SLOVENSKI STANDARD
SIST ENV 1402-7:1998

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Neoblikovani ognjevzdržni izdelki - 7. del: Preskusi predhodno izdelanih oblikovancev

Unshaped refractory materials - Part 7: Tests on pre-formed shapes

Ungeformte feuerfeste Erzeugnisse - Teil 7: Prüfungen an Fertigteilen

Produits réfractaires non façonnés - Partie 7: Essais sur pieces pré-formées

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81.080 Ognjevzdržni materiali Refractories

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Unshaped refractory materials - Part 7: Tests on pre-formed shapes

Produits réfractaires non façonnés - Partie 7: Essais sur pièces pré-formées

Ungeformte feuerfeste Erzeugnisse - Teil 7: Prüfungen an Fertigteilen

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

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Contents

Foreword

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

ENV 1402 'Unshaped refractory products' consists of seven Parts:

Part 1: Introduction and definitions;
Part 2: Sampling;
Part 3: Characterization as received;
Part 4: Consistency testing;
Part 5: Preparation and treatment of test pieces;
Part 6: Determination of properties of test pieces;
Part 7: Tests on pre-formed shapes.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this European Prestandard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Prestandard specifies methods for the testing of as-delivered pre-formed shapes. It applies to shapes fabricated from dense and insulating castables and mouldable materials (plastics and ramming mixes) as defined in ENV 1402-1.

NOTE: Acceptance values for the individual test methods described should be agreed between the parties involved.

2 Normative references

This European Prestandard incorporates, by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Prestandard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

ENV 1402-1 Unshaped refractory products - Introduction and definitions

ENV 1402-6 Unshaped refractory products - Determination of properties of test pieces

3 Definitions

For the purposes of this European Prestandard the following definitions apply:

3.1 corner defect
A missing corner, defined by the three dimensions *a*, *b* and *c* as indicated in figure 1.

3.2 edge defect
A missing edge, defined by the three dimensions, *e*, *f*, and *g* as indicated in figure 2.

3.3 crater
A clearly defined hole in the surface of a shape whose parameters, i.e. maximum diameter, minimum diameter and depth, can be measured.

NOTE : Its origin can be a bubble produced during manufacture.

3.4 hairline cracks
Fine cracks visible on the surface of a shape whose length can be measured and whose width is less than or equal to 0,2 mm. See figure 3.

3.5 surface crazing
A network of hairline cracks confined to the surface of the shape. See figure 3.

3.6 open cracks
Cracks or tears on the surface whose length is more than 10 mm and whose width is more than 0,2 mm. See figure 3.

3.7 protrusions and indentations
Imperfections that can occur during fabrication or firing, if applicable.

3.8 fins
A thin layer of material on the face of a shape that projects beyond the edge.

3.9 segregation
Separation of aggregate and fines during fabrication to leave a honeycomb appearance and/or a layer of excess fines.

3.10 friability
Crumbly texture due to poor consolidation and/or mould leakage.

3.11 warpage
The deviation of a plane surface from being flat.

4 Principle

Testing of pre-formed shapes by qualitative and/or quantitative methods. These methods are of two types:

a) Inspection by attributes (evaluation of the integrity of a refractory shape by visual inspection of cracks or other surface defects and by conformance to dimensional tolerances);

b) Inspection by variables (evaluation of the quality of a refractory shape by determining physical properties using appropriate destructive or non-destructive test methods).

NOTE: It is not obligatory to use all the test methods described in this European Prestandard when determining the quality of a pre-formed shape.

5 Apparatus

5.1 *Linear measuring devices,* steel tape and/or callipers in accordance with the tolerance required and conforming to an accuracy twice the intended accuracy of the measurement.

NOTE: Where possible, linear tolerances less than 1 mm should be measured with callipers. Steel tape measurements are accurate to the millimetre (0,5 mm can be estimated) whereas callipers are accurate to 0,1 mm.

5.2 *Steel straightedge,* at least 5 mm thick and of sufficient length to span the diagonal of the largest shape to be measured.

5.3 *Two steel measuring wedges,*. which shall be either:

a) type 1, at least 50 mm in length and 10 mm in thickness at one end, of uniform cross section for a length of at least 10 mm from that end and then tapering to zero thickness at the other end (see for example figure 4a), or

b) type 2, up to 160 mm in length with an even taper from 4 mm to zero (see for example figure 4b).

Each wedge shall be graduated and numbered along the slope to show the thickness of the wedge between the base and the slope in increments of either 0,5 mm (type 1) or 0,1 mm (type 2).

5.4 *Graticule,* with 0,1 mm graduations and/or feeler gauges of an appropriate size and accuracy to be used for the measurement of crack width. If necessary, the gauges can be replaced by measuring wedges of appropriate accuracy.

5.5 *Sliding bevel,* for the measurement of angles.

5.6 *Depth gauge* calibrated in millimetres of depth, having a probe of 3 mm diameter.

5.7 *Breakage defect sizer,* with a slot uncovering 2 mm on both surfaces, for determination of minimum defect sizes for corner and edge defects, according to figure 5.

NOTE 1 : One breakage defect sizer can be used together with a steel straightedge for the measurement of corner defects (see 6.5). Two breakage defect sizers can be used together with a linear measuring device for the measurement of edge defects (see 6.6).

NOTE 2 : A breakage defect sizer permits an objective definition of the point of departure for the measurement of the size of a broken edge.

5.8 *Balance,* capable of measuring to an accuracy of 1%.

5.9 *Ultrasonic pulse velocity measuring equipment.*

5.10 *Equipment for determining the resonant frequency by mechanical shock.*

5.11 *Rebound hammer.*

5.12 *Drying oven,* capable of being controlled at 110 °C ± 5 °C.

5.13 *Furnace,* capable of operating at 1050 °C ± 5 °C.

6 Inspection by attributes

6.1 Preparation of the test piece

The shape of the test piece shall be prepared by first measuring any protrusions or indentations. Any protrusions or indentations shall be removed by light abrasion.

6.2 Measurement of dimensions

Linear dimensions shall be measured by means of a linear measuring device (see 5.1), and unless otherwise agreed, shall be measured to the nearest 0,5 mm.

6.3 Measurement of angles

Angles shall be measured by adjusting the sliding bevel to fit the shape (see figure 12) and the angle determined by use of a protractor (see figure 13).

6.4 Measurement of warpage

For a concave surface, place the straightedge on edge across a diagonal of the surface being tested, insert a wedge at the point of maximum warpage (ensuring that the reading is not affected by raised imperfections on the castable surface) and record the maximum obtainable reading to the nearest
0,5 mm at the point of contact between the wedge and the straightedge.

For a convex surface, insert a wedge at each end of the straightedge and perpendicular to it as shown in figure 6. Adjust the wedges, to a position not more than 15 mm from the corner of the shape, so that equal readings are obtained from each of them, making certain that contact is maintained by the straightedge at the point of maximum convexity. Record the readings to the nearest 0,5 mm.

The expression of results can be given as a ratio of warpage, W, in per cent, according to the formula:

$$W = \frac{100h}{l} \qquad (1)$$

where:
l is the length of the diagonal of the surface being tested, in millimetres;
h is the reading of the amount of warpage, in millimetres.

6.5 Measurement of corner defects

Measure the dimensions a, b and c of corner defect using a steel straightedge, a breakage defect sizer and a steel tape, as indicated in figure 7 . The breakage defect sizer shall be positioned along the edge to be measured in such a way that the leading edge of the slot coincides with the broken corner on at least one surface of the shape, as shown in figure 8. The dimensions a, b, and c are measured between the steel straightedge and the leading edge of the breakage defect sizer, to the nearest mm.

6.6 Measurement of edge defects

Measure the length, *g*, of an edge defect using two breakage defect sizers and a steel tape, as indicated in figure 9. Measure the depth of the edge defect as defined by *e* and *f* using a steel straightedge and a steel tape. Measure all dimensions to the nearest mm.

6.7 Measurement of craters and bubbles

Measure the maximum, *D*, and minimum, *d*, diameters of a crater using a steel tape as indicated in figure 10. The apparent crater diameter is given by the equation:

$$\text{Apparent crater diameter} = \frac{D + d}{2} \qquad (2)$$

Measure the depth, *h*, of a crater using a depth gauge as indicated in figure 10.
Measure all dimensions to the nearest mm.

6.8 Measurement of cracks

Measure the length of a crack with a steel tape in one or more straight lines. If the crack continues on more than one surface, then the crack length is equal to the sum of the crack lengths on each surface.

Measure the width of a crack either with a graticule or with feeler gauges (see 5.4).

Table 1: Accuracy of measurement.

Measurement	Accuracy of measurement
Length of crack	1 mm
Width of open crack: between 0,2 mm and 1mm	0,2 mm
Width of open crack: greater than 1 mm	0,5 mm

Measure the dimensions of cracks to the accuracy given in table 1. Surface crazing (see 3.5) shall be measured using a steel tape and reported in cm^2.

6.9 Measurement of protrusions and indentations

Measure the height of a protrusion from the surface of the shape by means of a straightedge (see 5.2) and measuring wedges (see 5.3), to the nearest 0,5 mm. Place the straightedge parallel to the surface and in contact with the protrusion and adjust the measuring wedges so that equal readings are obtained on each of them, as indicated in figure 11. Measure indentations using the same method as used for craters (see 6.7).

6.10 Measurement of fins

Measure the height of fins to the nearest mm by depth gauge or steel tape.

6.11 Segregations

Measure the extent of the honeycombed structure using a linear measuring device. Measure dimensions to the nearest mm.

NOTE : If possible, the extent of fines segregation should be measured using a linear measuring device.

6.12 Friability

For dense castables, measure the extent to which areas of a block can be rubbed away using hand pressure.

7 Inspection by variables

7.1 Destructive test methods.

The position in the shape from where test pieces will be taken shall be agreed between parties and noted in the final report. If agreement cannot be reached or in the case of litigation the reference for the location of the sample will be the centre of the shape. If a wet cutting method has been used to obtain a test piece from a pre-formed shape, it shall be dried immediately following preparation.

7.1.1 Physical properties

Wherever possible, the dimensions and testing of test pieces cut from pre-formed shapes shall be in accordance with ENV 1402-6. If this is not feasible, for example, if test pieces have to be cored or are of non standard dimensions, the test data will vary due to different test piece geometry.

NOTE: The results obtained on testing a pre-formed shape will not equate to those obtained from a laboratory prepared test piece prepared according to ENV 1402-5.

7.1.2 Moisture content (see Note 2 of 7.1.3)

Weigh the shape or test piece on appropriate sized balance to an accuracy of 1%, and place in a drying oven at 110 °C ± 5 °C to constant mass. Express the loss in mass as a percentage of the original mass using the following equation;

$$M = \frac{m_1 - m_2}{m_1} \cdot 100 \qquad (3)$$

where:

M is the moisture content, as a percentage;
m_1 is the original mass in kilograms;
m_2 is the dried mass in kilograms.