SLOVENSKI STANDARD
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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 a température ambiante

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

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

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Contents

Foreword

This European Standard has been prepared by the Technical Committee CEN/TC 187 "Refractory products and materials", the secretariat of which is held by BSI.

It is closely based on the corresponding International Standard, ISO 5014 "Shaped refractory products - Determination of modulus of rupture at ambient temperature", published by the International Organization for Standardization (ISO).

Reproducibility and repeatability data are not available at present but may be included in a subsequent edition.

EN 993 'Methods of test for dense shaped refractory products' consists of 18 Parts:

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

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 August 1995, and conflicting national standards shall be withdrawn at the latest by August 1995.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

1 Scope

This Part of EN 993 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.

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, the details of which are outside the scope of this standard, is a matter of agreement between the interested parties and shall be described in the test report.

2 Definition

For the purposes of this Part of EN 993, the following definition applies:

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

3 Principle

Loading of test pieces of the product to be tested at a constant rate of increase of stress until failure occurs.

4 Apparatus

4.1 Loading device

4.1.1 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 breadth (b) of the test piece. The line contact of thre three edges shall be parallel to each other in a direction perpendicular to the length and the plane of the breadth 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 2 and the loadbearing edge shall be positioned equidistantly, at $\pm$ 2 mm from each supporting edge. (See figures 1 and 2).

4.1.2 The loading device shall be capable of applying a load uniformly across the centre of the test piece and of increasing it at a uniform rate. A means shall be provided of recording or indicating the load at failure with an accuracy of ± 2 %.

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

5 Preparation of test pieces

5.1 Number

5.1.1 The number of items (for example, bricks, shapes, nozzles) to be tested shall be determined by agreement between the interested parties.

5.1.2 If test pieces are cut out of bricks or blocks, the same number shall be cut from each one, in order to facilitate statistical analysis.

NOTE : The number of test pieces to be cut from each item (which detail is outside the scope of this standard) is a matter for agreement between the interested parties. It should be stated in the test report.

5.2 Shape and size

Each test piece shall be a whole standard rectangular brick (230 mm x 114 mm x 76 mm or 230 mm x 114 mm x 64 mm) or one of the other sizes shown in table 1.

5.3 Preparation

5.3.1 Standard size bricks (see 5.2) shall be tested as received.

5.3.2 If test pieces are cut out of bricks, it shall be done in such a way that, if the direction in which the brick was pressed is known, the upper longitudinal face in the testing position (the face in compression) is parallel to, or coincides with, one of the original faces of the brick perpendicular to the direction of pressing.

NOTE : Cutting with a continuous rim diamond wheel is recommended. If a serrated rim wheel is used, the edges of the cut where the wheel emerges are often frayed; it is therefore recommended that such a wheel should enter the face of the brick that is to form the tensile face of the test piece during the test.

5.3.3 The direction of pressing, if known, shall be marked on the test piece.

6 Procedure

6.1 Dry the test piece to constant mass in the oven (see 4.2), controlled at (110 ± 5) °C, cooling it each time away from moisture.

6.2 Measure the breadth and height of each test piece at its mid-point with an accuracy of ± 0,1 mm and the distance between the supporting edges with an accuracy of ± 0,5 mm.

6.3 Place the test piece on the lower bearing edges of the loading device (see 4.1) so that it rests symmetrically across them. When the test piece is a normal standard brick, the face bearing any brand mark, i.e. the upper face, shall be in compression. If the test pieces have been cut out of the brick, the face of the test piece which corresponds to the original face of the brick (if it has been preserved) shall be in compression.

6.4 Apply the load vertically on to the test piece until failure occurs. The rate of increase of stress shall be:

a) for a dense shaped refractory product or material:

0,15 MPa/s ± 0,015 MPa/s.

b) for a shaped insulating refractory product or material:

0,05 MPa/s ± 0,005 MPa/s.

6.5 Record the load at which failure of the test piece occurs ($F_{(max)}$) and the temperature at which the test was conducted.

7 Expression of results

7.1 The modulus of rupture σF is the ratio of the bending moment at the point of failure $M_{(max)}$ to the moment of resistance W (the section modulus), and is calculated from the following equation:

$$\sigma F = \frac{M_{max}}{W} = \frac{3}{2} \times \frac{F_{max} L_s}{bh^2}$$

where

$F_{(max)}$ is the maximum force exerted on the test piece, in N;

L_s is the distance between the points of support of the test piece, in mm;

b is the breadth of the test piece, in mm;

h is the height of the test piece, in mm.

7.2 The result shall be expressed in megapascals.

7.3 For bricks of standard size, the value obtained for a brick constitutes the result of that item.

7.4 For cut test pieces, record the individual values and the mean value for each item; these constitute the result for that item.

8 Test report

The test report shall include the following information:

a) the name of the testing establishment;

b) the date of the test;

c) a reference to this European Standard, i.e. determined in accordance with EN 993-6;

d) the designation of the bricks tested (manufacturer, type, shape, batch number;

e) the number of items tested;

f) the pre-treatment, if any, given to the test pieces (see 1.2);

g) the number of test pieces per item;

h) the dimensions of the test pieces;

i) the position of the test pieces in the item;

j) the distance between the supports;

k) the nominal rate of tensile stress increase for each test piece;

either

l) the individual values and the mean values of the modulus of rupture for each item (when more than one test piece is cut from each item);

or

m) the value of the modulus of rupture for each item (when whole bricks are used).