SLOVENSKI STANDARD
SIST ENV 658-5:2000

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Advanced technical ceramics - Mechanical properties of ceramic composites at room temperature - Part 5: Determination of shear strength by short span bend test (three-point)

Advanced technical ceramics - Mechanical properties of ceramic composites at room temperature - Part 5: Determination of shear strength by short span bend test (three-point)

Hochleistungskeramik - Mechanische Eigenschaften von keramischen Verbundwerkstoffen bei Raumtemperatur - Teil 5: Bestimmung der Scherfestigkeit im Dreipunkt Biegeversuch mit kurzem Auflagerabstand

Céramiques techniques avancées - Propriétés mécaniques des céramiques composites a température ambiante - Partie 5: Détermination de la résistance au cisaillement par essai de flexion sur appuis rapprochés (trois points)

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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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Contents list

Foreword

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

ENV 658 has 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 Prestandard by resolution 4/1992 during its fifth meeting, held in Brussels on 1992-03-31.

In accordance with the CEN/CENELEC Internal Regulations, 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 United Kingdom.

1 Scope

This Part of ENV 658 specifies the conditions for the determination of the interlaminar shear strength matrix composite materials with continuous fibre reinforcement at ambient temperature, by subjecting a test specimen to a short-span, three-point, bend test. The method applies to unidirectionally and bidirectionally reinforced ceramic matrix composites, as well as to tridirectional composites with weak reinforcement in the third direction.

NOTE : Two other methods for the determination of shear strength are given in further Parts of ENV 658. The interlaminar shear characteristics can vary significantly depending on specimen preparation and dimensions, rate of application of the test force, surface condition, etc. Comparison of test results is only valid for tests performed under identical conditions.

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 system of the tensile testing machine

ISO 3611 : Micrometer callipers for external measurements

3 Principle

The test consists of measuring the force required to fracture a test specimen subjected to a short-span, three-point bend test. The geometry of loading in the direction normal to the plies and the specimen dimensions shall be such that failure occurs in the form of interlaminar shear in plane 12 (see figure 1). The test is performed at constant crosshead displacement rate.

4 Definitions and symbols

4.1 Shear failure force (F)

The maximum force required to fracture a shear loaded test specimen in a test up to failure.

4.2 Interlaminar shear strength (ILSS)

Ratio calculated on the basis of the shear failure force and the shear loaded area.

NOTE : The notation ILSS is supplemented by a small letter referring to the test method described; in this case ILSS(b) for the interlaminar shear strength obtained from a short-span, three-point bend test.

5 Apparatus

5.1 Test machine

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

5.2 Micrometer

Micrometers used for the measurement of the specimen dimensions (distance between notches), shall be accurate to ± 0.1 mm and in accordance with ISO 3611.

5.3 Test jig

The test jig shall have a central mandrel and outer support rollers, capable of rolling outwards. The dimensions shall be as given in table 1. The length of the mandrel and the rollers shall not be less than the width of the test specimen. The test jig shall ensure that the longitudinal axis of the test specimen remains perpendicular to the support rollers. The deviation of parallelism between the support rollers and the central mandrel shall not exceed 0.05 mm for a test specimen of width 10 mm (see table 2). The hardness of the mandrel and the support rollers shall not exceed that of the test material.

Table 1 : Test jig dimensions

(dimensions in millimetre)

Measurement	Dimension	Tolerance
Radius of central mandrel, r(1)	3	± 0,1
Radius of outer support rollers, r(2)	3	± 0,1
Support span, S	15	± 0,1

NOTE : The support span of 15 mm is derived from the specimen thickness of 3 mm given in table 2. If different thicknesses are used the span should be altered in the ratio:

$$S = 5\ h \pm 1$$

See also figure 2.

6 Test specimens

The dimensions of the test specimen shall be as given in table 2.

Table 2 : Recommended test specimen dimensions

(dimensions in millimetre)

Measurement	Dimensions	Tolerance
total length, L(T)	20 to 25	± 1
thickness, h	3	± 0,1
width, b	10	± 0,1
plan parallelism of machined parts		0,05 to 0,1

7 Test specimen preparation

7.1 Machining

During cutting out, care shall be taken that the specimen axes coincide with the fibre directions. Machining parameters which avoid damage to the material shall be established and documented. These parameters shall be adhered to during test piece preparation.

7.2 Number of specimens

At least five valid test results, (see 8.4) are required.

8 Procedure

8.1 Test rate

Use a constant cross head speed which allows completion of the test within 15 s, and record the speed used.

8.2 Measurement of test specimens

Measure the width and thickness to the nearest 0,1 mm in the centre and at each end of the specimen. Report the arithmetic means of the measurement and measure the support span to the nearest 0,1 mm.

8.3 Testing technique

Install the test specimen in the test machine and set the crosshead speed. Make a record of force versus time during the test. Verify the failure location and failure mode.

8.4 Testing validity

The following circumstances will invalidate a test:

a) failure to specify and record test conditions
b) failure to note the mode and location of fracture
c) specimen failure not occurring within a distance from the mid-point of the specimen of $\pm \frac{h}{4}$

9 Calculation of result

The following expression shall be used to calculate the interlaminar shear strength:

$$ILSS(b) = \frac{3F}{4B.h}$$

where ILSS(b) is the interlaminar shear strength, in plane 12 (MPa)

F is the shear failure force (N)

b is the mean specimen width (mm)

h is the mean specimen thickness (mm).

NOTE : Care should be exercised in interpreting the results of the proposed testing methods to obtain absolute values of the interlaminar shear strength of ceramic matrix composites for design purposes.

10 Test report

The test report shall contain the following information:

a) Name and address of the testing establishment
b) Date of the test, unique identification of report and of each page, customer name and address and signatory
c) A reference to this standard, i.e. determined in accordance with ENV 658 : Part 5
d) Test specimen drawing showing the orthotropic directions of the material
e) Description of the test material (material type, manufacturing code, batch number)
f) The area and orientation of test specimens taken from a sample of material
g) Number of test carried out and the number of valid results obtained
h) Force and time record
i) Individual results and arithmetic means
j) Mode and failure location of all the test specimens used for obtaining the above results.
k) Any comments about the test or test results.