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Refractory mortars —

Part 4: Determination of flexural bonding strength

Mortiers réfractaires —

Partie 4: Détermination de la résistance des liaisons à la flexion

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 13765-4 was prepared by Technical Committee ISO/TC 33, *Refractories*.

ISO 13765 consists of the following parts, under the general title *Refractory mortars*:

— *Part 1: Determination of consistency using the penetrating cone method*

— *Part 2: Determination of consistency using the reciprocating flow table method*

— *Part 3: Determination of joint stability*

— *Part 4: Determination of flexural bonding strength*

— *Part 5: Determination of grain size distribution (sieve analysis)*

— *Part 6: Determination of moisture content of ready-mixed mortars*

Refractory mortars —

Part 4:
Determination of flexural bonding strength

1 Scope

This part of ISO 13765 describes a method of determination of the flexural bonding strength of the bonded face between refractory bricks laid with refractory mortars (after drying and firing).

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.

ISO 8656-1, *Refractory products — Sampling of raw materials and unshaped products — Part 1: Sampling scheme*

ISO 13765-1, *Refractory mortars — Part 1: Determination of consistency using the penetrating cone method*

ISO 13765-2, *Refractory mortars — Part 2: Determination of consistency using the reciprocating flow table method*

3 Terms and definitions

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

3.1
flexural bonding strength
maximum stress that a specimen can withstand when it is bent on a three-point bending device

4 Principle

A prismatic specimen of a given size is made by bonding two test pieces of refractory brick with the refractory mortar to be tested. After drying and firing, a bending stress is applied at a given loading rate on the bonding face of the specimen at room temperature until failure of the bonding face occurs.

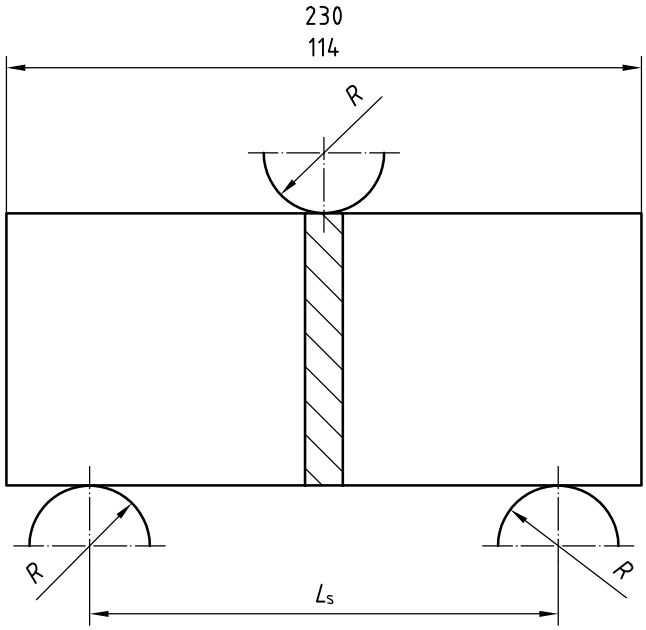
5 Apparatus

5.1 Loading device, consisting of two bearing edges and a loading edge which are parallel to each other, as shown in Figure 1.

The loading edge shall be located between, and isometric to, the two bearing edges. The values of L_s and R, the tolerances for the parallelism of the cross section sides and the parallelism of the top and bottom faces shall be as specified in Table 1. The loading device shall be able to apply a load at a uniform rate on the middle of the specimen and have the loading rate shown in Table 1.

5.2 Mixer, as specified in ISO 13765-1 or ISO 13765-2.

Dimensions in millimetres



Key

L_s distance between the supports

R radius of curvature of the loading edge and bearing edges

Figure 1 — Loading device

Table 1 — Dimensions, tolerances and loading rates associated with test pieces of various sizes

Test piece size $l \times b \times h$ mm	**Tolerance for the breadth,** b**, and height,** h mm	**Tolerance for the parallelism of the cross-section sides** mm	**Tolerance for the parallelism of the top and bottom faces** mm	**Distance between the supports** L_s mm	**Radius of curvature,** R**, of the loading edge and bearing edges** mm	**Loading rate** N/s	
						Dense shape mm	**Insulating shape** mm
115 × 114 × 76	—	—	—	180 ± 1	15 ± 0,5	370 ± 37	120 ± 12
115 × 114 × 64	—	—	—	180 ± 1	15 ± 0,5	260 ± 26	86 ± 8,6
100 × 40 × 40	± 1	± 0,15	± 0,25	180 ± 1	5 ± 0,5	36 ± 3,6	12 ± 1,2
57,5 × 25 × 25	± 1	± 0,1	± 0,2	100 ± 1	5 ± 0,5	13 ± 1,3	4,2 ± 0,42
57 × 40 × 40	± 1	± 0,15	± 0,25	100 ± 1	4 ± 0,5	64 ± 6,4	21 ± 2,1

5.3 Electrical drying oven, fitted with a temperature controller and capable of operating at 110 °C ± 5 °C.

5.4 Consistency determining device, as specified in ISO 13765-1 or ISO 13765-2.

5.5 Balance, with a maximum weighing capacity of 2 kg and capable of weighing to the nearest 1 g.

5.6 Callipers, capable of measuring to the nearest 0,1 mm.

5.7 Furnace, capable of meeting the heating requirements specified in 7.3.

5.8 Thermocouple pyrometer.

5.9 Cutting tool.

6 Sampling and preparation of the test pieces

6.1 Sampling

For dry mortar, sample the mortar in accordance with ISO 8656-1 or as agreed between parties. Reduce the sample to 5 kg by quartering or with a riffle sampler.

Sample ready-mixed mortars by emptying the entire contents of the container in which the mortar is supplied into another container of larger capacity and mixing thoroughly. It is important that any supernatant liquid not be discarded. Ensure that a representative sample of the wet mixture is obtained.

6.2 Preparation of the test pieces

The size of the test pieces is shown in Table 1. The actual dimensions used shall be agreed upon between parties prior to testing.

Ten test pieces are required. These are used for making five test specimens, each specimen being constituted of two test pieces bonded with mortar.

Cut test pieces from the refractory bricks for test following the sizes and the tolerances shown in Table 1. The adjacent edges of the test pieces shall be perpendicular to each other and the corners shall be square. The surfaces of the test pieces shall be smooth and have no cracks and the faces to be bonded shall be clean. Each test piece shall have an uncut face for bonding. The bricks used in the test shall be compatible with the mortar being tested.

Before testing, place the test pieces in the drying oven, raise the temperature to 110 °C ± 5 °C and keep for 8 h or until constant weight is achieved. Then cool to room temperature naturally.

7 Procedure

7.1 Preparation of the test specimens

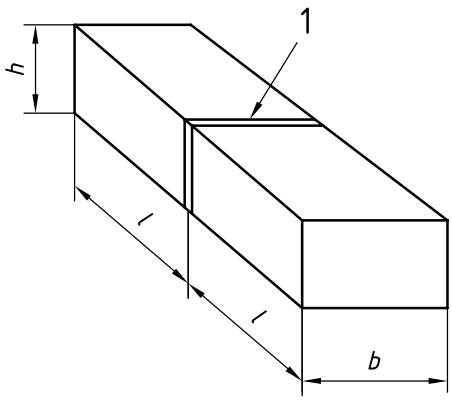
7.1.1 For dry mortars, take 1,5 kg using the balance and mix with water in accordance with ISO 13765-1 or ISO 13765-2 to attain the desired consistency. Determine the consistency and allow to rest for 30 min or in accordance with the manufacturer's instructions.

For wet mortars, mix thoroughly and then take about 1 kg.

After determining the consistency, carry out the procedures described in 7.1.2.

7.1.2 Take a pair of dried test pieces and apply a layer of the well-mixed mortar to both of the uncut faces and then remove the mortar. Apply the mortar again to both of the uncut faces and then join the two mortar-covered faces together (see Figure 2). Force out the excess mortar to form a joint of 2 mm, unless otherwise agreed, by pressing the top test piece and at the same time moving it laterally. Remove the excess mortar forced out. The specimen shall not be wrapped and the displacement shall not be greater than 0,5 mm.

Repeat the above operation using the 10 test pieces to make five specimens.



Key

1 mortar

Figure 2 — Test specimen

7.2 Drying the test specimens

Air dry the test specimens naturally at room temperature for 24 h, with each specimen resting on a face parallel to the bonded face.

Carefully place the air-dried specimens on a face parallel to the bonded face in the drying oven. Raise the temperature to 65 °C ± 5 °C and hold for 4 h. Then raise the temperature to 110 °C ± 5 °C and hold for 12 h.

7.3 Firing the test specimens

Place the dried specimens on the soaking zone of the furnace. The distance between the specimens themselves and that between the specimens and the soaking plates shall not be less than 10 mm. The distance between the specimens and the heating element shall not be less than 20 mm. If the soaking plates are absent, the radiant heat of the heating elements shall not directly reach the bonded faces of the specimens.

When heating, maintain an oxidizing atmosphere in the furnace. Use the following heating rates:

— normally 5 °C/min;

— silica mortar 3 °C/min.

When the specified temperature is reached, hold for 3 h (5 h for silica-based mortar), over which the fluctuation of the temperature shall not exceed ± 10 °C.

After the holding period, cool the specimens in the furnace to room temperature naturally.

7.4 Determination of flexural bonding strength

7.4.1 Measure the width, b, and height, h, of each test specimen at the bonded faces after drying and firing. Take two measurements at different points for each test specimen. Calculate the mean value to the nearest 0,1 mm for each test specimen.

7.4.2 Place a specimen on the bearing edges. Align the loading edge with the joint of the specimen. The deviation shall not exceed 2 mm. Apply load vertically at a rate specified in Table 1 until the failure of the bonded face occurs. Record the maximum load.

7.4.3 Inspect the specimens one by one with care. If the area of voids in the bonded face of a specimen is 20 % or more, or the full bonded face of a specimen is clean and smooth, disregard that result. In this case, if the normal specimens are less than three, conduct the test again from 6.2.

8 Calculation

Calculate the flexural bonding strength for each test specimen as the modulus of rupture, σ_F, in megapascals, to the nearest 0,1 MPa, using the equation

$$\sigma_F = \frac{3\,F_{max}\,L_s}{2\,bh^2}$$

where

F_{max} is the maximum force exerted on the specimen, in newtons;

L_s is the distance between the supports, in millimetres;

b is the width of the specimen at the bonded face, in millimetres;

h is the height of the specimen at the bonded face, in millimetres.

Report the result as the mean of the five determinations, excluding any disregarded in accordance with 7.4.3, to the nearest 0,1 MPa.

9 Test report

The test report shall include the following information:

a) all information necessary for identification of the material tested, including a description of the material, manufacturer, type, brand, batch number, size of test pieces, etc.;

b) a reference to this part of ISO 13765 (ISO 13765-4);

c) the name of the testing establishment;

d) in the case of a dry mortar, the percentage of water (or specified liquid) added;

e) the results of the test, i.e. the flexural bonding strength in megapascals, including the results of the individual determinations and their mean, calculated as specified in Clause 8, and noting if the failure did not occur at the bonded face;

f) the consistency of the mortar tested and the method used to determine the consistency, i.e. ISO 13765-1 or ISO 13765-2;

g) the firing temperature and holding time;

h) any deviations from the procedure specified;

i) any unusual features (anomalies) observed during the test;

j) the date of the test.

ICS 81.080

Price based on 5 pages