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Refractory mortars —

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

Mortiers réfractaires —

Partie 5: Détermination de la répartition granulométrique (analyse par tamisage)

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 13765-5 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 5:
Determination of grain size distribution (sieve analysis)

1 Scope

This part of ISO 13765 describes a method for determining the grain size distribution of refractory mortars by sieve analysis.

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 565, *Test sieves — Metal wire cloth, perforated metal plate and electroformed sheet — Nominal sizes of openings*

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

ISO 13765-6, *Refractory mortars — Part 6: Determination of moisture content of ready-mixed mortars*

3 Terms and definitions

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

3.1
grain size distribution
mass fraction, as a percentage, of each grain size

4 Principle

The material is passed through a series of sieves of progressively decreasing aperture, so that it is divided into fractions that are defined by the apertures of the sieves used.

Grain size distributions of dry refractory mortars can be determined by either dry or wet test methods, the latter giving more reproducible results.

The grain size distribution of ready-mixed mortars should be determined by the wet test method and of chemically bonded mortars by the dry test method.

5 Apparatus

5.1 Standard sieves and receiver, 200 mm diameter conforming to the requirements of ISO 565.

5.2 Sieve brush.

5.3 Balance, capable of weighing to the nearest 0,1 g.

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

5.5 Sieve shaking device, capable of holding at least five standard sieves at the same time.

6 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.

7 Procedure

7.1 General

Analyse each sample in duplicate.

Ensure that the sieves are clean and dry before use.

7.2 Dry sieve analysis

Take a sample of at least 50 g, dry in an oven at 110 °C ± 5 °C to constant mass. Allow to cool to room temperature in a desiccator and weigh to the nearest 0,1 g. Record the mass m_1.

Place the series of sieves on the shaking device, with the coarsest at the top and the finest and the receiver at the bottom.

Place the sample on the top sieve and operate the sieve shaking device for 15 min. If necessary, for example when very fine powders adhere to the upper screen, the sample can be lightly brushed over the sieve to assist the transfer of screenable material onto the next sieve.

Remove the sieves from the shaking device, carefully separate and, one at a time, empty the contents of the sieves onto separate pieces of clean paper.

Weigh the material collected on each sieve and in the receiver to the nearest 0,1 g. Record the mass m_R for each fraction, where R denotes the sieve size.

7.3 Wet sieve analysis of dry mortar

Weigh a sample of at least 50 g, in a clean, dry evaporating dish (or suitable glass dish), spreading the sample evenly within the dish. Dry in an oven at 110 °C ± 5 °C until constant mass is attained, i.e. until two successive weighings made 10 min apart and after a minimum of 2 h in the oven do not differ by more than 0,2 g or 0,5 %.

Allow to cool to room temperature in a desiccator and weigh to the nearest 0,1 g. Record the mass as m_1.

Immerse the sample in a sufficient amount of water to ensure that the fines are completely separated from the coarse particles and do not ball together. Place the sample on the finest sieve and wash with water, using a rubber tube attached to a tap, until the water running through the sieve is clear.

NOTE It might be necessary to disperse the sample of mortar in a volume of water using mechanical agitation prior to washing through the sieve.

After washing, transfer all the material retained on the sieve to an evaporating dish. Dry the dish and contents at 110 °C ± 5 °C for 1 h or until constant weight is achieved. Remove the sample from the dish and weigh to the nearest 0,1 g. Record the mass as m_2.

Place the series of sieves on the shaking device, with the coarsest at the top and the finest and the receiver at the bottom. Place the sample on the top sieve and operate the shaking device for 15 min. If necessary, the sample can be lightly brushed over the sieve to assist the transfer of screenable material onto the next sieve.

Remove the sieves from the shaking device, carefully separate and, one at a time, empty the contents of the sieves onto separate pieces of clean paper.

Weigh the material collected on each sieve to 0,1 g. Record the mass as m_R for each fraction, where R denotes the sieve size.

7.4 Wet sieve analysis of ready-mixed mortars

Take a sample in duplicate, each at least 50 g, and weigh to 0,1 g. Record the mass as m_1. Use one sample for determining the percentage moisture content of the mortar, w_w, in accordance with ISO 13765-6, and the other for wet sieve analysis as follows.

Immerse the sample in a sufficient amount of water to ensure that the fines are completely separated from the coarse particles and do not ball together.

Place the sample on the finest sieve and wash with water, using a rubber tube attached to a tap, until the water running through the sieve is clear. After washing, transfer all the material retained on the sieve to an evaporating dish. Dry the evaporating dish and contents at 110 °C ± 5 °C for 1 h or until constant mass is attained, i.e. until two successive weighings made 10 min apart do not differ by more than 0,2 g or 0,5 %.

Allow to cool to room temperature in a desiccator. Remove the sample from the evaporating dish and weigh to the nearest 0,1 g. Record the mass as m_2.

Place the series of sieves on the shaking device, with the coarsest at the top and the finest at the bottom. Place the sample on the top sieve and operate the shaking device for 15 min. If necessary, the sample can be lightly brushed over the sieve to assist the transfer of screenable material onto the next sieve.

Remove the sieves from the shaking device, carefully separate and, one at a time, empty the contents of the sieves onto separate pieces of clean paper. Weigh the material collected on each sieve to the nearest 0,1 g. Record the mass as m_R for each fraction, where R denotes the sieve size.

8 Calculation

8.1 Sieve analysis

8.1.1 Dry sieve analysis

Calculate the incremental percentage (mass fraction), w_R, of the sample retained on sieve of mesh size R, using the equation:

$$w_R = \frac{m_R}{m_1} \times 100 \qquad (1)$$

where

m_R is the mass of material retained by the sieve of mesh size R, in grams;

m_1 is the mass of sample sieved, in grams.

Calculate the percentage of the material passing through the finest sieve from the mass of material held in the receiver.

8.1.2 Wet sieve analysis of dry mortars

Calculate the percentage (mass fraction), w_R, of the sample retained on the sieve of mesh size R using the equation:

$$w_R = \frac{m_R}{m_1} \times 100 \tag{2}$$

where

m_R is the mass of material retained by the sieve of mesh size R, in grams;

m_1 is the mass of sample sieved, in grams.

Calculate the percentage (mass fraction), w_F, of material passing through the finest sieve, using the equation:

$$w_F = \frac{m_1 - m_2}{m_1} \times 100 \tag{3}$$

where m_2 is the mass of material retained on the finest sieve after washing and drying, in grams.

8.1.3 Wet sieve analysis of ready-mixed mortars

Calculate the mass of the original sample after drying, m_d, in grams, using the equation:

$$m_d = \frac{m_1 \times (100 - w_w)}{100} \tag{4}$$

where

m_1 is the mass of the wet sample, in grams;

w_w is the moisture content (mass fraction) of the wet sample, in percentage.

Calculate the incremental percentage (mass fraction), w_R, of the sample retained on sieve of mesh size R, using the equation:

$$w_R = \frac{m_R}{m_d} \times 100 \tag{5}$$

where

m_R is the mass of material retained by the sieve of mesh size R, in grams;

m_d is the equivalent mass of the original sample after drying, in grams.

Calculate the percentage of material, w_F, passing through the finest sieve using the equation:

$$w_F = \frac{m_d - m_2}{m_d} \times 100 \tag{6}$$

where

m_2 is the mass of material retained on the finest sieve after washing and drying, in grams.

8.2 Reporting the results

Report the result as the mean value of the duplicate results to the nearest 1 %.

If the difference in the sum of the incremental grain size distributions for the duplicate samples exceeds 1 %, the result should be disregarded and the test repeated.

The grain size distribution can be reported as either:

a) Incremental percentage retained by individual sieves,

e.g. $-0{,}150$ mm $+$ 0,075 mm $=$ 7,4 %;

or

b) as a cumulative size distribution, in which all the sample that does not pass a particular sieve is reported as a percentage against that sieve number.

9 Test report

The 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, etc.;

b) a reference to this part of ISO 13765 (ISO 13765-5);

c) the test method used, i.e. wet or dry sieve analysis;

d) the name of the testing establishment;

e) the results of the test, calculated as specified in Clause 8, including:

- the mesh size of sieves used;
- the mean grain size distribution;
- whether the distribution is quoted as “incremental % retained” or “cumulative % greater than”;

f) the ambient temperature at which the test was conducted;

g) any deviations from the procedure specified;

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

i) the date of the test.