

---

---

**Plastics — Determination of creep  
behaviour —**

**Part 1:  
Tensile creep**

*Plastiques — Détermination du comportement au fluage —*

*Partie 1: Fluage en traction*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

ISO 899-1:2017

<https://standards.iteh.ai/catalog/standards/sist/76d55712-2b05-4a7a-ab0b-bab8baf03af7/iso-899-1-2017>



**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

ISO 899-1:2017

<https://standards.iteh.ai/catalog/standards/sist/76d55712-2b05-4a7a-ab0b-bab8baf03af7/iso-899-1-2017>



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2017, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
Ch. de Blandonnet 8 • CP 401  
CH-1214 Vernier, Geneva, Switzerland  
Tel. +41 22 749 01 11  
Fax +41 22 749 09 47  
copyright@iso.org  
www.iso.org

# Contents

	Page
<b>Foreword</b> .....	<b>iv</b>
<b>1 Scope</b> .....	<b>1</b>
<b>2 Normative references</b> .....	<b>1</b>
<b>3 Terms and definitions</b> .....	<b>1</b>
<b>4 Apparatus</b> .....	<b>3</b>
<b>5 Test specimens</b> .....	<b>4</b>
<b>6 Procedure</b> .....	<b>4</b>
6.1 Conditioning and test atmosphere.....	4
6.2 Measurement of test-specimen dimensions.....	5
6.3 Mounting the test specimens.....	5
6.4 Selection of stress value.....	5
6.5 Loading procedure.....	5
6.5.1 Preloading.....	5
6.5.2 Loading.....	5
6.6 Extension-measurement schedule.....	5
6.7 Time measurement.....	5
6.8 Temperature and humidity control.....	6
6.9 Measurement of recovery rate (optional).....	6
<b>7 Expression of results</b> .....	<b>6</b>
7.1 Method of calculation.....	6
7.1.1 Tensile-creep modulus, $E_t$ .....	6
7.1.2 Nominal tensile-creep modulus, $E_t^*$ .....	6
7.2 Presentation of results.....	7
7.2.1 Creep curves.....	7
7.2.2 Creep-modulus/time curves.....	7
7.2.3 Isochronous stress-strain curves.....	8
7.2.4 Three-dimensional representation.....	8
7.2.5 Creep-to-rupture curves.....	8
7.3 Precision.....	9
<b>8 Test report</b> .....	<b>9</b>
<b>Annex A (informative) Physical-ageing effects on the creep of polymers</b> .....	<b>10</b>
<b>Bibliography</b> .....	<b>14</b>

## 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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html) (standards.iteh.ai)

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical behaviour*.

This third edition cancels and replaces the second edition (ISO 899-1:2003), of which it constitutes a minor revision to update the normative references in [Clause 2](#). It also incorporates the Amendment ISO 899-1:2003/Amd.1:2015.

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

# Plastics — Determination of creep behaviour —

## Part 1: Tensile creep

### 1 Scope

This document 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.

The method is suitable for use with rigid and semi-rigid non-reinforced, filled and fibre-reinforced plastics materials in the form of dumb-bell-shaped test specimens moulded directly or machined from sheets or moulded articles.

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).

Tensile creep can 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 are intended to be carefully controlled.

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

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

ISO 472, *Plastics — Vocabulary*

ISO 527-1:2012, *Plastics — Determination of tensile properties — Part 1: General principles*

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

### 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 terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

**3.1**  
**creep**

increase in strain with time when a constant force is applied

**3.2**  
**initial stress**

$\sigma$   
tensile force per unit area of the initial cross-section within the gauge length

Note 1 to entry: It is given by the formula

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

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 to entry: 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 1 to entry: It is given by the formula

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

iTeh STANDARD PREVIEW  
(standards.iteh.ai)  
<https://standards.iteh.ai/catalog/standards/sist/76d55712-2b05-4a7a-ab0b-bab8baf03af7/iso-899-1-2017>  
ISO 899-1:2017

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 1 to entry: It is given by the formula

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

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

$\varepsilon_t$

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 to entry: It is given by the formula

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

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

### 3.6 nominal tensile-creep strain

$\varepsilon_t^*$

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

Note 1 to entry: It is given by the formula

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

Note 2 to entry: 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

### 3.8 nominal tensile-creep modulus

$E_t^*$

ratio of initial stress to nominal tensile-creep strain

### 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 ( $\sigma_{B,t}$ ) 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.

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  $\pm 1\%$  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  $\pm 0,01$  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 (see ISO 10350-1). 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  $\geq t_{90}$  (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  $\pm 2$  °C.

## 6.2 Measurement of test-specimen dimensions

Measure the dimensions of the conditioned test specimens in accordance with ISO 527-1:2012, 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 formula 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 tensile 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,  $\sigma$ , by the tensile-creep strain,  $\varepsilon_t$ , at each of the selected measurement times.

It is given, in megapascals, by [Formula \(1\)](#):

$$E_t = \frac{\sigma}{\varepsilon_t} = \frac{F \cdot L_0}{A \cdot (\Delta L)_t} \tag{1}$$

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,  $\sigma$ , by the nominal tensile-creep strain,  $\varepsilon^*_t$ , at each of the selected measurement times.

It is given, in megapascals, by [Formula \(2\)](#):

$$E^*_t = \frac{\sigma}{\varepsilon^*_t} = \frac{F \cdot L^*_0}{A \cdot (\Delta L^*)_t} \tag{2}$$

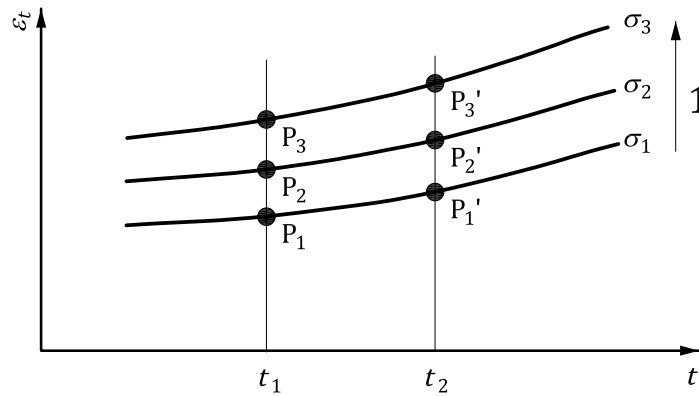
where

- $F$  is the applied force, in newtons;
- $L^*_0$  is the initial distance between the grips, in millimetres;
- $A$  is the initial cross-sectional area of the specimen, in square millimetres;
- $(\Delta L^*)_t$  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

- $t$   $\log_{10}$  time
- $\varepsilon_t$  creep strain
- 1 increasing stress

iTeh STANDARD PREVIEW  
(standards.iteh.ai)

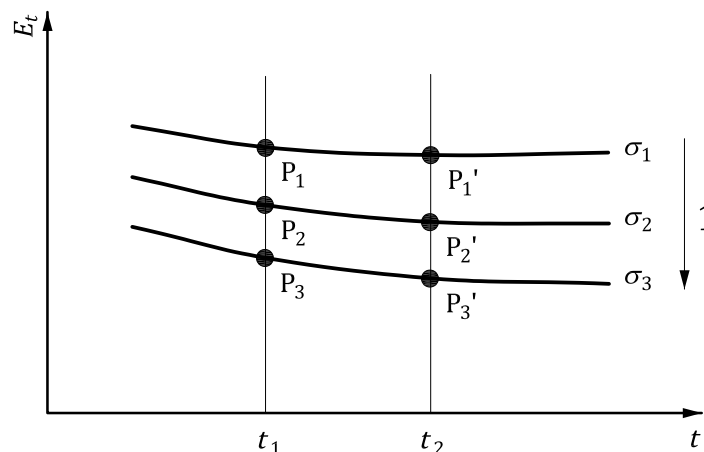
Figure 1 — Creep curves

ISO 899-1:2017

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](#)).



#### Key

- $t$   $\log_{10}$  time
- $E_t$  creep modulus
- 1 increasing stress

Figure 2 — Creep-modulus/time curves