INTERNATIONAL STANDARD

ISO 7685

First edition
1998-07-15

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

Systèmes de canalisation en matières plastiques — Tubes en plastiques thermodurcissables renforcés de verre (PRV) — Détermination de la rigidité annulaire spécifique initiale

Foreword

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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.

International Standard ISO 7685 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 CEN/TC 155, *Plastics piping systems and ducting systems*.

This International Standard is one of a series of standards on test methods for plastics piping systems and ducting systems.

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Printed in Switzerland

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

1 Scope

This International Standard specifies methods for determining the initial specific ring stiffness of glass-reinforced thermosetting plastics (GRP) pipes. Two methods are given, and within the specified deflection limits each is equally valid and may be used for any diameter.

2 Definitions

For the purposes of this International Standard, the following definitions apply:

2.1
compressive load (F)
load applied to a pipe to cause a diametric deflection

It is expressed in newtons.

2.2
vertical deflection (y)
vertical change in diameter of a pipe in a horizontal position in response to a vertical compressive load (see 2.1)

It is expressed in metres.

2.3
relative vertical deflection (y/d_m)
ratio of the vertical deflection y (see 2.2) to the mean diameter of the pipe d_m (see 2.4)

2.4
mean diameter (d_m)
diameter of the circle corresponding with the middle of the pipe wall cross-section

It is given, in metres, by either of the following equations:

$$d_m = d_i + e$$

$$d_m = d_e - e$$

where

d_i is the average of the measured internal diameters (see 5.3.3), in metres;

d_e is the average of the measured external diameters (see 5.3.3), in metres;

e is the average of the measured wall thicknesses of the pipe (see 5.3.2), in metres.

2.5
specific ring stiffness (S)
a physical characteristic of the pipe, which is a measure of the resistance to ring deflection under external load

This characteristic is determined by testing and is defined, in newtons per square metre, by the equation

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

where

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

I is the second moment of area in the longitudinal direction per metre length, expressed in metres to the fourth power per metre, i.e.

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

where

e is the wall thickness of the test piece, in metres;

d_m is the mean diameter (see 2.4) of the test piece, in metres.

2.6
initial specific ring stiffness (S_0)
initial value of S obtained by testing in accordance with this International Standard

It is expressed in newtons per square metre.

3 Principle

A length of pipe is loaded throughout its length to compress it diametrically. Two ways are given for doing this, method A (constant load) and method B (constant deflection), either of which can be used:

Method A: After applying the load necessary to give a relative deflection of (3 ± 0,5) %, the load is kept constant for a specified period of time and the final deflection is determined at the end of this period.

Method B: After applying the load necessary to give the initial relative deflection specified in the referring standard, the deflection is kept constant for a specified period of time and at the end of this period the final load being applied is determined.

NOTE — It is assumed that the following test parameters are set by the standard making reference to this International Standard:

a) the method to be used (A or B);

b) the length of the test pieces (see 5.1);

c) the number of test pieces (see 5.2);

d) if applicable, the details of conditioning of the test pieces (see clause 6);

e) for method B, the relative deflection to be applied (see 7.3.3).

4 Apparatus

4.1 Compressive-loading machine, comprising a system capable of applying, without shock, a compressive force (suitable for method A or B) at a controlled rate through two parallel load application surfaces conforming to 4.2 so that a horizontally orientated pipe test piece conforming to clause 5 can be compressed vertically. The accuracy of loading shall be ± 1 % of the maximum indicated load.

4.2 Load application surfaces

4.2.1 General arrangement

The surfaces shall be provided by a pair of plates (see 4.2.2), or a pair of beam bars (see 4.2.3), 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 the load F by the compressive-loading machine, as shown in figure 1. The surfaces in contact with the test piece shall be flat, smooth, clean and parallel.

Plates and beam bars shall have a length at least equal to that of the test piece (see clause 5) and a thickness such that visible deformation does not occur during the test.

4.2.2 Plates

The plate(s) shall have a width of at least 100 mm.

4.2.3 Beam bars

Each beam bar shall have rounded edges, a flat face (see figure 1) without sharp edges and a width dependent upon the pipe as follows:

a) for pipes with a nominal size not greater than DN 300, the width shall be 20 mm ± 2 mm;

b) for pipes of nominal sizes greater than DN 300, the width shall be 50 mm ± 5 mm.

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

4.3 Dimension-measuring instruments, capable of determining

— the necessary dimensions (length, diameter, wall thickness) to an accuracy of within ± 0,1 mm;

— the deflection of the test piece in the vertical direction to an accuracy of within ± 1,0 % of the maximum value.

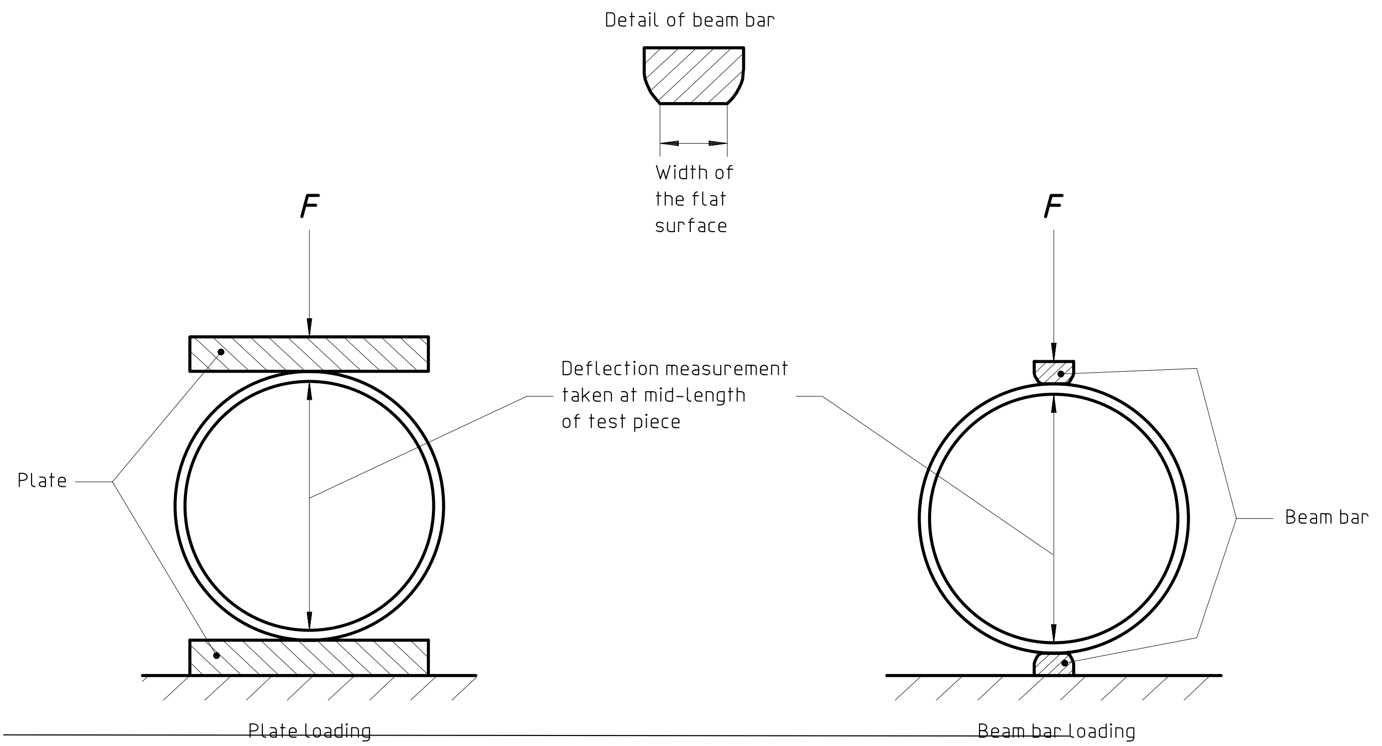

Figure 1 — Schematic diagram of the test arrangement

5 Test pieces

5.1 Preparation

Each test piece shall be a complete ring cut from the pipe to be tested. The length of the test piece shall be as specified in the referring standard, with permissible deviations of ± 5 %. Where a referring standard does not exist or does not specify the length of the test piece, the said length shall be 300 mm ± 15 mm.

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

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

5.2 Number

The number of test pieces shall be as specified in the referring standard. Where a referring standard does not exist or does not specify the number of test pieces the said number shall be one per pipe size.

5.3 Determination of dimensions

5.3.1 Length

Measure the length of the test piece along each reference line to an accuracy of 0,2 mm.

Calculate the average length L, in metres, of the test piece from the six measured values.

5.3.2 Wall thickness

Measure to within ± 0,2 mm the wall thickness of the test piece at each end of each reference line.

Calculate the average wall thickness e, in metres, of the 12 measured values.

5.3.3 Mean diameter

Measure to an accuracy of within ± 0,5 mm either of the following:

a) the internal diameter d_i of the test piece between each pair of diametrically opposed reference lines at their mid-length, e.g. by means of a pair of calipers;

b) the external diameter d_e of the test piece at the mid-points of the reference lines, e.g. by means of circumferential-wrap steel tape.

Calculate the mean diameter d_m of the test piece using the values obtained for wall thickness and either the internal or the external diameter (see 2.4).

6 Conditioning

Unless otherwise specified by the referring standard, store the test pieces for at least 0,5 h at the test temperature (see 7.1) prior to testing.

In cases of dispute, condition the test pieces for 24 h at 23 °C ± 3 °C before testing, or subject them to a mutually agreed conditioning schedule.

7 Procedure

7.1 Test temperature

Conduct the following procedure at the temperature specified in the referring standard.

7.2 Positioning of the test piece

Place a test piece in the apparatus with a pair of diametrically opposed reference lines in contact with the plate(s) and/or beam bar(s).

Ensure that the contact between the test piece and each plate or beam bar is as uniform as possible and that the plate(s) and/or beam bar(s) are not tilted laterally.

7.3 Application of load and measurement of deflection

7.3.1 General

Carry out a test in accordance with 7.3.2 or 7.3.3 at each pair of reference lines (see 5.1). Allow the test piece to recover between each test. In cases of dispute, allow 15 min between each test.

7.3.2 Method A: Using constant load

See figure 2.

Apply the compressive load at an approximately constant rate so that a relative deflection between 2,5 % and 3,5 % is reached in 60 s ± 10 s;

Keep this load constant for 2 min, and at the end of this period determine and record the load and the deflection.

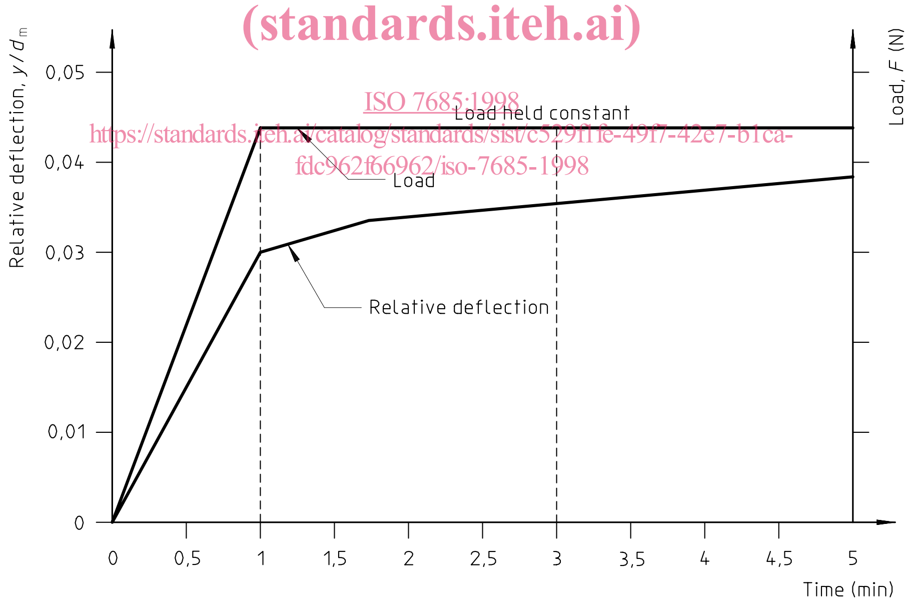

Figure 2 — Method A: Load and corresponding deflection versus time

7.3.3 Method B: Using constant deflection

See figure 3.

Apply the compressive load at an aproximately constant rate so that a relative deflection between 2,5 % and 3,5 % is reached in 60 s ± 10 s.

Keep this deflection constant for 2 min, and at the end of this period determine and record the deflection and the load.

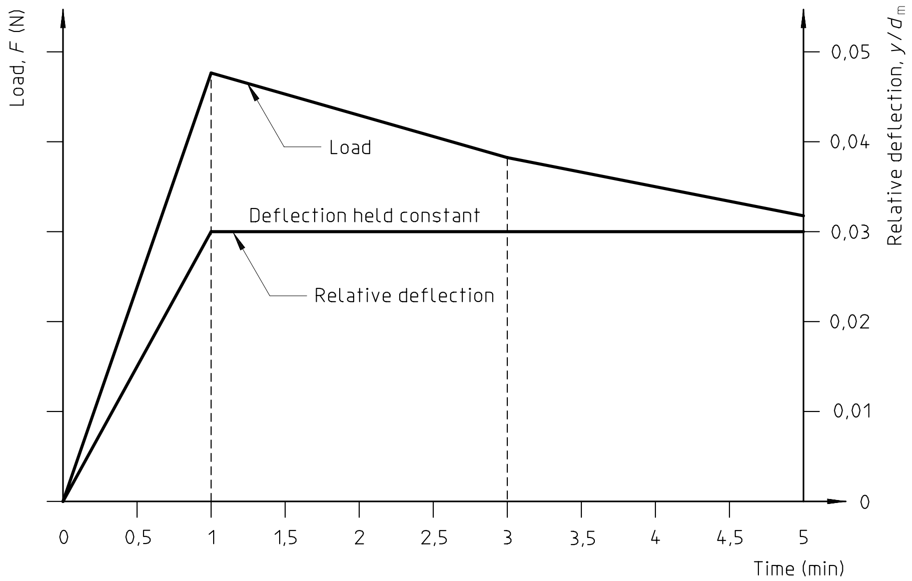

Figure 3 — Method B: Deflection and corresponding load versus time

8 Calculation

Calculate the initial specific ring stiffness S_0 for each of the three positions using the following equation:

$$S_0 = \frac{f \times F}{L \times y}$$

where

f is the deflection coefficient, given by the equation

$$f = \{1860 + (2\,500 \times y / d_m)\} \times 10^{-5};$$

L is the average length of the test piece, expressed in metres;

F is the applied load, expressed in newtons;

y is the deflection, expressed in metres;

d_m is the mean diameter, expressed in metres.

Calculate the average of the three values and record this value as the initial specific ring stiffness of the test piece.

9 Test report

The test report shall include the following information:

a) a reference to this International Standard and the referring standard;

b) all details necessary for complete identification of the pipe tested;

c) the dimensions of each test piece;

d) the number of test pieces;

e) the positions in the pipe from which the test pieces were obtained;

f) the equipment details, including whether beam bars and/or plates were used;

g) the test temperature;

h) the test method used, i.e. method A or B;

i) for each test piece, the loads and corresponding deflections used to calculate the initial specific ring stiffness;

j) the initial specific ring stiffness of each test piece;

k) any factors which may have affected the results, such as any incidents which may have occurred or any operating details not specified in this International Standard;

l) the date of the test.