INTERNATIONAL STANDARD

ISO 13967

Second edition
2009-12-15

Thermoplastics fittings — Determination of ring stiffness

Raccords en matières thermoplastiques — Détermination de la rigidité annulaire

Reference number
ISO 13967:2009(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13967 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

This second edition cancels and replaces the first edition (ISO 13967:1998), which has been technically revised.

Thermoplastics fittings — Determination of ring stiffness

1 Scope

This International Standard specifies a method of determining the ring stiffness of bends and branches made from thermoplastic material and for use with plastics pipes having a circular cross-section.

The method can be used to determine the stiffness of bends, equal branches and unequal branches, provided the fitting allows a diametric deflection of at least 4 %.

NOTE 1 If a fitting has the same wall thickness, wall construction, material and diameter as a pipe tested according to ISO 9969, then, because of its geometry, its stiffness can be equal to or greater than that of the pipe. In this case, the fitting can be classified as having the same stiffness class as the pipe, without testing.

NOTE 2 Any unequal branch can be expected to have at least the same stiffness as an equal branch, provided that it has the same main diameter, wall construction and material as the equal branch.

NOTE 3 A reducer having the same wall thickness, wall construction and material in the transition zone as a tested bend or branch can be expected to have at least the same stiffness as the tested bend or branch with the largest diameter of that reducer.

NOTE 4 The result of the test reflects the resistance the fitting has against deflection when installed. Advice on the significance of the test result is given in Annex A.

2 Terms and definitions

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

2.1
ring stiffness
S
mechanical characteristic of a fitting, which is a measure of the resistance to diametric deflection under an external force applied between two parallel planes, as determined in accordance with this International Standard

NOTE 1 This method uses a deflection of 3 % as the reference at which to determine this characteristic.

NOTE 2 Throughout this International Standard, the term “ring stiffness” is used. In ISO 9969 that describes a method of determining the stiffness of a plastics pipe; the word “ring” is appropriate and is used to differentiate the circumferential stiffness or ring stiffness from the axial stiffness or longitudinal stiffness. The pipe test pieces have the shape of rings. Although fittings do not have the shape of rings, to emphasize the relationship between this International Standard and ISO 9969 and to stress that in both cases the stiffness is related to the resistance of the product to diametric deflection, the word “ring” has been retained in this International Standard for the determination of the stiffness of fittings.

2.2
compressive force
compressive load
F
force applied to cause the diametric deflection during testing in accordance with this International Standard

2.3
diametric deflection
y
change in diameter caused by a compressive force

2.4
percent deflection
diametric deflection, y, expressed as a percentage of the inside diameter, D_i, of the fitting

NOTE Percent deflection is expressed as Equation (1):

$$\frac{y}{D_i} \times 100 \qquad (1)$$

2.5
fitting wall height
e_c
overall thickness of the wall of a fitting, measured across the entire cross-section of the wall

NOTE For examples of fitting wall heights, see Figure 1.

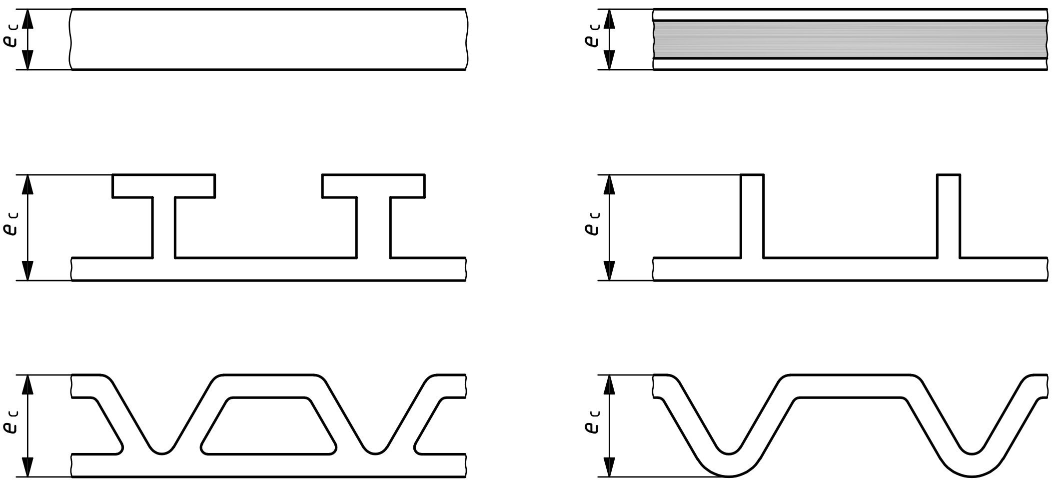


Figure 1 — Typical fitting wall heights, e_c

2.6
calculation length
L
external free length of a fitting, excluding sockets, spigots, inlet zones and half of the transition zones between body and sockets, measured along a line parallel to the fitting axis

NOTE 1 The calculation length, L, depends on the geometry of the fitting, as specified in Clause 6. See Figures 3, 4 and 5.

NOTE 2 The length of loading is normally slightly shorter than the calculation length. This difference has no significant influence on the result of the test.

3 Symbols

Symbol	Description	Unit
D_i	Inside diameter of fitting	mm
D_n	Nominal diameter of fitting	mm
e_c	Height of fitting wall	mm
F	Force	N
L	Calculation length	mm
S	Calculated ring stiffness	kN/m^2
S_a	Ring stiffness of test piece “a”	N/m^2
S_b	Ring stiffness of test piece “b”	N/m^2
S_c	Ring stiffness of test piece “c”	N/m^2
y	diametric deflection	mm

4 Principle

Test pieces shall be compressed across their diameter at a constant rate of deflection between two parallel plates. Force versus deflection data shall be generated.

The force shall be applied as a load distributed along the body of the fitting without loading the spigot(s) and/or socket(s).

The ring stiffness shall be calculated as a function of the force necessary to produce a 3 % diametric deflection of the fitting.

NOTE As fittings are normally installed with socket and spigot connections, creating zones of high stiffness, the load is only applied to the body of the fitting and the equation used to calculate the stiffness uses the length of the body and not the overall length of the fitting.

5 Apparatus

5.1 Compression testing machine, capable of a constant rate of crosshead movement appropriate to the nominal diameter of the fitting in accordance with Table 1, with sufficient force and travel to produce the specified diametric deflection via a pair of bearing plates.

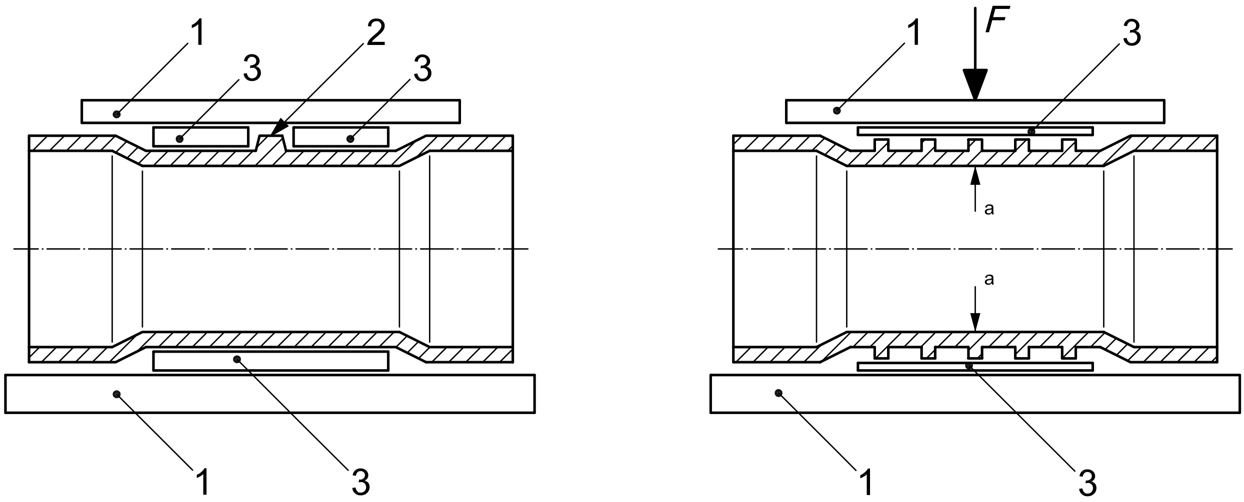
5.2 Bearing plates, capable of transferring the force and movement of the test machine (5.1) to the test piece and comprising a pair of bearing plates alone or in combination with insert plates as described in 5.2 b). If the fitting has a ribbed or structured wall construction, the plates shall make initial contact only with the top(s) of the ribs or structures (see Figure 2).

a) Bearing plates

The plates shall be flat and clean. The stiffness of the plates shall be sufficient to prevent them from deforming during the test. The geometry of the plates shall be such that the force is equally distributed over the loaded area of the test piece when the test piece is compressed over the length of loading (see Figures 3, 4 and 5), e.g. by means of insert plates. The width of the bearing plates shall be at least 50 mm. When equal branches are tested without the use of insert plates, the width of the bearing plates shall be (50 ± 1) mm.

b) Insert plates

When insert plates are needed in order to distribute the force equally over the loaded area of the test piece (see Figures 3, 4 and 5), they shall be flat and clean. The stiffness of the plates shall be sufficient to prevent them from deforming during the test. The geometry of the plates shall be appropriate to the type of fitting and shall be such that the force is applied evenly to the fitting without loading the socket(s) and/or spigot(s). The width of the plates shall be at least 50 mm. When equal branches are tested, the width shall be (50 ± 1) mm.



Key

1 bearing plate

2 injection-moulding point

3 insert plate

[a] Deflection measurement point.

Figure 2 — Typical positioning of bearing plates and insert plates for various constructions

5.3 Dimension-measuring instruments, capable of determining the following dimensions:

— the individual values of the lengths defined in 6.3, to within 1 mm;

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

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

5.4 Force-measuring instrument, capable of determining, to within 2 %, the force necessary to cause diametric deflection of the test piece up to 4 %.

6 Test pieces

6.1 Preparation

Each test piece shall comprise a complete fitting with its attachments, such as retaining caps or rings. To improve the linearity of the test curve, small protrusions on the fitting which would come into contact with the deflection plates may be removed. Alternatively, insert plates adapted to the geometry of the fitting may be used (see Figure 2).

6.2 Number

The test shall be carried out on three test pieces. They shall be marked “a”, “b” and “c”.

6.3 Determination of dimensions

6.3.1 Inside diameter

The vertical inside diameter of each test piece shall be determined at the deflection measurement point (which is at the mid-point of the overall length of the body) (see Figures 3, 4 and 5) to an accuracy of within 0,2 % or 0,1 mm, whichever is the greater.

6.3.2 Calculation length of bends

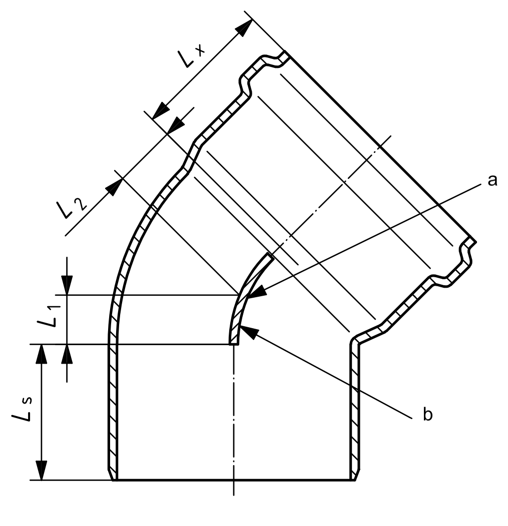
6.3.2.1 General

The method of determining the calculation length, L, of a bend depends on its bending radius at the centre line.

6.3.2.2 Bends with a radius $\leqslant$ 1,5 times nominal size of the bend

The calculation length, L, of a bend with a radius $\leqslant$ 1,5 times the nominal size shall be determined as the length $L_1 + L_2$ as shown in Figure 3 in which L_s is the spigot length as defined by the manufacturer. If L_s is not provided by the manufacturer, it shall be taken as the length L_x.

The values of L_1, L_2 and L_s shall be taken from the product drawing provided by the manufacturer or shall be measured from the product. When measured from the product, the values of L_1 and L_2 shall be determined to an accuracy of within 1 % or 1 mm, whichever is the greater.



$L = L_1 + L_2$

a Deflection measurement point.

b Length of loading.

Figure 3 — Calculation length, L, of a bend with a radius $\leqslant$ 1,5 times nominal size

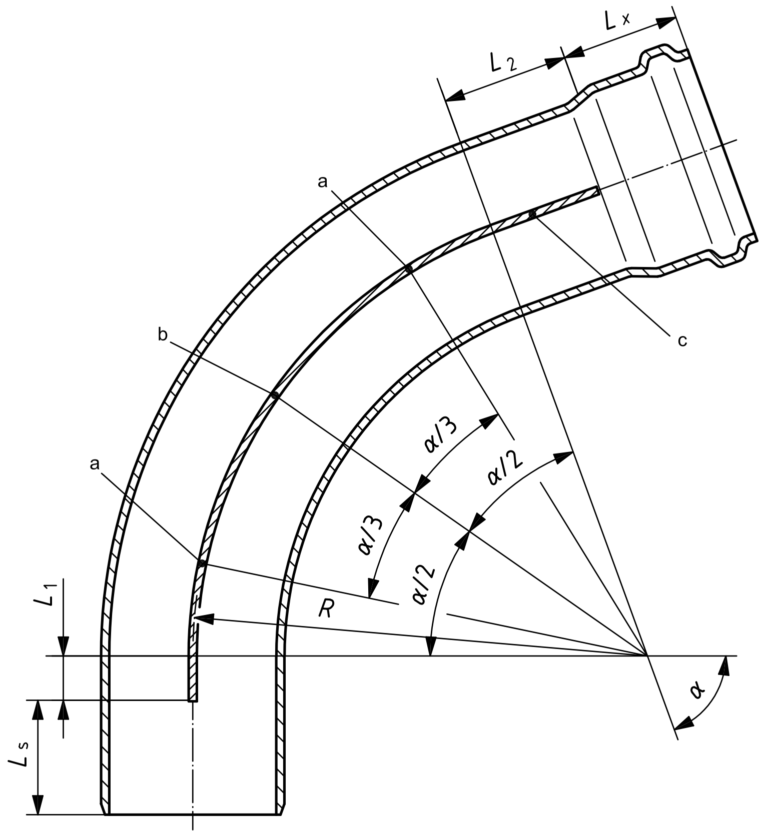
6.3.2.3 Bends with a radius > 1,5 times nominal size of the bend

The calculation length, L, of a bend with a radius > 1,5 times nominal size shall be determined in the same way as for bends with a radius $\leqslant$ 1,5 times nominal size, except that the following shall be observed:

— the length of the arc shall be calculated using the dimensions shown in Figure 4 and Equation (2):

$$L = \frac{2\pi R\alpha}{360} + L_1 + L_2 \qquad (2)$$

— if, in a bend with a radius > 1,5 times nominal size, it is impracticable to measure the change in inside diameter at the mid-point of the body, the average value of the change in inside diameter at two other points each at $\alpha/3$ from the mid-point may be taken (see Figure 4).



Key

α angle of fitting, in degrees

a Alternative deflection measurement point.

b Normal deflection measurement point.

c Length of loading.

Figure 4 — Calculation length, L, of a bend with a radius > 1,5 times nominal size

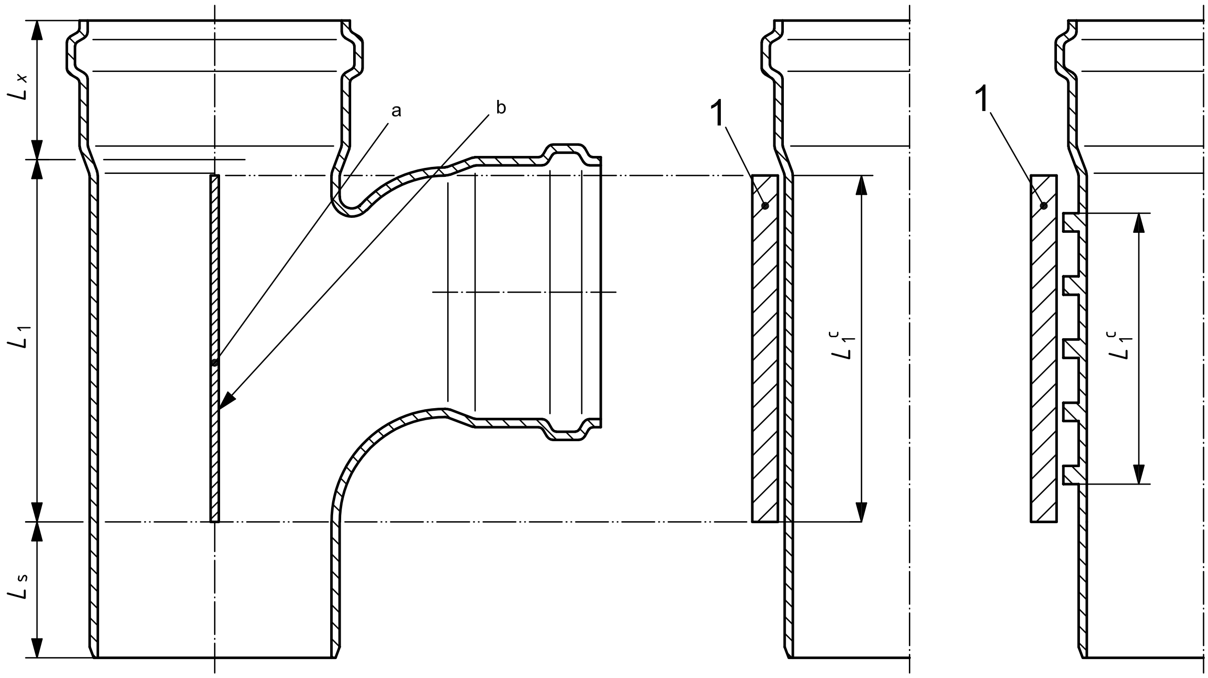
6.3.3 Calculation length of branches

The calculation length, L_1, of a branch ($L = L_1$) shall be determined as shown in Figure 5, in which L_s is the spigot length as defined by the manufacturer.

The values of L_1 and L_s shall be taken from the product drawing provided by the manufacturer or shall be measured from the product.

When measured from the product, the values of L_1 and L_s shall be measured to an accuracy of within 1 % or 1 mm, whichever is the greater.

If L_s cannot be determined, it shall be taken as the length L_x.



$L = L_1$

Key

1 insert plate

a Deflection measurement point.

b Length of loading.

c Examples of length of loading L_1.

Figure 5 — Calculation length, L, of a branch

6.4 Age

At the start of testing in accordance with Clause 9, 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 ± 2) days.

7 Conditioning

The test pieces shall be conditioned in air at the test temperature (see Clause 8) for at least 24 h immediately prior to testing in accordance with Clause 9.

8 Test temperature

Unless otherwise specified, thermoplastics fittings shall be tested at (23 ± 2) °C or, in countries where 27 °C is used as the standard laboratory temperature, at (27 ± 2) °C. In cases of dispute, (23 ± 2) °C shall be used.

9 Procedure

9.1 Place lower insert plates (see Note 1) on the lower bearing plate of the test machine such that they follow the shape of the body of the test piece and so that the socket(s) do not make contact with the bearing plates during the test.

NOTE 1 When the design of the bearing plates is such that contact between the bearing plates and the socket(s) or spigot(s) can be avoided without insert plates, the latter are not required.

When a fitting has a ribbed or structured wall construction, ensure that only the tops of the ribs or structures are in initial contact with the insert plates or bearing plates (see Figure 2).

Position a test piece with its longitudinal axis parallel to the bearing plates and centre it laterally in the test machine. In order to obtain the correct reading from the load cell, position the test piece such that the axis of the expected resulting force is approximately in line with the axis of the load cell.

NOTE 2 The position of the resulting force depends on the geometry of the fitting and the design of the transition between the socket, if any, and the body of the fitting, so an accurate determination is very difficult, but a good estimation can be made.

Unless otherwise specified, the axes of the inlets of branches shall be parallel to the bearing plates.

Place upper insert plates (see Note 1) on top of the body of the test piece such that they do not make contact with the socket(s) during the test.

Bring the upper bearing plate into contact with the upper insert plates. Use only sufficient force to hold the insert plates in position. Ensure that the contact between all the insert plates and the bearing plates is as uniform as possible.

9.2 Compress the test piece at a constant speed in accordance with Table 1, recording the force and deflection continuously as described below until a diametric deflection of at least 4 % is reached.

Table 1 — Deflection speed as a function of nominal diameter of fitting

Nominal diameter D_n	**Deflection speed** mm/min
$D_n \leqslant 100$	2 ± 0,1
$100 < D_n \leqslant 200$	5 ± 0,25
$200 < D_n \leqslant 400$	10 ± 0,5
$400 < D_n \leqslant 710$	20 ± 1
$D_n > 710$	$0{,}03 \times D_i \pm 5$ %[a]

[a] D_i shall be determined in accordance with 5.3.

The force versus deflection plot shall be generated by measuring the change in inside diameter of the test piece and the corresponding load. The vertical change in d_1 shall be measured at the centre of the body of the fitting.

Provided the fitting wall height, e_c (see Figure 1) is not reduced to less than 95 % of the original fitting wall height during the test, the force versus deflection plot may be generated by measuring the displacement of one of the bearing plates. In case of dispute, the change of inside diameter shall be used as a reference.

9.3 The force versus deflection plot is typically a smooth curve. Use its origin to determine the origin for calculation and definition of the 3 % deflection force as follows (see Figure 6):

a) Draw a vertical line at a distance of 2,5 % deflection from the origin of the force versus deflection plot ($d_{2,5}$).

   Determine the point of intersection of this line with the force-deflection curve (point D 2,5).

b) Draw a second vertical line at a distance of 3,5 % deflection from the origin of the force versus deflection plot ($d_{3,5}$).

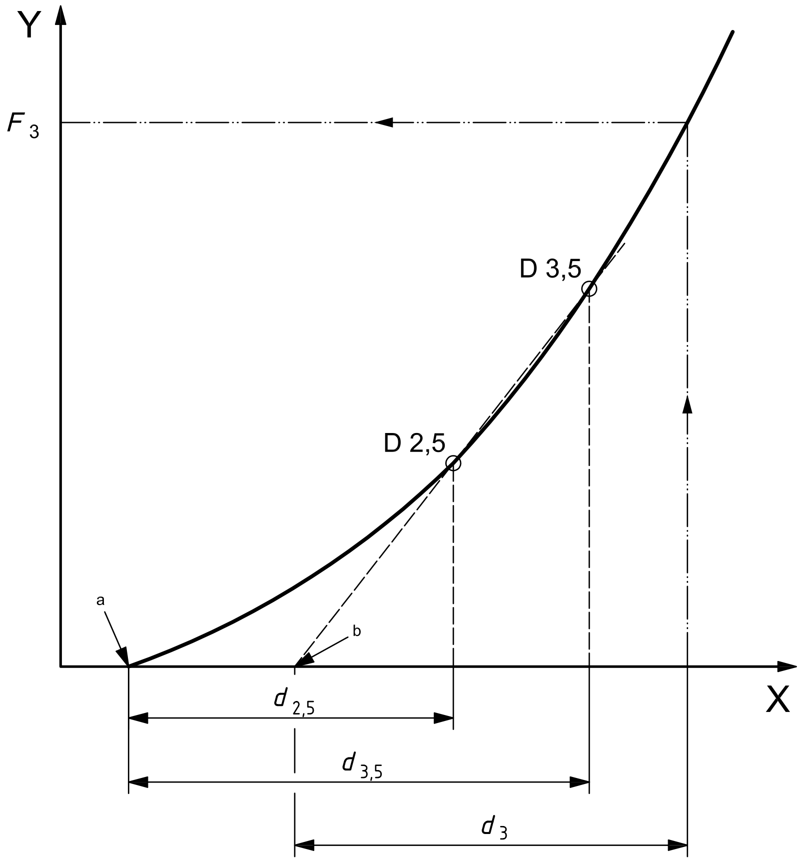
   Determine the point of intersection of this line with the force-deflection curve (point D 3,5).

c) Draw a straight line through points D 2,5 and D 3,5. Take the point of intersection of this line with the horizontal axis as the origin for calculation (point 0,0).

d) Draw a vertical line at a distance of 3 % deflection from the origin for calculation (d_3).

   Determine the point of intersection of this line with the curve and read the corresponding force, F_3, off the vertical axis.

9.4 Repeat the procedure given in 9.1, 9.2 and 9.3 for the remaining test pieces, identifying the individual results “a”, “b” and “c”, respectively.



Key

X deflection, y, in percent

Y force, F, in Newton

[a] Origin of the force versus deflection plot.

[b] Origin for calculation (point 0,0).

Figure 6 — Method of determining the origin for calculation and the 3 % deflection force

10 Calculation of ring stiffness

Calculate the ring stiffness, S, of the three individual test pieces, in newtons per square metre (N/m^2), using Equations (3), (4) and (5):

$$S_a = 18\,600 \frac{F_{3,a}}{L_a \times y_a} \qquad (3)$$

$$S_b = 18\,600 \frac{F_{3,b}}{L_b \times y_b} \qquad (4)$$

$$S_c = 18\,600 \frac{F_{3,c}}{L_c \times y_c} \qquad (5)$$

where

F_3 is the force, in newtons, which corresponds to 3 % deflection of the fitting;

L is the calculation length of the test piece, in millimetres, determined in accordance with 6.3;

y is the deflection, in millimetres, which corresponds to 3,0 % deflection.

Calculate the ring stiffness of the fitting as the arithmetic average of the three calculated values, expressed in kilonewtons per square metre (kN/m^2), using Equation (6):

$$S = \frac{S_a + S_b + S_c}{3\ 000} \tag{6}$$

Round the result to three significant figures.

11 Test report

The test report shall include at least the following information:

a) a reference to this International Standard, i.e. ISO 13967:2009 and to the referring standard, if any;

b) identification of the thermoplastics fitting, including:

1) the identification of the manufacturer;

2) the type of fitting and the fitting material;

3) the dimensions and class, either stiffness class or SDR or S series, as applicable;

4) the production date;

5) the mass of the fitting;

c) the calculation length, L, determined in accordance with 6.3.2 or 6.3.3;

d) the test temperature;

e) the details of the equipment used;

f) the values of F and y determined for each fitting tested;

g) the calculated values of the individual ring stiffness (S_a, S_b and S_c);

h) the calculated value of S;

i) the load-deflection plot for each test piece, if required;

j) the details of any factors that could have affected the results, such as any incident or operation not specified in this International Standard;

k) the date of the test.

Annex A
(informative)

Comments on the use of this test method

A.1 General

The determination of the stiffness of fittings is used for the classification of structured wall fittings.

Solid wall fittings are normally classified according to their wall-thickness/diameter ratio.

The design of fittings, however, results in different stiffness of fittings when determined in accordance with this International Standard, even if they are made from the same material and have exactly the same wall thickness/profile and other design parameters, except, for instance, bending degree.

Therefore, it is recommended to be careful and critical when expressing the results of the test in practical classification.

It is well known that with a buried pipe system, the deflection of fittings is much lower than that of the pipes with the same material, diameter and wall thickness. This indicates that even high stiffness values obtained by using this method can be realistic when considering the actual behaviour of a buried fitting.

This behaviour is due to the short free length between the joints of the fittings and their support to the fitting body combined with the geometry of the fitting.

The deflections in a given pipeline are determined more by the pipe stiffness than the fitting stiffness and a number of other characteristics of the fittings are more important than stiffness for assuring good performance of the piping system.

A brief explanation of the behaviour of various fittings subjected to this test is given in A.2.

A.2 Bends

A.2.1 Bends with a radius $\leqslant$ 1,5 times nominal size

There are great differences in the determined stiffness of bends with the same wall thickness, diameter and material depending on the bending angle. Small bending angles result in higher values than bends with larger angles.

All socket bends give higher values than socket/spigot bends.

In all cases, the values are much higher than those measured on a pipe with the same material, diameter and wall thickness/profile.

A.2.2 Bends with a radius $>$ 1,5 times nominal size

Since the calculation length of a long radius bend is much longer than for a short radius bend and the support from the transition to the socket(s)/spigot(s) remains in principle the same, the measured stiffness is closer to that expected if measured on a pipe of the same material, diameter and wall thickness/profile.

A.3 Branches

There are great differences in the determined stiffness of branches with the same material, angle, diameter and wall thickness/profile, depending on whether they are equal or reduced.

All socket branches give higher values than socket/spigot branches.

Large connection angles give higher values than smaller connection angles.

The equal branch shows a value close to the one expected from a pipe of the same material, angle, diameter and wall thickness/profile.

A reduced branch shows a higher value than an equal branch of the same material, angle, diameter and wall thickness/profile.

Bibliography

[1] ISO 9969, *Thermoplastics pipes — Determination of ring stiffness*

ICS 23.040.45

Price based on 14 pages