SLOVENSKI STANDARD
SIST ENV 658-2:2000

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Advanced technical ceramics - Mechanical properties of ceramic composites at room temperature - Part 2: Determination of compressive strength

Advanced technical ceramics - Mechanical properties of ceramic composites at room temperature - Part 2: Determination of compressive strength

Hochleistungskeramik - Mechanische Eigenschaften von keramischen Verbundwerkstoffen bei Raumtemperatur - Teil 2: Bestimmung der Druckfestigkeit

Céramiques techniques avancées - Propriétés mécaniques des céramiques composites a température ambiante - Partie 2: Détermination de la résistance a la compression

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English version

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CEN members are required to announce the existance of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

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CEN

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

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Contents list

Foreword

This European pre-standard has been prepared by CEN/TC 184 "Advanced technical ceramics" of which the secretariat is held by BSI.

EN 658 consists of six parts:

Part 1: Determination of tensile strength
Part 2: Determination of compressive strength
Part 3: Determination of flexural strength
Part 4: Determination of shear strength by compression loading of notched specimens
Part 5: Determination of shear strength by short span bend test (three-point)
Part 6: Determination of shear strength by double-punch shearing

CEN/TC 184 approved this European pre-standard by resolution 2/1991 during its fourth meeting held in Nuremberg, 1991-09-10

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

1 Scope

This Part of ENV 658 specifies the conditions for determination of compressive properties of ceramic matrix composite materials with continuous fibre reinforcement at ambient temperature.

This standard applies to all ceramic matrix composites with a continuous fibre reinforcement, unidirectional (1D) bidirectional (2D), and tridirectional (3D), loaded along one principal axis of reinforcement, loaded along the principal axis of reinforcement. This standard does not apply to ceramic composites with a short fibre recinforcement.

Two cases are distinguished:

a) compression between platens
b) compression using special fixture

2 Normative references

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

EN 10002-2	-	Metallic materials- tensile testing Part 2 : Verification of the force measuring systems of the tensile testing machine
ISO 3611	-	Micrometer callipers for external measurements

3 Principle

A test specimen of specified dimensions is loaded in a compression test. The test is performed at constant crosshead displacement rate or at constant deformation rate. The longitudinal force and deformation (and if applicable transverse strains) are measured and recorded simultaneously.

4 Definitions and symbols

4.1 Gauge length L(o) mm

Initial distance between the reference points of the extensometer installed on the part of the test specimen in the measurement zone.

4.2 Longitudinal deformation, A

Increase in the gauge length between reference points under a compressive force, as measured by an extensometer. Its value corresponding to the maximum compressive force shall be recorded as A(cm).

4.3 Compressive strain, ε(c)

Relative change in the gauge length defined as the ratio A : L(o). Its value corresponding to the maximum tensile force shall be recorded as

4.4 Compressive stress, σ(c)

Ratio of the compressive force carried by the test specimen at any time in the test divided by the initial cross sectional area of the section of the test specimen in the measurement zone.

4.5 Maximum compressive force, F(m)

Highest recorded compressive force in a compression test on the test specimen when tested to failure.

4.6 Compressive strength, σ(cm)

Ratio of the maximum compressive force to the initial cross-sectional area of the section of the test specimen in the measurement zone.

4.7 Proportionality ratio or pseudo-elastic modulus, EP

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

a) Material with a linear section in the stress-strain curve. For ceramic matrix composites that have a mechanical behaviour characterised by a linear section, the proportionality ratio is defined as:

$$EP\ (\sigma_1, \sigma_2) = \frac{\sigma_2 - \sigma_1}{\epsilon_2 - \epsilon_1} \times 10^{-3}$$

Where (ϵ_1, σ_1) and (ϵ_2, σ_2) lie on the linear section to the stress-strain curve (see figure 1)

The proportionality ratio or pseudo-elastic modulus is termed the elastic modulus, E, in the single case where the linearity starts from the origin (see figure 2).

b) Material with non-linear stress-strain behaviour. In this case only stress-strain couples can be fixed (see figure 3).

5 Apparatus

5.1 Compression test machine

The machine shall be equipped with a system for measuring the force applied to the test specimen. The machine shall conform to grade 1 in EN 10002-2.

There are two alternative means of load application:

a) Compression patterns are fixed on the load cell and on the moving crosshead. The parallelism of these platens shall be reported to the nearest 0,01 mm.

NOTE : The use of platens is not recommended for compression testing of 1D and 2D materials.

b) Special fixtures are used to clamp and load the test specimen. These fixtures shall prevent the test specimen from slipping and buckling (see figures 6 and 7).

The attachment fixtures shall align the test specimen axis with the applied force direction. This point shall be verified and documented.

5.2 Extensometer and strain gauges

Extensometry shall be capable of continuously recording the longitudinal deformation as a function of the applied force. If the extensometer contacts the specimen, it shall do so in a manner which shall prevent slip and be without influence on the failure initiation site.

The use of an extensometer with the greatest measurement base compatible with the measured zone length of the test specimen is recommended. The linearity tolerances shall be lower than 0,05 % of the extensometer range used.

Strain gauges may only be used for determination of elastic moduli.

5.3 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.

5.4 Data recording

A calibrated recorder shall be used for recording force-deformation curves. The use of a calibrated digital data acquisition system is recommended.

6 Test specimens

NOTE : See figures 4 and 5.

Test specimens shall be flat and parallel and manufactured according to a drawing in which the dimensions are specified. The dimensions shall be chosen so as to avoid buckling in the calibrated section. A length/width ratio of between 2 and 2,5 is recommended. For compressive testing along the fibre axis, the geometries described in table 1 are recommended. For the material geometries not listed in table 1, an adapted specimen shall be defined.

Table 1 : Recommended test specimen dimension

Dimensions in millimetres

Material	1D and 2D		3D		
	Type 1	Type 2	Type 1	Type 2	Tolerances
Total length L	170	110	40	60	± 0,5
Length of calibrated section l	20	8	15	-	± 0,2
Thickness h	3	2	8	16	± 0,15
Width B	10	6,35	14	-	± 0,2
Width of the calibrated section b	8	6,35	8	16	± 0,05 to 0,1
Blend radius R	30	-	30	-	± 0,2
Plan parallelism of machined parts	0,05 to 0,1		0,05 to 0,1		

7 Test specimen preparation

7.1 Machining

During cutting out, care shall be taken to align the test specimen axis with the desired fibre related loading axis.

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.

The test specimen thickness shall be as far as possible, a whole number of individual plies, representative of the composite structure in the gauge length of the test specimen.

7.2 Number of test specimens

At least three valid test results, as specified in 8.4, are required for any condition.