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Metallic materials - Uniaxial creep testing in tension - Method of test (ISO/DIS 204:2005)

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EUROPEAN STANDARD

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English Version

Metallic materials - Uniaxial creep testing in tension - Method of test (ISO/DIS 204:2005)

Matériaux métalliques - Essai de fluage uniaxial en traction - Méthode d'essai (ISO/DIS 204:2005)

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Foreword

This document (prEN ISO 204:2005) has been prepared by Technical Committee ISO/TC 164 "Mechanical testing of metals" in collaboration with Technical Committee ECISS/TC 1 "Steel - Mechanical testing", the secretariat of which is held by AFNOR.

This document is currently submitted to the parallel Enquiry.

Endorsement notice

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ISO/TC **164**/SC **1** Secretariat: **AFNOR**

Voting begins on: **2005-09-08**

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Metallic materials — Uniaxial creep testing in tension — Method of test

Matériaux métalliques — Essai de fluage uniaxial en traction — Méthode d'essai

[Revision of first edition (ISO 204:1997)]

ICS 77.040.10

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Foreword

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ISO 204 was prepared by Technical Committee ISO/TC 164, *Mechanical testing of metals*, Subcommittee SC 1, and by Technical Committee ECISS/TC1, *Steel testing - Mechanical testing* in collaboration.

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This second edition cancels and replaces the first edition (EN ISO 204:1997).

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Metallic materials — Uniaxial creep testing in tension — Method of test

1 Scope

This International Standard specifies the method for the uninterrupted and interrupted creep tests and defines the properties of metallic materials which can be determined from these tests, in particular the creep elongation and the time of creep rupture, at a specified temperature.

NOTE The stress rupture test is also covered by this standard, as is the testing of notched test pieces.

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.

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ISO 286-2, *ISO system of limits and fits — Part 2: Tables of standard tolerances grades and limit deviations for holes and shafts.*

ISO 783-1999, *Metallic materials — Tensile testing method at elevated temperature*

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ISO 7500-2, *Metallic materials — Verification of static uniaxial testing machines — Part 2: Tensile creep testing machines — Verification of the force applied.*

ISO 9513, *Metallic materials — Calibration of extensometers used in uniaxial testing.*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply:

3.1
reference length (L_r)
base length used for the calculation of elongation

NOTE A method to calculate this value is given in 7.5.

Distinction is made between :

3.1.1
original reference length (L_{ro})
reference length determined at ambient temperature before the test

3.1.2
final reference length (L_{ru})
reference length determined at ambient temperature after rupture, with the pieces carefully fitted back together with their axes in a straight line

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3.2
original gauge length (L_o)
length between gauge length marks on the test piece measured at ambient temperature before the test

3.3
final gauge length after rupture (L_u)
length between gauge length marks on the test piece measured after rupture, at ambient temperature, with the pieces carefully fitted back together with their axes in a straight line

3.4
parallel length (L_c)
length of the parallel reduced section of the test piece

3.5
extensometer gauge length (L_e)
distance between the measuring points of extensometer

NOTE In some cases, $L_e = L_o$.

3.6
original cross-sectional area (S_o)
cross-sectional area of the parallel length as determined at ambient temperature prior to testing

3.7
minimum cross-sectional area after rupture (S_u)
minimum cross-sectional area of the parallel length as determined at ambient temperature after rupture, with the pieces carefully fitted back together with their axes in a straight line

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3.8
initial stress (σ_o)
applied force divided by the original cross-sectional area (S_o) of the test piece

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3.9
elongation (ΔL_r)
increase of the reference length (L_r), see 6.2

3.10
percentage elongation (A)
elongation expressed as a percentage of the original reference length L_{ro}, see Figure 1

NOTE In the case of the terms for elongation in 3.10 (except A_u, in 3.10.6), the symbol "ε" may replace "*A*".

However, when "ε" is used, the following convention should apply :

- ε % = percentage strain/elongation ;
- ε = absolute strain.

3.10.1
percentage initial plastic elongation (A_i)
non-proportional increase of the original reference length L_{ro} due to the application of the test force

3.10.2
percentage creep elongation (A_f)
increase in reference length at time t (ΔL_{rt}) at a specified temperature expressed as a percentage of the original reference length (L_{ro}):

$$A_f = \frac{\Delta L_{rt}}{L_{ro}} \text{x} 100 \qquad (1)$$

NOTE 1 A_f may have the specified temperature (T) in Celsius degrees as superscript and s the initial stress (σ_o) in megapascals [1)] and time t (in hours) as subscript.

NOTE 2 By convention the beginning of creep elongation measurement is the time at which the initial stress (σ_o) is applied to the test piece (see Figure 1).

3.10.3
percentage plastic elongation (A_p)
non-proportional increase of the original reference length (L_{ro}) at time t :

$$A_p = A_i + A_f \quad (2)$$

3.10.4
percentage anelastic elongation (A_k)
non-proportional decrease of the original reference length (L_{ro}) at time t due to unloading

3.10.5
percentage permanent elongation (A_{per})
total increase of the original reference length (L_{ro}) at time t determined after unloading :

$$A_{per} = A_p - A_k \quad (3)$$

3.10.6
percentage elongation after creep rupture (A_u)
permanent increase of the original reference length (L_{ro}) after rupture (L_{ru} - L_{ro}) expressed as a percentage of the original reference length (L_{ro}) :

$$A_u = \frac{L_{ru} - L_{ro}}{L_{ro}} \text{x} 100 \quad (4)$$

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NOTE A_u may have the specified temperature (T) in Celsius degrees as superscript and the initial stress (σ_o) in megapascals as subscript.

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3.11
percentage reduction of area after creep rupture (Z_u)
maximum change in cross-sectional area measured after rupture (S_o - S_u) expressed as a percentage of the original cross-sectional area (S_o) :

$$Z_u = \frac{S_o - S_u}{S_o} \text{ x } 100 \quad (5)$$

NOTE Z_u may have the specified temperature (T) in Celsius degrees as superscript and the initial stress (σ_o) in megapascals .

3.12
creep elongation time (t_{fx})
time required for a strain test piece to obtain a specified percentage creep elongation (x) at the specified temperature (T) and the initial stress (σ_o).

EXAMPLE $t_{f0,2}$

3.13
plastic elongation time (t_{px})
time required to obtain a specified percentage plastic deformation (x) at the specified temperature (T) and the initial stress (σ_o).

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1) 1 MPa = 1 N/mm^2.

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3.14
creep rupture time (t_u)
time to rupture for a test piece maintained at the specified temperature (T) and the initial stress (σ_o).

NOTE The symbol t_u may have as superscript the specified temperature (T) in Celsius degrees and as subscript the initial stress (σ_o) in megapascals

3.15
Single test piece machine
a testing machine that permits straining of a single test piece

3.16
multiple test piece machine
a testing machine that permits straining of more than one test piece simultaneously at the same temperature

4 Symbols and designations

The symbols and corresponding designations are given in Table 1.

Table 1 — Symbols and designations

Reference number [a]	Symbol [b]	Unit	Designation
1	D	mm	Diameter of the cross-section of the parallel length of a cylindrical test piece
2	B	mm	Width of the cross-section of the parallel length of a test piece of square or rectangular cross-section
3	L_r	mm	Reference length
4	A	mm	Thickness of a test piece of square or rectangular cross-section
-	L_{ro}	mm	Original reference length
-	L_{ru}	mm	Final reference length
-	ΔL_r	mm	Elongation
	ΔL_{rt}	mm	Increase in reference length at time t
5	L_o	mm	Original gauge length
-	L_u	mm	Final gauge length after rupture
6	L_c	mm	Parallel length
7	L_e	mm	Extensometer gauge length
8	R	mm	Transition radius
9	S_o	mm^2	Original cross-sectional area of the parallel length
-	S_u	mm^2	Minimum cross-sectional area after rupture
10	σ_o	MPa	Initial stress

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Table 1 — Symbols and designations **(*continued*)**

Reference number [a]	Symbol [b]	Unit	Designation
11	A_e [c]	%	Percentage elastic elongation
12	A_i [c]	%	Percentage initial plastic elongation
13	A_k [c]	%	Percentage anelastic elongation
14	A_p [c]	%	Percentage plastic elongation
15	A_{per} [c]	%	Percentage permanent elongation
16	A_f [c]	%	Percentage creep elongation : $A_f = \frac{\Delta L_{rt}}{L_{ro}} \times 100$ NOTE As an example, the symbol may be completed as follows : $A_{f\,50/5000}^{375}$: percentage creep elongation with an initial stress of 50 MPa after 5 000 h at the specified temperature of 375 °C.
23	A_u [c]	%	Percentage elongation after creep rupture : $A_u = \frac{L_{ru} - L_{ro}}{L_{ro}} \times 100$ NOTE As an example, the symbol may be completed as follows : $A_{u\,50}^{375}$: percentage elongation after creep rupture with an initial stress of 50 MPa at the specified temperature of 375 °C.
-	Z_u	%	Percentage reduction of area after creep rupture : $Z_u = \frac{S_o - S_u}{S_o} \times 100$ NOTE As an example, the symbol may be completed as follows : $Z_{u\,50}^{375}$: percentage reduction of area after creep rupture with an initial stress of 50 MPa at the specified temperature of 375 °C.
	t_{fx}	h	Creep elongation time
	t_{px}	h	Plastic elongation time
24	t_u	h	Creep rupture time NOTE As an example, the symbol may be completed as follows : $t_{u\,50}^{375}$: creep rupture time with an initial stress of 50 MPa at the specified temperature of 375 °C.
-	t_{ue}	h	Creep rupture time of a notched test piece

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