INTERNATIONAL STANDARD

ISO 899-1

Second edition
2003-06-01

Plastics — Determination of creep behaviour —

Part 1:
Tensile creep

Plastiques — Détermination du comportement au fluage —
Partie 1: Fluage en traction

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.

---

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 899-1:2003
https://standards.iteh.ai/catalog/standards/sist/478516c7-41d2-42ed-9f7e-
1688a7f87663/iso-899-1-2003

Contents

iTeh STANDARD PREVIEW
(standards.iteh.ai)

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 899-1 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties*.

This second edition cancels and replaces the first edition (ISO 899-1:1993), which has been technically revised.

ISO 899 consists of the following parts, under the general title *Plastics — Determination of creep behaviour*:

— *Part 1: Tensile creep*

— *Part 2: Flexural creep by three-point loading*

Plastics — Determination of creep behaviour —

Part 1:
Tensile creep

1 Scope

1.1 This part of ISO 899 specifies a method for determining the tensile creep of plastics in the form of standard test specimens under specified conditions such as those of pretreatment, temperature and humidity.

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) in the form of dumb-bell-shaped test specimens moulded directly or machined from sheets or moulded articles.

1.3 The method is intended to provide data for engineering-design and research and development purposes. Data for engineering-design purposes requires the use of extensometers to measure the gauge length of the specimen. Data for research or quality-control purposes may use the change in distance between the grips (nominal extension).

1.4 Tensile 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 must be carefully controlled.

1.5 If tensile-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.

2 Normative references

The following referenced documents are indispensable for the application 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 62:1999, *Plastics — Determination of water absorption*

ISO 291:1997, *Plastics — Standard atmospheres for conditioning and testing*

ISO 472:1999, *Plastics — Vocabulary*

ISO 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 10350-1:1998, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*

     1

ISO 11403-1:2001, *Plastics — Acquisition and presentation of comparable multipoint data — Part 1: Mechanical properties*

3   Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and the following apply.

3.1
creep
increase in strain with time when a constant force is applied

3.2
initial stress
σ
tensile force per unit area of the initial cross-section within the gauge length

NOTE 1   It is given by the equation

$$\sigma = \frac{F}{A}$$

where

    F is the force, in newtons;

    A is the average initial cross-sectional area within the narrow (gauge) section of the specimen, in square millimetres.

NOTE 2   It is expressed in megapascals.

3.3
extension
$(\Delta L)_t$
increase in the distance between the gauge marks, expressed in millimetres, at time t

NOTE   It is given by the equation

$$(\Delta L)_t = L_t - L_0$$

where

    L_t is the gauge length, in millimetres, at any given time t during the test;

    L_0 is the original gauge length, in millimetres, of the specimen after application of a preload but prior to application of the test load.

3.4
nominal extension
$(\Delta L^*)_t$
increase in the distance between the grips (increase in grip separation)

NOTE   It is given by the equation

$$(\Delta L^*)_t = L^*_t - L^*_0$$

where

L^*_t is the distance between the grips at any given time t during the test, in millimetres;

L^*_0 is the initial distance between the grips, expressed in millimetres, holding the specimen after application of a preload but prior to application of the test load.

3.5
tensile-creep strain
ε_t
change in the distance between the gauge marks, relative to the initial distance, produced by the applied load at any given time t during a creep test

NOTE 1   It is given by the equation

$$\varepsilon_t = \frac{(\Delta L)_t}{L_0}$$

iTeh STANDARD PREVIEW
(standards.iteh.ai)

NOTE 2   It is expressed as a dimensionless ratio or as a percentage.

3.6
nominal tensile-creep strain
ε^*_t
change in the distance between the grips, relative to the initial distance, produced by the applied load at any given time t during a creep test

ISO 899-1:2003
https://standards.iteh.ai/catalog/standards/sist/478516c7-41d2-42ed-9f7e-
1688a7f87663/iso-899-1-2003

NOTE 1   It is given by the equation

$$\varepsilon^*_t = \frac{(\Delta L^*)_t}{L^*_0}$$

NOTE 2   It is expressed as a dimensionless ratio or as a percentage.

3.7
tensile-creep modulus
E_t
ratio of initial stress to tensile-creep strain, calculated as in 7.1.1

3.8
nominal tensile-creep modulus
E^*_t
ratio of initial stress to nominal tensile-creep strain, calculated as in 7.1.2

3.9
isochronous stress-strain curve
Cartesian plot of stress versus creep strain, at a specific time after application of the test load

3.10
time to rupture
period of time the specimen is under full load until rupture

3.11
creep-strength limit
initial stress which will just cause rupture ($\sigma_{\mathrm{B},t}$) or will produce a specified strain ($\sigma_{\varepsilon,t}$) at a specified time t, at a given temperature and relative humidity

3.12
recovery from creep
decrease in strain at any given time after completely unloading the specimen, expressed as a percentage of the strain just prior to the removal of the load

4   Apparatus

4.1   Gripping device, capable of ensuring that the direction of the load applied to the test specimen coincides as closely as possible with the longitudinal axis of the specimen. This ensures that the test specimen is subjected to simple stress and that the stresses in the loaded section of the specimen may be assumed to be uniformly distributed over cross-sections perpendicular to the direction of the applied load.

NOTE   It is recommended that grips be used that will allow the specimen to be fixed in place, correctly aligned, prior to applying the load. Self-locking grips which allow the specimen to move as the load increases are not suitable for this test.

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   Extension-measuring device, comprising any contactless or contact device capable of measuring the extension of the specimen gauge length or the increase in the distance between the clamp grips 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.

In the case of contactless (optical) measurement of the strain, the longitudinal axis of the specimen shall be perpendicular to the optical axis of the measuring device. To determine the increase in length of the test specimen, an extensometer shall be used which records the increase in the distance between the clamp grips. The accuracy of the extension-measuring device shall be better than ± 0,01 mm.

For creep-to-rupture tests, it is recommended that the extension be measured by means of a contactless optical system operating on the cathetometer principle. Automatic indication of time to rupture is highly desirable. The gauge length shall be marked on the specimen, either by attaching (metal) clips with scratched-on gauge marks, or by ruling the gauge marks with an inert, thermally stable paint.

Electrical-resistance strain gauges are suitable only if the material tested is of such a nature as to permit such strain gauges to be attached to the specimen by means of adhesive and only if the adhesion quality is constant during the duration of the test. The modulus of the strain gauge when bonded to the specimen shall be such that the specimen is not reinforced.

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.

5   Test specimens

Use test specimens of the same shape and dimensions as specified for the determination of tensile properties by the relevant material standard or, by default, as specified in ISO 527-2.

6 Procedure

6.1 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. If the specimen is not in humidity equilibrium, creep will be affected in the following way: a specimen which is too dry will produce an additional strain due to water absorption during the test and a specimen which is too humid will contract due to water desorption. It is recommended that a conditioning time $\geqslant t_{90}$ (see ISO 62) 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.

6.2 Measurement of test-specimen dimensions

Measure the dimensions of the conditioned test specimens in accordance with ISO 527-1:1993, Subclause 9.2.

6.3 Mounting the test specimens

Mount a conditioned and measured specimen in the grips and set up the extension-measuring device as required.

6.4 Selection of stress value

Select a stress value appropriate to the application envisaged for the material under test, and calculate, using the equation given in 3.2, the load to be applied to the test specimen.

If the initial strain is specified instead of the stress, the stress value may be calculated using Young's modulus for the material (see ISO 527-1).

6.5 Loading procedure

6.5.1 Preloading

When it is necessary to preload the test specimen prior to increasing the load to the test load, for example in order to eliminate backlash by the test gear, 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 (gripped in the test apparatus) correspond to the test conditions. Measure the gauge length after application of the preload. Maintain the preload during the whole duration of the test.

6.5.2 Loading

Load the test specimen smoothly 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.

6.6   Extension-measurement schedule

Record the point in time at which the specimen is fully loaded as t = 0. Unless the extension 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.

6.7   Time measurement

Measure, to within $\pm$ 0,1 % or $\pm$ 2 s (whichever is the less severe tolerance), the total time which has elapsed up to each creep measurement.

6.8   Temperature and humidity control

Unless temperature and relative humidity (where applicable) are recorded automatically, record them at the beginning of the test and then at least three times a day initially. When it has become evident that the conditions are stable within the specified limits, they may be checked less frequently (but at least once a day).

6.9   Measurement of recovery rate (optional)

Upon completion of non-rupture tests, remove the load rapidly and smoothly and measure the recovery rate using, for instance, the same schedule as was used for creep measurement.

7   Expression of results

7.1   Method of calculation

7.1.1   Tensile-creep modulus, E_t

Calculate the tensile-creep modulus, E_t, by dividing the initial stress, σ, by the tensile-creep strain, ε_t, at each of the selected measurement times.

It is given, in megapascals, by the equation

$$E_t = \frac{\sigma}{\varepsilon_t} = \frac{F \cdot L_0}{A \cdot (\Delta L)_t}$$

where

   F is the applied force, in newtons;

   L_0 is the initial gauge length, in millimetres;

   A is the initial cross-sectional area, in square millimetres, of the specimen;

   $(\Delta L)_t$ is the extension, in millimetres, at time t.

7.1.2 Nominal tensile-creep modulus, E^*_t

Calculate the nominal tensile-creep modulus, E^*_t, by dividing the initial stress, σ, by the nominal tensile-creep strain, ε^*_t, at each of the selected measurement times.

It is given, in megapascals, by the equation

$$E^*_t = \frac{\sigma}{\varepsilon^*_t} = \frac{F \cdot L^*_0}{A \cdot (\Delta L^*)_t}$$

where

$\quad F \quad$ is the applied force, in newtons;

$\quad L^*_0 \quad$ is the initial distance between the grips, in millimetres;

$\quad A \quad$ is the initial cross-sectional area of the specimen, in square millimetres;

$\quad (\Delta L^*)_t \quad$ is the increase in the distance between the grips, in millimetres, at time t.

7.2 Presentation of results

7.2.1 Creep curves

If testing is carried out at different temperatures, the raw data should preferably be presented, for each temperature, as a series of creep curves showing the tensile strain plotted against the logarithm of time, one curve being plotted for each initial stress used (see Figure 1).
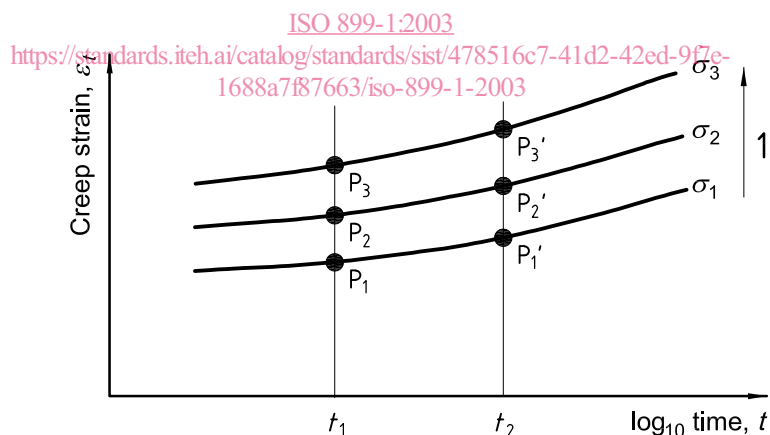
Key

1   increasing stress

Figure 1 — Creep curves

The data may also be presented in other ways, e.g. as described in 7.2.2 and 7.2.3, to provide information required for particular applications.

7.2.2 Creep-modulus/time curves

For each initial stress used, the tensile-creep modulus, calculated in accordance with 7.1.1, may be plotted against the logarithm of the time under load (see Figure 2).