SLOVENSKI STANDARD
SIST-TS CEN/TS 843-9:2010

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Sodobna tehnična keramika - Mehanske lastnosti monolitske keramike pri sobni temperaturi - 9. del: Metoda preskušanja odpornosti proti krušenju robov

Advanced technical ceramics - Mechanical properties of monolithic ceramics at room temperature - Part 9: Method of test for edge-chip resistance

Hochleistungskeramik - Mechanische Eigenschaften monolithischer Keramik bei Raumtemperatur - Teil 9: Prüfverfahren zur Bestimmung der Kantenbeständigkeit gegen Abplatzung

Céramiques techniques avancées - Propriétés mécaniques des céramiques monolithiques à température ambiante - Partie 9: Méthode d'essai de résistance à l'écaillage des bords

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English Version

Advanced technical ceramics - Mechanical properties of monolithic ceramics at room temperature - Part 9: Method of test for edge-chip resistance

Céramiques techniques avancées - Propriétés mécaniques des céramiques monolithiques à température ambiante - Partie 9: Méthode d'essai de résistance à l'écaillage des bords

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Foreword

This document (CEN/TS 843-9:2010) has been prepared by Technical Committee CEN/TC 184 "Advanced technical ceramics", the secretariat of which is held by BSI.

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1 Scope

This Technical Specification describes requirements and methods for undertaking tests to determine the resistance of the edges of brittle ceramic materials to be damaged by chipping or flaking. It is limited to homogeneous monolithic ceramics with flat surfaces and straight sharp or chamfered edges.

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

3 Terms and definitions

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

3.1
chip or flake
detached piece of material from the edge of a component or test piece

3.2
edge chipping or edge flaking
process of producing a chip or flake from the edge of a component or test piece

3.3
edge chip resistance
measure of the resistance of the edge of a component or test piece to chipping or flaking determined by dividing the force applied by the maximum thickness of the flake or the distance of the centre of the applied force from the edge at which it is formed

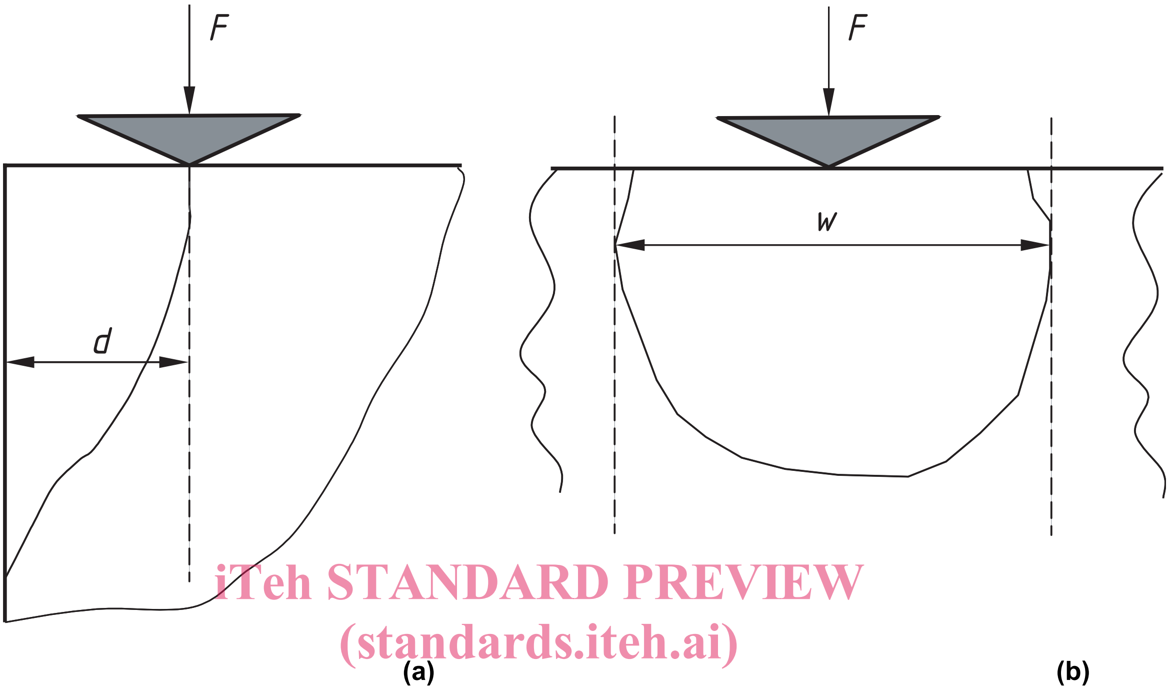
NOTE The term ‘edge toughness’ has an equivalent meaning.

4 Principle and use

Localised loading near the edge of a ceramic component can lead to spalling of the edge, and hence to loss of function of the component. The test methods in this standard provide means of quantifying the resistance of a ceramic product to edge damage, either by applying a monotonically increasing force to an indenter positioned a fixed distance from the edge (Method A), or by applying a predetermined force to an indenter positioned remotely from the edge, and dragging it towards the edge (Method B). In the case of method A, the force required to cause an edge flake to form at a pre-determined position is recorded; while in the case of Method B, the distance from the edge at which the flake is formed under a pre-determined force is measured.

In both cases (see Figure 1), the force applied, *F*, divided by the distance from the edge at which the flake is formed, *d*, commonly known as the 'edge toughness', is then a measure of edge chip resistance.

This test can also be used to determine the effectiveness of chamfers placed on edges. A chamfer prevents direct loading near the edge. The size of the chamfer required for the component to withstand a given near-edge loading can be determined by this test.



Key:

F Indenter applying force normal to plane

d maximum flake depth into bulk

w maximum flake width on face

Figure 1 — Schematic of indentation near an edge using a hard indenter (a) cross-sectional view of a flake formed at an edge, and (b) flake shape viewed from edge side

5 Method A: Direct force application

5.1 Apparatus

5.1.1 General

The force required shall be applied by any suitable mechanical testing machine which operates either in a constant displacement rate mode or in a constant force increase rate mode. The machine shall drive an indenter (5.1.4) into the surface of a component or test piece at a pre-determined location near the edge until the flake forms.

NOTE The mechanism of flake formation is thought be the preferred extension of those radial cracks emanating from the indentation which are roughly parallel with the edge. Owing to the lack of elastic constraint near the edge, these propagate sideways and into the material to form a shell-shaped crack, which once past a certain size becomes unstable and forms a detached flake.

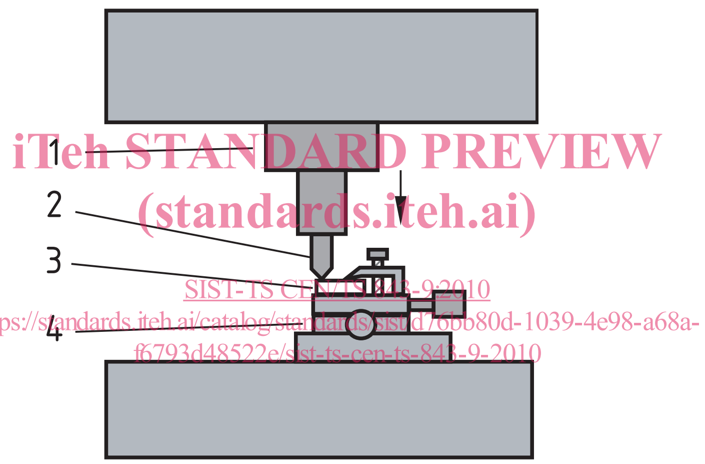
5.1.2 Test machine

A mechanical testing machine shall be used, which is capable of applying a force to the test jig at a constant displacement rate. The test machine shall be equipped for recording the load applied to the test jig at any point in time, and preferably of capturing the peak force applied. The accuracy of the test machine shall be in accordance with EN ISO 7500-1, Grade 1 (1 % of indicated load), and shall be capable of recording to a sensitivity of better than 1 % of the maximum load employed. The calibration shall have recently been checked.

5.1.3 Test piece holder

The test-piece shall be held in a clamping device which enables the component or test piece to be held in a fixed position in the testing machine (Figure 2). Preferably the clamping device incorporates two orthogonal means of adjusting position so that the location of the indenter (5.1.4) can be adjusted precisely, e.g. using an X-Y micrometer screw table which can be locked when indenting.

NOTE It is convenient to be able to view the indentation position by sighting normal to the indentation surface using a microscope or other suitable device, e.g. by moving the indenter out of the line of sight. Such an arrangement permits the indenter to be positioned an exact distance from the edge of the test piece.



1 Load cell 2 Indenter 3 Test piece or test items 4 X-Y lockable table

Figure 2 — Schematic of indentation technique for method A

5.1.4 Indenter

A sharp or a blunt diamond indenter shall be used for this test, as appropriate to requirements.

NOTE It is recommended that for reliability, especially in high force tests, a Rockwell geometry diamond (see EN 843-4) with a tip radius or 0,2 mm and manufactured from polycrystalline diamond is employed. If a Vickers or Knoop diamond is used, ensure that the diagonal length of the indentation is consistently aligned with the edge of the test piece.

5.2 Test piece

The principal requirement is that the component or test piece to be tested has a flat surface which is capable of being rigidly mounted with its normal parallel to the direction of indentation.

NOTE 1 Any edge profile may be tested, although square edges are more appropriate for materials comparison purposes.

NOTE 2 The surface and edge condition of the test piece is not critical for this test unless the machining damage is severe, in which case the damage introduced can interfere with the crack development process.

5.3 Test procedure

Position the component or test piece in the test piece holder (5.1.3) and clamp it into position. Adjust the position of the test piece relative to the indenter to the required indentation distance from the edge.

NOTE 1 The distance of indentation from the edge may be chosen arbitrarily. It is recommended that a distance of approximately 0,5 mm is used as a starting point with an unknown material. Depending on the material behaviour, the distance of indentation from the edge can then be either increased or decreased according to requirements.

Apply a force to the indenter with the test machine at a displacement rate of no more than 0,5 mm/min and record the peak force at which the flake is produced. Record the distance of indentation from the edge to the nearest 0,1 mm.

NOTE 2 The distance from the edge may be recorded via the positioning of the test piece under the indenter, or may be measured after the test using a travelling microscope or other suitable device measuring to the nearest 0,01 mm.

Retract the indenter and move the test-piece to a new indentation position at the same distance from the edge. If indenting on the same edge, ensure that there is no overlap of flakes produced, i.e. the lateral separation of indentation positions should be greater than the flake width (see Figure 1 (*w*)), or typically greater than 10 times the distance of indentation from the edge (see Figure 1 (*d*)).

Repeat the procedure.

Make at least 10 tests.

5.4 Calculation of results

For each flake produced, calculate the edge chip resistance, R_{eA}, by dividing the maximum flaking force, *F*, expressed in N, by the distance of indentation from the edge, *d*, expressed in mm.

$$R_{eA} = \frac{F}{d} \qquad (1)$$

Compute the average value of R_{eA}

$$\overline{R}_{eA} = \sum_{i=1}^{n} R_{eAi} / n \qquad (2)$$

where *n* is the number of tests.

Compute the standard deviation *sd* of $\overline{R}_{eA}$:

$$sd = \frac{\sum_{i=1}^{n} (\overline{R}_{eA} - R_{eAi})^2}{n(n-1)} \qquad (3)$$