INTERNATIONAL STANDARD

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Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of the interlaminar shear strength of continuous-fibre-reinforced composites at ambient temperature by the compression of double-notched test pieces and by the Iosipescu test

Céramiques techniques — Détermination de la résistance au cisaillement interlaminaire des composites renforcés de fibres connues à température ambiente par compression d'éprouvettes doublement entaillées et par l'essai de Iosipescu

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 20505 was prepared by Technical Committee ISO/TC 206, *Fine ceramics*.

Fine ceramics (advanced ceramics, advanced technical ceramics) — Determination of the interlaminar shear strength of continuous-fibre-reinforced composites at ambient temperature by the compression of double-notched test pieces and by the Iosipescu test

1 Scope

This International Standard specifies a method for the determination of interlaminar shear strength of continuous-fibre-reinforced ceramic composites at ambient temperature, by the compression of a double-notched test piece or by the Iosipescu test. Methods for test piece fabrication, testing modes and rates (load rate or displacement rate), data collection, and reporting procedures are addressed.

This International Standard applies primarily to advanced ceramic or glass-matrix composites with continuous-fibre reinforcement having uni-directional (1-D) or bi-directional (2-D) fibre architecture. This test method does not address composites with (3-D) fibre architecture or discontinuous-fibre-reinforced, whisker-reinforced or particulate-reinforced ceramics.

NOTE 1 Values expressed in this International Standard are in accordance with the International System of Units (SI).

NOTE 2 This International Standard is based on ASTM C1292.

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.

ISO 3611, *Micrometer callipers for external measurement*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ASTM C1292, *Standard Test Method for Shear Strength of Continuous Fiber-Reinforced Advanced Ceramics at Ambient Temperatures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
fine ceramic (advanced ceramic, advanced technical ceramic)
highly engineered, high-performance predominately non-metallic, inorganic, ceramic material having specific functional attributes

3.2
continuous-fibre-reinforced ceramic composite
CFCC
ceramic matrix composite in which the reinforcing phase consists of a continuous fibre, continuous yarn, or a woven fabric

3.3
shear-failure load
maximum load required to fracture a shear-loaded test piece

3.4
shear strength
maximum shear stress which a material is capable of sustaining

NOTE Shear strength is calculated from the shear-fracture load and the shear-loaded area.

4 Symbols and abbreviated terms

The symbols used throughout this International Standard and their designations are given in Table 1.

Table 1 — Symbols and designations

Symbol	Designation	Unit	References
L	Test piece length	mm	Tables 2, 3
h	Distance between notches	mm	Tables 2, 3 Equations 2, 4
w	Test piece width	mm	Tables 2, 3 Equation 2
t	Test piece thickness	mm	Tables 2, 3 Equation 4
d	Notch width, double-notched test piece	mm	Table 2
R	Notch radius, Iosipescu test piece	mm	Table 3
Θ	Notch angle, Iosipescu test piece	°	Table 3
n	Number of valid tests	1	Equations 5, 6 subclause 12.2
P_{max}	Maximum load	N	Equations 1, 3
A_1	Shear area for double-notched test piece	mm^2	Equations 1, 2
A_2	Shear area for Iosipescu test piece	mm^2	Equations 3, 4
τ_{IL}	Interlaminar shear strength	MPa	Equations 1, 3
$\overline{X}$	Mean value	MPa	Equations 5, 6, 7
SD	Standard deviation	MPa	Equations 6, 7
CV	Coefficient of variation	1	Equation 8

5 Principle

This International Standard is for material development, material comparison, quality assurance, characterization, reliability and design data generation. The interlaminar shear strength of continuous-fibre-reinforced ceramic composites, as determined by this International Standard, can be measured by the compression of double-notched test pieces or by the Iosipescu test. In the case of the former, a double-notched test piece of uniform width is loaded in compression to induce failure by shear between two centrally located notches machined halfway through the thickness and spaced a fixed distance apart on opposing faces. Schematics of the test setup and the test piece are shown in Figures 1 and 2.

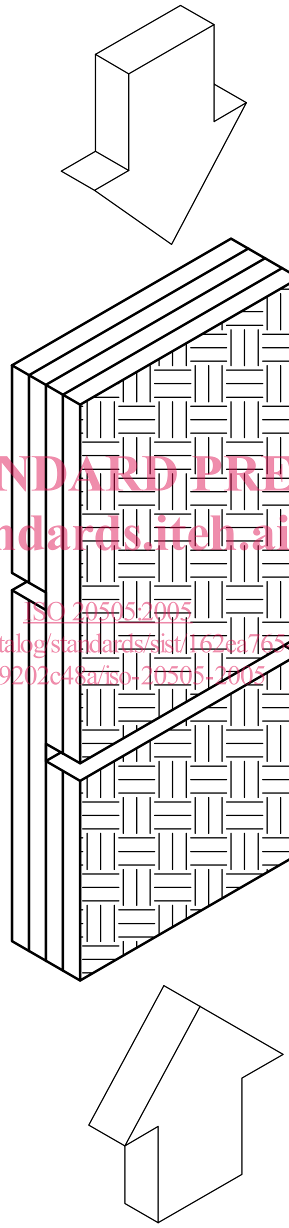

Figure 1 — Schematic of double-notched test piece subjected to compressive loading

Dimensions in millimetres

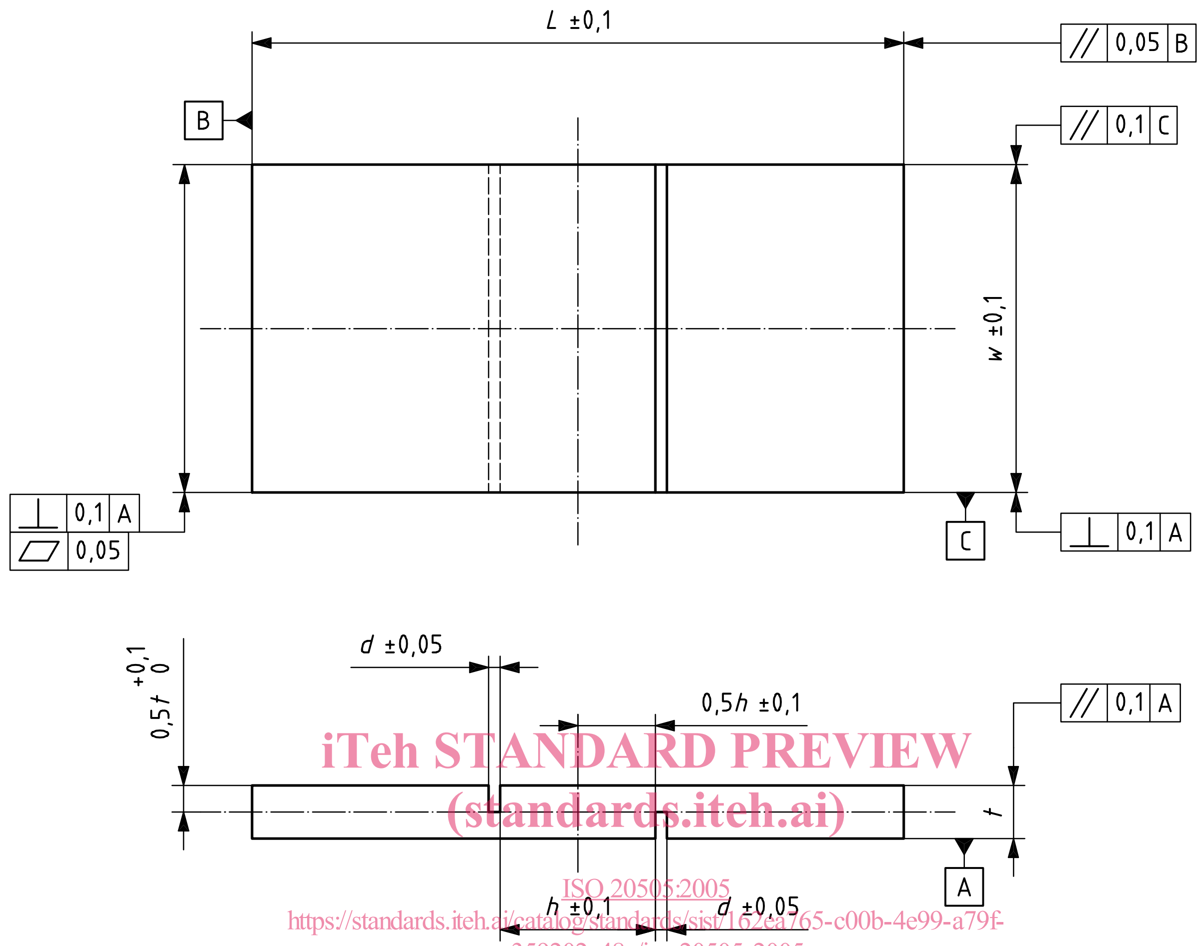

Figure 2 — Geometry and dimensions of double-notched test piece

For the Iosipescu test, the shear strength is determined by loading a test coupon in the form of a rectangular flat strip with symmetric, centrally located V-notches using a mechanical testing machine and an asymmetric four-point bending fixture. Failure of the test piece occurs by shear between the V-notches. Schematics of the test setup and test piece are shown in Figures 3 and 4.

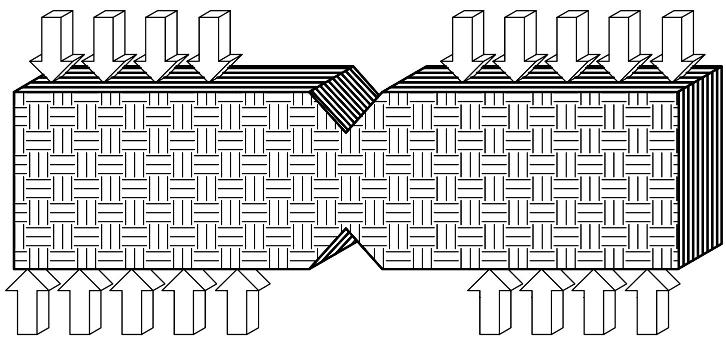

Figure 3 — Schematic of Iosipescu test piece subjected to asymmetric four-point bending loading

Dimensions in millimetres

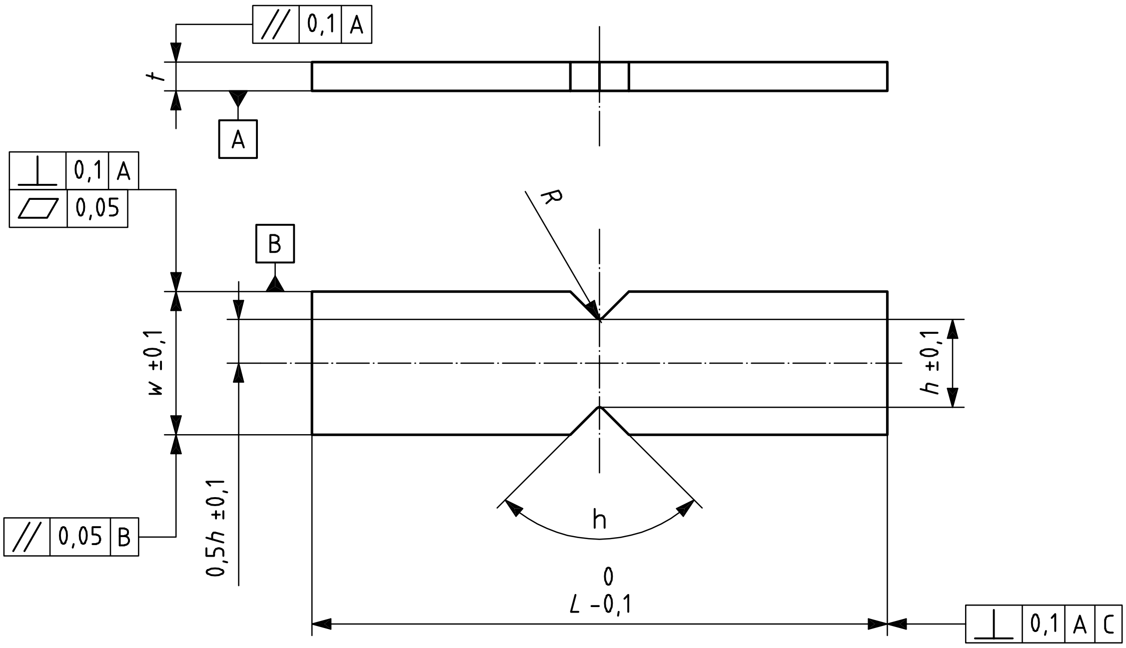

Figure 4 — Geometry and dimensions of Iosipescu test piece

6 Interferences

6.1 Test environment

The test environment may have an influence on the measured shear strength. In particular, the behaviour of materials susceptible to slow-crack-growth fracture will be strongly influenced by the test environment and testing rate. Testing to evaluate the maximum strength potential of a material shall be conducted in inert environments and/or at sufficiently rapid testing rates, so as to minimize slow-crack-growth effects. Conversely, testing can be conducted in environments and testing modes and rates representative of service conditions, to evaluate material performance under those conditions. When testing is conducted in uncontrolled ambient air with the objective of evaluating maximum strength potential, relative humidity and temperature shall be monitored and reported.

6.2 Preparation of test pieces

Preparation of test pieces, although normally not considered a major concern with continuous-fibre-reinforced ceramic composites, can introduce fabrication flaws which may have pronounced effects on the mechanical properties and behaviour (e.g. shape and level of the resulting load-displacement curve and shear strength). Machining damage introduced during test piece preparation can be either a random interfering factor in the determination of shear strength of pristine material, or an inherent part of the strength characteristics to be measured. Universal or standardized test methods of surface preparation do not exist. Final machining steps may, or may not, negate machining damage introduced during the initial machining. Thus, the history of test piece fabrication may play an important role in the measured strength distributions and shall be reported.

6.3 Bending

Bending of uniaxially loaded shear test pieces (during the compression of double-notched test pieces) can cause or promote non-uniform stress distributions that may alter the desired uniform state of stress during the test.