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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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Published in Switzerland

## Contents

Page

Foreword .....	iv
<b>1 Scope .....</b>	<b>1</b>
<b>2 Normative references .....</b>	<b>1</b>
<b>3 General test conditions and procedures .....</b>	<b>1</b>
3.1 Sampling.....	1
3.2 Test conditions .....	1
3.3 Test materials .....	2
3.4 Mixing procedures.....	2
3.5 Test report.....	3
<b>4 Test methods .....</b>	<b>3</b>
4.1 Determination of flexural and compressive strength .....	3
4.2 Determination of water absorption.....	5
4.3 Determination of shrinkage.....	6
4.4 Determination of resistance to abrasion.....	7
4.5 Determination of transverse deformation.....	8
4.6 Determination of chemical resistance.....	8
<b>Annex A (normative) Test apparatus .....</b>	<b>9</b>
<b>Bibliography.....</b>	<b>21</b>

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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 tiles*.

This second edition cancels and replaces the first edition (ISO 13007-4:2005), which has been technically revised.

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

- *Part 1: Terms, definitions and specifications for adhesives*  
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- *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 describes methods for determining characteristics of grouts used in the installation of ceramic tiles. The test methods described are the following:

- a) determination of flexural and compressive strength;
- b) determination of water absorption;
- c) determination of shrinkage;
- d) determination of resistance to abrasion;
- e) determination of transverse deformation;
- f) determination of chemical resistance.

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### 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 10545-6, *Ceramic tiles — Part 6: Determination of resistance to deep abrasion for unglazed tiles*

ISO 13007-2:2010, *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 in Table 1:

**Table 1 — Allowable tolerance window for testing time for all samples after conditioning**

Sample conditioning time <sup>a</sup>	Allowed tolerance for testing <sup>b</sup>
24 h	±0,5 h
7 days	±3 h
14 days	±6 h
21 days	±9 h
28 days	±12 h
<sup>a</sup> Testing shall be performed within the specified time window. <sup>b</sup> Allowed tolerance in testing time for all samples requiring conditioning.	

**3.3 Test materials**

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

**3.4 Mixing procedures**

**3.4.1 Cementitious grouts — CG**

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The amount of water and liquid admix, or one or the other, required for preparing the grout shall be as stated by the manufacturer in mass fraction, 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 13007-2:2010, Figures 1 and 2) running at the slow speed settings (140 ± 5) r/min and (62 ± 5) r/min planetary movement.

Carry out the following procedure:

- a) pour the liquid into the pan;
- b) scatter the dry powder over the liquid;
- c) mix for 30 s;
- d) take out the mixing paddle;
- e) scrape down the paddle and pan within 1 min;
- f) 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 used, the manufacturer's instructions shall be followed.

### 3.5 Test report

#### 3.5.1 General

The test report shall specify the following:

- a) reference to this part of ISO 13007, i.e. ISO 13007-4:2010;
- 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) any other factor that could have affected the result.

#### 3.5.2 Test results

The test report shall specify the following:

- a) flexural and compressive strength;
- b) water absorption;
- c) shrinkage; <https://standards.iteh.ai/catalog/standards/sist/3456dce1-4981-4a6a-9988-2cbb38b190d1/iso-13007-4-2010>
- d) abrasion.

## 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 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 (such as part number 62-L0009/1<sup>1)</sup> or equivalent) shall be pierced into the sides of the moulds corresponding to the ends of test specimens (see Figure A.1).

**4.1.1.2 Jolting apparatus**, or jolting table used for the settlement of  $10 \text{ mm} \times 40 \text{ mm} \times 160 \text{ mm}$  grout specimen in accordance with Figure A.2.

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1) Part number 62-L0009/1 is an example of a suitable product available commercially (from Invensys Controls S.R.L., Italy). This information is given for the convenience of users of this part of ISO 13007 and does not constitute an endorsement by ISO of this product.

**4.1.1.3 Testing machine**, of flexural strength type, 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 A.3.

**4.1.1.4 Testing jig**, in accordance with Figure A.4, 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. 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 ± 2) °C and (50 ± 5) % relative humidity. 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.

#### 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 ± 10) 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 ± 0.5 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 ± 200) 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 ISO 13007-2:2010, 4.4.4.5. 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,  $R_f$ , is calculated using Equation (1):

$$R_f = \frac{(1,5 F_f)(L)}{b^3} \text{ N/mm}^2 \quad (1)$$



where

- $b$  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;
- $L$  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,  $R_c$ , is calculated using Equation (2):

$$R_c = \frac{F_c}{1\ 600} \text{ N/mm}^2 \quad (2)$$

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 information listed in 3.5.1, list items a) to h), plus the following shall be provided: 3.5.2, list item a): results of visual inspection of each specimen before and after flexural and compressive strength testing with test results individual and mean values for each condition in N/mm<sup>2</sup>.

## 4.2 Determination of water absorption

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

### 4.2.1 Apparatus

- 4.2.1.1 **Gang moulds**, as described in 4.1.1.1.
- 4.2.1.2 **Three inserts**, 1 mm thick, of rigid plastic (e.g. PTFE) or HDPE with no release agent.
- 4.2.1.3 **Jolting apparatus**, or jolting table as described in 4.1.1.2.
- 4.2.1.4 **Tray**, with a flat base large enough to contain three test specimens.

### 4.2.2 Preparation of test samples

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 × 80 mm by means of a neutral curing silicone sealant such that they are water impermeable. Then condition the samples for 7 additional days.

#### 4.2.3 Test procedure

Twenty-eight days after mixing, weigh each test sample to the nearest 0,1 g and then place them vertically in the tray, with the unsealed surface down on round or triangular spacers with dimension 40 mm × 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 200 min and 210 min.

#### 4.2.4 Evaluation and expression of results

Calculate the water absorption,  $W_{mt}$ , in grams, of each sample using Equation (3):

$$W_{mt} = m_t - m_d \quad (3)$$

where

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

$m_t$  the mass of the specimen after immersion in grams.

Calculate the mean of at least three test samples.

#### 4.2.5 Test report

The information listed in 3.5.1, list items a) to h), plus the following shall be reported: 3.5.2 list item b): test results for water absorption expressed as individual and mean values after 30 min and 240 min.

### 4.3 Determination of shrinkage

ISO 13007-4:2010

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

#### 4.3.1 Apparatus

##### 4.3.1.1 Three gang mould, with optional pin inserts as described in 4.1.1.1.

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.

##### 4.3.1.2 Jolting apparatus, as described in Figure A.2.

**4.3.1.3 Measuring apparatus**, consisting 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 A.5, A.6 and A.7).

**4.3.1.4 Calibration rod**, or reference rod, 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<sup>2)</sup>].

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2) Invar is an example of a suitable product available commercially. This information is given for the convenience of users of this part of ISO 13007 and does not constitute an endorsement by ISO of this product.

#### 4.3.2 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  $(50 \pm 5) \%$  relative humidity. After 24 h, carefully remove the specimens from the mould. Prepare three specimens for each grout.

#### 4.3.3 Test procedure

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

#### 4.3.4 Evaluation of results

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

#### 4.3.5 Test report

The information listed in 3.5.1, list items a) to h), shall be provided plus the following: 3.5.2, list item c): test results for shrinkage (individual and mean values) in millimetres per metre.

### 4.4 Determination of resistance to abrasion

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

#### 4.4.1 Apparatus

**4.4.1.1 Abrasion apparatus**, (see Figure A.8), consisting essentially of a rotating disc, a storage hopper with a dispensing device for the abrasive material, a test specimen support and a counterweight. The disc is made of E 235 A (Fe 360 A) in accordance with ISO 10545-6 with a diameter of  $(200 \pm 0,2)$  mm and thickness at the edge of  $(10 \pm 0,1)$  mm, and with a revolution rate of 75 r/min. The pressure with which the test specimens are held against the steel disc is determined by calibrating the apparatus against transparent fused silica. The pressure is adjusted such that, after 150 revolutions using white fused aluminium oxide of grain size 80 (see ISO 10545-6) abrasive, a chord of  $(24 \pm 0,5)$  mm is produced. Transparent fused silica shall be used as a primary standard. A secondary standard of float glass or other products may be used. When the diameter has worn by 0,5 % of the initial diameter, the steel disc shall be replaced.

**4.4.1.2 Abrasive material**, made of white fused aluminum oxide of grain size 80 in accordance with ISO 10545-6.

**4.4.1.3 Measuring gauge**, accurate to 0,1 mm.

**4.4.1.4 Template**, with a smooth, square, rigid, non-absorbent frame (e.g. in polyethylene or PTFE), with internal dimensions of  $(100 \pm 1)$  mm  $\times$   $(100 \pm 1)$  mm and thickness of  $(10 \pm 1)$  mm.