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**Ceramic tiles — Grouts and adhesives —**  
**Part 2:**  
**Test methods for adhesives**

*Carreaux céramiques — Mortiers de joints et colles —*  
*Partie 2: Méthodes d'essai pour les colles*



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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 189, *Ceramic tile*.

This third edition cancels and replaces the second edition (ISO 13007-2:2010), of which it constitutes a minor revision.

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 2: Test methods for adhesives

### 1 Scope

This part of ISO 13007 describes the methods for determining the characteristics for adhesives used in the installation of ceramic tiles. The following test methods are described:

- determination of open time (4.1);
- determination of slip (4.2);
- determination of shear adhesion strength (4.3);
- determination of tensile adhesion strength (4.4);
- determination of transverse deformation (4.5).

### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13006, *Ceramic tiles — Definitions, classification, characteristics and marking*

ISO 13007-1, *Ceramic tiles — Grouts and adhesives — Part 1: Terms, definitions and specifications 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 the speed of air in the testing area shall be 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 shown in [Table 1](#) below.

**Table 1 — Allowed tolerance in testing time for all samples requiring conditioning**

Sample conditioning time	Allowed tolerance for testing
24 h	$\pm 0,5$ h
7 d	$\pm 3$ h
14 d	$\pm 6$ h
21 d	$\pm 9$ h
28 d	$\pm 12$ h
NOTE Testing must be performed within the specified time window.	

### 3.3 Test materials

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

#### 3.3.1 Ceramic tiles

The tiles shall be checked prior to conditioning to ensure that they are unused, clean, and dry. The type of tile shall be as specified under the specific test procedures found in [Clause 4](#).

### 3.4 Mixing procedures

#### 3.4.1 Cementitious adhesives (C)

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

Using a minimum quantity of 2 kg of the powder and the recommended quantity of liquid, prepare the adhesive in a planetary mixer using the following slow speed settings:  $(140 \pm 5)$  rotations per minute and  $(62 \pm 5)$  rotations per minute planetary movement. See [Figures 1](#) and [2](#).

Carry out the following procedure.

- 1) Pour the liquid into the pan.
- 2) Scatter the dry powder over the liquid.
- 3) Mix for 30 s.
- 4) Take out the mixing paddle.
- 5) Scrape down the paddle and pan within 1 min.
- 6) Replace the paddle and mix for 1 min.

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

#### 3.4.2 Dispersion adhesive (D) and reaction resin adhesive (R)

Where ready-to-use dispersion adhesives or reaction resin adhesives are to be used, the manufacturer's instructions shall be followed.

### 3.5 Test substrate

#### 3.5.1 Concrete test substrate

The mandatory concrete test substrate shall be  $(40 \pm 5)$  mm thick, have a moisture content of less than 3 % by mass, and have a surface water absorption in the range of  $0,5 \text{ cm}^3$  to  $1,5 \text{ cm}^3$  after 4 h of testing. The cohesive strength as referenced in [A.3.3](#) shall be at least  $1,5 \text{ N/mm}^2$ . A method for manufacturing a suitable concrete test slab and the procedures for measuring the cohesive strength and surface water absorption is given in informative [Annex A](#).

#### 3.5.2 Other substrates

Other substrates may be used upon agreement if the substrate is recommended for ceramic tile application by the adhesive manufacturer. To demonstrate compatibility with other optional substrates, the adhesive shall be applied to the selected substrate in accordance with the open time test method (see [4.1](#)). When a result of  $\geq 0,5 \text{ N/mm}^2$  is achieved or cohesive failure occurs in the substrate, the requirement is considered satisfied.

### 3.6 Failure patterns

#### 3.6.1 Adhesion failure (AF-S or AF-T)

Failure occurs at the interface between the adhesive and the substrate (AF-S) [see [Figure 3](#), a)] or between the tile and the adhesive (AF-T) [see [Figure 3](#), b)]. The test value is equal to the adhesive strength. In some cases, failure may occur in the adhesive layer between the tile and the pull-head plate (BF) [see [Figure 3](#), c)]. In this case, the adhesive strength is greater than the test value and the test should be repeated.

#### 3.6.2 Cohesive failure within the adhesive (CF-A)

Failure occurs within the adhesive layer [see [Figure 3](#), d)].

#### 3.6.3 Cohesive failure in the substrate or in the tile (CF-S or CF-T)

Failure occurs within the substrate (CF-S) [see [Figure 3](#), e)] or within the body of the tile (CF-T) [see [Figure 3](#), f)]. In this case, the strength of the adhesive is greater than the test value.

The modes of failure may be a combination of any of the above. An approximate percentage of each shall be recorded.

### 3.7 Test report

#### 3.7.1 General

The test report shall specify the following:

- a) a reference to this part of ISO 13007 (i.e. ISO 13007-2:2013);
- b) the date of test;
- c) the type of adhesive, commercial designation, and manufacturer's name;
- d) the source, date obtained, and complete identification of test sample;
- e) the handling and storage of samples before testing;
- f) the test conditions;
- g) the amount of water or liquid used for preparing the adhesive;

- h) any other factor that could have affected the result;
- i) the test results (individual and mean values and mode of failure where required).

### 3.7.2 Test results of cementitious and dispersion adhesives

The test report shall specify the following:

- a) open time;
- b) slip;
- c) shear adhesion strength;
- d) adhesion strength;
- e) deformation.

### 3.7.3 Test results of chemical resistance

The test report shall specify the following:

- a) test conditions;
- b) change in colour and surface appearance during the test;
- c) total duration of the test and exposure periods.

## 4 Test methods

### 4.1 Determination of open time

#### 4.1.1 General

Open time shall be tested following the general test conditions and procedures given in [Clause 3](#) and the specific instructions which follow.

#### 4.1.2 Test materials

**4.1.2.1 Ceramic tiles**, Group BIII porous body tile complying with ISO 13006, with a water absorption of  $(15 \pm 3) \%$  by mass, facial dimensions of  $(50 \pm 1) \text{ mm} \times (50 \pm 1) \text{ mm}$ , thickness in the range of 7 mm to 10 mm, and a profile back pattern of less than 0,25 mm deep.

**4.1.2.2 Test substrate**, conforming to the requirements given in [3.5.1](#).

#### 4.1.3 Apparatus

**4.1.3.1 Test mass**, less than 50 mm  $\times$  50 mm cross-sectional area and capable of exerting a uniform force of  $(20 \pm 0,05) \text{ N}$ .

**4.1.3.2 Pull-head plates**, square metallic plates with a dimension of  $(50 \pm 1) \text{ mm}$ , a minimum thickness of 10 mm, and a suitable fitting for connection to the test machine.

**4.1.3.3 Test machine**, for the direct pull tensile force test, with suitable capacity and sensitivity. The machine shall be capable of applying the load to the pull-head plate at the rate of  $(250 \pm 50) \text{ N/s}$  through a suitable fitting that does not exert any bending force.



#### 4.1.4 Procedure

Apply a thin layer of the adhesive, mixed in accordance with [3.4.1](#), to the concrete slab using a straight edge trowel. Then, apply a thicker layer and comb using a notched trowel having 6 mm × 6 mm notches at 12 mm centres. The trowel shall be held at an angle of approximately 60° to the substrate at a right angle to one edge of the slab and shall be drawn across the slab parallel to that edge (in a straight line).

After 5 min, 10 min, 20 min, 30 min, or longer, place at least 10 test tiles 50 mm apart on the adhesive within 30 s. Tiles are placed on no more than four ribs for all adhesives. Load each tile with  $(20 \pm 0,05)$  N for 30 s.

After storing for 27 d under standard conditions, bond the pull-head plates to the tiles with a suitable high-strength adhesive (e.g. epoxy adhesive).

After a further 24 h storage under standard conditions, determine the tensile adhesion strength of the adhesive by applying a force increasing at a constant rate of  $(250 \pm 50)$  N/s.

#### 4.1.5 Evaluation and expression of results

The individual tensile adhesion strengths are quoted to 0,1 N/mm<sup>2</sup> using Formula (1):

$$A_s = \frac{L}{A} \quad (1)$$

where

$A_s$  is the individual tensile adhesion strength, in N/mm<sup>2</sup>;

$L$  is the total tensile load, in N;

$A$  is the bonding area, in mm<sup>2</sup> (2 500 mm<sup>2</sup>).

The tensile adhesion strength for each time interval is determined as follows.

- 1) Determine the mean of the 10 values.
- 2) Discard the values falling out of the range of  $\pm 20$  % of the mean value.
- 3) If five or more values remain, determine the new mean.
- 4) If less than five values remain, repeat the test.
- 5) Determine the mode of failure of the test units (see [3.6](#)).

The open time, in minutes, is the maximum time interval at which the adhesive meets the tensile adhesion strength requirement defined in ISO 13007-1 for open time.

#### 4.1.6 Test report

The information listed in [3.7.1](#), items a) to i), shall be provided as well as [3.7.2](#), item a) (open time in minutes).

### 4.2 Determination of slip

#### 4.2.1 General

Slip shall be tested following the general test conditions and procedures given in [Clause 3](#) and the specific instructions which follow.

## 4.2.2 Test materials

**4.2.2.1 Ceramic tiles**, Group BI<sub>a</sub> fully vitrified tile in accordance with ISO 13006, with a water absorption of  $\leq 0,5$  % by mass, unglazed, with plain adhering surface, and with facial dimensions of  $(100 \pm 1)$  mm  $\times$   $(100 \pm 1)$  mm, mass of  $(200 \pm 10)$  g, and a thickness in the range of 8 mm to 10 mm.

**4.2.2.2 Concrete test substrate**, conforming to the requirements given in [3.5](#).

## 4.2.3 Apparatus

**4.2.3.1 Steel straight edge**

**4.2.3.2 Clamps**

**4.2.3.3 Masking tape**, 25 mm wide.

**4.2.3.4 Spacers**, two pieces, made from stainless steel, with a thickness of  $(25 \pm 0,5)$  mm  $\times$   $(25 \pm 0,5)$  mm  $\times$   $(10 \pm 0,5)$  mm.

**4.2.3.5 Mass**, capable of exerting a force of  $(50 \pm 0,1)$  N, with a cross-sectional area of less than  $(100 \pm 1)$  mm  $\times$   $(100 \pm 1)$  mm.

**4.2.3.6 Vernier caliper**, accurate to 0,01 mm.

## 4.2.4 Procedure

Secure the steel straight edge at the top of the concrete substrate so that its bottom edge is horizontal when the slab is raised to its vertical position. Position a 25-mm-wide masking tape immediately below the steel straight edge and apply a thin layer of the adhesive to the concrete slab using a straight edge trowel.

Then, apply a thicker layer of adhesive to the surface of the concrete substrate so that it just overlaps the bottom edge of the masking tape. Comb the adhesive at right angles to the straight edge using a notched trowel having 6 mm  $\times$  6 mm notches at 12 mm centres.

Hold the trowel at an angle of 60° to the substrate and parallel to the straight edge.

Immediately remove the masking tape and position 25 mm spacers (or the spacing bar) against the straight edge. After 2 min, place a type BI<sub>a</sub> tile against the spacers, as shown in [Figure 4](#), and load with a weight of  $(50 \pm 0,1)$  N for  $(30 \pm 5)$  s.

Remove the spacers and measure the gap between the straight edge and the tile using the Vernier caliper to within  $\pm 0,1$  mm. Immediately and carefully lift the slab into a vertical position. After  $(20 \pm 2)$  min, re-measure the gap, as before, at its maximum point. The maximum slip of the tile under its own weight is the difference between the two readings.

Carry out the test for each of the three tiles for each adhesive. Report the individual results and the mean value in mm.

## 4.2.5 Test report

The information listed in [3.7.1](#), items a) to i), shall be provided as well as [3.7.2](#), item b) [slip in mm (individual and mean values)].

### 4.3 Determination of shear adhesion strength (D, R)

#### 4.3.1 General

Shear adhesion strength shall be tested following the general test conditions and procedures given in [Clause 3](#) and the specific instructions which follow.

#### 4.3.2 Test materials and apparatus

##### 4.3.2.1 Ceramic tiles

The tiles for this test shall be the following:

- a) **dispersion adhesives (D)** — Group BIII glazed porous body tiles in accordance with ISO 13006; with water absorption of  $(15 \pm 3) \%$  by mass, facial dimensions of  $(108 \pm 1) \text{ mm} \times (108 \pm 1) \text{ mm}$ , thickness in the range of 7 mm to 10 mm, and a profile back pattern of less than 0,25 mm thick;
- b) **reaction resin adhesives (R)** — Group BI<sub>a</sub> fully vitrified tiles in accordance with ISO 13006; with water absorption of  $\leq 0,2 \%$  by mass, unglazed with plane adhering surface, and with facial dimensions of  $(100 \pm 1) \text{ mm} \times (100 \pm 1) \text{ mm}$ .

**4.3.2.2 Template**, smooth non-absorbent frame (e.g. polytetrafluoroethylene) in accordance with [Figure 5](#) for D adhesives and [Figure 7](#) for R adhesives.

**4.3.2.3 Spacers**, spacer rods with 0,8 mm diameter and approximately 40 mm long.

**4.3.2.4 Mass**, less than 100 mm × 100 mm cross-sectional area, capable of exerting a uniform force of  $(70 \pm 0,15) \text{ N}$ .

**4.3.2.5 Test machine**, with suitable capacity and sensitivity for the test and with a variable testing speed. The machine shall be capable of applying the load to the tile through a suitable jig.

**4.3.2.6 Shear test jig**, any suitable jig used to transfer the compression or tensile load exerted by the testing machine into shear load. Examples of suitable jigs are shown in [Figures 9](#) and [10](#).

**4.3.2.7 Air-circulating oven**, capable of controlling the temperature to within  $\pm 3 \text{ }^{\circ}\text{C}$ .

#### 4.3.3 Procedure

Each test unit shall be prepared with two Group BIII tiles for D adhesives or Group BI<sub>a</sub> tiles for R adhesives.

Draw a straight line on the adhering side of one tile, 6 mm from the tile edge (to serve as a guide for overlapping the tile as explained below).

Place the template (see [Figures 5](#) and [7](#)) over the unglazed back of the first test tile. Trowel sufficient adhesive across the template and then screed it clean so as to neatly and completely fill the holes in the template. Carefully remove the template vertically (see [Figures 6](#) and [8](#)).

Place spacer rods at each corner of the first tile, approximately 20 mm over the tile. After 2 min, place a second standard test tile over the coated tile offset with a displacement of 6 mm to provide an overlap between tiles, using the previously scribed line as a guide and ensuring that the edges of the tiles are parallel. See [Figure 6](#) for D adhesives and [Figure 8](#) for R adhesives.

Place the test units on a plane surface and carefully load with  $(70 \pm 0,15) \text{ N}$  for 3 min. After removing the weight, carefully remove the spacer rods without disturbing the relative position of the tiles in the test units. A total of 10 test units is required per conditioning.

#### 4.3.4 Adhesion strength (D, R)

**4.3.4.1** Condition 10 test units under standard test conditions (see [3.2](#)) for 7 d for R adhesives or 14 d for D adhesives.

**4.3.4.2** After conditioning has been completed, place the test units in a shear test jig and apply a shear force by moving the crosshead at a speed of  $(5 \pm 0,5)$  mm/min until failure occurs. Report the results in Newtons.

#### 4.3.5 Adhesion strength after water immersion (D, R)

Condition 10 test units under standard conditions (see [3.2](#)) for 21 d for adhesives (D2) or 7 d for accelerated drying adhesives (D2A) and reaction resin adhesives (R). Then, immerse the test unit in water at  $(23 \pm 2)$  °C for 21 d for reaction resin adhesives or 7 d for dispersion adhesives (D2, D2A). Remove the units and wipe with a cloth. Test them as described in [4.3.4.2](#).

Report the results in Newtons.

NOTE This test is only for dispersion adhesives used in internal installations subject to wet conditions.

#### 4.3.6 Adhesion strength after heat aging (D)

Condition 10 test units under standard conditions (see [3.2](#)) for 14 d and then place them in an air-circulating oven at  $(70 \pm 2)$  °C for a further 14 d, ensuring that air is free to circulate around each test unit.

Condition the units for a further 24 h under standard conditions and test them as described in [4.3.4](#).

Report the results in Newtons.

#### 4.3.7 Adhesion strength at elevated temperature (D)

Use the procedure described in [4.3.6](#) but test the tile adhesion 1 min after the removal of the test unit from the air-circulating oven.

Report the results in Newtons.

#### 4.3.8 Adhesion strength after thermal shock (R)

After conditioning 10 test units under standard conditions for 7 d, place the test pieces in a water bath maintained at  $(23 \pm 2)$  °C for 30 min and then in a  $(100 \pm 2)$  °C water bath for a further 30 min.

Repeat the cycle for a total of four times and then place the test pieces in the  $(23 \pm 2)$  °C water bath for approximately 30 min for cooling.

Remove each test piece from the water, wipe off the excess water, and test as described in [4.3.4](#).

Report the results in Newtons.

#### 4.3.9 Evaluation and expression of results

Divide the individual values, in Newtons, by the area of adhesive contact ( $D = 5\,480\text{ mm}^2$ ;  $R = 1\,660\text{ mm}^2$ ).

Determine the shear adhesion strength as follows.

- 1) Determine the mean of the 10 values.
- 2) Discard the values falling out of the range of  $\pm 20\%$  from the mean value.
- 3) If five or more values remain, determine the new mean value.
- 4) If less than five values remain, repeat the test.

#### 4.3.10 Test report

The information listed in [3.7.1](#), items a) to i), shall be provided as well as [3.7.2](#), item c) (shear adhesion strength for each condition, in N/mm<sup>2</sup>).

### 4.4 Determination of tensile adhesion strength (C)

#### 4.4.1 General

Tensile adhesion strength shall be tested following the general test conditions and procedures given in [Clause 3](#) and the specific instructions which follow.

#### 4.4.2 Test materials

**4.4.2.1 Ceramic tiles**, Group BI<sub>a</sub> fully vitrified tile complying with ISO 13006, with a water absorption of  $\leq 0,5$  % by mass, unglazed and with a plain, matt, adhering surface, and with facial dimensions of  $(50 \pm 1)$  mm  $\times$   $(50 \pm 1)$  mm.

**4.4.2.2 Test substrate**, conforming to the requirements given in [3.5](#).

#### 4.4.3 Apparatus

**4.4.3.1 Mass**, less than 50 mm  $\times$  50 mm cross-sectional area, capable of exerting a force of  $(20 \pm 0,05)$  N.

**4.4.3.2 Pull-head plate**, square metallic plates, with dimensions of  $(50 \pm 1)$  mm  $\times$   $(50 \pm 1)$  mm, minimum thickness of 10 mm, and a suitable fitting for connection to the test machine.

**4.4.3.3 Tensile testing apparatus**, a test machine for direct pull tensile force test, with suitable capacity and sensitivity. The machine shall be capable of applying the load to the pull-head plate at the rate of  $(250 \pm 50)$  N/s through a suitable fitting that does not exert any bending force.

**4.4.3.4 Air-circulating oven**, capable of controlling the temperature to within  $\pm 3$  °C.

#### 4.4.4 Procedure

##### 4.4.4.1 Preparation of test units

Apply a thin layer of the adhesive to the concrete slab using a straight edge trowel. Then, apply a thicker layer and comb using a notched trowel having 6 mm  $\times$  6 mm notches at 12 mm centres.

The trowel shall be held at an angle of approximately 60° to the substrate at a right angle to one edge of the slab and shall be drawn across the slab parallel to that edge (in a straight line).

After 5 min, place 10 type BI<sub>a</sub> tiles on the adhesive at a distance of 50 mm apart and load each tile with  $(20 \pm 0,05)$  N for 30 s.

##### 4.4.4.2 Tensile adhesion strength

After storing for 27 d under standard conditions, bond the pull-head plates to the tiles with a suitable high-strength adhesive (e.g. epoxy).

After a further 24 h storage under standard conditions, determine the tensile adhesion strength of the adhesive by applying a force at a constant rate of  $(250 \pm 50)$  N/s.

If fast-setting properties of adhesives are to be tested, bond the pull-head plates for a minimum of 2 h before determining the tensile adhesion strength.

Report the results in Newtons.

#### 4.4.4.3 Tensile adhesion strength after water immersion

Condition the test units under standard conditions for 7 d and immerse in water at standard temperature.

After 20 d, remove the test units from the water, wipe with a cloth, and bond the pull-head plates to the tiles. After a further 7 h under standard conditions, immerse the test units in water at standard temperature.

On the following day, remove the test units from water and immediately determine the tensile adhesion strength of the adhesive by applying a force at a constant rate of  $(250 \pm 50)$  N/s.

Report the results in Newtons.

#### 4.4.4.4 Tensile adhesion strength after heat aging

Condition the test units under standard conditions for 14 d and then place the units in an air-circulating oven at  $(70 \pm 3)$  °C for a further 14 d. Remove from the oven and bond the pull-head plates to the tiles with a suitable high-strength adhesive (e.g. epoxy).

Condition the test units for a further 24 h under standard conditions and immediately determine the tensile adhesion strength of the adhesive by applying a force at a constant rate of  $(250 \pm 50)$  N/s.

Report the results in Newtons.

#### 4.4.4.5 Tensile adhesion after freeze-thaw cycle

Prepare the test units in accordance with 4.4.4.1. In addition, a layer of the adhesive approximately 1 mm thick shall be applied, using a straight edge trowel, to the back face of the type tile before placing.

Condition the test units for 7 d under standard conditions and immerse in water for 21 d before carrying out 25 freeze-thaw cycles.

Perform the following for each freeze-thaw cycle.

- 1) Remove the test units from the water and lower the temperature to  $(-15 \pm 3)$  °C within  $2 \text{ h} \pm 20 \text{ min}$ .
- 2) Maintain the test units at  $(-15 \pm 3)$  °C for  $2 \text{ h} \pm 20 \text{ min}$ .
- 3) Immerse in water at  $(20 \pm 3)$  °C, raise the temperature to  $(15 \pm 3)$  °C, and maintain this temperature for a minimum of 2 h before commencing the next freeze-thaw cycle.
- 4) Repeat the cycle 25 times.

After 25 cycles, bond the pull-head plates to the tiles. Allow the test units to reach standard conditions in air. Determine the tensile adhesion strength of the adhesive in less than 24 h by applying a force at a constant rate of  $(250 \pm 50)$  N/s.

Report the results in Newtons.

#### 4.4.5 Evaluation and expression of results

The individual tensile adhesion strength shall be determined to an accuracy of 0,1 N/mm<sup>2</sup> using Formula (2):

$$A_s = \frac{L}{A} \quad (2)$$

where

$A_s$  is the individual tensile adhesion strength, in N/mm<sup>2</sup>;

$L$  is the total load, in N;

$A$  is the bonding area, in mm<sup>2</sup> (2 500 mm<sup>2</sup>).

The tensile adhesion strength for each set of conditions shall be determined as follows.

- 1) Determine the mean of the 10 values.
- 2) Discard the values falling out of the range of  $\pm 20$  % from the mean value.
- 3) If five or more values remain, determine the new mean value.
- 4) If less than five values remain, repeat the test.
- 5) Determine the mode of failure of each test unit (see [Figure 3](#)).

#### 4.4.6 Test report

The information listed in [3.7.1](#), items a) to i), shall be provided as well as [3.7.2](#), item d) (adhesion strength for each condition, in N/mm<sup>2</sup>).

### 4.5 Determination of transverse deformation

#### 4.5.1 General

Transverse deformation shall be tested following the general test conditions and procedures given in [Clause 3](#) and the specific instructions which follow.

#### 4.5.2 Test materials and apparatus

**4.5.2.1 Substrate**, polyethylene film with minimum thickness of 0,15 mm.

**4.5.2.2 Plastic container**, capable of being sealed to make it airtight, with an internal volume of  $(26 \pm 5)$  l, e.g. a container with dimensions of  $(600 \pm 20)$  mm  $\times$   $(400 \pm 10)$  mm  $\times$   $(110 \pm 10)$  mm.

**4.5.2.3 Support**, rigid, smooth, and flat support for the polyethylene film.

**4.5.2.4 Anvil**, metallic construction conforming to the dimensions shown in [Figure 11](#).

**4.5.2.5 Test jig**, two metallic cylindrical supports, with a diameter of  $(10 \pm 0,1)$  mm, spaced  $(200 \pm 1)$  mm centre to centre, and with a minimum length of 60 mm. See [Figure 12](#).

**4.5.2.6 Template A**, smooth, rigid, non-absorbent rectangular frame, with internal dimensions of  $(280 \pm 1)$  mm  $\times$   $(45 \pm 1)$  mm and thickness of  $(5 \pm 0,1)$  mm, e.g. made from polytetrafluoroethylene (PTFE) or metal.



NOTE A 2-mm-diameter round hole drilled at each internal corner is recommended to ease production of the test piece. See [Figure 13](#).

**4.5.2.7 Template B**, smooth, rigid, non-absorbent mould (see [Figure 14](#)) or similar device capable of producing a test specimen with dimensions of  $(300 \pm 1) \text{ mm} \times (45 \pm 1) \text{ mm} \times (3 \pm 0,05) \text{ mm}$ .

**4.5.2.8 Test machine**, a press capable of applying the anvil ([4.5.2.4](#)) to the test piece at a rate of 2 mm/min.

**4.5.2.9 Flow table**, used for the compaction of the  $280 \text{ mm} \times 45 \text{ mm} \times 5 \text{ mm}$  specimen, shall comply with [Figure 15](#).

### 4.5.3 Procedure

#### 4.5.3.1 Preparation of substrate

Fix the polyethylene film ([4.5.2.1](#)) firmly to the rigid support ([4.5.2.3](#)), ensuring the surface, to which the adhesive is to be applied, is not distorted, e.g. without pleats or wrinkles.

#### 4.5.3.2 Preparation of test units

Hold template A firmly onto the polyethylene film.

Trowel sufficient adhesive across the template and then screed clean so as to neatly and completely fill the hole in the template.

Clamp the mould firmly to the flow table and compact the sample using 70 jolts.

Lift the mould gently from the flow table and carefully remove the template vertically.

Apply a layer of release agent to template B and position it centrally over the specimen. Load the template with a weight capable of exerting a force of  $(100 \pm 0,1) \text{ N}$  and an approximate cross-sectional area of  $290 \text{ mm} \times 45 \text{ mm}$ . The applied pressure ensures that the material fully fills the recess of the template to the required thickness. Remove any excess material from the sides of the template and, after 1 h, remove the weight.

After 48 h, remove template B.

Prepare six samples for each test.

#### 4.5.3.3 Conditioning

Immediately after the removal of template B, place six specimens, on the support, horizontally into the plastic container and seal it to make it airtight.

Condition the test units at  $(23 \pm 2) ^\circ\text{C}$ . After 12 d, remove them from the plastic container and condition them for 14 d in air under standard conditions.

#### 4.5.3.4 Transverse deformation

After conditioning has been completed, remove the specimens from the polyethylene film and measure their thickness, using a caliper with 0,01 mm precision, at three positions, i.e. in the middle and  $(50 \pm 1) \text{ mm}$  from each end. If the three values fall within the required tolerance of  $(3,0 \pm 0,1) \text{ mm}$ , calculate the average value; discard any specimen which falls outside the required permissible thickness. If a test specimen has a raised burr edge along one or both of the long dimensions as an artefact of the removal of excess material in [4.5.3.2](#), it is permissible to gently sand the burr edge using an ISO 6344 compliant sandpaper of P120 grit. Only the burr edge may be sanded and the sample must otherwise fully meet the thickness criteria. Unless removed, the burr edges can create variation in the test results.



Place the test sample on the test jig (see [Figure 12](#)). Orient the test sample so that any natural curve in the test specimen points down, away from the anvil.

The starting point is defined when the anvil touches the sample. Deform the sample, from the starting point, with a transverse load applied by the anvil at a rate of 2 mm/min until failure.

Record the deformation from the starting point, in millimetres.

Repeat the test on the other test pieces. Test data from specimens with transverse deformation values that deviate by  $\pm 20\%$  from the calculated average should be excluded. A minimum of three remaining test specimens is required.

#### 4.5.4 Evaluation and expression of results

The transverse deformation is determined to 0,1 mm by calculating the average value of the deformations obtained in the test. The classes are designated in ISO 13007-1, Table 3.

#### 4.5.5 Test report

The information listed in [3.7.1](#), items a) to i), shall be provided as well as [3.7.2](#), item e) (deformation, individual and mean values, in millimetres).

Dimensions in millimetres

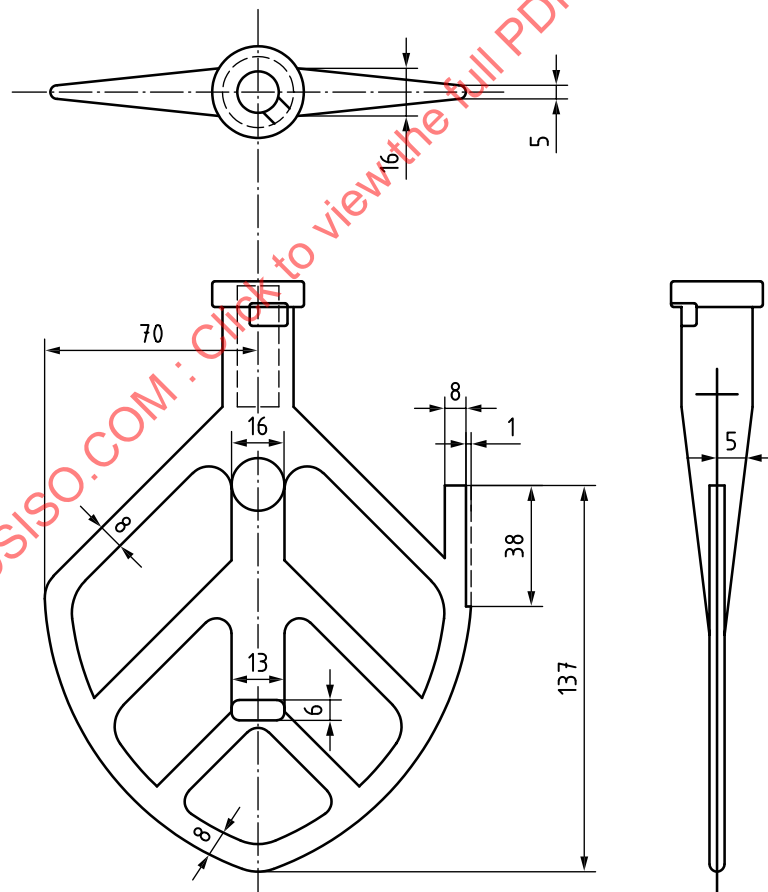
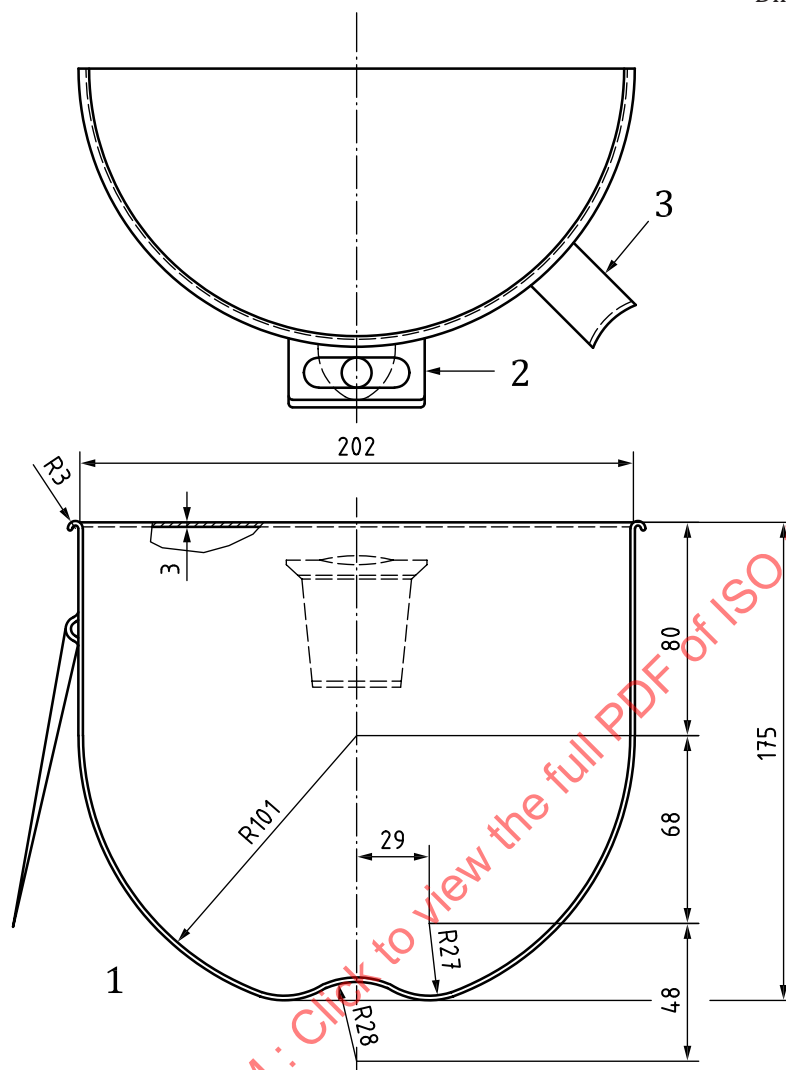


Figure 1 — Paddle

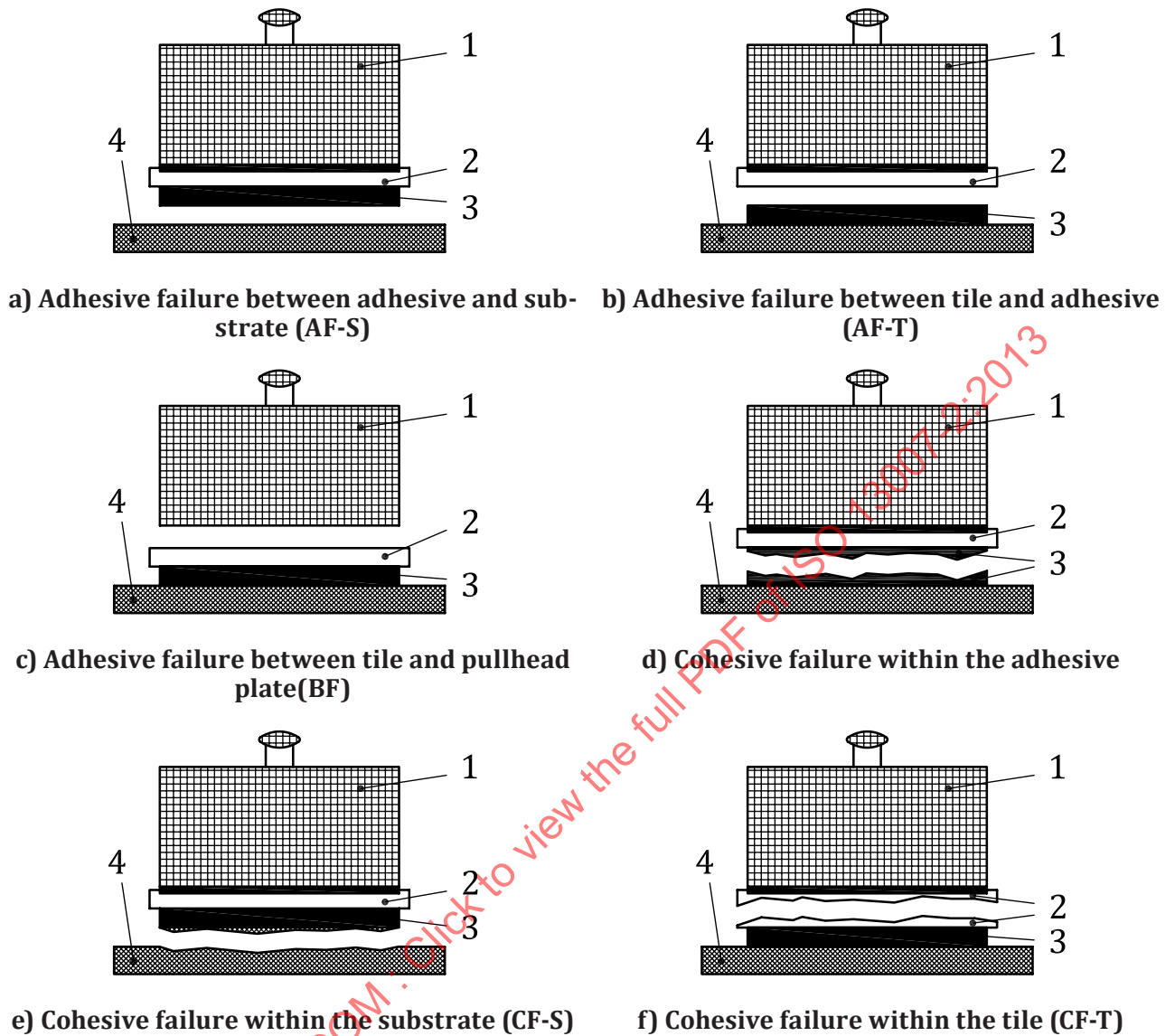
Dimensions in millimetres



### Key

- 1 back bowl pin assembly
- 2 side handle
- 3 front handle

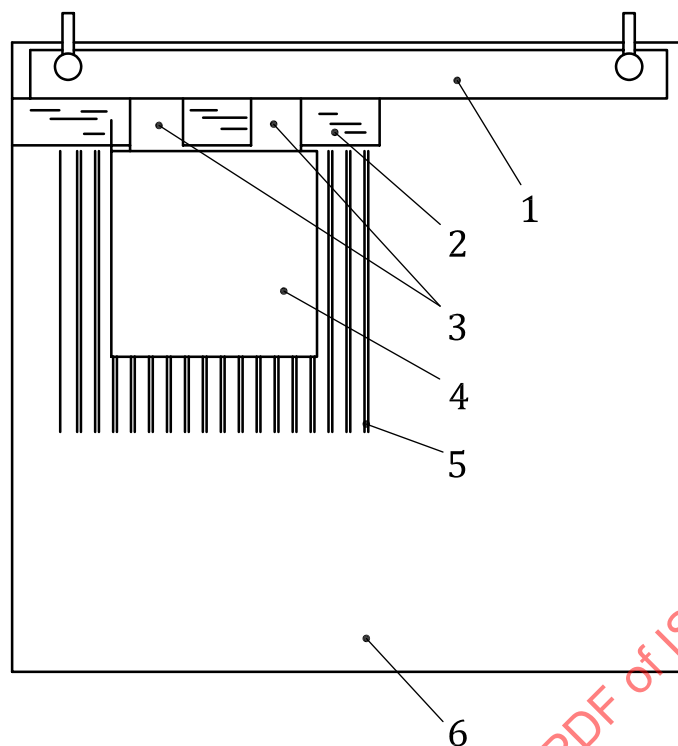
### Figure 2 — Mixing bowl



**Key**

- 1 pull head plate
- 2 tile
- 3 adhesive
- 4 substrate (concrete slab)

**Figure 3 — Failure pattern**

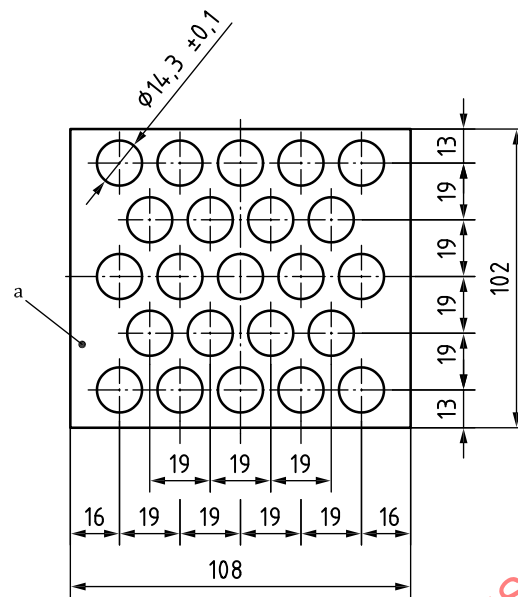


**Key**

- 1 steel straight edge
- 2 masking tape 25 mm wide
- 3 (25 × 25 × 10) mm thick spacer of spacing bars
- 4 tile: (100 × 100) mm
- 5 adhesive
- 6 concrete substrate

**Figure 4 — Slip apparatus**

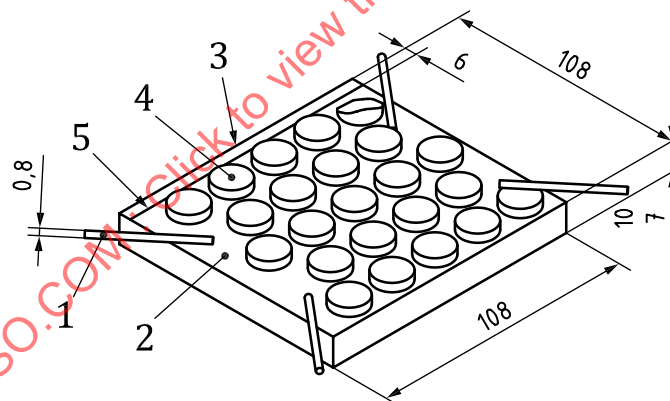
Dimensions in millimetres



NOTE Material PTFE or similar material with non-stick properties; hole diameter:  $(14,3 \pm 0,1)$  mm; actual coverage:  $(50 \pm 5)$  %; thickness:  $(1,5 \pm 0,1)$  mm.

**Figure 5 — Template for testing dispersion (D) adhesives**

Dimensions in millimetres

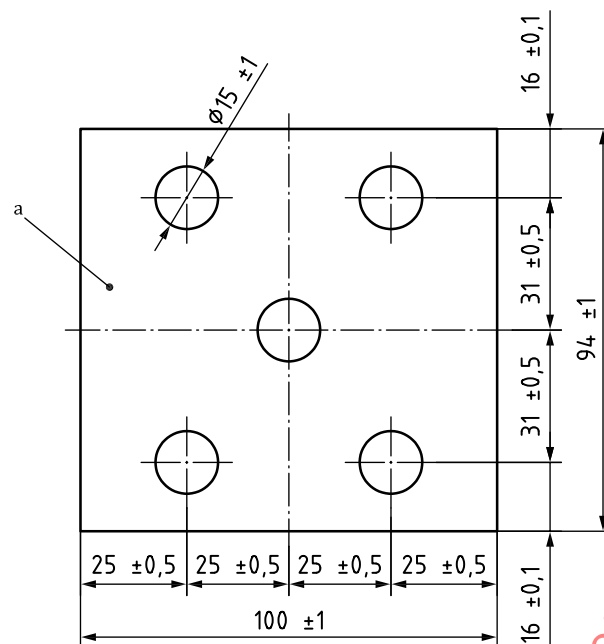


**Key**

- 1 spacer rods 0,8 mm diameter and 40 mm long, to be positioned as indicated
- 2 ceramic test tile 108 mm × 108 mm
- 3 direction of application of load
- 4 adhesive
- 5 pencil guide line

**Figure 6 — Preparation of tile test unit (D)**

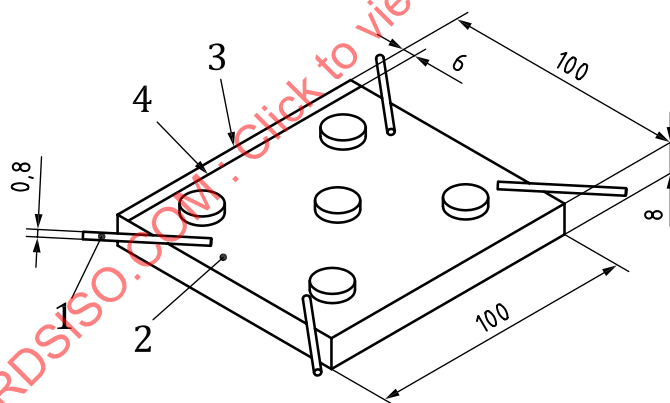
Dimensions in millimetres



NOTE Material PTFE or similar material with non-stick properties; hole diameter:  $(15 \pm 0,1)$  mm; actual coverage: 1 660 mm<sup>2</sup>; thickness:  $(1,5 \pm 0,1)$  mm.

Figure 7 — Template for testing reaction resin (R) adhesive

Dimensions in millimetres

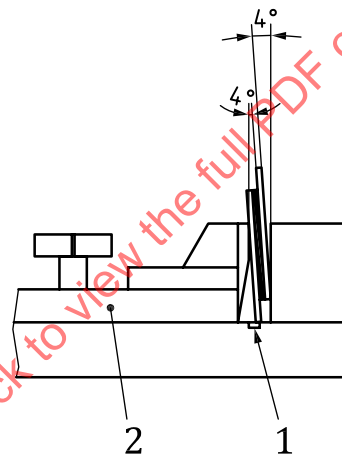
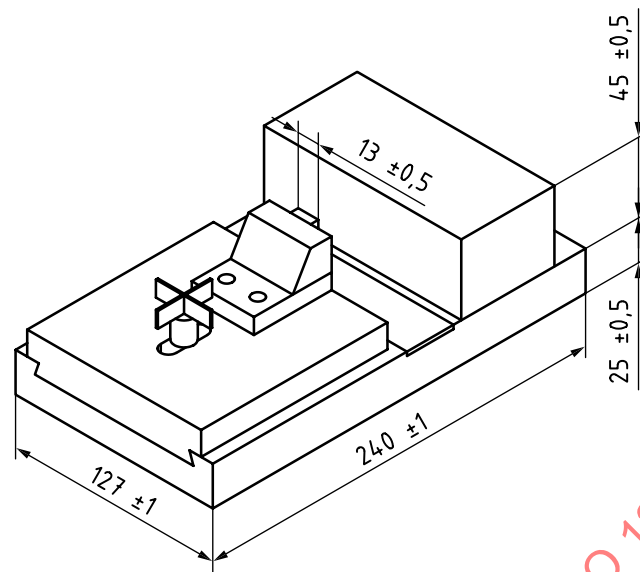


**Key**

- 1 spacer rods
- 2 ceramic test tile
- 3 force direction
- 4 pencil guide line

Figure 8 — Preparation of tile test unit (R)

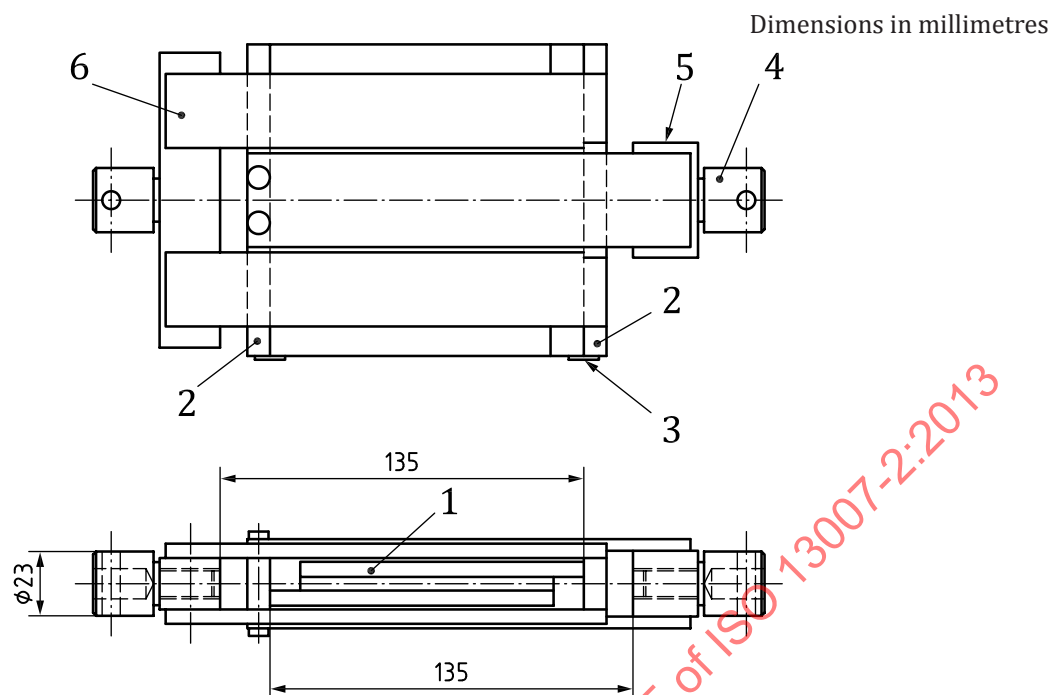
Dimensions in millimetres



**Key**

- 1 hardened insert
- 2 adjustable jaws (from 12 mm to 45 mm)

**Figure 9** — Jig for shear adhesion test using a vertical compression machine



**Key**

- 1 test unit
- 2 pressure plate
- 3 stops
- 4 adapter
- 5 "U" section frame
- 6 box section frame

**Figure 10 — Jig for shear adhesion test using a tensile machine**



Dimensions in millimetres

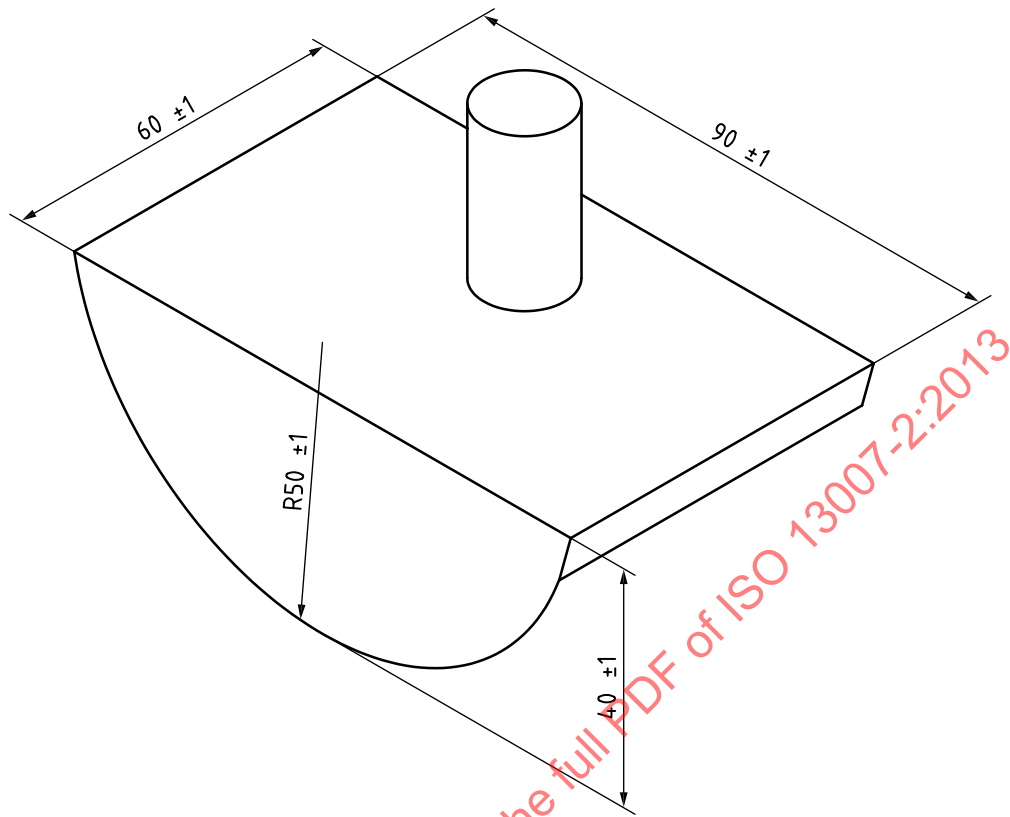
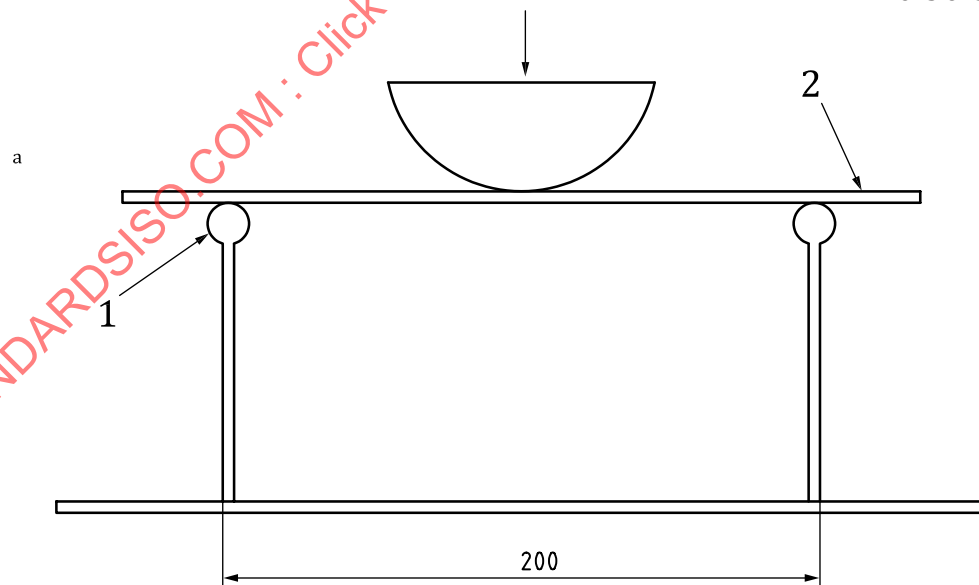


Figure 11 — Anvil

Dimensions in millimetres



**Key**

- 1 cylindrical support, diameter  $(10 \pm 0,1)$  mm, length 60 mm minimum
- 2 adhesive  $(3 \pm 0,1)$  mm thick
- a Horizontal plane.

Figure 12 — Test jig