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# Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the ring creep properties under wet or dry conditions

*Tubes en plastiques thermodurcissables renforcés de verre (PRV) — Détermination des propriétés de fluage annulaires en conditions humides ou sèches*



Reference number
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# Contents

Page

# Foreword

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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,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 10468:2018), which has been technically revised.

The main changes are as follows:

— the Introduction has been deleted as the information is no longer relevant to this edition of the document;

— in the test report, the “plot of measured deflection versus time” has been changed from an obligation into an option of plotting deflection versus time or stiffness versus time;

— initial ring stiffness according to ISO 7685 can now be measured by constant load or constant deflection.

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 plastics (GRP) pipes — Determination of the ring creep properties under wet or dry conditions

## 1 Scope

This document specifies methods for determining the ring creep properties for glass-reinforced thermosetting plastics (GRP) pipes. Properties include the creep factor and the long-term creep stiffness. Testing is performed under either wet (total immersion in water) or dry conditions.

Dry creep testing is typically performed for the assessment and control of raw material consistency. Wet creep testing is typically undertaken to determine the long-term creep performance in simulated use conditions.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.



ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 7685, *Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial ring stiffness*

ISO 10928:2016, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analysis and their use*



## 3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

**3.1**
**vertical compressive force**
*F*
vertical force, applied to a horizontal pipe to cause a *vertical deflection* (3.7)

Note 1 to entry: Vertical compressive force is expressed in Newtons.

**3.2**
**ring stiffness**
*S*
measure of the resistance of a pipe to ring deflection, per metre of length, under external load as defined by Formula (1):

$$S = \frac{E \times I}{d_m^3} \quad (1)$$

where

$d_m$ is the *mean diameter* (3.3) of the pipe, in metres;

$E$ is the apparent modulus of elasticity as determined in a ring stiffness test, in Newtons per square metre;

$I$ is the second moment of area in the longitudinal direction per metre length, in metres to the fourth power per metre ($m^4/m$), as shown in Formula (2):

$$I = \frac{e^3}{12} \quad (2)$$

where $e$ is the wall thickness of the pipe, in metres.

Note 1 to entry: Ring stiffness is expressed in Newtons per square metre.

### 3.3
**mean diameter**

$d_m$

diameter of the circle corresponding with the middle of the pipe wall cross-section and given by either Formula (3) or Formula (4):

$$d_m = d_i + e \quad (3)$$

$$d_m = d_e - e \quad (4)$$

where

$d_i$ is the internal diameter, in metres;

$d_e$ is the external diameter, in metres;

$e$ is the wall thickness of the pipe, in metres.



Note 1 to entry: Mean diameter is expressed in metres.

### 3.4
**initial ring stiffness**

$S_0$

value of *ring stiffness*, $S$ (3.2), determined by testing in accordance with ISO 7685

Note 1 to entry: Initial ring stiffness is expressed in Newtons per square metre.

### 3.5
**long-term ring creep stiffness at position 1**

$S_{x,1,creep}$

value of *ring stiffness*, $S$ (3.2), at a reference position, position 1, at $x$ years, obtained by extrapolation of long-term stiffness measurements at a constant force ()

Note 1 to entry: See 10.2.

Note 2 to entry: Long-term ring creep stiffness at position 1 is expressed in Newtons per square metre.

### 3.6
**creep factor**

$\alpha_{x,creep}$

ratio of the long-term ring creep stiffness to the *initial ring stiffness* (3.4), both at a reference position, position 1 (see 10.2), and given by Formula (5):

$$\alpha_{x,creep} = \frac{S_{x,1,creep}}{S_{0,1}} \quad (5)$$

where

$S_{0,1}$ is the ring stiffness at position 1, in Newtons per square metre at 0,1 h;

$S_{x,1,\text{creep}}$ is the *long-term ring creep stiffness at position 1* (3.5) at time $x$, in Newtons per square metre.

**3.7**
**vertical deflection**
$y$
vertical change in diameter of a pipe in a horizontal position, in response to a *vertical compressive force* (3.1)

Note 1 to entry: Vertical deflection is expressed in metres.

**3.8**
**long-term vertical deflection**
$y_{x,1}$
value of the *vertical deflection*, $y$, (3.7) at the reference position, position 1 (see 10.2), at $x$ years

Note 1 to entry: Long-term vertical deflection is expressed in metres.

**3.9**
**deflection coefficient**
$f$
dimensionless factor which takes into account general second-order theory as applied to deflection and is given by Formula (6):



$$f = [1\ 860 + (2\ 500 \times y_1 / d_m)] \times 10^{-5} \tag{6}$$

where



$y_1$ is the *long-term vertical deflection* (3.8) at position 1, in metres;

$d_m$ is the *mean diameter* (3.3) of the pipe, in metres.

**3.10**
**calculated strain**
$\varepsilon_{\text{calc},1}$
strain on the inner surface at the crown and invert of a pipe at the reference position, position 1, given in percent by Formula (7):

$$\varepsilon_{\text{calc},1} = \frac{4{,}28 \times \dfrac{e}{d_m} \times \dfrac{y_1}{d_m} \times 100}{\left(1 + \dfrac{y_1}{2 \times d_m}\right)^2} \tag{7}$$

where

$y_1$ is the *vertical deflection* (3.7) at position 1, in metres;

$d_m$ is the *mean diameter* (3.3) of the pipe, in metres;

$e$ is the wall thickness of the pipe, in metres.

## 4 Principle

A cut length of pipe supported horizontally is loaded throughout its length to compress it diametrically to a prescribed level of strain calculated using Formula (7). The force application surfaces are either bearing plates or beam bars.

The pipe is subjected to a force which remains constant and the vertical deflection is measured at intervals. The long-term ring creep stiffness is estimated by extrapolation. For wet creep determinations the pipe is immersed in water at a given temperature.

The creep factor is then determined from the long-term ring creep stiffness and the ring stiffness of the same test piece at 0,1 h. The declared creep factor is the average of the results from two test pieces.

It is assumed that values for the following test parameters will be set by the referring standard:

a) the time to which the values are to be extrapolated (see 3.6 and 11.1);

b) the test temperature (see 5.3 and 10.1);

c) the length of the test piece (see Clause 6);

d) if applicable, the conditioning parameters, i.e. temperature, humidity and duration (see Clause 9);

e) the time limits for maintaining the test piece under load (see 10.6);

f) the level of strain at which the test is to be conducted;

g) whether the testing is to be conducted in wet or dry conditions.



## 5 Apparatus



### 5.1 Compressive loading machine

The machine shall comprise a system capable of applying a force, without shock, through two parallel force application surfaces in accordance with 5.2 so that a horizontally orientated test piece of pipe in accordance with Clause 6, immersed in water if applicable, can be compressed vertically and maintained under a constant force for the duration of the test in accordance with 10.6.

Equipment shall be capable of determining the force applied to within ±1 % of the value to be applied.

Ensure that the applied force is not affected by buoyancy effects for wet creep testing, or friction.

### 5.2 Force application surfaces

#### 5.2.1 General arrangement

The method allows the use of either bearing plates or beam bars for loading the test piece, subject to reporting the choice used. The same loading arrangement (plates, bars, or plate and bar) shall be used for the determination of both initial and long-term stiffness.

The surfaces shall be provided by a pair of plates, in accordance with 5.2.2, or a pair of beam bars, in accordance with 5.2.3, or a combination of one such plate and one such bar, with their major axes perpendicular to and centred on the direction of application of force $F$, exerted by the compressive loading machine, as shown in Figure 1. The surfaces to be in contact with the test piece shall be flat, smooth, clean and parallel.

### 5.2.2 Plates

The plate(s) shall have a width of at least 100 mm and a length at least equal to the length of the test piece (see Clause 6). They shall be sufficiently stiff so that they do not visibly bend or otherwise deform during the test.

### 5.2.3 Beam bars

Each beam bar shall be sufficiently stiff that it does not visibly bend or otherwise deform during the test. Each beam bar shall have a length at least equal to the length of the test piece (see Clause 6) and a flat face (see Figure 1) without sharp edges. The width of the flat face shall be 15 mm to 55 mm.

The beam bars shall be constructed and supported so that no other surface of the beam bar structure comes into contact with the test piece during the test.

## 5.3 Water container

If testing under wet conditions,, a container large enough to accommodate the submerged test pieces in accordance with Clause 6 while they are subject to the compressive force in accordance with 10.5, and containing tap water having a pH of 7 ± 2 and kept at the specified temperature (see 10.1).

The water level shall be maintained sufficiently constant to avoid any significant effect on the value of the vertical force applied to the test piece.

## 5.4 Measuring devices



The requirements for the measuring devices are as follows:

a) The devices used to measure dimensions (length, diameter, wall thickness) as specified in Clause 8 shall have a calibrated accuracy of within ±1 % of the dimension being measured.

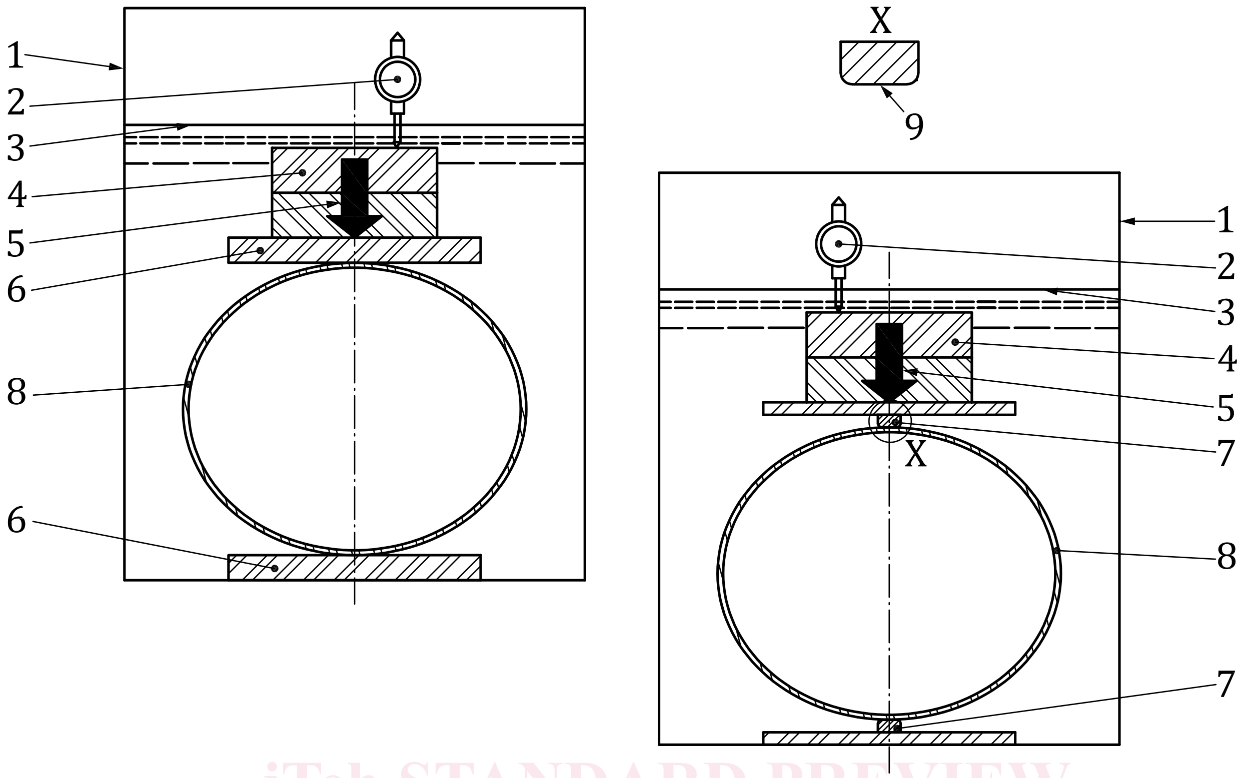
b) The devices used to measure deflection of the test piece in the vertical direction during the test shall have a calibrated accuracy of within ±1 % of the initial deflection value.

c) The devices used to measure load shall have a calibrated accuracy of ±1 % of the value applied.

When selecting the device to measure the change in diameter of the test piece, consideration should be given to the potentially corrosive environment in which the device is to be used.

# 6 Test piece

The test piece shall be a complete ring. The length, $L$, in metres, of the test piece shall be as specified in the referring standard, subject to permissible deviations of ±5 %. If not specified in the referring standard, the length of the test piece shall be (300 ± 15) mm.




a) Plate loading

b) Beam bar loading



**Key**

1 water container
2 deflection-measuring device
3 water level
4 dead-weights
5 direction of compressive force, *F*
6 bearing plate
7 beam bar
8 test piece
9 flat face

NOTE 1 For wet creep testing it is permissible for the device for measuring deflection, the dead-weights, and the bearing plate and beam bar above the test piece to be located above the water level, providing the test piece is completely immersed for the duration of the test.

NOTE 2 The test arrangements shown include a water container as would be used for wet creep testing. For dry creep testing the test arrangements are the same except for the elimination of the water and container.

**Figure 1 — Typical creep test arrangements**

The ends shall be smooth, shall be cut perpendicular to the axis of the pipe and may be sealed.

Straight lines shall be drawn on the inside or the outside along the length of the test piece and repeated at 60° intervals around its circumference, to serve as reference lines.

## 7 Number of test pieces

Two test pieces shall be used (see also 11.3).

## 8 Determination of the dimensions of the test pieces

The dimensions of the test pieces (length, thickness and mean diameter) shall be determined in accordance with ISO 3126.