SIST

SLOVENSKI STANDARD
SIST EN 843-1:2007

01-maj-2007

Nadomeġļ a:
SIST EN 843-1:2000

Sodobna tehniļ na keramika - Mehanske lastnosti monolitske keramike pri sobni temperaturi - 1. del: Doloļ anje upogibne trdnosti

Advanced technical ceramics - Mechanical properties of monolithic ceramics at room temperature - Part 1: Determination of flexural strength

Hochleistungskeramik - Mechanische Eigenschaften monolithischer Keramik bei Raumtemperatur - Teil 1: Bestimmung der Biegefestigkeit

Céramiques techniques avancées - Propriétés mécaniques des céramiques monolithiques a température ambiante - Partie 1: Détermination de la résistance en flexion

Ta slovenski standard je istoveten z: EN 843-1:2006

ICS:

81.060.30	Sodobna keramika	Advanced ceramics

SIST EN 843-1:2007 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 843-1

December 2006

ICS 81.060.30

Supersedes EN 843-1:1995

English Version

Advanced technical ceramics - Mechanical properties of monolithic ceramics at room temperature - Part 1: Determination of flexural strength

Céramiques techniques avancées - Propriétés mécaniques des céramiques monolithiques à température ambiante - Partie 1: Détermination de la résistance en flexion

Hochleistungskeramik - Mechanische Eigenschaften monolithischer Keramik bei Raumtemperatur - Teil 1: Bestimmung der Biegefestigkeit

This European Standard was approved by CEN on 11 November 2006.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 843-1:2006: E

Contents

Page

Foreword

This document (EN 843-1:2006) 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 June 2007, and conflicting national standards shall be withdrawn at the latest by June 2007.

This document supersedes EN 843-1:1995.

EN 843 *Advanced technical ceramics — Mechanical properties of monolithic ceramics at room temperature* comprises six parts:

Part 1: *Determination of flexural strength*

Part 2: *Determination of Young’s modulus, shear modulus and Poisson’s ratio*

Part 3: *Determination of subcritical crack growth parameters from constant stressing rate flexural strength tests*

Part 4: *Vickers, Knoop and Rockwell superficial hardness*

Part 5: *Statistical analysis*

Part 6: *Guidance for fractographic investigation*

At the time of publication of this Revision of Part 1, Part 6 was available as a Technical Specification.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This part of EN 843 specifies methods for determining the nominal flexural strength of advanced monolithic technical ceramic materials at ambient temperature. The available loading geometries are three- and four-point flexure, using rectangular section test pieces of two prescribed geometries: 20 mm support span (A) and 40 mm support span (B).

NOTE This part of EN 843 differs from ISO 14704 (see Bibliography) in respect of span A (not included in the ISO version), the absence of the 30 mm span option, and the required use of a fully articulating test jig.

The test applies to materials with grain size less than 200 µm.

The test prescribes four categories of surface finish applied to the test pieces:

I: as-fired or annealed after machining;

II: standard finishing by grinding;

III: standard finishing by lapping/polishing;

IV: machined using agreed grinding procedures and material removal rates.

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 623-4, *Advanced technical ceramics — Monolithic ceramics — General and textural properties — Part 4: Determination of surface roughness*

EN 843-5, *Advanced technical ceramics — Mechanical properties of monolithic ceramics at room temperature — Part 5: Statistical analysis*

EN 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 (ISO 7500-1:2004)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

ISO 3611, *Micrometer callipers for external measurement*

ISO 4677-1, *Atmospheres for conditioning and testing — Determination of relative humidity — Part 1: Aspirated psychrometer method*

ISO 4677-2, *Atmospheres for conditioning and testing — Determination of relative humidity — Part 2: Whirling psychrometer method*

3 Terms and definitions

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

3.1
nominal flexural strength
maximum nominal stress supported by the material at the instant of failure when loaded in linear elastic bending

3.2
three-point flexure
means of bending a beam test piece whereby the test piece is supported on bearings near its ends and a central force is applied

3.3
four-point flexure
means of bending a beam test piece whereby the test piece is supported on bearings near its ends and is loaded equally at two positions symmetrically disposed about the centre of the supported span

3.4
quarter-point flexure
four-point flexure (3.3) wherein the loading bearings are each one-quarter of the support span from the support bearings

4 Significance and use

This test is intended to be used for material development, quality control, characterization and design data acquisition purposes. The strength level determined by the test is calculated on the basis of linear elastic bending of a thin beam on the assumption that the material being tested is elastically homogeneous and isotropic, and shows linear (Hookean) stress-strain behaviour.

The result obtained from a strength test is determined by a large number of factors associated with the microstructure of the material, the surface finishing procedure applied in preparation of the test pieces, the size and shape of the test piece, the mechanical function of the testing apparatus, the rate of load application and the relative humidity of the ambient atmosphere. As a consequence of the brittle nature of ceramics, there is usually a considerable range of results obtained from a number of nominally identical test pieces. These factors combined mean that caution in the interpretation of test results is required. For many purposes, and as described in this European Standard, the results of strength tests may be described in terms of a mean value and a standard deviation. Further statistical evaluation of results is required for design data acquisition, and may be desirable for other purposes (see EN 843-5).

This method places closely defined restrictions on the size and shape of the test piece and on the function of the test apparatus in order to minimize the errors that can arise as a consequence of the test method.

NOTE The basis for the choice of dimensions and tolerances of test pieces and of the requirements of the test-jig may be found in reference [4].

All other test factors are required to be stated in the test report (see Clause 9) in order to allow inter-comparison of material behaviours. It is not possible to rigorously standardize particular surface finishes, since these are not absolutely controllable in mechanical terms. The inclusion of a standard grinding procedure (see 6.3) as one of the surface finish options in this method is intended to provide a means of obtaining a minimum amount of residual grinding damage in the test material.

The extrapolation of flexural strength data to other geometries of stressing, to multiaxial stressing, to other rates of stressing or to other environments should be viewed with caution.

The origin of fracture in a flexural test can be a valuable guide to the nature and position of strength-limiting defects. Fractography of test pieces is highly recommended. In particular, the test may identify fracture origins as being edge defects (caused by edge preparation), surface defects (caused by surface preparation), or internal defects (caused by manufacturing inhomogeneities such as pores, large grains, impurity concentrations etc.). Not all advanced monolithic technical ceramics are amenable to clear fractography.

5 Apparatus

5.1 Test jig

The test jig shall be capable of either three-point or four-point flexure and functioning as specified below in order to minimize misalignments, twist and frictional forces applied to the test piece.

NOTE 1 The precise test jig design is not specified, only the function.

Schematic arrangements of the test jig function are shown in Figure 1 a) for three-point flexure, and Figure 1 b) for four-point flexure.

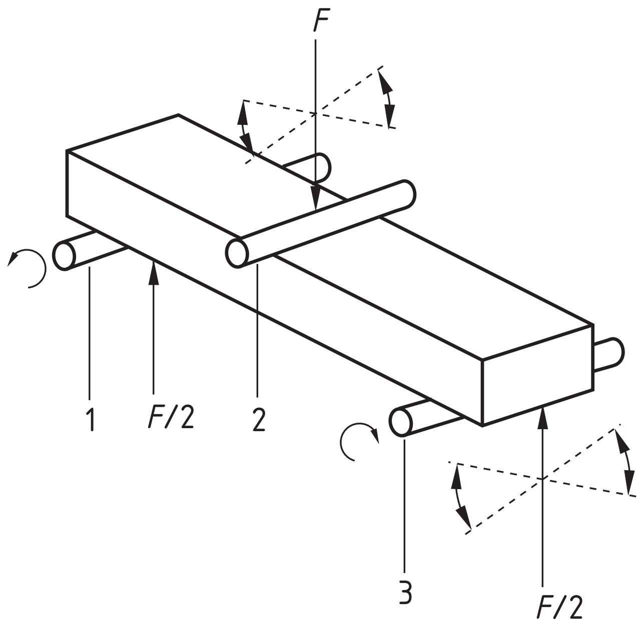
The test piece shall be supported on two bearing edges perpendicular to its length. The outer support bearing edges shall be parallel rollers of diameter approximately 1,5 times the test piece thickness. Diameters of between 2,2 mm and 2,5 mm (for span A - see 6.2) or between 4,5 mm and 5,0 mm (for span B - see 6.2) are recommended. The rollers shall be capable of rolling outward on flat support surfaces. One of the rollers shall additionally be capable of rotating about an axis parallel to the length of the test piece such that torsional loading is minimized. The two rollers shall be positioned initially with their centres 20 mm ± 0,5 mm apart (span A) or 40 mm ± 0,5 mm apart (span B) with their axes parallel to 0,2 mm over their lengths (≥ 12 mm). See Figure 2.

For three-point flexure, a third roller shall be located at the mid-point between and parallel to the two support rollers (Figures 2 a) and 2 c)). This roller shall have the same diameter as the support rollers and shall be similarly free to rotate about an axis parallel to the length of the test piece. Its position relative to the midpoint between the support rollers shall be better than 0,2 mm, measured to the nearest 0,1 mm in a direction parallel to the length of the test piece using the travelling microscope or other suitable device (see 5.4).

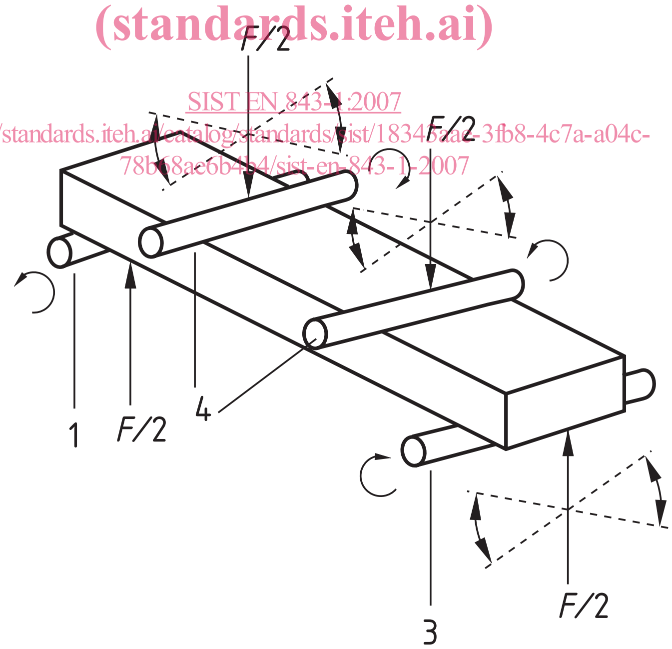
For four-point flexure, two loading rollers shall be located at the quarter points (see 3.4), i.e. with inner spans 10 mm ± 0,2 mm (outer span A) or 20 mm ± 0,2 mm (outer span B), and shall be free to roll inwards (Figures 2 b) and 2 d)). As with the three-point apparatus, the two rollers shall also be free to rotate separately about an axis parallel to the length of the test piece to allow alignment. The loading rollers shall be symmetrically positioned to within ± 0,1 mm. The distances between the centres of the support rollers and adjacent loading rollers shall be measured to the nearest 0,1 mm along the length of the test piece perpendicular to the direction of loading, using the travelling microscope or other suitable device (see 5.4). The arrangement for loading shall ensure that equal forces are applied to the two loading rollers.

The separation of the centres of the rollers in their starting positions shall be measured to the nearest 0,1 mm with the travelling microscope (see 5.3.2) or other suitable device. The rollers shall be made from hardened steel or other hard material with a hardness greater than 40 HRC (Rockwell C-scale) for strengths less than 1,4 GPa and not less than 46 HRC for strengths greater than 1,4 GPa. The rollers shall have a smooth burr-free surface finish with roughness less than 0,5 µm R_a and shall have diameter uniform to ± 0,015 mm.

NOTE 2 The accurate and repeatable lateral positioning of the rollers can best be achieved by ensuring that in the unloaded position, the support rollers are in lateral contact with stops which allow them to roll outwards on their support planes towards the ends of the test piece, and the inner loading rollers (four-point flexure) are in contact with stops which allow rolling inwards towards the middle of the test piece. The rotation of the rollers is thus unhindered when the test force is applied.



a) three-point bend jig



b) four-point bend jig

Key

1 rolling but non-articulating support roller

2 articulating loading roller

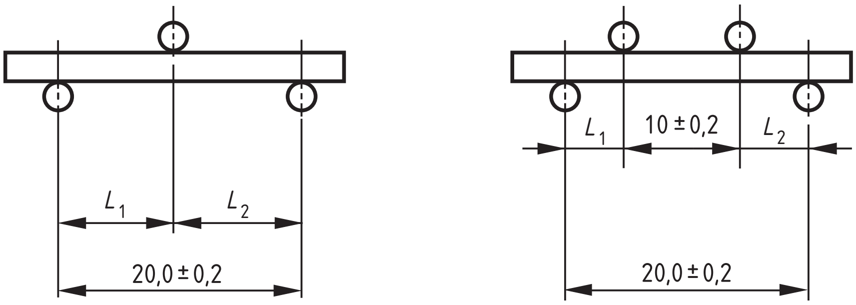
3 rolling and articulating support roller

4 rolling and articulating loading roller

Figure 1 — Schematic diagrams of function of test jigs indicating the articulation and rotation required for the rollers

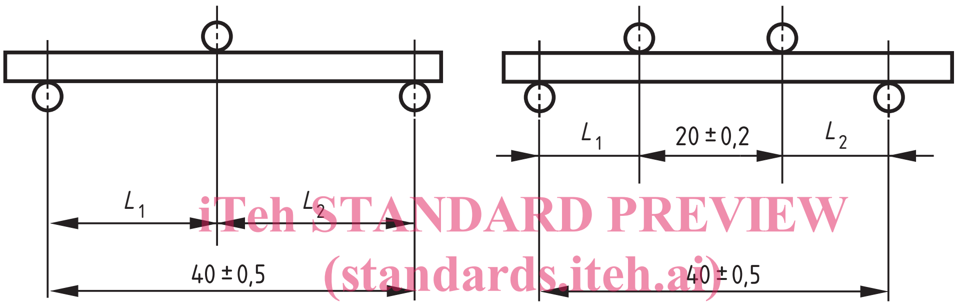
Dimension in millimetres

Size A



a) Three-point flexure b) Four-point flexure

Size B



c) Three-point flexure d) Four-point flexure

$L_1 = L_2 \pm 0,2$ $L_1 = L_2 \pm 0,1$

Figure 2 — Test span dimensions and tolerances

5.2 Test machine

The test machine shall be capable of applying a force to the loading roller (three-point flexure) or equally to the two loading rollers (four-point flexure) in order to stress the test piece. The machine shall be capable of applying the force at a constant loading or displacement rate. The test machine shall be equipped for recording the peak load applied to the test piece. The accuracy of the test machine shall be in accordance with EN ISO 7500-1, Grade 1 (accuracy 1 % of indicated load).

5.3 Micrometer or alternative calibrated device

A micrometer conforming to ISO 3611 and with a resolution 0,002 mm, or an alternative calibrated device measuring to this resolution, shall be used for the measurement of test piece dimensions.

5.4 Travelling microscope

A travelling microscope or other suitable device accurate to 0,05 mm shall be used for the measurement of distance between loading rollers.

5.5 Humidity measuring device

A humidity measuring device accurate to ± 5 % RH, for example one conforming to ISO 4677-1 or ISO 4677-2 shall be used.

6 Test pieces

6.1 General

The test pieces shall be selected and prepared according to agreement between the parties. They may either be specially processed to, or close to, the final required dimensions specified below, or may be machined from larger blocks or components.

NOTE 1 On occasion it may be desirable to test piece geometries that fall outside the scope of this method. In such a case, although the test method may not be cited, it is still advisable to follow the guidelines given in this European Standard concerning jig function to minimise errors of measurement.

NOTE 2 The strength of many types of advanced monolithic technical ceramics is strongly influenced by the machining procedure adopted in the preparation of the test pieces. Low strengths may be caused by grinding with coarse diamond grit sizes, and conversely, very high strengths may be obtained if care in polishing is taken. Some materials, especially those containing transformable zirconia, may be markedly strengthened by appropriate grinding schedules. Reporting of surface preparation conditions is therefore an important aspect of this test method.

6.2 Dimensions and tolerances

Dimensions and tolerances of test pieces shall be as shown in Table 1 and Figure 3.

Table 1 — Dimensions and tolerances on test pieces

Test piece type	Surface condition	Parameter	Dimensions, mm		
			Length	Width	Thickness
Size A	All	Dimensional range	≥ 25	2,5 ± 0,2	2,0 ± 0,2
	Machined	Parallelism tolerance	-	± 0,02	± 0,02
	As-fired	Parallelism tolerance	-	± 0,05	± 0,05
Size B	All	Dimensional range	≥ 45	4,0 ± 0,2	3,0 ± 0,2
	Machined	Parallelism tolerance	-	± 0,02	± 0,02
	As-fired	Parallelism tolerance	-	± 0,10	± 0,10

Additionally, the cross-section of the test piece shall be rectangular to within conventional engineering practice. Out-of-squareness of sides to faces of the test pieces shall be less than 5° as determined by vernier protractor or engineering shadowgraph. For as-fired test pieces, the maximum tolerable twist along the length of the test piece shall be less than 2°, as determined by use of a shadowgraph or other suitable arrangement.