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**Ceramic tiles — Grouts and adhesives —  
Part 4:  
Test methods for grouts**

*Carreaux céramiques — Mortiers de joints et colles —  
Partie 4: Méthodes d'essai pour les mortiers de joints*

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 13007-4 was prepared by Technical Committee ISO/TC 189, *Ceramic Tile*.

ISO 13007 consists of the following parts, under the general title *Ceramic Tiles — Grouts and adhesives*:

- *Part 1: Terms, definitions and specifications for adhesives*
- *Part 2: Test methods for adhesives*
- *Part 3: Terms, definitions and specifications for grouts*
- *Part 4: Test methods for grouts*

# Ceramic tiles — Grouts and adhesives —

## Part 4: Test methods for grouts

### 1 Scope

This part of ISO 13007 specifies methods for determining characteristics for grouts used in the installation of ceramic tiles.

The following test methods are described:

- determination of flexural and compressive strength (4.1);
- determination of water absorption (4.2);
- determination of shrinkage (4.3);
- determination of resistance to abrasion (4.4);
- determination of transverse deformation (4.5);
- determination of chemical resistance (4.6).

### 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 409-1, *Metallic materials — Hardness test — Tables of Vickers hardness values for use in tests made on flat surfaces — Part 1: HV 5 to HV 100*

ISO 630, *Structural steels — Plates, wide flats, bars, sections and profiles*

ISO 1101, *Geometrical Product Specifications (GPS) — Geometrical tolerancing — Tolerances of form, orientation, location and run-out*

ISO 1302, *Geometrical Product Specifications (GPS) — Indication of surface texture in technical product documentation*

ISO 4200, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length*

ISO 8486-1, *Bonded abrasives — Determination and designation of grain size distribution — Part 1: Macrogrits F4 to F220*

ISO 13007-2:2005, *Ceramic tiles — Grouts and adhesives — Part 2: Test methods for adhesives*

### 3 General test conditions and procedures

#### 3.1 Sampling

A representative sample of at least 2 kg shall be used.

#### 3.2 Test conditions

Standard conditions shall be  $(23 \pm 2)^\circ\text{C}$  and  $(50 \pm 5)\%$  relative humidity and a circulation of air in the testing area less than 0,2 m/s. Other test conditions may be specified in Clause 4. The tolerance in the time of conditioning for all test specimens shall be as follows:

| Conditioning | Tolerance   |
|--------------|-------------|
| 24 h         | $\pm 0,5$ h |
| 7 days       | $\pm 3$ h   |
| 14 days      | $\pm 6$ h   |
| 21 days      | $\pm 9$ h   |
| 28 days      | $\pm 12$ h  |

#### 3.3 Test materials

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Condition all test materials including water for at least 24 h under standard conditions. The grout to be tested shall be within its shelf life, where this is specified.

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#### 3.4 Mixing procedures

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##### 3.4.1 Cementitious grouts (CG)

The amount of water and/or liquid admix required for preparing the grout shall be as stated by the manufacturer in parts by weight, i.e. liquid to dry powder (in the case where a range of values is given, the average shall be used).

Prepare a minimum quantity of 2 kg of the powder and the necessary liquid using a mixer of the planetary type (see ISO 13007-2:2005, Figures 1 and 2), running at the slow speed settings ( $140 \pm 5$ ) rev/min and ( $62 \pm 5$ ) rev/min planetary movement.

Carry out the following procedure:

- pour the liquid into the pan;
- scatter the dry powder over the liquid;
- mix for 30 s;
- take out the mixing paddle;
- scrape down the paddle and pan within 1 min;
- replace the paddle and mix for 1 min.

If required by the grout manufacturer's instructions, let the grout mature as specified and then mix for an additional 15 s.

### 3.4.2 Reaction resin grouts (RG)

Where reaction resin grouts are to be used, the manufacturer's instructions shall be followed.

### 3.5 Test report

The following information shall be provided in the test report:

- a) reference to this part of ISO 13007, i.e. "ISO 13007-4";
- b) date of test;
- c) type of grout, commercial designation and manufacturer's name;
- d) source, date obtained and complete identification of test sample;
- e) handling and storage of samples before testing;
- f) test conditions;
- g) amount of water or liquid used for preparing grout;
- h) test results (individual and mean values and mode of failure where required);
- i) any other factor that could have affected the result.

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## 4 Test methods

### 4.1 Determination of flexural and compressive strength

Flexural and compressive strength shall be tested following the general test conditions and procedures given in Clause 3 and the specific instructions which follow.

#### 4.1.1 Apparatus

**4.1.1.1 Gang moulds**, three gang moulds used to prepare prismatic specimens  $(40 \pm 0,1) \text{ mm} \times (40 \pm 0,1) \text{ mm} \times (160 \pm 0,4) \text{ mm}$ , with ground surfaces, made of steel.

Holes for fitting suitable pins shall be pierced into the sides of the moulds corresponding to the ends of test specimen (see Figure 1).

**4.1.1.2 Jolting apparatus or jolting table**, used for the settlement of  $40 \text{ mm} \times 40 \text{ mm} \times 160 \text{ mm}$  grout specimen in accordance with Figure 2.

#### 4.1.1.3 Testing machine.

The testing machine shall be capable of applying the load with suitable capacity and sensitivity for the test. The machine shall be provided with a flexure device in accordance with Figure 3.

#### 4.1.1.4 Testing jig.

The compressive strength test requires the use of a jig, in accordance with Figure 4, to be incorporated in the lower platen; the upper platen receives the load from the compressive strength testing machine through an intermediate spherical seating.

#### 4.1.2 Preparation of test units

Mould the specimens immediately after the mixing of the grout, with the mould firmly clamped to the jolting table.

Introduce, using a suitable scoop, the first of two layers of grout into each of the compartments, directly from the mixing bowl.

Spread the layer uniformly, then compact using 60 jolts.

Introduce the second layer of grout, level and compact with a further 60 jolts.

Prepare three specimens for each grout.

Lift the mould gently from the jolting table, strike off excess of material and smooth the surface with a flat trowel.

Wipe off the grout left on the perimeter of the mould.

Place a 210 mm × 185 mm plate glass sheet of 6 mm thickness on the mould. A plate of steel or other impermeable material of similar size may be used.

Place the mould, suitably identified, on a horizontal base in standard conditions,  $(23 \pm 2) ^\circ\text{C}$  and  $(50 \pm 5) \%$  R.H.

After 24 h, carefully remove the specimen from the mould.

Prepare three specimens for each grout.

For fast setting grout, demould the specimen immediately before the test.

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#### 4.1.3 Flexural strength under standard conditions

Keep the demoulded prism in standard conditions for 27 days, leaving a clearance between prisms of at least 25 mm.

After conditioning has been completed, place the prism in the testing machine (4.1.1.3) with one side face on the supporting rollers and with the longitudinal axis normal to the support.

Apply the load vertically by means of the loading roller to the opposite side face of the prism, and increase it smoothly at the rate of  $(50 \pm 10) \text{ N/s}$  until fracture.

Keep the prism halves in standard conditions until tested in compression.

#### 4.1.4 Compressive strength under standard conditions

Test the prism halves broken in flexion, by means of the equipment specified in 4.1.1.4.

Centre the prism halves laterally to the platens of the machine within  $\pm 0,5 \text{ mm}$ , and longitudinally such that the end face of the prism overhangs the platens or auxiliary plates by about 10 mm.

Increase the load smoothly at the rate of  $(2\ 400 \pm 200) \text{ N/s}$  over the entire load application until fracture.

#### 4.1.5 Flexural and compressive strength after freeze-thaw cycles

Prepare the test units in accordance with 4.1.2.



Condition the test units for 6 days in standard conditions, and then immerse in water for 21 days before carrying out 25 freeze-thaw cycles, following the procedure given in 4.4.4.5 of ISO 13007-2.

Condition the test units for 3 days in standard conditions after the last cycle, and prior to test, examine them and record a brief description of surface appearance of the specimen.

Determine the flexural strength in accordance with 4.1.3 and the compressive strength in accordance with 4.1.4

#### 4.1.6 Evaluation of results

##### 4.1.6.1 Flexural strength

The flexural strength ( $S_f$ ) is calculated from:

$$S_f = \frac{(1,5 F_f)(D)}{l^3} \text{ N/mm}^2$$

where

$l$  is the length of the side of the square section of the prism, in millimetres;

$F_f$  is the load applied to the middle of the prism at fracture, in newtons;

$D$  is the distance between the supports, in millimetres.

Calculate the mean of the three determinations to the nearest 0,1 N/mm<sup>2</sup>.

##### 4.1.6.2 Compressive strength

The compressive strength ( $S_c$ ) is calculated from:

$$S_c = \frac{F_c}{1600} \text{ N/mm}^2$$

where

$F_c$  is the maximum load at fracture, in newtons;

1 600 = 40 mm × 40 mm is the area of the platens or auxiliary plates, in square millimetres.

Calculate the mean of the six results obtained from the test to the nearest 0,1 N/mm<sup>2</sup>.

##### 4.1.7 Test report

The following information shall be provided in the test report:

- reference to this part of ISO 13007, i.e. "ISO 13007-4";
- date of test;
- type of grout, commercial designation and manufacturer's name;
- source, date obtained and complete identification of test sample;
- handling and storage of samples before testing;

- f) test conditions;
- g) amount of water or liquid used for preparing grout;
- h) test results (individual and mean values and mode of failure where required);
- i) any other factor that could have affected the result;
- j) results of visual inspection of each specimen before and after testing, with test results individual and mean values for each condition in newtons per square millimetre;

## 4.2 Determination of water absorption

### 4.2.1 General

Water absorption shall be tested following the general test conditions and procedures given in Clause 3 and the specific instructions which follow.

### 4.2.2 Apparatus

- 4.2.2.1 **Gang moulds**, three gang moulds as described in 4.1.1.1.
- 4.2.2.2 **Inserts**, three, 1 mm thick of rigid plastic (e.g. PTFE) or HDPE with no release agent.
- 4.2.2.3 **Jolting apparatus or jolting table**, as described in 4.1.1.2.
- 4.2.2.4 **Tray**, with a flat base large enough to contain three test specimens.

### 4.2.3 Preparation of test samples

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Place the inserts approximately in the middle of the mould parallel to the smaller faces. Following the procedure described in 4.1.2, prepare six specimens of each grout. After demoulding, condition the samples for 20 days in standard conditions. Seal the four sides with dimension 40 mm by 80 mm by means of a neutral curing silicone sealant so as to be water impermeable. Then condition the samples for 7 additional days.

### 4.2.4 Test procedure

Twenty eight days after mixing, weigh each test sample to the nearest 0,01 g and then place them vertically in the tray, with the unsealed surface down on round or triangular spacers with dimension 40 mm by 40 mm, immersed in water, 5 mm to 10 mm deep, taking care to prevent the prism faces from coming in contact with each other.

Maintain the water level constant by adding water when necessary.

After 30 min, remove the test samples from water, quickly dry them by blotting with a dampened cloth and immediately weigh.

Replace in the tray and repeat the procedure after an additional 210 min.

### 4.2.5 Evaluation and expression of results

Calculate the water absorption  $W_{ab}$ , in grams, of each sample using the following formula:

$$W_{ab} = m_t - m_d$$

where

$m_d$  is the mass of the dry specimen, in grams;

$m_w$  is the mass of the specimen after immersion, in grams.

Calculate the mean of at least three test samples.

#### 4.2.6 Test report

The following information shall be provided in the test report:

- a) reference to this part of ISO 13007, i.e. "ISO 13007-4";
- b) date of test;
- c) type of grout, commercial designation and manufacturer's name;
- d) source, date obtained and complete identification of test sample;
- e) handling and storage of samples before testing;
- f) test conditions;
- g) amount of water or liquid used for preparing grout;
- h) test results (individual and mean values and mode of failure where required);
- i) any other factor that could have affected the result;
- j) test results expressed as individual and mean values after 30 min and 240 min.

### 4.3 Determination of shrinkage

#### 4.3.1 General

Shrinkage shall be tested following the general test conditions and procedures given in Clause 3 and the specific instructions which follow.

#### 4.3.2 Apparatus

**4.3.2.1 Gang moulds**, three gang moulds with optional inserts as described in 4.1.1.1.

**4.3.2.2 Inserts**, six smooth inserts: rigid, non-absorbent frames (e.g. in polyethylene or PTFE), with dimensions of  $(40 \pm 0,1 \times 160 \pm 0,4)$  mm and thickness of  $(15 \pm 0,1)$  mm.

**4.3.2.3 Jolting apparatus**, as described in Figure 2.

**4.3.2.4 Measuring apparatus.**

Measuring apparatus shall consist of a measurement attachment and a base with adjustment screws. The measurement attachment shall be formed by a dial gauge, which reads accurately to 0,01 mm, rigidly mounted in a measuring frame (see Figures 5, 6 and 7).

**4.3.2.5 Calibration rod.**

Calibration rod or reference rod shall be used as a standard length against which gauge readings can be tested. The rod shall be made of material having a negligible coefficient of expansion (e.g. Invar).

### 4.3.3 Preparation of test samples

Assemble suitable mould to prepare samples.

Mould the specimens immediately after the mixing of the grout, with the mould firmly clamped to the jolting table. Introduce, using a suitable scoop, the first of two layers of grout into each of the compartments, directly from the mixing bowl.

Spread the layer uniformly, then compact using 60 jolts.

Introduce the second layer of grout, level and compact with a further 60 jolts.

Lift the mould gently from the jolting table, strike off excess material and smooth the surface with a flat trowel.

Wipe off the grout left on the perimeter of the mould.

Cover with a glass plate according to 4.1.2.

Place the mould, suitably identified, on a horizontal base in standard conditions,  $(23 \pm 2)^\circ\text{C}$  and  $(50 \pm 5) \% \text{R.H.}$

After 24 h, carefully remove the specimens from the mould.

Prepare three specimens for each grout.

### 4.3.4 Test procedure

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Immediately after demoulding determine the length of the test samples (initial reading) using the measuring apparatus (see 4.3.1.4).

Keep the demoulded prisms on a 10 mm dimension under standard conditions, leaving a clearance of at least 25 mm between specimens.

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Take a reading of each specimen after 27 days  $\pm$  12 h from the initial reading.

### 4.3.5 Evaluation of results

The linear shrinkage is reported in millimetres per metre as the mean of three values based on the initial measurement.

### 4.3.6 Test report

The following information shall be provided in the test report:

- a) reference to this part of ISO 13007, i.e. "ISO 13007-4";
- b) date of test;
- c) type of grout, commercial designation and manufacturer's name;
- d) source, date obtained and complete identification of test sample;
- e) handling and storage of samples before testing;
- f) test conditions;
- g) amount of water or liquid used for preparing grout;