensions shall conform to figure 4.



Key

1 Direction of loading
2 Angle approximately 80°
3 Radius 10 mm min.
4 Width of test section (15 mm min.)
5 Width of test piece, b (25 mm min.)
6 Wall thickness, e

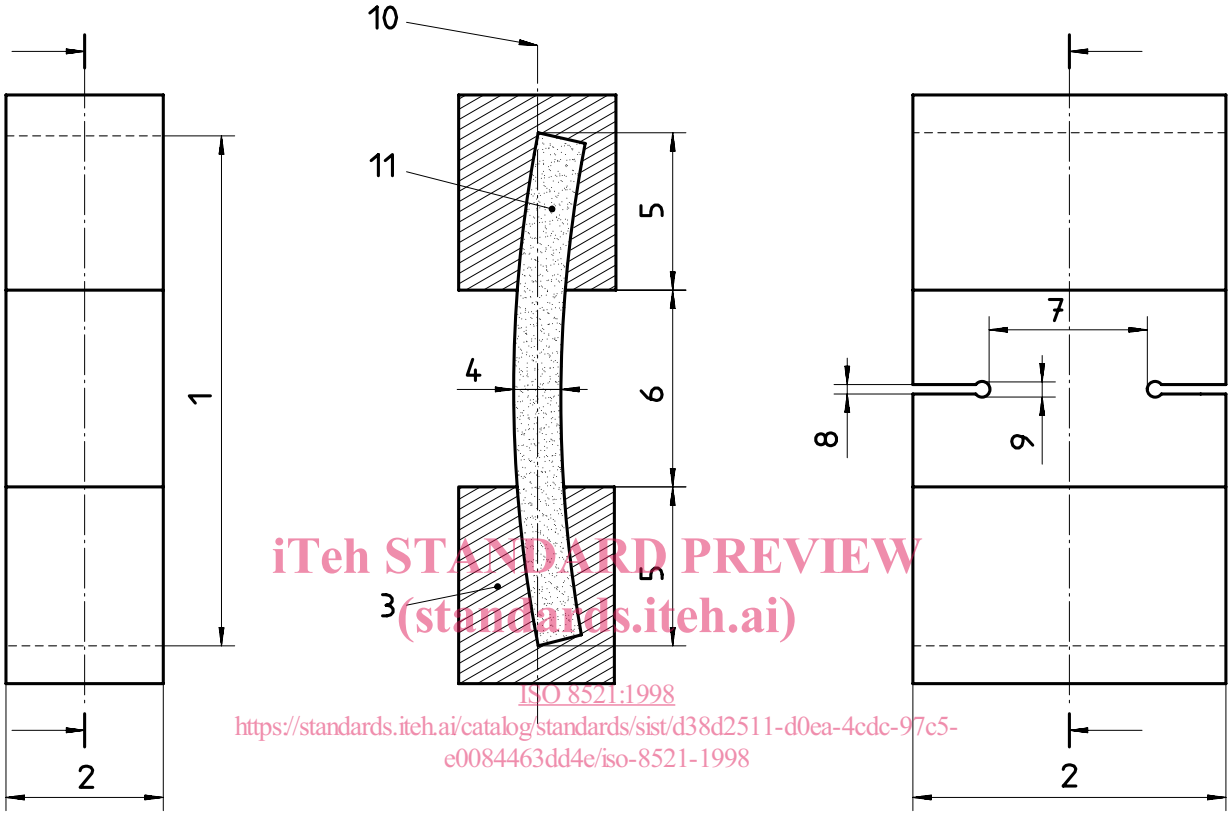
Figure 4 — Test piece for split disc test

The width of the test piece shall not exceed the width of the split disc.

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

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 l + 100 mm
2 b_{tot}
3 Cast resin end
4 Wall thickness, e
5 50 mm
6 l (between 4e and 5e)
7 b (25 mm min.)
8 Free slot width (between 1 mm and 5 mm)
9 5 mm
10 Centreline
11 Test piece

Figure 5 — Test piece for strip test

The test piece conforming to case 1 (see figure 5) shall be used when helically wound reinforcing layers (i.e. $\theta > 70°$) are not present. The test piece conforming to case 2 (see figure 5) shall be used when helically wound reinforcing layers are present.

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

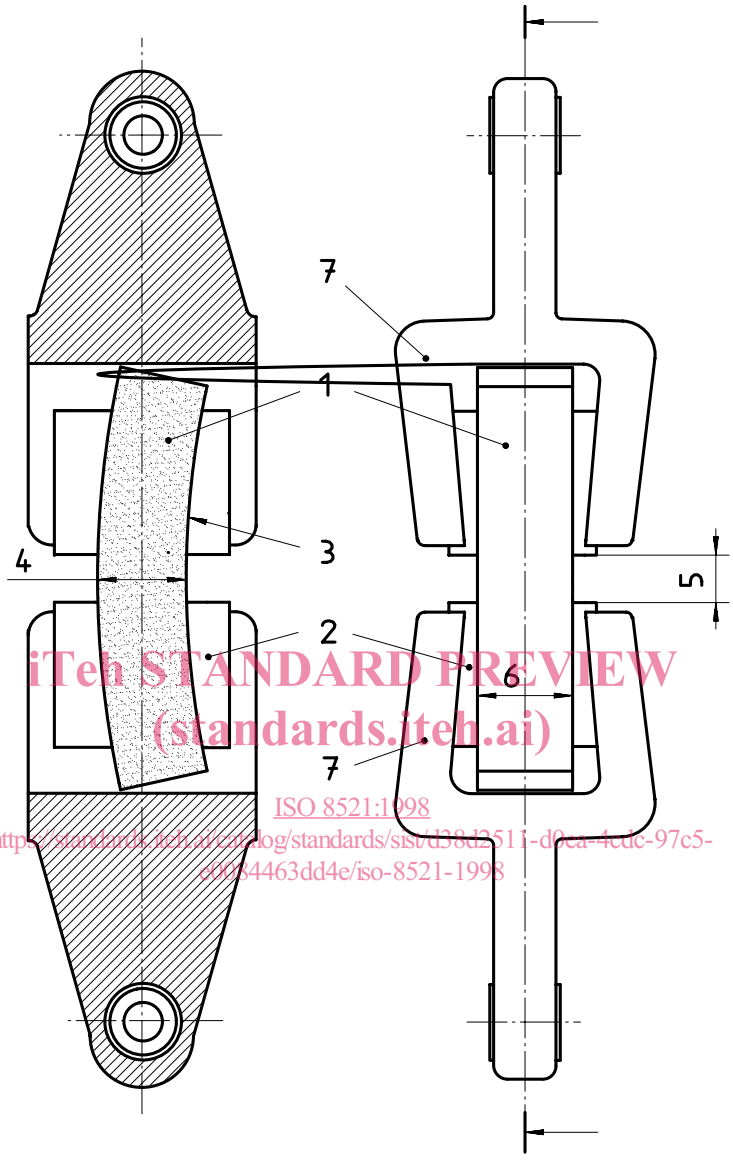
For case 1 the total width, b_{tot}, shall be as specified in the referring standard but at least (25 ± 0,5) mm.

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

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

5.4 For method D

The test piece (see figure 6) shall be cut from the pipe in the circumferential direction.



Key

1 Test piece
2 Tapered clamp
3 Inside diameter
4 Pipe wall thickness, e
5 Distance between grips (between 10 mm and 20 mm)
6 Width of test piece, b (10 mm min.)
7 Grip

Figure 6 — Typical test arrangement for modified strip test

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

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

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.