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Thermoplastics pipes — Determination of creep ratio

Tubes en matières thermoplastiques — Détermination du taux de fluage

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Foreword

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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 9967 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 9967:1994), which has been technically revised.

Introduction

Experience shows that when a pipe is installed in the soil in accordance with an appropriate code of practice its increase in deflection virtually stops after a short period. Depending on the soil and installation conditions this period will vary but normally not exceed two years.

Therefore, the two-year creep ratio as determined in accordance with this International Standard is intended for use when long-term static calculations are carried out.

The theory of creep in thermoplastics materials is briefly explained in Annex A.

For experiments, the test can be carried out based on other ages of the test pieces, other test temperatures and/or other test durations.

Thermoplastics pipes — Determination of creep ratio

1 Scope

This International Standard specifies a method for determining the creep ratio of thermoplastics pipes having a circular cross-section.

2 Symbols

		Unit
d_n	nominal diameter of pipe	mm
d_i	inside diameter of test piece of pipe	mm
F	loading force	kN
F_0	pre-load force	N
L	length of test piece	mm
y_0	measured initial deflection	mm
Y_t	calculated deflection at time t	mm
Y_2	extrapolated two-year deflection	mm
δ	vertical deflection used to determine the loading force	mm
γ	creep ratio	

3 Principle

A cut length of pipe is placed between two parallel flat horizontal plates and a constant compressive force is applied for 1 008 h (42 days).

The deflection of the pipe is recorded at specified intervals so as to prepare a plot of pipe deflection against time. The linearity of the data is analysed and the creep ratio is calculated as the ratio between the two years' extrapolated deflection value and the measured 6 min (0,1 h) deflection.

NOTE It is assumed that the test temperature, as appropriate (see 7.1), is set by the referring standard.

4 Apparatus

4.1 Compressive loading machine, capable of applying via plates (4.2) and maintaining to within 1 % both the applicable pre-load force, F_0 (see 7.4), and the necessary loading force, F (see 7.5), on the pipe.

The force may be applied either directly or indirectly, e.g. by use of a lever arm arrangement.

4.2 Two 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 contact surface with the test piece while under load plus 25 mm.

4.3 Dimensional measuring devices, capable of determining:

— individual values for the length of a test piece (see 5.2) to within 1 mm;

— the inside diameter of a test piece to within 0,1 mm or 0,2 % d_i, whichever is the greater;

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

The change in inside diameter may be measured inside the pipe or be determined from the movement of the upper plate. In case of dispute the inside diameter shall be used as reference.

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

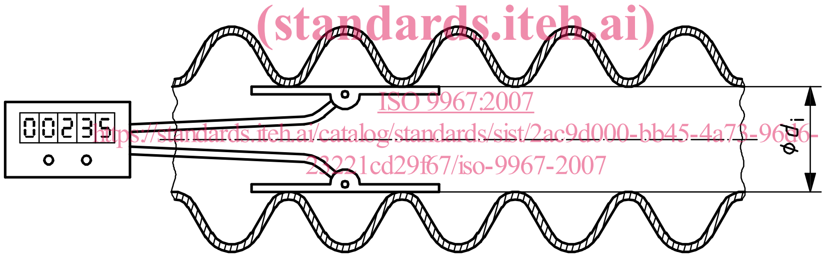


Figure 1 — Example of device for measuring the inside diameter of a corrugated pipe

4.4 Timer, capable of determining the first 6 min with an accuracy to within 1 s and the remaining times to within 0,1 % (see 7.5 and 7.6).

5 Test pieces

5.1 Marking and number of test pieces

The pipe of which the creep ratio is to be determined shall be marked on its outside with a line along one generatrix for its full length. 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 average of three to six measurements of length equally spaced around the perimeter of the pipe as given in Table 1. The length of each test piece shall conform to 5.2.2, 5.2.3, 5.2.4 or 5.2.5, as applicable.

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

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

Table 1 — Number of length measurements

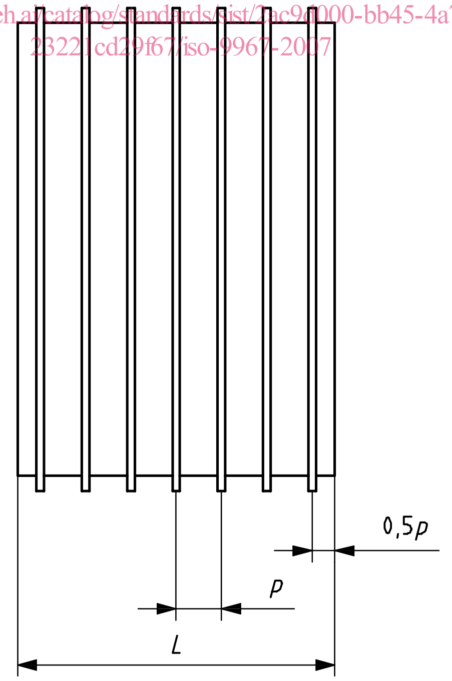
Nominal diameter, d_n, of pipe mm	Number of length measurements
$d_n \leqslant 200$	3
$200 < d_n < 500$	4
$d_n \geqslant 500$	6

5.2.2 For pipes that have a nominal diameter, d_n, less than or equal to 1 500 mm, the average length of the test pieces shall be (300 ± 10) mm.

5.2.3 For pipes that have a nominal diameter, d_n, larger than 1 500 mm, the average length of the test pieces in millimetres shall be at least $0{,}2d_n$.

5.2.4 Structured wall pipes with perpendicular ribs, corrugations or other regular structures shall be cut such that each test piece contains a whole number of ribs, corrugations or other structures. The cuts shall be made at the mid-point between the ribs, corrugations or other structures.

The length of the test pieces shall be the minimum whole number of ribs, corrugations or other structures resulting in a length of 290 mm or greater, or $0{,}2d_n$ or greater for pipes larger than 1 500 mm.



Key

p pitch

L test piece length

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

5.2.5 Structured-wall pipes with helical ribs, corrugations or other regular structures shall be cut square such that the length of the test pieces is equal to the inside diameter ± 20 mm but not less than 290 mm or greater than 1 000 mm.

5.3 Inside diameter of test piece(s)

The inside diameters, d_{iA}, d_{iB} and d_{iC}, of the respective test pieces, A, B and C (see 5.1), shall be determined either as

a) the arithmetic average of four measurements at 45° intervals of one cross-section at mid-length, where each measurement shall be determined to within 0,1 mm or 0,2 % d_i, whichever is the greater, or

b) measured at mid-length of cross-section by means of a π-tape in accordance with ISO 3126 [1].

NOTE ISO 3126 is listed in the Bibliography because the user has the choice of whether to use it [option b) or option a)]. However, if option b) is chosen, ISO 3126 can be considered as being indispensable to the use of this International Standard and thus a normative reference.

The calculated or measured average inside diameter for each test piece, A, B and C, shall be recorded as d_{iA}, d_{iB} and d_{iC} respectively.

The average value, d_i, of these three calculated values shall be calculated using Equation (1):

$$d_i = \frac{d_{iA} + d_{iB} + d_{iC}}{3} \tag{1}$$

5.4 Age of test pieces

At the start of testing in accordance with Clause 7, the age of the test pieces shall be (21 ± 2) days.

6 Conditioning

The test pieces shall be conditioned in air at the test temperature (see 7.1) for at least 24 h immediately prior to testing in accordance with Clause 7.

7 Test procedure

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

In case of dispute, (23 ± 2) °C shall be used.

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 its loading device.

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

Rotate the two others, B and C, 120° and 240° respectively, in relation to the position of the first test piece when placing them in their loading devices.

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

7.4 Lower the loading plate until it touches the upper part of the test piece.

Apply one or the other of the following pre-load forces, F_0, as applicable, rounded to the next higher integer if calculated from Equation (2) [see Item b)] and, if applicable, taking the mass of the loading plate into account:

a) for pipes with d_n less than or equal to 100 mm, F_0 shall be 7,5 N.

b) for pipes with d_n larger than 0,1 m, F_0 shall be calculated using the Equation (2) and rounding the result where necessary to the next higher integer:

$$F_0 = 0{,}000\,25 d_n \times L \qquad (2)$$

where

F_0 is the calculated pre-load, in newtons;

d_n is the nominal outside diameter of the pipe, in millimetres;

L is the calculated average length of the test piece, in millimetres.

The applied pre-load force shall be between 95 % and 105 % of the calculated force.

7.5 Within 5 min of having applied the pre-load force, F_0, adjust the deflection gauge to zero and commence applying to the test piece an increasing compressive force such that after between 20 s and 30 s a loading force, F, is achieved. This force, F, shall be chosen such that after 360 s (6 min) the test piece shows a deflection ratio of (1,5 ± 0,2) %, i.e.:

$$\frac{\delta}{d_i} = 0{,}015 \pm 0{,}002 \qquad (3)$$

At the moment that the full force F is achieved, start the timer.

7.6 Determine the initial deflection, y_0, 6 min after the application of the full load. Then determine the deflection after application of the full load after 1 h, 4 h, 24 h, 168 h, 336 h, 504 h, 600 h, 696 h, 840 h and 1 008 h.

If the value of y_0 is outside the limits specified in 7.5, interrupt the test, recondition the test piece for at least one hour and restart the test at 7.3.

Where it is not possible to read the deflection gauges at the appropriate times between 500 h and 1 008 h, it is permitted to deviate by ± 24 h, providing the actual time for measurement is used for plotting in accordance with Clause 8.

EXAMPLE Instead of reading at 840 h, the deflection is read after 862 h. In this case the value of 862 h is used in the regression analysis.

NOTE When the creep test is started on a Monday or Thursday, interference with weekends does not occur.

8 Determination of the creep ratio

8.1 For each of the three test pieces, plot the deflection in metres against the logarithm of time in hours in a single logarithmic co-ordinate system (see Figure 3) and determine by linear regression the equation of the straight line:

$$Y_t = B + M \log t \qquad (4)$$