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Thermoplastics pipes — Determination of ring stiffness

Tubes en matières thermoplastiques — Détermination de la rigidité annulaire

Reference number
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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.

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 9969 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Sub-Committee SC 1, *Plastics pipes and fittings for soil, waste and drainage (including land drainage)*.

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Thermoplastics pipes — Determination of ring stiffness

1 Scope

This International Standard specifies a method of determining the ring stiffness of thermoplastics pipes having a circular cross-section.

2 Symbols

The following symbols are used in this International Standard:

		Units
d_n	nominal diameter of pipe	mm
d_i	internal diameter of pipe test piece	m
F	loading force	kN
L	length of test piece	m
S	ring stiffness	kN/m^2
y	vertical deflection	m

3 Principle

The ring stiffness is determined by measuring the force and the deflection while deflecting the pipe at a constant rate.

A length of pipe supported horizontally is compressed vertically between two parallel flat plates moved at a constant speed which is dependent upon the diameter of the pipe.

A plot of force versus deflection is generated. The ring stiffness is calculated as a function of the force necessary to produce a deflection of $0{,}03d_i$ diametrically across the pipe.

4 Apparatus

4.1 Compressive-testing machine, capable of a constant rate of crosshead movement adjustable as appropriate to the nominal diameter of the pipe in conformance with table 1, with sufficient force and travel to produce the specified deflection (see clause 7) via a pair of parallel plates (4.2).

Table 1 — Deflection speeds

Nominal diameter d_n of pipe mm	Deflection speed mm/min
$d_n \leqslant 100$	2 ± 0,4
$100 < d_n \leqslant 200$	5 ± 1
$200 < d_n \leqslant 400$	10 ± 2
$400 < d_n \leqslant 1\ 000$	20 ± 2
$d_n > 1\ 000$	50 ± 5

4.2 Two steel plates, through which the compressive force can be applied to the test piece. The plates shall be flat, smooth and clean and shall not deform during the test to an extent that would affect the results.

The length of each plate shall be at least equal to the length of the test piece. The width of each plate shall be not less than the maximum width of the surface in contact with the test piece while under load plus 25 mm.

4.3 Measuring devices, capable of determining

— the length of the test piece to within 1 mm (see 5.2);

— the inside diameter of the test piece to within 0,5 %;

— the change in inside diameter of the test piece in the direction of loading with an accuracy of 0,1 mm, or 1 % of the deflection, whichever is the greater.

An example of a device for measuring the inside diameter of corrugated pipes is shown in figure 1.

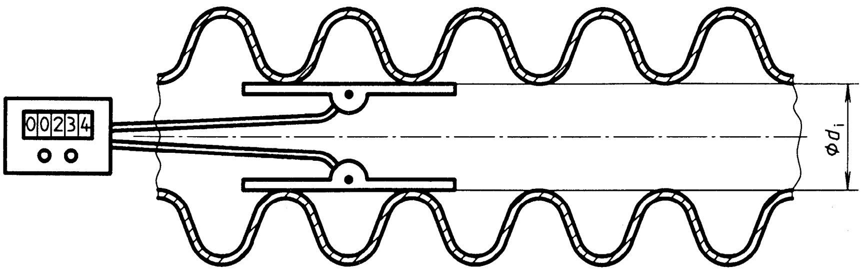


Figure 1 — Example of a device for measuring the inside diameter of a corrugated pipe

4.4 Force-measuring device, capable of determining to within 2 % the force necessary to produce a 1 % to 4 % deflection of the test piece diametrically across the test piece.

5 Test pieces

5.1 Marking and number of test pieces

The pipe for which the ring stiffness is to be determined shall be marked on the outside along its full length with a line along one generatrix. Three test pieces, **a**, **b** and **c**, respectively, shall be taken from this marked pipe such that the ends of the test pieces are perpendicular to the pipe axis and their lengths conform to 5.2.

5.2 Length of test pieces

5.2.1 The length of each test piece shall be determined by calculating the arithmetic mean of three to six length measurements equally spaced around the perimeter of the pipe as given in table 2. The length of each test piece shall conform to 5.2.2, 5.2.3, 5.2.4 or 5.2.5, as applicable.

Table 2 — Number of length measurements

Nominal diameter d_n of the pipe mm	Number of length measurements
$d_n \leqslant 200$	3
$200 < d_n < 500$	4
$d_n \geqslant 500$	6

Each of the three to six length measurements shall be made to within 1 mm.

For each individual test piece, the smallest of the three to six length measurements shall not be less than 0,9 times the largest measurement.

5.2.2 For pipes that have nominal diameters less than or equal to 1 500 mm, the average length of each test piece shall be 300 mm ± 10 mm.

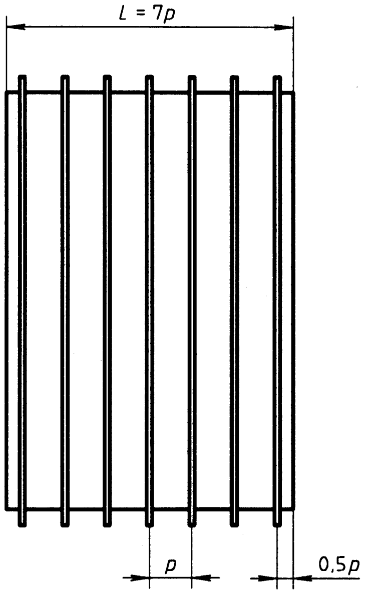
5.2.3 For pipes that have nominal diameters greater than 1 500 mm, the average length, in millimetres, of each test piece shall be at least $0{,}2d_n$.

5.2.4 Structured-wall pipes with perpendicular ribs or corrugations or other regular structures shall be cut such that each test piece contains the minimum whole number of ribs, corrugations or other structures necessary to satisfy the requirement on length given in 5.2.2 or 5.2.3, as applicable (see figure 2).

The cuts shall be made at the mid-point between the ribs, corrugations or other structures.

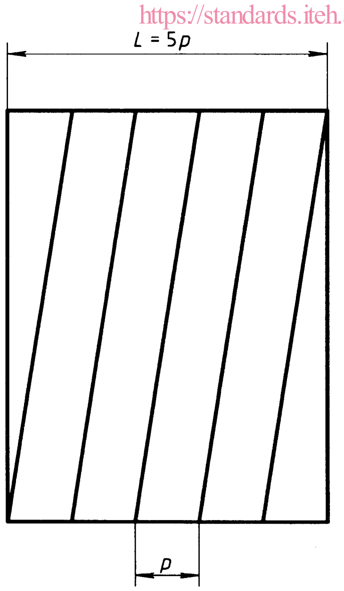
5.2.5 For helically wound pipes (see figure 3), the length of each test piece shall be such that it contains the minimum whole number of helical windings necessary to satisfy the requirement on length given in 5.2.2 or 5.2.3, as applicable.

For pipes with helical stiffeners in the form of ribs, corrugations, etc., the length of each test piece shall be such that it comprises a whole number of stiffeners, with a minimum of three, and shall conform to 5.2.2 or 5.2.3, as applicable.



e.g. $p = 45$ mm

Figure 2 — Test piece cut out of a perpendicularly ribbed pipe



e.g. $p = 65$ mm

Figure 3 — Test piece cut out of a helically wound pipe

5.3 Inside diameter of test pieces

Determine the inside diameters d_{ia}, d_{ib} and d_{ic} of the respective test pieces **a**, **b** and **c** (see 5.1) as the arithmetic mean of four measurements obtained at 45° intervals on one cross-section at mid-length, each measurement being made to within 0,5 %.

Record the calculated mean inside diameter d_{ia}, d_{ib} and d_{ic} for each test piece **a**, **b** and **c**, respectively.

Calculate the average value d_i of these three values using the following equation:

$$d_i = \frac{d_{ia} + d_{ib} + d_{ic}}{3}$$

5.4 Age of test pieces

At the start of the test, the age of the test pieces shall be at least 24 h.

For type testing, and in cases of dispute, the age of the test pieces shall be 21 days ± 2 days.

6 Conditioning

Condition the test pieces in air at the test temperature (see 7.1) for at least 24 h immediately prior to testing.

7 Procedure

7.1 Unless otherwise specified in the referring standard, carry out the test procedure at 23 °C ± 2 °C or, in countries where 27 °C is used as the standard laboratory temperature, at 27 °C ± 2 °C.

In cases of dispute, 23 °C ± 2 °C shall be used.

NOTE 1 It is probable that the test temperature has an influence on the ring stiffness.

7.2 If it can be determined in which position the test piece has the lowest ring stiffness, place the first test piece **a** in this position in the compressive-testing machine.

Otherwise, place the first test piece in such a way that the marking line is in contact with the upper plate.

Rotate the two others **b** and **c** by 120° and 240°, respectively, in relation to the first test piece when placing them in the testing machine.

7.3 For each test piece, attach the deflection gauge and check the angular position of the test piece with respect to the upper plate.

Position the test piece with its longitudinal axis parallel to the plates and centre it laterally in the testing machine.

Bring the upper plate in contact with the test piece with no more force than is needed to hold it in position.

Compress the test piece at the constant speed specified in table 1, while continuously recording force and deflection in conformance with 7.4, until a deflection of at least $0{,}03d_i$ is reached.

NOTE 2 When determination of ring flexibility is required, compression may be continued until the deflection required for ring flexibility has been reached.

7.4 Typically, the force and deflection measurements are generated continuously by measuring the displacement of one of the plates, but if, during the test, the pipe-wall height e_c (see figure 4) changes by more than 10 %, generate the force/deflection plot by measuring the change in the inside diameter of the test piece.

If the force deflection plot, which is typically a smooth curve, indicates that the zero point may be incorrect, as shown in figure 5, extrapolate back the initial straight-line portion of the curve and use the intersect with the horizontal axis as the (0,0) point (origin).

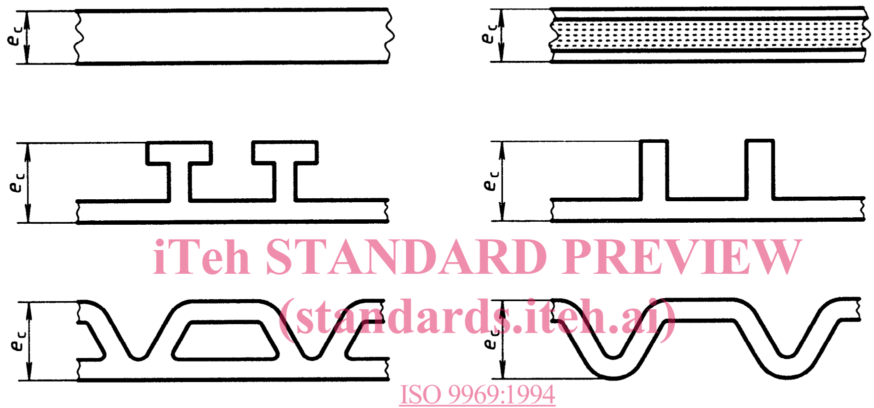


Figure 4 — Examples of the pipe-wall height e_c

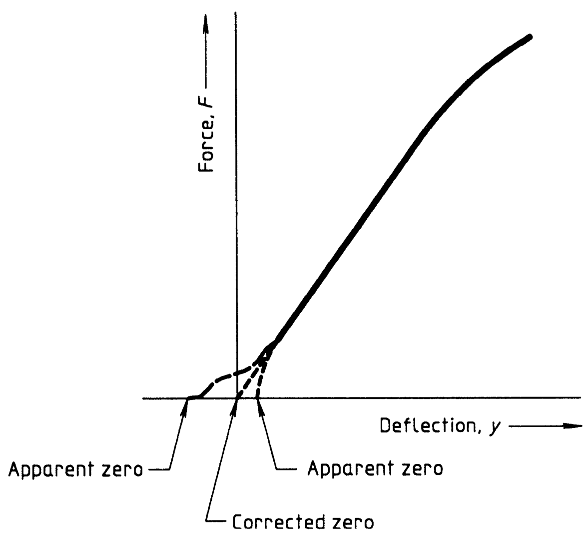


Figure 5 — Method of correcting the origin

8 Calculation of ring stiffness

Calculate the ring stiffness of each of the three test pieces **a**, **b** and **c**, using the following equations:

$$S_a = \left(0{,}018\,6 + 0{,}025\,\frac{y_a}{d_i}\right)\frac{F_a}{L_a y_a}$$

$$S_b = \left(0{,}018\,6 + 0{,}025\,\frac{y_b}{d_i}\right)\frac{F_b}{L_b y_b}$$

$$S_c = \left(0{,}018\,6 + 0{,}025\,\frac{y_c}{d_i}\right)\frac{F_c}{L_c y_c}$$

where

F is the force, in kilonewtons, corresponding to 3,0 % pipe deflection;

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

y is the deflection, in metres, corresponding to 3,0 % deflection, i.e.

$$\frac{y}{d_i} = 0{,}03$$

Calculate the ring stiffness of the pipe, in kilonewtons per square metre, as the mean of these three values, using the following equation:

$$S = \frac{S_a + S_b + S_c}{3}$$

9 Test report

The test report shall include the following information:

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

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

— the manufacturer,

— the type of pipe (including the material),

— the dimensions,

— the nominal stiffness and/or the pressure class,

— the date of production,

— the age of the pipe at the date of test,

— the length L_a, L_b and L_c of the test pieces;

c) the test temperature;

d) the calculated values S_a, S_b and S_c of the ring stiffness for each test piece, to three decimal places;

e) the calculated value of the ring stiffness S, to two decimal places;

f) if required, the force/deflection plot for each test piece;

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

h) the date of the test.

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