SLOVENSKI STANDARD
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Metode za preskušanje gostih oblikovanih ognjevzdržnih izdelkov - 5. del: Ugotavljanje tlačne trdnosti ob porušitvi pri sobni temperaturi

Methods of test for dense shaped refractory products - Part 5: Determination of cold crushing strength

Prüfverfahren für dichte geformte feuerfeste Erzeugnisse - Teil 5: Bestimmung der Kaltdruckfestigkeit

Méthodes d'essai pour produits réfractaires façonnés denses - Partie 5: Détermination de la résistance à l'écrasement

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81.080	Ognjevzdržni materiali	Refractories

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EUROPEAN STANDARD

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Methods of test for dense shaped refractory products - Part 5: Determination of cold crushing strength

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This European Standard was approved by CEN on 5 October 2018.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 993-5:2018) has been prepared by Technical Committee CEN/TC 187 “Refractory products and materials”, 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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 993-5:1998.

Reproducibility and repeatability data are available only for a limited number of testing methods and materials, but may be complemented in subsequent edition.

The series of standards EN 993 'Methods of test for dense shaped refractory products' consists of 20 Parts, some of which have been withdrawn and replaced by equivalent standards:

— *Part 1: Determination of bulk density and porosity*

— *Part 2: Determination of true density*

— *Part 3: Test methods for carbon-containing refractories*

— *Part 4: Determination of permeability to gases*

— *Part 5: Determination of cold crushing strength*

— *Part 6: Determination of modulus rupture, ambient temperatures*

— *Part 7: Determination of modulus of rupture, elevated temperatures*

— *Part 8: Determination of refractoriness-under-load* – withdrawn – replaced by EN ISO 1893

— *Part 9: Determination of creep in compression*

— *Part 10: Determination of permanent change in dimensions on heating*

— *Part 11: Determination of resistance to thermal shock (ENV)*

— *Part 12: Determination of pyrometric cone equivalent*

— *Part 13: Specification for pyrometric cones*

— *Part 14: Determination of thermal conductivity (hot wire, cross-array)* – withdrawn – replaced by EN ISO 8894-1

— *Part 15: Determination of thermal conductivity (hot wire, parallel)*

— *Part 16: Determination of resistance to acids*

— *Part 17: Determination of bulk density of granular material (mercury method)*

— *Part 18: Determination of bulk density of granular material (water method)*

— *Part 19: Determination of thermal expansion by a differential method*

— *Part 20: Determination of resistance to abrasion at ambient temperature* – withdrawn – replaced by EN ISO 16282

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

1 Scope

This document specifies a method of determination of the cold crushing strength of dense shaped refractory products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Callipers; Design and metrological characteristics*

ISO 5022, *Shaped refractory products — Sampling and acceptance testing*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
cold crushing strength
maximum load per unit area, applied under specified conditions at room temperature, that a refractory product will withstand before failure occurs

3.2
dense shaped refractory product
product with specific dimensions, having a true porosity of less than 45 % by volume, when measured in accordance with EN 993-1

3.3
sample
representative collection of items that can be obtained by sampling in accordance with ISO 5022

3.4
item
refractory brick or shape

3.5
test piece
piece of material extracted from an item (3.4) and suitably shaped and prepared for the test

4 Principle

A test piece of known dimensions is subjected under specified conditions to a steadily increasing compressive load until its failure, when it cannot support a further increase in load. The cold crushing strength is calculated from the maximum load indicated at failure and the mean cross-sectional area over which the load is applied.

5 Apparatus

5.1 A mechanical or hydraulic compression testing machine, fitted with a measuring device capable of measuring the load exerted on the test piece to within ± 2 %.

The machine shall be capable of increasing the stress at the rate of 1,0 MPa·s^{-1} ± 0,1 MPa·s^{-1}, until the test piece is unable to support the load.

The platens of the machine shall:

a) have a Rockwell hardness value between 58 HCR and 62 HCR;

b) be ground plane to a flatness tolerance of 0,03 mm over the area to be in contact with the test piece;

c) have a surface texture (mean roughness value R_a) between 0,8 mm and 3,2 mm. This can be checked visually or by feeling with a “mean-roughness” reference standard such as is used for flat grinding.

The area of the upper platen shall not be greater than 100 cm^2, but shall have an area greater than the cross section of the test piece. The upper platen shall work on a seating that will compensate for small deviations from parallelism between the platens and the test piece.

A testing machine whose platens does not comply with the above requirements for size can be used in conjunction with an ancillary adaptor, such as shown in Figure 1, placed centrally between the platens of the machine. The platens of the adaptor shall comply with the machine platens requirements for hardness and flatness given in this clause. They shall have a thickness of at least 10 mm.

The platens should be replaceable to allow re-machining and should not be matted.

5.2 Vernier callipers in accordance with ISO 13385-1, for measurement of test pieces (see 6.3 and Clause 7)

5.3 Set square

5.4 Drying oven, capable of being controlled at (110 ± 5) °C

5.5 Feeler gauges

5.6 Levelling plate

5.7 Ancillary adaptor (see Figure 1) if needed (see 5.1)

6 Test pieces

6.1 Geometry of the test piece

The test pieces shall be either

a) cylinders 50 mm ± 0,5 mm in diameter and 50 mm ± 0,5 mm in height,

or

b) cubes 50 mm ± 0,5 mm in edges length.

When it is not possible to obtain this size from the test item, cylinders 36 mm ± 0,3 mm in diameter and 36 mm ± 0,3 mm in height shall be used.

It is not recommended to compare the tests results obtained using test pieces of different dimensions

6.2 Number of test pieces

At least four items form a sample. In the case of acceptance testing, the number of items forming the sample to be tested shall be determined according to ISO 5022.

Only one test piece shall be taken from each item to be tested, unless otherwise agreed and reported (see Clause 9).

6.3 Test piece preparation and verification

6.3.1 The test piece shall be extracted from the middle of the item, unless otherwise agreed.

When more than one test piece is taken from an item, it is recommended to include at least one test piece taken from the centre, and one test piece adjacent to the hot face.

6.3.2 Test pieces shall be cut from the item(s) so that the load applied during testing is in the same direction as the forming pressure during manufacture of the item, when this is known. The original position of the test pieces in the item(s) shall be reported. Test pieces containing cracks or visible defects shall be discarded and this shall also be reported. Both ends of the test piece shall be made plane and parallel, grinding the surfaces where required. Water sensitive material where hydration is expected during the time of test piece preparation and handing shall be machined dry or by using a non-reacting liquid.

To ensure that the top and bottom ends of the test pieces are plane over their entire surface, each end shall in turn be pressured with a load of 3 kN ± 1 kN on to a levelling plate which is lined with carbon or blue paper and hard filter paper (0,15 mm in thickness). Test pieces that do not show two complete, clearly visible coloured impressions shall be reground (see Figures 2 to 5 for examples of cylindrical test pieces).

A steel straight edge can be used to assist in checking the surfaces. Mortar should not be used to plane the surfaces.

6.3.3 The parallelism of the test pieces shall be checked by four measurements of the height, at the extremities of two perpendicular diameters for a cylinder, or for a cube, along the four edges between the load-bearing faces. The difference between any two of these measurements of height shall not exceed 0,2 mm.

6.3.4 The perpendicularity shall be checked by placing the test piece on a plane surface and using a set square, placed against the side of the test piece, at four positions corresponding to the height measurements. No gap between the side of the test piece and the set square shall exceed 0,5 mm, measured with feeler gauges.

6.3.5 Drying of test piece. The prepared test pieces shall be carefully dried by placing them in a drying oven at (110 ± 5) °C to constant mass. They are then cooled to room temperature and stored in a dry place until the test is performed.

7 Procedure

Measure two perpendicular diameters or medians of each test piece surface to within 0,1 mm. From the arithmetic mean of these four measurements, calculate the initial cross-sectional area A_0.

Place the test piece or the ancillary adaptor with the test piece in it centrally between the platens of the machine, without using any packing between the test piece and the platens.

Select the load range so that the expected load at failure is greater than 10 % of the load range.

Apply the load smoothly and continuously, increasing the stress at the rate of (1,0 ± 0,1) MPa·s^{-1} until the test piece fails, when it is unable to support the load.