SLOVENSKI STANDARD
SIST ENV 12289:2000

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Advanced technical ceramics - Mechanical properties of ceramic composites at ambient temperature - Determination of in-plane shear properties

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Hochleistungskeramik - Mechanische Eigenschaften von keramischen Verbundwerkstoffen bei Raumtemperatur - Bestimmung der Schereigenschaften in der Ebene

Céramiques techniques avancées - Propriétés mécaniques des céramiques composites a température ambiante - Détermination des caractéristiques en cisaillement plan

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English version

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

This European Prestandard has been prepared by Technical Committee CEN/TC 184 "Advanced technical ceramics", the secretariat of which is held by BSI.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to announce this European Prestandard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Prestandard ENV 12289 specifies the conditions for the determination of the in-plane shear properties at ambient temperature of ceramic matrix composite materials with continuous fibre reinforcement.

This Prestandard applies to ceramic matrix composites with a continuous fibre reinforcement, bidirectionnal (2D) and tridirectionnal (xD, with $2 < x \leq 3$).

2 Normative references

This European Prestandard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of publication referred to applies.

EN 10002-2 Metallic materials - Tensile testing - Part 2 : Verification of the force measuring system of the tensile testing machines

ISO 3611 Micrometer callipers for external measurements

3 Principle

A test specimen with two centrally located V notches (see figure A.1 in annex A) is submitted to a translation of its part B parallel to the plane 1,2 along the direction 2 while its part A (see figure A.1 in annex A) is kept still.

The directions 1 and 2 correspond to the principal reinforcement directions of the material. The displacement of part B with respect to part A results in a pure shear zone in the section between the notches subjecting the material to an in-plane shear.

Force and shear strain along the principal directions in the plane 1,2 are measured and recorded simultaneously, from which shear modulus and shear strength can be determined.

The test is performed at constant displacement rate, up to failure.

4 Definitions and symbols

4.1 initial cross section area, A_o

The area of the test piece cross section in the 2,3 plane between the two notches (see figure A.1 in annex A).

4.2 measurement zone (see figure A.1 in annex A)

It is the part of the test piece, in the 1,2 plane, between the notches, in which a uniform shear field is assumed.

NOTE : For practical purposes, it is generally assumed to be ± 2 mm on the longitudinal axis of the test piece, on each side of the cross section area.

4.3 in-plane shear strain, γ_{12}

The change in angle of an originally orthogonal set of lines parallel to the directions 1 and 2 as a consequence of load application.

4.4 in-plane shear stress, τ_{12}

Ratio of applied force to the cross section area .

4.5 in-plane shear strength, $\tau_{12,m}$

Ratio of the maximum force applied, to the cross section area.

4.6 proportionality ratio or pseudo-elastic shear modulus, Gp_{12} elastic shear modulus G_{12}

The slope of the linear section of the shear stress-shear strain curve, if any. Examination of the shear stress-shear strain curves for ceramic matrix composites allows definition of the following cases :

a) Material with a linear section in the shear stress-shear strain curve.

For ceramic matrix composites that have a mechanical behaviour characterised by a linear section, the proportionality ratio is defined as :

$$Gp_{12}\left(\tau_{12,1},\ \tau_{12,2}\right) = \frac{\tau_{12,2} - \tau_{12,1}}{\gamma_{12,2} - \gamma_{12,1}} \qquad (1)$$

where :

$(\gamma_{12,1},\ \tau_{12,\ })$ and $(\gamma_{12,2},\ \tau_{12,2})$ lie on the linear section of the shear stress-shear strain curve.

The proportionality ratio or pseudo elastic shear modulus is termed the elastic shear modulus, G_{12}, in the single case where the linearity starts from the origin.

b) Material with non linear shear stress-strain behaviour.

In this case, only stress strain couples can be fixed.

5 Apparatus

5.1 Test machine

The machine shall be equiped with a system for measuring the force applied to the test specimen which shall conform to grade 1 or better according to EN 10002-2.

5.2 Test jig

The test jig shall be designed so that the force is applied in the 1,2 plane, normal to the longitudinal axis of the test piece. It shall allow the displacement of part B, relatively to part A.

The jig shall allow accurate mounting of the specimen, so that the notches are midway between the loading points.

NOTE : This is usually achieved with an alignement pin or similar tool.

The jig shall prevent out-of-plane loading of the specimen. This shall be verified using a dummy specimen made of an homogenous isotropic material equiped with strain gauges on the front and back faces located as specified in 5.3.

The dummy test piece shall be loaded to at least 50 % of the expected failure load of the material to be tested, and readings taken from all four strain gauges. The average strain gauge reading shall be calculated. Individual strain gauge readings at any load shall not differ by more than 5 % from the average of that load. The dummy test piece shall remain linear elastic during this verification.

NOTE : An example of a jig is shown in figure B.1 in annex B.

5.3 Strain gauges

At least one face of the specimen shall be equiped with two strain gauges in the measurement zone, orientated at ± 45° with respect to the longitudinal axis of the specimen (see example in figure B.2 in annex B).

The gauge length shall be at least equal to the length of the representative volume element of the material structure in the direction of the gauge and compatible with the size of the measurement zone.

5.4 Data recording system

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

5.5 Micrometers

Micrometers used for the measurement of the cross-sectional dimensions of the test specimen shall be accurate to ± 0,01 mm, and in accordance with ISO 3611.

6 Test specimens

Test piece sides used to apply the forces shall be flat and parallel.(see figure A.2 in annex A). Recommended dimensions are given in table 1.

Table 1

	2D and xD	Tolerance
l_t, Total length	50 mm to 100 mm	± 0,5 mm
b, Width	> 12 mm	± 0,2 mm
h, Thickness (indicative)	> 3 mm	± 0,2 mm
Notch angle	90° to 120°	± 2°
Depth of each notch	20 % of b	± 0,2 mm
r, Notch radius	1,0 mm < r < 1,5 mm	± 0,2 mm
Parallelism between machined parts and notch root	0,05 mm	
Perpendicularity of machined parts and notch root	0,05 mm	

NOTE : Bonded tabs on front face and rear face would help prevent buckling and/or damages from the application of load.

7 Test specimen preparation

7.1 Machining

During cutting out, care shall be taken to align the test specimen axis with the desired reinforcement direction.

Machining parameters which avoid damage (initial breaking, structure modification) to the material shall be established and documented. These parameters shall be adhered to during test piece preparation.

7.2 Bonding of the gauges

The gauges are positioned as close as possible to the centre of the measurement zone.

If the material is porous, care shall be taken that penetration of adhesive into the material does not modify its behaviour.

7.3 Number of test specimens

At least three valid test results, as specified in 8.3, are required for any condition.

8 Test procedure

8.1 Measurement of test specimens dimensions

The thickness h shall be measured at three points in the measurement zone, and also the distance w, between notch roots, with an accuracy of 0,1 mm. The arithmetic means of the measurements shall be documented.