SLOVENSKI STANDARD
SIST EN 1007-5:2010

01-maj-2010

Nadomešča:

SIST EN 1007-5:2004

Sodobna tehnična keramika - Keramični kompoziti - Preskusne metode za ojačitve - 5. del: Ugotavljanje porazdelitve natezne trdnosti in deformacij/obremenitev vlaken v svežnjih pri visoki temperaturi

Advanced technical ceramics - Ceramic composites - Methods of test for reinforcements - Part 5: Determination of distribution of tensile strength and of tensile strain to failure of filaments within a multifilament tow at ambient temperature

Hochleistungskeramik - Keramische Verbundwerkstoffe - Verfahren zur Prüfung der Faserverstärkungen - Teil 5: Bestimmung der Verteilung von Zugfestigkeit und Zugdehnung von Fasern im Faserbündel bei Raumtemperatur

Céramiques techniques avancées - Céramiques composites - Méthodes d'essais pour renforts - Partie 5: Détermination de la distribution de la résistance en traction et de la déformation de traction à la rupture des filaments dans un fil à température ambiante

Ta slovenski standard je istoveten z: **EN 1007-5:2010**

ICS:

81.060.30	Sodobna keramika	Advanced ceramics

SIST EN 1007-5:2010 **en,fr,de**

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1007-5

March 2010

ICS 81.060.30

Supersedes EN 1007-5:2003

English Version

Advanced technical ceramics - Ceramic composites - Methods of test for reinforcements - Part 5: Determination of distribution of tensile strength and of tensile strain to failure of filaments within a multifilament tow at ambient temperature

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 1007-5:2010: E

Contents

Foreword

This document (EN 1007-5:2010) has been prepared by Technical Committee CEN/TC 184 “Advanced technical ceramics”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2010, and conflicting national standards shall be withdrawn at the latest by September 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1007-5:2003.

EN 1007 *Advanced technical ceramics — Ceramic composites — Methods of test for reinforcements* has 7 parts:

— Part 1: *Determination of size content*

— Part 2: *Determination of linear density*

— Part 3: *Determination of filament diameter and cross-section area*

— Part 4: *Determination of tensile properties of filaments at ambient temperature*

— Part 5: *Determination of distribution of tensile strength and of tensile strain to failure of filaments within a multifilament tow at ambient temperature*

— Part 6: *Determination of tensile properties of filaments at high temperature*

— Part 7: *Determination of the distribution of tensile strength and of tensile strain to failure of filaments within a multifilament tow at high temperature*

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1 Scope

This European Standard specifies the conditions, apparatus and procedure for determining the distribution of tensile strength and tensile strain to failure of ceramic filaments in multifilament tows at ambient temperature.

This European Standard applies to tows of continuous ceramic filaments, which are assumed to act freely and independently under loading, and behave linearly elastic up to failure.

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 1007-2, *Advanced technical ceramics — Ceramic composites — Methods of test for reinforcement — Part 2: Determination of linear density*

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

ISO 10119, *Carbon fibre — Determination of density*

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
gauge length
L_0
initial distance between two reference points on the tow

NOTE Usually the gauge length is taken as the distance between the gripped ends of the tow.

3.2
initial cross sectional area
A_0
sum of the cross sectional areas of all the filaments in the tow

3.3
tow elongation
ΔL
increase of the gauge length between the two reference points on the tow

3.4
tow strain
ε
ratio of the tow elongation ΔL to the gauge length L_o

3.5
tow maximum tensile force
F_{tow}
highest recorded tensile force on the test specimen when tested to failure

3.6
tow strength
σ_{tow}
ratio of the tow maximum tensile force to the cross sectional area of all unbroken filaments at maximum tensile force, F_{tow}

3.7
force at step *j*
F_j
force applied on the test specimen at step j

3.8
filament strain
ε_j
strain at step j in the non-linear parts of the force-displacement graph

3.9
filament stress
σ_j
ratio of the tensile force to the cross sectional area of all unbroken filaments at step j in the non-linear parts of the force-displacement curve

3.10
average filament rupture strain
$\overline{\varepsilon_r}$
statistical average rupture strain of the filaments in the tow for each test determined from the Weibull strain distribution parameters of the filaments

3.11
overall average filament rupture strain
$\overline{\overline{\varepsilon_r}}$
arithmetic mean of the average filament rupture strains

3.12
average filament strength
$\overline{\sigma_r}$
statistical average strength of the filaments in the tow for each test determined from the Weibull strength distribution parameters of the filaments

3.13
overall average filament strength
$\overline{\overline{\sigma_r}}$
arithmetic mean of the average filament strengths

3.14
compliances

3.14.1
initial total compliance
C_t
inverse slope of the linear part of the force-displacement curve

3.14.2
instantaneous total compliance
$C_{t,j}$
inverse slope of the secant at any point j in the non-linear part of the force-displacement curve

NOTE The slope is taken from a line through any point of the force-displacement curve and the intersection point of the line of the initial total compliance with the abscissa (true origin).

3.14.3
load train compliance
C_l
ratio of the cross head displacement to the force, excluding any contribution of the test specimen to the displacement during the tensile test

3.14.4
compliance of the tow
C_{tow}
instantaneous total compliance of the tow at maximum tensile force

4 Principle

A multifilament tow is loaded in tension. The test is performed at a constant displacement rate up to failure of all fibres. Force and cross-head displacement are measured and recorded simultaneously. When required, the longitudinal deformation is derived from the cross-head displacement using a compliance correction. From the force-displacement curve, the two-parameter Weibull distribution of the rupture strain and the distribution of the rupture strength of the filaments are obtained by sampling the non-linear parts of the curve at discrete intervals j, which correspond to an increasing number of failed filaments in the tow. The test duration is limited to reduce time dependent effects.

5 Significance and use

The measurement of strain directly on the tow is difficult, so it is usually achieved indirectly via a compliance measurement that includes contributions of the loading train, grips, tab materials, etc. When it is possible to measure the tow elongation directly (by using a suitable extensometer system) this correction is not needed. The calculation of the results in Clause 10 also applies in this case by setting the load train compliance equal to zero.

The evaluation method is based on an analysis of the non-linear increasing and decreasing parts of the force-displacement curve, which are caused by progressive filament failure during the test. The occurrence of these stages is promoted by a higher stiffness of the loading and gripping system. This method of evaluation is only applicable when the force-displacement curve shows these non-linear parts.

The distribution of filament rupture strains does not depend on the number of filaments in the tow and is hence not affected by the number of filaments that are broken before the test. The determination of the filament strength distribution and of the elastic modulus necessitates knowledge of the initial cross sectional area of the tow. Because the number of unbroken filaments within the tow prior to the test is usually unknown, the values for the filament strength and for the elastic modulus necessarily represent lower bounds to these quantities. Also, the variation in filament diameter, which affects the strength values, is not accounted for.

6 Apparatus

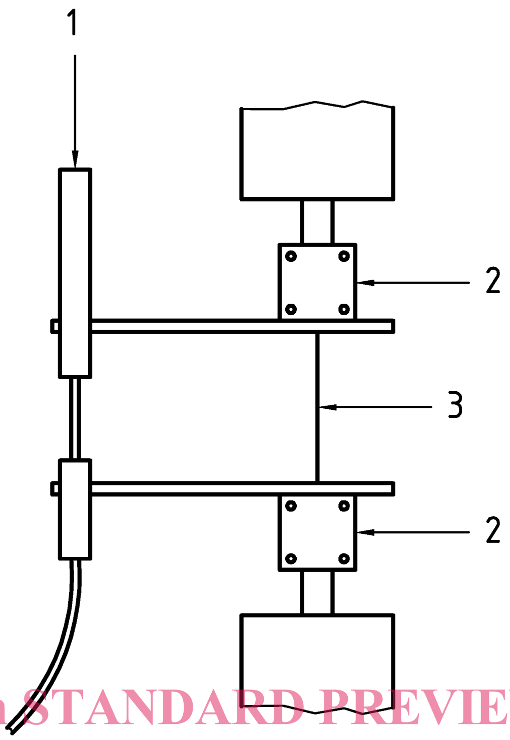
6.1 Tensile testing equipment

The test machine shall be equipped with a system for measuring the force applied to the specimen and the displacement, or directly the tow elongation. Additionally, the machine shall be equipped with a system for measuring the crosshead displacement with accuracy better than 1 µm.

6.2 Load train

The grips shall align the test specimen with the direction of the force. Slippage of the test specimen in the grips shall be prevented as well as avoiding pre-damage due to gripping.

NOTE The use of a displacement transducer placed at the ends of the grips (see Figure 1) should limit the contribution of different parts of the load train to the measured displacement, and hence should increase the accuracy.



Key

1 displacement transducer

2 grips

3 tow

Figure 1 — Displacement transducer at the ends of the grips (principle sketch)

6.3 Data recording

A calibrated recorder shall be used to record force-displacement curves. The use of a digital data recording system combined with an analogue recorder is recommended.

7 Test specimens

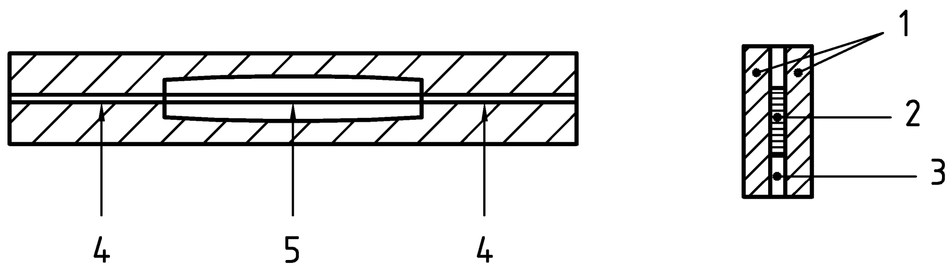
7.1 General

Specimens with a gauge length of 200 mm shall be used to establish the filament strength and filament rupture strain distributions. Specimens with gauge lengths of 100 mm and 300 mm shall be used to determine, if necessary, the load train compliance. Examples of two types of test specimens are given below.

7.2 Window type specimen

A window type specimen is shown in Figure 2. A stretched tow is fixed between two identical sheets of material (e.g. cardboard plates), each containing a central window. When the displacement is not measured directly on the tow, the height of the window defines the gauge length.

NOTE This type of specimen has the advantage of easy handling.



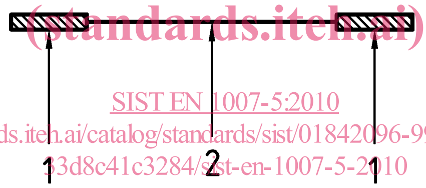
Key

1 cardboard plates with window
2 tow
3 glue
4 tow, glued between cardboard plates
5 tow, gauge length equals height of the window

Figure 2 — Window type specimen (principle sketch)

7.3 Cylindrical end type specimen

A cylindrical end type specimen is shown in Figure 3. Both ends of a stretched tow are fixed (glued) in small diameter cylindrical tubes. When the displacement is not measured directly on the tow, the distance between the inner ends of the tubes with the tow in a stretched condition defines the gauge length.



Key

1 cylindrical tubes
2 stretched tow

Figure 3 — Cylindrical end type specimen (principle sketch)

8 Test specimen preparation

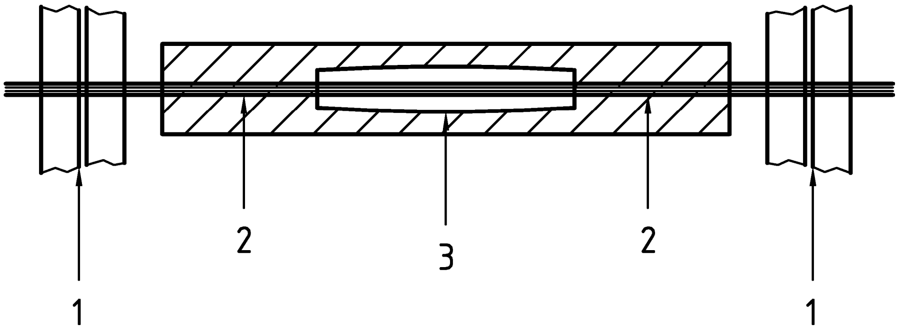
8.1 General

When preparing the specimen, ensure that the procedure is repeatable from specimen to specimen. When a glue is used, the same type and the same bonding length shall be used for the preparation of all test specimens of a given series. Avoid breaking filaments when handling specimens.

NOTE High repeatability in specimen preparation is necessary to enable a correct determination of the load train compliance.

8.2 Window type specimen

An untwisted multifilament tow is glued between two identical plates made of cardboard or another suitable material. The filaments shall be stretched. To achieve this, both ends of the two plates are well soaked by the glue, and then the tow is placed on the centreline of one of the plates under a small axial pre-stress. The ends of the tow extending beyond the plate are fixed by adhesive tapes onto a support (see Figure 4) and the parts of the tow in the gripping area are soaked with glue. The second plate is then pressed face to face to the first one.



Key

1 adhesive tapes

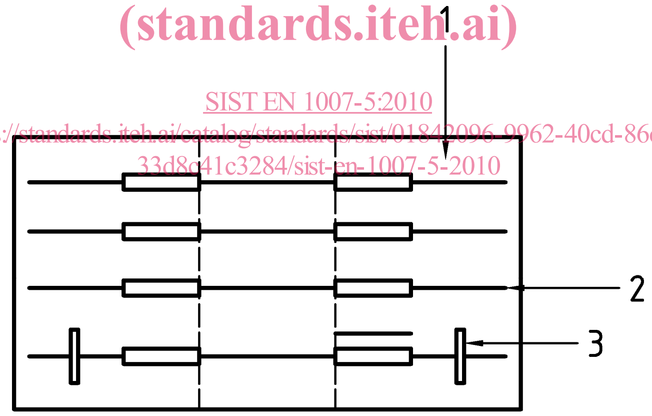
2 pre-stressed tow

3 gauge length of the tow equals height of the window

Figure 4 — Window type specimen, preparation (principle sketch)

8.3 Cylindrical end type specimen

The specimens are prepared on a support provided with alignment grooves in which the cylindrical tubes are placed. The untwisted multifilament tow is introduced into the tubes, stretched and glued (see Figure 5). The diameter of the cylindrical tubes should be as small as possible, compatible with the size of the tow.



Key

1 support with alignment grooves

2 tow with cylindrical tubes

3 pre-stressing by adhesive tapes

Figure 5 — Cylindrical end type specimen, preparation (principle sketch)

8.4 Number of test specimens

For the establishment of the distribution of filament strength and filament rupture strain, three valid tests of specimens with a 200 mm gauge length are necessary. When the elongation of the tow is not measured directly, additionally three valid tests at the other two gauge lengths of 100 mm and 300 mm are performed for the establishment of the load train compliance.

8.5 Determination of the initial cross sectional area

To determine the filament strength distribution, as well as the elastic modulus on the specimens with a 200 mm gauge length, the initial cross sectional area of the multifilament tow is calculated from the linear density