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# Glass-reinforced thermosetting plastic (GRP) pipes — Test methods for the determination of the initial circumferential tensile wall strength

*Tubes en plastiques thermodurcissables renforcés de verre (PRV) — Méthodes d'essai pour la détermination de la résistance à la traction circonférentielle initiale de la paroi*



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# Contents

Page


**Foreword** .... **iv**

**1 Scope** .... **1**

**2 Normative references** .... **1**

**3 Terms and definitions** .... **1**

**4 Principle** .... **2**
- 4.1 General .... 2
- 4.2 Method A .... 3
- 4.3 Method B .... 3
- 4.4 Methods C, D and E .... 3
- 4.5 Method F .... 3

**5 Apparatus** .... **3**
- 5.1 For method A .... 3
- 5.2 For method B .... 4
- 5.3 For method C .... 6
- 5.4 For method D .... 7
- 5.5 For method E .... 7
- 5.6 For method F .... 8

**6 Test pieces** .... **9**
- 6.1 For method A .... 9
- 6.2 For method B .... 9
- 6.3 For method C .... 10
- 6.4 For method D .... 11
- 6.5 For method E .... 12
- 6.6 For method F .... 13
- 6.7 Number of test pieces .... 15

**7 Conditioning** .... **15**

**8 Test temperature** .... **15**

**9 Procedure** .... **16**
- 9.1 For method A .... 16
- 9.2 For method B .... 16
- 9.3 For method C .... 17
- 9.4 For method D .... 17
- 9.5 For method E .... 17
- 9.6 For method F .... 17

**10 Calculation** .... **18**
- 10.1 For method A .... 18
- 10.2 For method B .... 18
- 10.3 For methods C, D and E .... 19
- 10.4 For method F .... 19

**11 Test report** .... **19**

# 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).

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For an explanation of the voluntary nature of standards, 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 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 third edition cancels and replaces the second edition (ISO 8521:2009), which has been technically revised.



The main changes compared to the previous edition are as follows:

— For methods C and D, an allowance for using a notched specimen has been added.

— The way to grip samples for methods C and D has been clarified.

— For method D, an alternative allowed splitting of samples lengthwise has been added.

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.

# Glass-reinforced thermosetting plastic (GRP) pipes — Test methods for the determination of the initial circumferential tensile wall strength

## 1 Scope

This document 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 document 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) is not always 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 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**
**initial circumferential tensile wall strength**
$\sigma^*_{cA}, \sigma^*_{cB}, \sigma^*_{cC}, \sigma^*_{cD}, \sigma^*_{cE}, \sigma^*_{cF}$
*ultimate tensile force* (3.4) per unit length in the circumferential direction

Note 1 to entry: The upper-case subscripts denote the method of test used.

Note 2 to entry: It is expressed in newtons per millimetre of circumference.

**3.2**
**burst pressure**
$p_{ult}$
internal pressure at *bursting* (3.3)

Note 1 to entry: It is expressed in bars[1)] or megapascals.

**3.3**
**bursting**
failure by rupture of the pipe wall

**3.4**
**ultimate tensile force**
$F_{ult}$
tensile force at failure

Note 1 to entry: It is expressed in newtons.

**3.5**
**test width**
$b$
width of the test piece in the notched area

Note 1 to entry: It is expressed in millimetres.

**3.6**
**total width**
$b_{tot}$
total width of the test piece

Note 1 to entry: It is expressed in millimetres.



**3.7**
**winding angle**
$\theta$
angle between the direction of the continuous reinforcement and the longitudinal axis of the pipe

Note 1 to entry: It is expressed in degrees.

**3.8**
**helically wound**
filament wound pipes made with a balanced *winding angle* (3.7)

# 4 Principle

## 4.1 General

It is assumed that the following test parameters are set by the referring standard:

a) for method A, the distance between end sealing devices (see 6.1);

b) the number of test pieces (see 6.7);

c) the requirements for conditioning (see Clause 7);

d) the test temperature (see Clause 8).

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

### 4.2 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 3.3). The test conditions are such that a mainly uniaxial circumferential stress is obtained.

### 4.3 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.

### 4.4 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.

### 4.5 Method F

The 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.



## 5 Apparatus

### 5.1 For method A

**5.1.1 Hydrostatic pressurising 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 pressurising system shall prevent air from entering the test piece during pressurization to failure.

**5.1.2 Pressure measuring device**, calibrated within an accuracy of ±2,0 %.

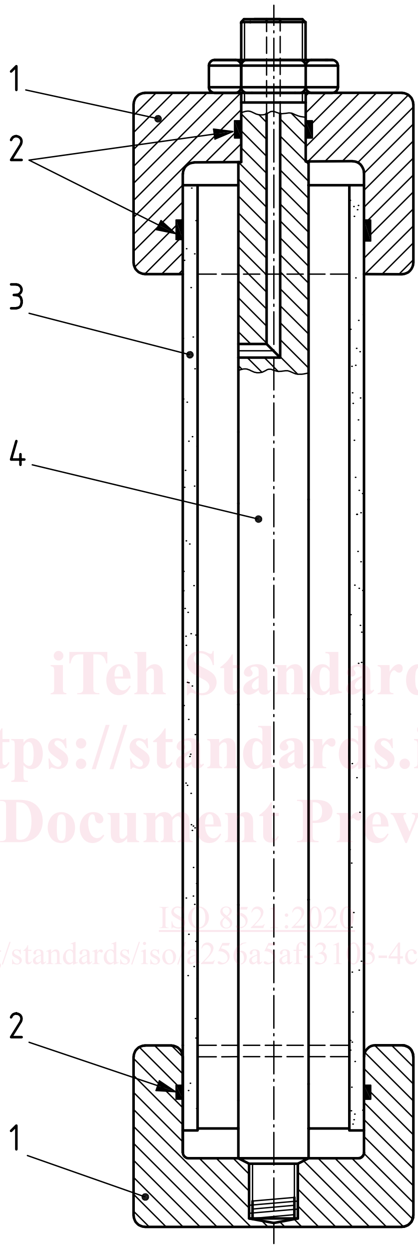
**5.1.3 End sealing devices for the test pieces**, capable of inducing in the test piece, during the test, a mainly uniaxial state of stress in the circumferential direction in the test piece (see Figure 1).

**5.1.4 Dimension measurement devices**, calibrated within an accuracy of ±0,1 mm.

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

**5.1.6 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.

**5.1.7 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)**

## 5.2 For method B

**5.2.1 Test machine**, 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;

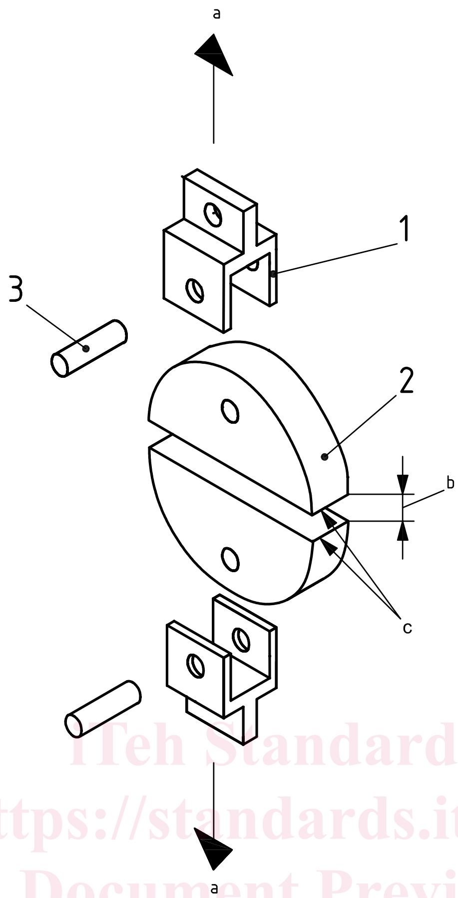
d) a load indicator, capable of measuring the force applied. This shall be virtually free from inertia at the specified rate of testing and shall indicate the force to an accuracy of within 1 % of the measured value.

**5.2.2 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.

**5.2.3 Dimension measuring devices**, calibrated within 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)**

## 5.3 For method C

**5.3.1 Test machine**, 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. Grips that tighten automatically may 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.