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Konstruktionskeramer – Mekaniska egenskaper hos keramiska fibrer vid hög temperatur i icke reaktiv miljö – Bestämning av krypegenskaper genom varmändesmetoder

Advanced technical ceramics – Mechanical properties of ceramic fibres at high temperature under non-reactive environment – Determination of creep behaviour by the hot end method

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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

TECHNISCHE SPEZIFIKATION

CEN/TS 15658

September 2007

ICS 81.060.30

English Version

Advanced technical ceramics - Mechanical properties of ceramic fibres at high temperature under non-reactive environment - Determination of creep behaviour by the hot end method

Céramiques techniques avancées - Propriétés mécaniques des fibres céramiques à haute température sous environnement non réactif - Détermination du comportement au fluage par la méthode des mors chauds

Hochleistungskeramik - Mechanische Eigenschaften von Keramikfasern bei hohen Temperaturen in einer reaktionsfreien Umgebung - Bestimmung des Kriechverhaltens im Heißverbindungsverfahren

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Contents

Page

Foreword....3
1 Scope....4
2 Normative references....4
3 Terms and definitions....4
4 Principle....7
5 Significance and use....7
6 Apparatus....7
6.1 Test installations....7
6.2 Load train....7
6.3 Adhesive....7
6.4 Test chamber....8
6.5 Set-up for heating....8
6.6 Temperature measurement....8
6.7 Control of deformation....8
6.8 Data recording system....8
7 Test specimens....8
7.1 General....8
7.2 Test specimen preparation....8
7.3 Number of test specimens....9
8 Test Procedure....9
8.1 Determination of the temperature profile....9
8.2 Test set-up: other considerations....9
8.3 Loading considerations....10
8.4 Testing technique....10
8.5 Measurements....11
8.6 Test validity....11
9 Calculation of results....12
9.1 Creep stress....12
9.2 Creep strain at time *t*....12
9.3 Drawing of the creep curve....12
9.4 Creep strain at rupture....12
9.5 Creep rupture time....12
9.6 Creep strain rate curve....12
10 Test report....13
Bibliography....14

Foreword

This document (CEN/TS 15658:2007) has been prepared by Technical Committee CEN/TC 184 “Advanced technical ceramics”, the secretariat of which is held by BSI.

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1 Scope

This Technical Specification specifies the conditions for the determination of the tensile creep deformation and failure behaviour of single filaments of ceramic fibres at high temperature and under test conditions that prevent changes to the material as a result of chemical reaction with the test environment.

This Technical Specification applies to continuous ceramic filaments taken from tows, yarns, braids and knitted structures, that have strains to failure less than or equal to 5 %.

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.

EN 1007-3, *Advanced technical ceramics — Ceramic composites — Methods of test for reinforcement — Part 3: Determination of filament diameter and cross-section area*

EN 1007-4, *Advanced technical ceramics — Ceramic composites — Methods of test for reinforcement — Part 4: Determination of tensile properties of filaments at ambient temperature*

CEN/TR 13233:2007 , *Advanced technical ceramics — Notations and symbols*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

EN 60584-1, *Thermocouples — Part 1: Reference tables (IEC 60584-1:1995)*

EN 60584-2, *Thermocouples — Part 2: Tolerances (IEC 60584-2:1982 + A1:1989)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in CEN/TR 13233:2007 and the following apply.

3.1
creep
time-dependent increase of gauge length starting from the time when the constant specified level of force is reached

3.2
gauge length
L_0
initial distance between the gripped ends of filament

3.3
test temperature
T
temperature of the filament in the gauge length

3.4
initial cross section area
A_0
initial cross section area of the filament within the gauge length

3.5
applied tensile force
F
constant force applied to the filament during the test

3.6
applied tensile stress
σ
applied tensile force divided by the initial cross sectional area

3.7
longitudinal deformation
ΔL
change of the gauge length L_0 caused by creep

3.8
creep rupture time
$t_{\mathrm{cr,m}}$
time elapsed from the moment when loading is completed until the moment of rupture

3.9
creep strain rate
$\dot{\varepsilon}_{\mathrm{cr(T)}}$
change in creep strain per unit time at time t at the temperature T

3.10 Creep types

3.10.1
primary creep
part of the creep strain versus time curve which presents a decreasing creep strain rate (see Figure 1a and Figure1b)

3.10.2
secondary creep
part of the creep strain versus time curve which presents a constant creep strain rate (see Figure 1a and Figure 1b)

3.10.3
tertiary creep
part of the creep strain versus time curve which presents an increasing creep strain rate (see Figure 1a and Figure 1b)

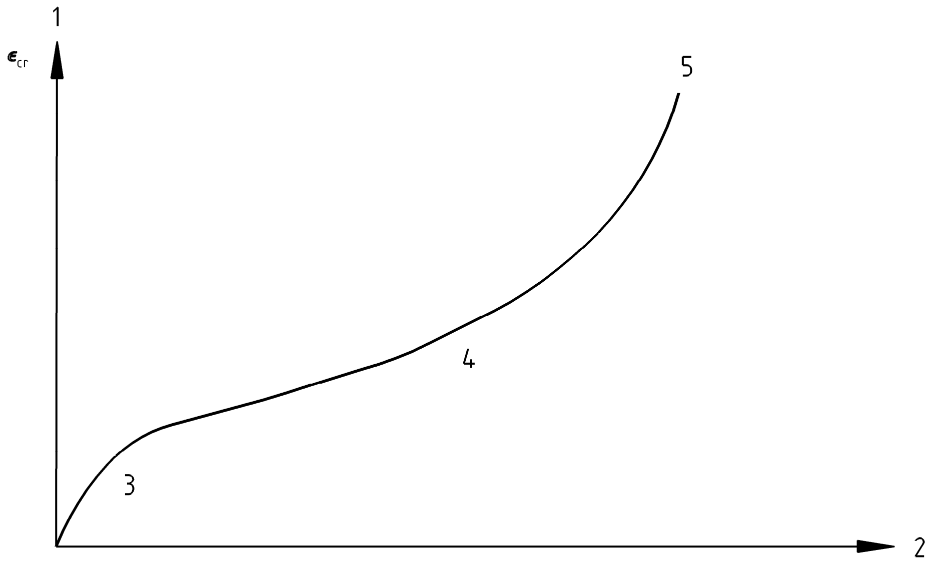

Figure 1a) — Creep strain versus time

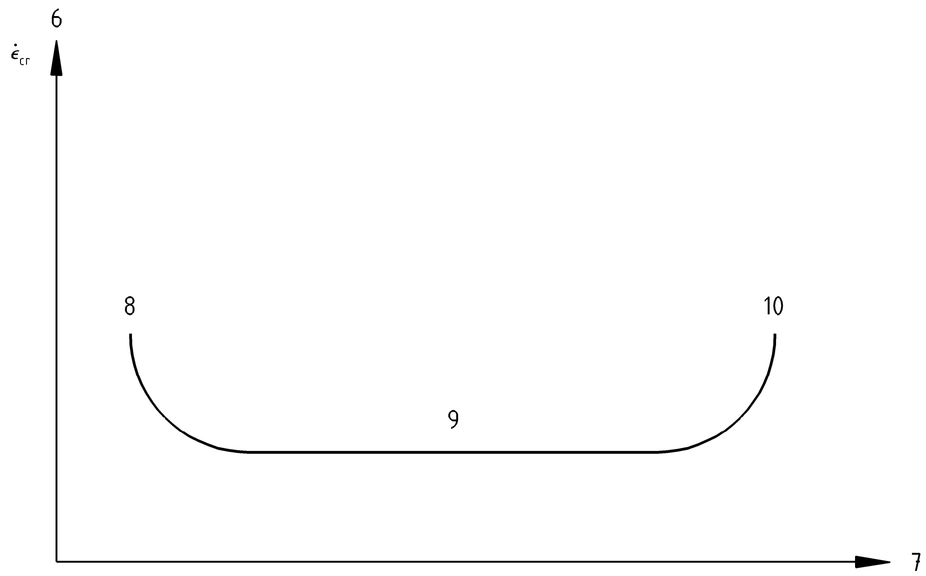

Figure 1b) — Creep strain rate versus time

Key

1 creep strain ε_{cr}	6 creep strain rate $\dot{\varepsilon}_{cr}$ (creep strain with time)
2 time t	7 time
3 primary creep	8 primary creep
4 secondary creep	9 secondary creep
5 tertiary creep	10 tertiary creep

Figure 1 — Creep strain and creep strain rate versus time curve

4 Principle

A ceramic filament is heated to the test temperature and loaded in tension until a specified level of force. This force is maintained at a constant level for a specified time or until rupture. The variation in the ceramic filament length is recorded in relation to time.

The filament is heated over its total length. The temperature is uniform over the gauge length. However subjecting the whole length of a filament to temperatures well above 1 000 °C may make it difficult to fix the ends of the test specimen into appropriate temperature proof extensions. However experimental solutions based on electric heating of fibre allow this difficulty to be alleviated at temperatures above 1 000 °C.

5 Significance and use

Creep tests allow the determination of data that characterize the deformation rate of materials under constant load at high temperatures. These are useful for the design of industrial parts with close control of tolerances for high temperature applications.

6 Apparatus

6.1 Test installations

6.1.1 General

Two different types of installation can be used, as described in 6.1.2 and 6.1.3.

6.1.2 Test machine

The machine shall be equipped with a system for measuring the force applied to the test specimen and a system for monitoring the applied load. The machine shall have a load cell with a resolution of 10^{-3} N for the applied force. This shall prevail during actual test conditions (pressure, temperature).

Care shall be taken to ensure that the force applied to the filament remains constant to within 10^{-3} N, even when the material properties change and the environmental conditions (temperature, pressure) fluctuate.

6.1.3 Creep testing rig

When a creep testing rig is used, the force application system shall be calibrated.

The testing rig shall be equipped with a system that allows smooth loading of the ceramic filament(s). When this system is used, care shall be taken to ensure that the force applied to the filament remains constant to within 10^{-3} N, even when the material properties change and the environmental conditions (temperature, pressure) fluctuate.

6.2 Load train

The gripping system shall align the test specimen axis with that of the applied force.

The load train configuration shall ensure that the load indicated by the load cell and the load experienced by the test specimen are the same. The load train performance including the alignment and the force transmission shall not change because of heating.

6.3 Adhesive

Use a suitable adhesive for fixing the filament ends to the grip, such as ceramic cement.