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Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the long-term ultimate bending strain and the long-term ultimate relative ring deflection under wet conditions

Tubes en plastiques thermodurcissables renforcés de verre (PRV) — Détermination de l'effort à la flexion ultime à long terme et déflexion annulaire relative ultime à long terme dans des conditions mouillées

Reference number
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Contents

Page

Foreword ... **iv**

1 Scope ... **1**

2 Normative references ... **1**

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

4 Principle ... **3**

5 Apparatus ... **4**
5.1 Compressive loading machine ... 4
5.2 Force application surfaces ... 5
5.2.1 General arrangement ... 5
5.2.2 Plates ... 5
5.2.3 Beam bars ... 5
5.3 Water container ... 5
5.4 Measuring devices ... 5

6 Test piece ... **6**

7 Number of test pieces ... **6**

8 Determination of the dimensions of the test pieces ... **7**
8.1 Length ... 7
8.2 Wall thickness ... 7
8.3 Mean diameter ... 7

9 Conditioning ... **7**

10 Procedure ... **7**

11 Calculation ... **8**
11.1 Extrapolation of the strain data to obtain the x-year value, $\varepsilon_{x,\mathrm{wet}}$ ... 8
11.2 Calculation of the long-term ultimate relative ring deflection under wet conditions, $y_{\mathrm{u,wet},x}/d_{\mathrm{m}}$ ... 8

12 Test report ... **8**

Annex A (informative) **Equal increments of lg (time in h)** ... **10**

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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*.

This third edition cancels and replaces the second edition (ISO 10471:2018), which has been technically revised.

The main changes are as follows:

— certain terms and definitions have been clarified and units have been changed from m to mm;

— a requirement on test temperature and pH of test water has been added in Clause 4;

— Figure 1 has been corrected concerning the level of water in the water container;

— the number of test lines in 8.1 has been corrected;

— an incorrect reference in 8.3 has been corrected;

— Clause 9 "Conditioning" has been aligned with ISO 23856.

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Glass-reinforced thermosetting plastics (GRP) pipes — Determination of the long-term ultimate bending strain and the long-term ultimate relative ring deflection under wet conditions

1 Scope

This document specifies a method for determining by extrapolation the long-term ultimate ring bending strain and for the calculation of the long-term ultimate relative ring deflection of glass-reinforced thermosetting plastics (GRP) pipes, under wet conditions.

Two methods of loading are given, one using plates the other using beam bars.

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, *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

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

3.2
mean diameter
d_m
diameter of the circle corresponding to the middle of the pipe wall cross-section and given by either of the following formulae:

$$d_m = d_i + e$$

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or

$$d_m = d_e - e$$

where

d_i is the internal diameter, in millimetres (mm);
d_e is the external diameter, in millimetres (mm);
e is the wall thickness of the pipe, in millimetres (mm)

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

3.3
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 millimetres.

3.4
relative vertical deflection
y/d_m
ratio of the *vertical deflection*, y (3.3), to the *mean diameter* (3.2) of the pipe, d_m

3.5
ultimate vertical deflection under wet conditions
$y_{u,wet}$
vertical deflection (3.3) of the pipe, y, when failure occurs under wet conditions

Note 1 to entry: Ultimate vertical deflection under wet conditions is expressed in millimetres.

3.6
ultimate relative vertical deflection under wet conditions
$y_{u,wet}/d_m$
ratio of the *ultimate vertical deflection under wet conditions*, $y_{u,wet}$ (3.5), to the *mean diameter* (3.2) of the pipe, d_m

3.7
long-term ultimate ring deflection under wet conditions
$y_{u,wet,x}$
extrapolated value of the *ultimate vertical deflection under wet conditions* (3.5) of the pipe, $y_{u,wet}$, when failure is expected to occur at a time, x, specified in the referring standard

Note 1 to entry: Long-term ultimate ring deflection under wet conditions is expressed in millimetres.

3.8
long-term ultimate relative ring deflection under wet conditions
$y_{u,wet,x}/d_m$
ratio of the long-term *ultimate ring deflection under wet conditions* (3.7) of the pipe, $y_{u,wet,x}$, to the *mean diameter* (3.2) of the pipe, d_m

3.9
failure
loss of the structural integrity of a test piece as evidenced by the inability of the test piece to carry the load or by significant, abrupt increase in deflection

3.10
time to failure
t_u
time elapsed until *failure* (3.9) occurs

Note 1 to entry: Time to failure is expressed in hours.

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3.11
ring stiffness
S
physical characteristic of a pipe, that is a measure of the resistance to ring deflection per metre length under external load and is defined by the following formula

$$S = \frac{E \times I}{d_m^3}$$

where

E is the apparent modulus of elasticity, in newtons per square metre (N/m^2), determined by testing in accordance with ISO 7685;

I is the second moment of area in the longitudinal direction per metre length, in millimetres to the fourth power per millimetre (mm^4/mm), i.e.

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

where

e is the wall thickness of the pipe, in millimetres (mm);

d_m is the mean diameter of the pipe, in millimetres (mm) (see 3.2)

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

3.12
initial ring stiffness
S_0
value of *ring stiffness S* (3.11), determined by testing in accordance with ISO 7685

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

3.13
strain factor
D_g
dimensionless factor used to transform a deflection value into a strain value

4 Principle

Each of several cut lengths of pipe is supported horizontally and loaded throughout its length to compress it diametrically to achieve a desired level of strain. The force application surfaces are either bearing plates or beam bars.

The pipe is immersed in water at a given temperature for a period of time during which the force remains constant and the increasing vertical deflection is measured at intervals until failure (see 3.9) occurs. The relative vertical deflection at failure [ultimate relative vertical deflection, $y_{u,wet}/d_m$ (see 3.6)] is converted into a bending strain at failure (ultimate bending strain, $\varepsilon_{u,wet}$, in percent), either calculated using Formula (1) or determined from a strain-deflection calibration curve (see 10.3).

The strain may also be measured directly by the use of waterproofed strain gauges.

The following strain calculations assume that the neutral axis is at the pipe wall midpoint. For pipe wall constructions that produce an altered neutral axis position, it is necessary to evaluate results by substituting $2\bar{y}$ for the wall thickness e where $\bar{y}$ is the distance from the appropriate pipe surface to the neutral axis.

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