International Standard

ISO 899-2

Plastics — Determination of creep behaviour —

Part 2: Flexural creep by three-point loading

Plastiques — Détermination du comportement au fluage —

Partie 2: Fluage en flexion par mise en charge en trois points

Third edition
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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical behavior*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 899-2:2003), which has been technically revised. It also incorporates the Amendment ISO ISO 899-2:2003/Amd. 1:2015.

The main changes are as follows:

— the accuracy requirements for the deflection measurement device have been updated;

— the normative references have been updated;

— the definition of "creep" has been adapted for clarity;

— the definitions for shape and dimensions of test specimens were adapted from ISO 178:2019;

— identified inconsistencies and mistakes have been corrected.

A list of all parts in the ISO 899 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plastics — Determination of creep behaviour —

Part 2:
Flexural creep by three-point loading

1 Scope

1.1 This document specifies a method for determining the flexural creep of plastics in the form of standard test specimens under specified conditions such as those of pre-treatment, temperature and humidity. It is only applicable to a simple freely supported beam loaded at mid-span (three-point-loading test).

1.2 The method is suitable for use with rigid and semi-rigid non-reinforced, filled and fibre-reinforced plastics materials (see ISO 472 for definitions) test specimens moulded directly or machined from sheets or moulded articles.

NOTE The method can be unsuitable for certain fibre-reinforced materials due to differences in fibre orientation.

1.3 The method is intended to provide data for engineering-design, quality control, research and development purposes.

1.4 The method might not be applicable for determining the flexural creep of rigid cellular plastics (attention is drawn in this respect to ISO 1209-1 and ISO 1209-2).

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 178, *Plastics — Determination of flexural properties*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 472, *Plastics — Vocabulary*

ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

ISO 16012, *Plastics — Determination of linear dimensions of test specimens*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following 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
creep
increase in strain with time under constant force, measured from the first moment when the loading of the specimen started

3.2
load
force applied to the test specimen at mid-span

Note 1 to entry: It is expressed in Newtons

3.3
flexural stress
σ
surface stress in the mid-span section of the test specimen

Note 1 to entry: It is expressed in megapascals.

Note 2 to entry: It is calculated from the relationship given in 7.1.3

3.4
deflection
s_t
distance over which the top or bottom surface of the test specimen at mid-span deviates from its unloaded original position during flexure

Note 1 to entry: It is expressed in millimetres.

3.5
flexural-creep strain
ε_t
strain at the surface of the test specimen produced by a stress at any given time *t* during a creep test

Note 1 to entry: It is calculated according to 7.1.4.

Note 2 to entry: It is expressed as a dimensionless ratio or as a percentage.

3.6
flexural-creep modulus
E_t
ratio of flexural stress to flexural-creep strain

Note 1 to entry: It is calculated as in 7.1.1.

Note 2 to entry: It is expressed in megapascals.

3.7
flexural-creep compliance
D_t
ratio of flexural-creep strain to flexural stress

Note 1 to entry: It is calculated as in 7.1.2.

Note 2 to entry: It is expressed in gigapascals^{-1}

3.8
isochronous stress-strain curve
Cartesian plot of stress versus creep strain, at a specific time after application of the load to the specimen

3.9
time to rupture
period of time the specimen is under full load until rupture

3.10
creep-strength limit
initial stress which will just cause rupture ($\sigma_{B,t}$) or will produce a specified strain ($\sigma_{\varepsilon,t}$) at a specified time *t*, at a given temperature and relative humidity

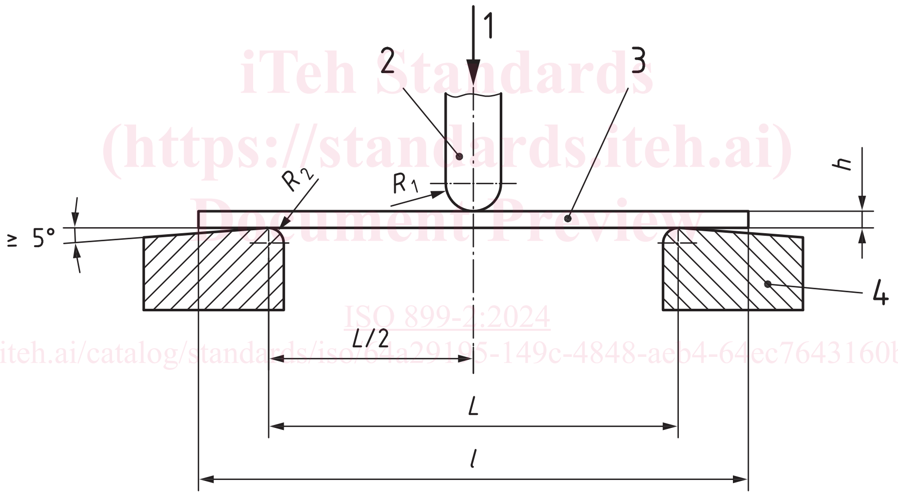
Note 1 to entry: It is expressed in megapascals.

3.11
initial distance between specimen supports
span
L
initial distance between lines of contact between test specimen and supports (see Figure 1)

Note 1 to entry: It is expressed in millimetres.

4 Apparatus

4.1 Test rack, comprising a rigid frame with two supports, one for each end of the test specimen, the distance between the supports being adjustable to (16 ± 1) times the thickness (height) of the specimen (see Figure 1) for normal specimens, or to greater than 17 times the thickness (height) of the specimen or a fixed distance (100 mm) for rigid unidirectional-fibre-reinforced test specimens (see 6.3). The test rack shall be levelled, and sufficient space shall be allowed below the specimen for the specimen to flex under constant loading at mid-span.



Key

1	applied force, *F*	*L*	initial distance between specimen supports
2	loading edge	*l*	specimen length
3	test specimen	*h*	specimen thickness
4	support	R_1	radius of the loading edge
		R_2	radius of the supports

Figure 1 — Characteristics of flexural-creep apparatus

The radius R_1 of the loading edge and the radius R_2 of the supports shall conform to the values given in Table 1.

Table 1 — Radii of the loading edge and the supports

Values in millimetres

Thickness of test specimen	Radius of loading edge R_1	Radius of supports R_2
≤ 3	5 ± 0,1	2 ± 0,2
> 3	5 ± 0,1	5 ± 0,2

4.2 Loading system, capable of ensuring that the load is applied smoothly, without causing transient overloading, and that the load is maintained to within ±1 % of the desired load. In creep-to-rupture tests, provision shall be made to prevent any shocks which occur at the moment of rupture being transmitted to adjacent loading systems. The loading mechanism shall allow rapid, smooth and reproducible loading.

4.3 Deflection-measuring device, comprising any contactless or contact device capable of measuring the deflection of the specimen under load without influencing the specimen behaviour by mechanical effects (e.g. undesirable deformations, notches), other physical effects (e.g. heating of the specimen) or chemical effects.

The deflection measurement device shall conform to class 1 of ISO 9513. At its calibration, the initial position of the deflection measurement device shall conform to its position at the unloaded specimen before test.

Data for engineering-design purposes requires the use of a deflectometer to measure the deflection of the specimen. Data for research or quality-control purposes may use the displacement between the loading edge and the supports.

4.4 Time-measurement device, accurate to 0,1 %.

4.5 Micrometer, reading to 0,01 mm or closer, for measuring the initial thickness and width of the test specimen.

4.6 Vernier callipers, accurate to 0,1 % of the span between the test supports or better, for determining the span.

5 Test specimens

5.1 Shape and dimensions

The dimensions of the test specimens shall comply with the relevant material standard and, as applicable, with 5.2 or 5.3. Otherwise, the type of specimen shall be agreed between the interested parties.

5.2 Preferred specimen type

The dimensions, in millimetres, of the preferred test specimen are:

length, l: 80 ± 2

width, b: 10,0 ± 0,2

thickness, h: 4,0 ± 0,2

In any one test specimen, the thickness within the central one third of the length shall not deviate by more than 2 % from its mean value. The width shall not deviate from its mean value within this part of the specimen by more than 3 %. The specimen cross section should preferably be rectangular, with no rounded edges.

The preferred specimen may be machined from the central part of a multipurpose test specimen complying with ISO 20753.

5.3 Other test specimens

If it is not possible or desirable to use the preferred test specimen, use a specimen with the dimensions given in Table 2.

NOTE Certain specifications require that test specimens from sheets of thickness greater than a specified upper limit be reduced to a standard thickness by machining one face only. In such cases, it is conventional practice to place the test specimen such that the original surface of the specimen is in contact with the two supports and the force is applied by the central loading edge to the machined surface of the specimen.

Table 2 — Values of specimen width, *b*, in relation to thickness, *h*

Dimensions in millimetres

Nominal thickness h	Width b[a] (± 0,5)
$1 \leq h \leq 3$	25,0
$3 < h \leq 5$	10,0
$5 < h \leq 10$	15,0
$10 < h \leq 20$	20,0
$20 < h \leq 35$	35,0
$35 < h \leq 50$	50,0

[a] For materials with very coarse fillers, the minimum specimen width shall be 30 mm.

6 Procedure

6.1 General

Flexural creep may vary significantly with differences in specimen preparation and dimensions and in the test environment. The thermal history of the test specimen can also have profound effects on its creep behaviour (see Annex A). Consequently, when precise comparative results are required, these factors shall carefully be controlled.

If flexural-creep properties are to be used for engineering-design purposes, the plastics materials should be tested over a broad range of stresses, times and environmental conditions.

6.2 Conditioning and test atmosphere

Condition the test specimens as specified in the International Standard for the material under test. In the absence of any information on conditioning, use the most appropriate set of conditions specified in ISO 291, unless otherwise agreed by the interested parties.

The creep behaviour will be affected not only by the thermal history of the specimen under test, but also by the temperature and (where applicable) humidity used in conditioning. It is recommended that a conditioning-time $\geq t_{90}$ be used.

Conduct the test in the same atmosphere as used for conditioning, unless otherwise agreed upon by the interested parties, e.g. for testing at elevated or low temperatures. Ensure that the variation in temperature during the duration of the test remains within ±2 °C.

6.3 Measurement of test-specimen dimensions and distance between supports

Measure the dimensions of the conditioned test specimens in accordance with ISO 16012 and ISO 178.

When using the preferred specimen type, adjust the initial distance between the test specimen supports, L, to

(16 ± 1) *h*

where *h* is the thickness of the specimen.

In the case of rigid unidirectional-fibre-reinforced test specimens, the distance between the supports may be adjusted to a value > 17*h* or to a fixed distance of 100 mm, if necessary, to avoid delamination by shearing or delamination in the compression zone.

Measure the distance between the supports to within ±0,5 %.

6.4 Mounting the test specimens

Mount a conditioned and measured specimen symmetrically with its long axis at right angles to the supports and set up the deflection-measuring device as required.

6.5 Selection of stress value

Select a stress value appropriate to the application envisaged for the material under test, and calculate, using the formula given in 7.1.3, the load to be applied to the test specimen.

Choose the stress such that the deflection is not greater than 0,1 times the distance between the supports at any time during the test.

6.6 Loading procedure

6.6.1 Preloading

When it is necessary to preload the test specimen prior to increasing the load to the test load, take care to ensure that the preload does not influence the test results. Do not apply the preload until the temperature and humidity of the test specimen (positioned in the test apparatus) correspond to the test conditions.

Set the load measurement system to zero before any contact with the specimen. The force applied by preload weights adds to the applied force, in case such preload weights are used.

Directly after application of the preload, set the deflection-measuring device to zero.

6.6.2 Loading

Load the test specimen progressively so that full loading of the specimen is reached between 1 s and 5 s after the beginning of the application of the load. Use the same rate of loading for each of a series of tests on one material.

Take the total load (including the preload) to be the test load.

6.7 Deflection-measurement schedule

Record the point in time at which the specimen is fully loaded as $t = 0$. Unless the deflection is automatically and/or continuously recorded, choose the times for making individual measurements as a function of the creep curve obtained from the particular material under test. It is preferable to use the following measurement schedule:

— 1 min, 3 min, 6 min, 12 min and 30 min;

— 1 h, 2 h, 5 h, 10 h, 20 h, 50 h, 100 h, 200 h, 500 h, 1 000 h, etc.

If discontinuities are suspected or observed in the creep-strain versus time plot, take readings more frequently.