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Refractory test-piece preparation — Gunning refractory panels by the pneumatic-nozzle mixing type guns

Préparation d'éprouvettes réfractaires — Panneaux réfractaires pour gunitage au pistolet mélangeur pneumatique

Reference number
ISO 20182:2008(E)

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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 20182 was prepared by Technical Committee ISO/TC 33, *Refractories* in collaboration with Technical Committee CEN/TC 187, *Rerfractory products and materials.*

This second edition cancels and replaces the first edition (ISO 20182:2005), which has been technically revised as follows:

— in 6.5, two acceptable support plates are now specified;

— in Clause 8, pH determination has been added in place of water hardness testing and predamping percentages are now given for both dense and insulating castables;

— in Clause 9 test report item c), the water pH, if determined, replaces the water hardness;

— in Clause 9 test report item d), by agreement between the interested parties, the total water content and rebound are measured and recorded.

Annex A has been added, giving procedures for the determination of the total water content and rebound.

Refractory test-piece preparation — Gunning refractory panels by the pneumatic-nozzle mixing type guns

WARNING — This International Standard may involve the use of hazardous materials, operations and equipment. It does not attempt to address the safety problems associated with its use. It is the responsibility of the user of this International Standard to establish appropriate safety and health practices, and to determine the applicability of regulatory limitations prior to use.

1 Scope

This International Standard describes the procedure for the preparation of test panels from refractory materials by gunning through pneumatic-nozzle mixing type guns at ambient temperatures.

NOTE The values obtained from test pieces cut from the panel prepared using this method might not correspond with those obtained from test pieces of the same material prepared at a gunning installation site.

This International Standard does not apply to plastic gunning mixes, and might not apply to those mixes that contain aggregates that are susceptible to hydration.

It also does not apply to shotcrete type mixes.

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 836, *Refractories — Vocabulary*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 836 and the following apply.

3.1
gun
assembly essentially comprising a chamber into which the refractory is added, together with a mechanism that controls the flow of the material through the unit

NOTE Depending on the type used, the gun may be open at the top, or a closed pressurized unit may be used.

3.2
rebound material
material that fails to adhere to the surface when being sprayed, and ricochets out of the immediate area

4 Principle

Refractory material is conveyed pneumatically in either a dry or predampened form to the test site, using equipment of the nozzle mixing type. Then water is introduced to the refractory mix at the nozzle and the mixture is projected onto a support plate (see 6.5).

5 Precision

Differences between various types of equipment and in operator techniques may result in variations in the physical properties of the gunned specimens. For referee testing, it is desirable that the same operator should use the same equipment to produce test specimens.

6 Apparatus

6.1 Gun, of the pneumatic-nozzle mixing type.

6.2 Air compressor, capable of supplying a steady airflow at the required pressure and volume.

6.3 Mixer, for use when predamping is carried out. The mixer shall be capable of producing a homogeneous mixture of the material to be tested.

6.4 Hose/nozzle assembly, comprising a reinforced pneumatic hose and a nozzle assembly suitable for the material being gunned.

6.5 Gunned-material support plate, flat, capable of producing a panel having minimum usable dimensions of 280 mm × 280 mm × 100 mm thickness that is suitable for the tests intended to be carried out, after allowance for any material to be cut off as described in Clause 8. The preferred support plate has ledges at both sides and the top edge. An example of the preferred support plate is given in Figure 1a).

An alternative support plate may be used, 300 mm to 500 mm in length, and having a bottom support edge 100 mm in width and of the same overall length as the support plate. An example of the alternative support plate is given in Figure 1b).

The support plate may be made of wood or steel and shall not flex during use. The support plate may be larger than the minimum panel size, to allow the edges to be removed from the gunned panel, for example, to remove trapped rebound material at the bottom, and other edge effects.

Interested parties shall agree which type of panel is used. The test report shall state the dimensions of the gunned-material support plate and panel produced, and the type of panel used.

6.6 Air pressure gauge, capable of measuring pressures up to 690 kPa, plus or minus 5 % at all pressures.

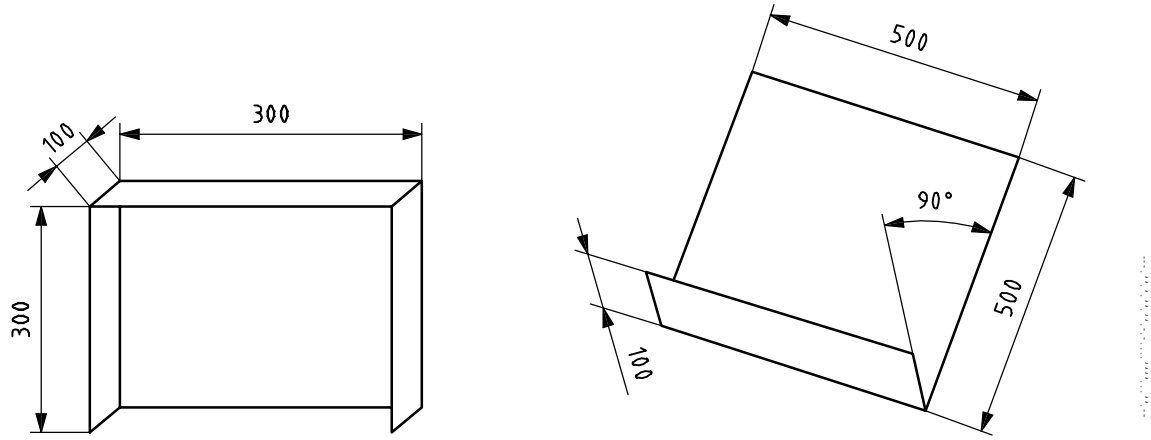
6.7 Water-measuring device, for use if predamping is carried out, capable of measuring the water quantity to the nearest 5 %.

6.8 Water-pressure gauge, capable of measuring pressures up to at least 50 kPa greater than the pressure in the supply lines being used and within plus or minus 5 % at all pressures.

6.9 Miscellaneous tools, including a trowel and a shovel.

6.10 Thermometer, capable of being read to the nearest 1 °C.

Dimensions in millimetres



a) Preferred gunned-material support plate **b) Alternative gunned-material support plate**

Figure 1 — Examples of gunned-material support plates

7 Sampling

Take the sample for preparation of a test panel in accordance with established sampling principles, such as those given in ISO 8656-1.

The additional volume of material required for sample preparation will depend on the amount left in the apparatus after the gunning operation, the amount of rebound material and the amount required to stabilize the gun. The mass of material required will depend on the total volume and the bulk density of the material.

Only full bags of the material to be tested shall be selected and their entire contents shall be used.

8 Procedure

Using Table 1 as a guide, choose the hose diameter appropriate to the particular refractory mix being gunned.

Table 1 — Feed systems

Maximum aggregate size in mix mm	**Internal diameter of hose** mm
< 5	$\leqslant 32$
5 to 8	32
> 8	5 × the largest aggregate sizes

The nozzle and the gun are usually held at the same elevation. If this is not the case, record the difference to the nearest metre.

The water pressure should be greater than 150 kPa above the gunning pressure at the nozzle, possibly requiring the use of a water pump. The watering and nozzle extension will be different for dense and lightweight materials.

Determine the pH of the water used for predampening and gunning using litmus paper or a pH meter. If measured, record the pH and method used in the test report (Clause 9).

Record the ambient temperature and the temperature of the refractory material to the nearest 1 °C.

Predampen the material in the mixer with the amount of water recommended by the manufacturer, ensuring that the material is used within 20 min of predamping. If there is no recommendation made by the manufacturer then, if necessary, predampen the material in the range 2 % to 5 % by mass for dense castables, and 5 % to 12 % by mass for insulating castables. Avoid stoppage in the gun, hose and/or nozzle caused by predampening.

Where necessary, to prevent sticking, apply a plate-release agent, such as light oil or grease, to the support plate.

Place the support plate against a rigid surface, typically at an angle of 60° to 80° to the horizontal. Record the angle of inclination and include it in the test report.

Using the minimum amount of water that allows the refractory to adhere to the sprayed surface, adjust the air pressure until the material flows freely from the nozzle. This operation should be performed remote from the support plate.

NOTE 1 The air pressure is dependent on whether the material gunned is dense or insulating.

Holding the nozzle at right angles to the work area and typically 0,5 m to 1 m from it, spray in a circular motion over the full width of the test plate, starting at the bottom of the support plate and working upward, being careful not to entrap rebound material. Continue until the panel's thickness is such that test pieces of the desired size can be cut from the panel, so that all gunned edges are removed in the cutting process.

Interested parties shall agree whether the top surface and edges may be trimmed. The surface shall not be trowelled to obtain a sleek finish.

If a determination of water content is required, take sufficient gunned material, typically 500 g, which is not rebound material.

To minimize moisture loss, either enclose the panel or cover its surface with an impervious membrane.

Allow the gunned panel to cure at a temperature of 20 °C to 25 °C for 24 h.

NOTE 2 The sample may be stripped after 16 h, provided that it remains in a humid atmosphere (minimum 95 % relative humidity) for a total of 24 h.

Cut test pieces from the gunned panel, with the longest side parallel to the ledge, to a size appropriate to the tests to be carried out, and mark the direction in which the forming/gunning pressure was applied. The cut surface of a test piece shall be at least 1 cm from the exposed edge of the gunned panel. Cut surfaces shall be smooth enough to allow for strength testing, if required. The rough, as-gunned faces shall not form part of the test pieces.

NOTE 3 The load in strength tests is applied to test-piece faces cut perpendicular to the direction of gunning.

Dry the samples at 110 °C for 24 h and store for testing. Ensure they do not re-absorb moisture prior to testing.

NOTE 4 For chemically bonded material, a special drying schedule may be required.

Where required, determine the total water content and proportion of rebound material by methods to be agreed between interested parties.

9 Test report

The test report shall include the following information:

a) all information necessary for identification of the sample tested, including a description of the as-received material, e.g. product name, lot number and production date;

b) a reference to this International Standard (ISO 20182:2007);

c) details of the process including the following:

- the gun type and operational specifications,
- the length and diameter of the material hose used,
- the type of nozzle mixing and delivery device,
- the temperature of the work area, refractory material and water,
- the mean air pressure measured in the air hose leading to the gun during the gunning operation, to the nearest 10 kPa,
- the mean water pressure during the gunning operation, to the nearest 10 kPa,
- the distance from the nozzle to the panel during the major part of the gunning operation, to the nearest 0,2 m,
- the angle of inclination of the support plate,
- the difference, if any, in elevation between the nozzle and the gun, to the nearest metre,
- the quantity of water used for predamping, if applicable, to the nearest 0,5 % by mass,
- the water pH, if determined,
- the dimensions of the gunned panel,
- the dimensions of the support plate;

d) if required (by agreement between interested parties) and determined (see Annex A):

- the total water mass fraction of the gunned material, to the nearest 0,1 %,
- the percentage of rebound material, to the nearest 1 %;

e) the identity of the operator;

f) any deviations from the procedure specified;

g) any unusual features (anomalies) observed during the test, in particular:

- any unusual gunning characteristics, such as surging,
- any unusual characteristics of the test pieces, such as lamination, segregation, honeycombing;

h) the date of the test.

Annex A
(informative)

Determination of total water content and rebound

A.1 Total water content

From the 500 g sample of gunned material taken in Clause 8, accurately weigh approximately 100 g to the nearest 0,1 g. Record the mass as m_1.

Heat in a muffle furnace at 800 °C for 2 h. Cool and reweigh. Record the mass as m_2.

Calculate the total water content, w, as a percentage mass fraction, to the nearest 0,1 %, using Equation (A.1):

$$w = \frac{m_1 - m_2}{m_1} \times 100 \qquad \text{(A.1)}$$

where

m_1 is the initial mass of sample, in grams;

m_2 is the final mass of sample, in grams.

NOTE If admixtures have been incorporated in the material, this calculation can include volatile products. The original material can contain organic fibre. Where the amount is known and is in excess of 0,1 %, it is subtracted from the total water content. Where the amount is not known, it is determined by carrying out a loss on heating test at 800 °C of the 100 g sample set aside in Clause 8; if it is found to be in excess of 0,1 %, it is subtracted from the total water content.

A.2 Rebound

Clean an area adjacent to the work area, enabling rebound material to be collected.

Carry out the procedure given in Clause 8.

Weigh the panel and record the mass m_p. Weigh the rebound and record the mass m_r.

Calculate the amount of rebound, R, as a percentage, on an as-gunned (wet) basis to the nearest 1 %, using Equation (A.2):

$$R = \frac{m_r}{m_r + m_p} \times 100 \qquad \text{(A.2)}$$

where

m_r is the mass of rebound, in grams;

m_p is the mass of panel, in grams.

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