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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
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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);

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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 %.

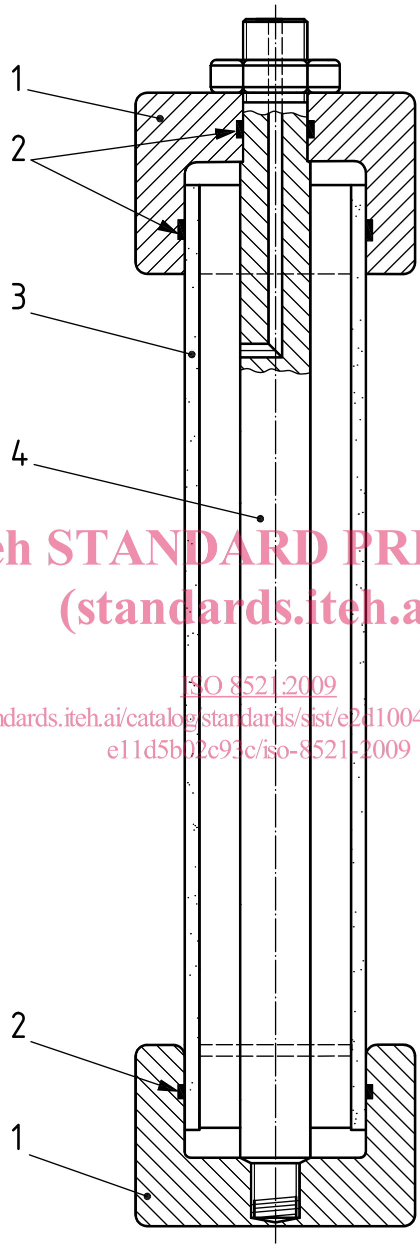
4.1.3 End sealing devices for the test pieces, capable of inducing in the test piece, during the test, a mainly uniaxial state of stress in the circumferential direction in the test piece (see Figure 1).

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;

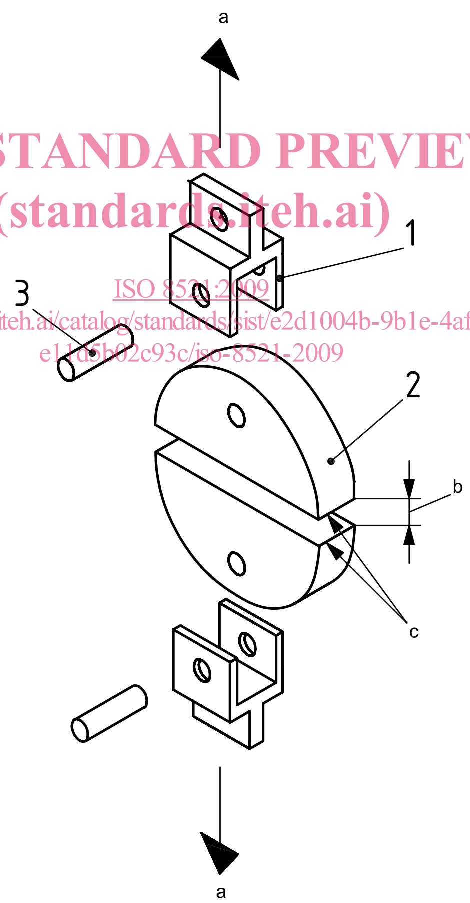
b) a moveable part;

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).

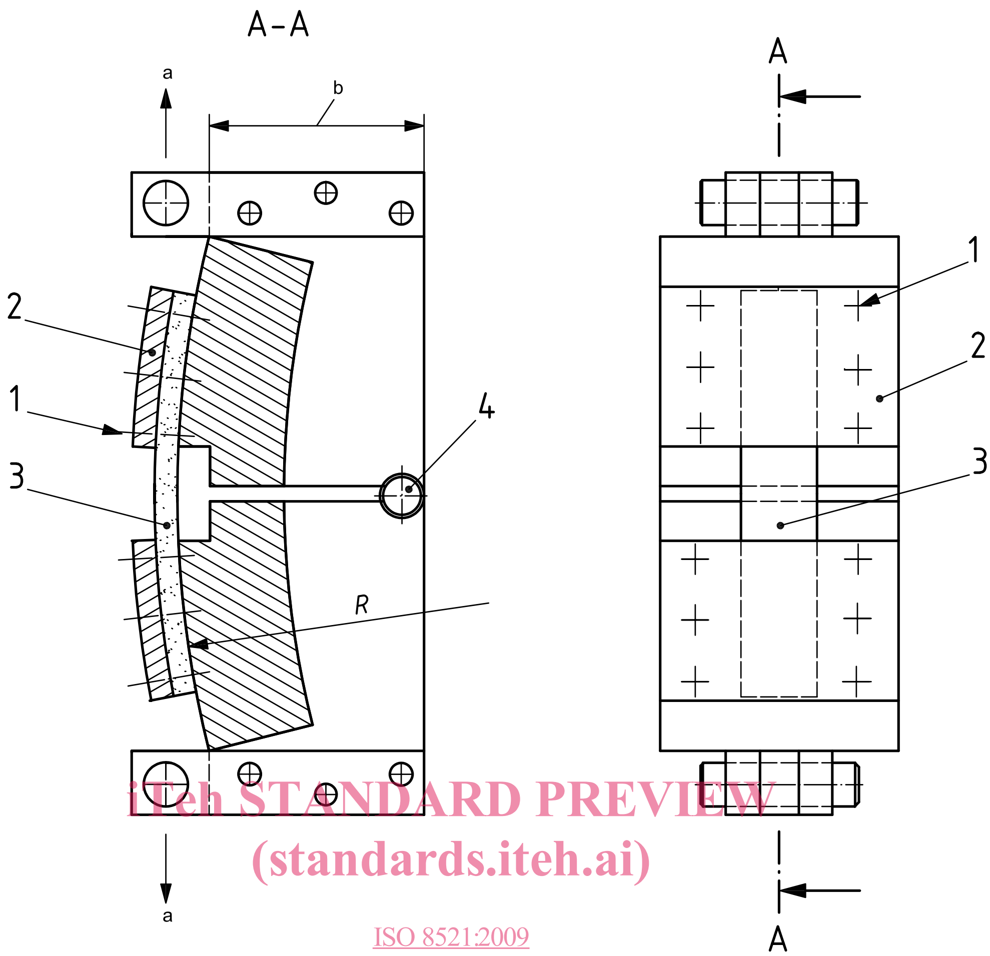
4.4.2 Dimension measuring device(s), capable of measuring the necessary dimensions of the test piece to an accuracy of ± 0,1 mm.

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°.

