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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 de la rigidité annulaire spécifique à long terme en fluage en conditions mouillées et calcul du facteur de fluage mouillé

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Foreword

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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 on 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 the following URL: 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 second edition cancels and replaces the first edition (ISO 10468:2003), which has been technically revised. It also incorporates the Amendment ISO 10468:2003/Amd1:2010.

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

— modified the title;

— clarified accuracy statements;

— combined wet and dry creep testing (ISO 7684) into a single document;

— referenced ISO 3126 for dimension determination.

Introduction

This edition of ISO 10468 includes both wet and dry creep testing. The basic procedures and calculations are the same for wet or dry creep testing with the only difference whether or not the test piece is immersed in water. This allows better maintenance of the test procedures and calculation methods and collects all material relating to creep testing of GRP pipe products into a single document. Upon publication of this edition of ISO 10468, it is intended to withdraw ISO 7684.

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 specific 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, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes — Determination of initial specific ring stiffness*

ISO 10928, *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 terminological databases for use in standardization at the following addresses:

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

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

3.1
vertical compressive force
F
vertical force, applied to a horizontal pipe to cause a vertical deflection

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

3.2
specific 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):

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

where

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), i.e.

$$I = \frac{e^3}{12} \tag{2}$$

where

e is the wall thickness of the pipe, in metres;

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

Note 1 to entry: Specific ring stiffness is expressed in newtons per square meter.

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 (4)

$$d_m = d_i + e \tag{3}$$

$$d_m = d_e - e \tag{4}$$

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 specific ring stiffness
S_0
value of S determined by testing using constant load in accordance with ISO 7685

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

3.5
long-term specific ring creep stiffness at position 1
$S_{x,1}$
value of S at a reference position, position 1 (see 10.2), at x years, obtained by extrapolation of long-term stiffness measurements at a constant force (see 3.2 and 10.2)

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

3.6
calculated long-term specific ring creep stiffness
$S_{x,\text{creep}}$

calculated value of S at x years obtained using Formula (5):

$$S_{x,\text{creep}} = S_0 \times \alpha_{x,\text{creep}} \tag{5}$$

where

x is the elapsed time, in years (or hours), specified in the referring standard;

$\alpha_{x,\text{creep}}$ is the *creep factor* (3.7);

S_0 is the initial specific ring stiffness, in newtons per square metre.

Note 1 to entry: Calculated long-term specific ring creep stiffness is expressed in newtons per square metre.

3.7
creep factor
$\alpha_{x,\text{creep}}$
ratio of the long-term specific ring creep stiffness to the initial specific ring stiffness, both at a reference position, position 1 (see 10.2), and given by Formula (6):

$$\alpha_{x,\text{creep}} = \frac{S_{x,1,\text{creep}}}{S_{0,1}} \tag{6}$$

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 specific ring creep stiffness at position 1 at time x, in newtons per square metre.

3.8
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.

3.9
long-term vertical deflection
$y_{x,1}$
value of the vertical deflection y, at the reference position, position 1 (see 10.2), at x years

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

3.10
deflection coefficient
f
dimensionless factor which takes into account general second-order theory as applied to deflection and is given by Formula (7):

$$f = \left[1\,860 + \left(2\,500 \times y_1 / d_\text{m}\right)\right] \times 10^{-5} \tag{7}$$

where

y_1 is the long-term vertical deflection at position 1, in metres;

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

3.11
calculated strain
$\varepsilon_{calc,1}$
strain on the inner surface at the crown and invert of a pipe at the reference position, position 1, given in percent by Formula (8):

$$\varepsilon_{calc,1} = \frac{4{,}28 \times \frac{e}{d_m} \times \frac{y_1}{d_m} \times 100}{\left(1 + \frac{y_1}{2 \times d_m}\right)^2} \tag{8}$$

where

y_1 is the vertical deflection 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 (8). 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 specific 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 specific 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.

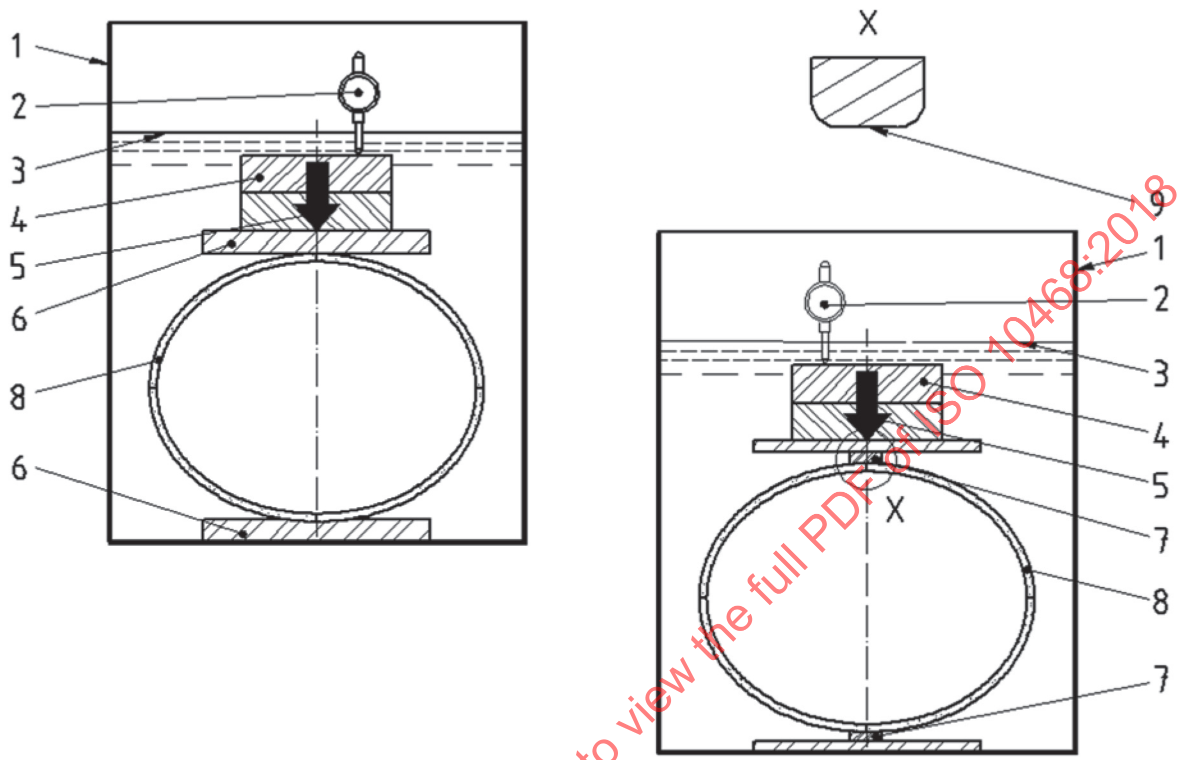
b) The devices used to measure deflection of the test piece in the vertical direction during the test shall have a calibrated accuracy of within ±1 % of the initial deflection value.

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

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).

