SLOVENSKI STANDARD
SIST EN 993-6:2019

01-februar-2019

Nadomešča:

SIST EN 993-6:1998

Metode za preskušanje (gostih) oblikovanih ognjevzdržnih izdelkov - 6. del: Ugotavljanje upogibne trdnosti pri sobni temperaturi

Methods of test for (dense) shaped refractory products - Part 6: Determination of modulus of rupture at ambient temperature

Prüfverfahren für (dichte) geformte feuerfeste Erzeugnisse - Teil 6: Bestimmung der Biegefestigkeit bei Raumtemperatur

Méthodes d'essai pour produits réfractaires façonnés (denses) - Partie 6 : Détermination du module de rupture par flexion à température ambiante

Ta slovenski standard je istoveten z: EN 993-6:2018

<u>ICS:</u>

81.080	Ognjevzdržni materiali	Refractories

SIST EN 993-6:2019 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 993-6

December 2018

ICS 81.080

Supersedes EN 993-6:1995

English Version

Methods of test for (dense) shaped refractory products - Part 6: Determination of modulus of rupture at ambient temperature

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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
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 993-6:2018 E

Contents

European foreword

This document (EN 993-6:2018) 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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.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 993-6:1995.

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standards EN 993 'Methods of test for dense shaped refractory products' consists of 20 Parts, some of which have been withdrawn and replaced by equivalent standards: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 for the determination of the modulus of rupture of dense and insulating shaped refractory products at ambient temperature, under conditions of a constant rate of increase of stress.

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*

EN ISO 7500-1, *Metallic materials - Calibration and verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system (ISO 7500-1)*

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
modulus of rupture
σ_F
maximum stress that a prismatic test piece of specified dimensions can withstand when it is bent in a three-point bending device

3.2
three-point bending
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
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

3.4
shaped insulating refractory
shaped refractory having a true porosity of not less than 45% by volume, when measured in accordance with EN 1094-4

3.5
sample
representative collection of items that can be obtained by sampling in accordance with ISO 5022

3.6
item
refractory brick or shape

3.7
test piece
piece of material extracted from an item (3.6) and suitably shaped and prepared for the test

4 Significance and use

This test is intended to be used for research, material development, manufacturing process control 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 modulus of rupture may be significantly affected 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 orientation of the test piece during testing, the geometry and functions of the testing jig, the rate of load application and the relative humidity of the ambient atmosphere. Comparisons of the results between different determinations should accordingly not be made if one or more of these parameters differ between the two determinations.

As a consequence of the brittle nature of refractories, there is usually a considerable range of results obtained from a number of nominally identical test pieces. Caution in the interpretation of test results is hence required. For many purposes, and as described in this standard, the results of the MOR test 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. In particular, any extrapolation of modulus of rupture data to other geometries of stressing, to multiaxial stressing, to other rates of stressing or to other environments should be viewed with caution.

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.

The method relates primarily to shaped and fired refractories. If it is to be applied to chemically bonded or tar-bonded bricks, they will usually require some form of preliminary heat treatment. This preliminary treatment is a matter of agreement between the interested parties and shall be described in the test report.

This method is also applicable to unshaped refractories, more specifically on test pieces prepared according to the requirements of EN ISO 1927-5 and EN ISO 1927-6.

5 Principle

Bending a prismatic test beam at a constant rate of increase of stress until failure occurs, whereby the test piece is supported on bearings near its ends, and a central force is applied.

6 Apparatus

6.1 Test jig

The loading device shall have three bearing edges, two to support the test piece and one for the application of the load (see Figure 1). The three edges shall have a radius of curvature in accordance with the requirements given in Table 1 and shall be of length not less than 5 mm greater than the width (b) of the test piece.

The line contact of the three edges shall be parallel to each other in a direction perpendicular to the length and the plane of the width of the test piece. Two supporting edges shall rest on an intermediate bearing piece, cylindrical on its lower surface, so that each edge may rotate independently in a vertical plane to accommodate any slight twist in the test piece. Alternatively, one supporting edge may be fixed, with the other supporting edge and the loadbearing edge being capable of rotation in a vertical plane.

The distance between the two supporting edges shall be in accordance with Table 1 and the loadbearing edge shall be positioned equidistantly, at ± 1 mm from each supporting edge (see Figures 1 and 2).

6.2 Testing machine, capable of applying a force uniformly to the loading roller in order to stress the test piece. The machine shall be capable of applying this force at a constant loading 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 2 (accuracy 2 % of indicated load).

6.3 Drying oven, capable of maintaining 110 °C ± 5 °C, or other device which has an equivalent heating effect.

6.4 Calliper, in accordance with ISO 13385-1, of resolution 0,1 mm, or alternative calibrated device measuring to this resolution, for measurement of test-piece dimensions.

7 Test pieces

7.1 Number of test pieces

7.1.1 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.

7.1.2 The number of test pieces to be cut from each item is a matter of agreement between the interested parties and shall be stated in the test report (see Clause 10). In order to facilitate statistical analysis, the same number of test pieces shall be cut from each item.

NOTE If only one item is available, whenever possible, at least four test pieces will be taken in order to compose a representative sample.

7.2 Shape and size

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

Table 1 — Test pieces dimensions and tolerances

Test piece dimensions ***L*** **x** ***b*** **x** ***h*** [mm]	**Tolerance on width and height** [mm]	**Tolerance for the parallelism of the cross-section sides**	**Tolerance for the parallelism of the top and bottom faces**	**Span,** L_s [mm]	**Radius of curvature for the loading edge and bearing edges** [mm]
230 × 114 × 76	-			180 ± 1	15 ± 0,5
230 × 114 × 64	-			180 ± 1	15 ± 0,5
L° x 40 × 40	±1	±0,15	±0,25	180 ± 1	5 ± 0,5
L° x 25 × 25	±1	±0,1	±0,2	125 ± 1	5 ± 0,5
L° ≥ Span + 10 mm					