BS EN 12004-2:2017

BSI Standards Publication

Adhesives for ceramic tiles

Part 2: Test methods

National foreword

This British Standard is the UK implementation of EN 12004-2:2017. It supersedes BS EN 1308:2007, BS EN 1323:2007, BS EN 1324:2007, BS EN 1346:2007, BS EN 1348:2007, BS EN 12003:2008 and BS EN 12002:2008 which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/539, Ceramic tiles and other rigid tiling.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2017

ISBN 978 0 580 88363 7

ICS 83.180; 91.100.10; 91.100.30

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 28 February 2017.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12004-2

February 2017

ICS 83.180; 91.100.10; 91.100.30

Supersedes EN 12002:2008, EN 12003:2008, EN 1308:2007, EN 1323:2007, EN 1324:2007, EN 1346:2007, EN 1348:2007

English Version

Adhesives for ceramic tiles - Part 2: Test methods

Colles à carrelage - Partie 2 : Méthodes d'essai

Mörtel und Klebstoffe für Fliesen und Platten - Teil 2: Prüfverfahren

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European foreword

This document (EN 12004-2:2017) has been prepared by Technical Committee CEN/TC 67 “Ceramic tiles”, the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2017, and conflicting national standards shall be withdrawn at the latest by August 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1308:2007, EN 1323:2007, EN 1324:2007, EN 1346:2007, EN 1348:2007, EN 12002:2008, EN 12003:2008.

EN 12004, Adhesives for tiles, is composed with the following parts:

— Part 1: Requirements, evaluation of conformity, classification and designation;

— Part 2: Test methods.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the methods for determining characteristics for adhesives used in internal and external installation of ceramic tiles.

This European Standard does not contain performance requirements or recommendations for the design and installation of ceramic tiles.

The following test methods are described:

— determination of open time (8.1);

— determination of slip (8.2);

— determination of tensile adhesion strength for cementitious adhesives (8.3);

— determination of shear adhesion strength of dispersion adhesives (8.4);

— determination of shear adhesion strength of reaction resin adhesives (8.5);

— determination of transverse deformation of cementitious adhesives (8.6).

NOTE Ceramic tile adhesives can be used also for other kinds of tiles (natural and agglomerated stones, etc.), if they do not adversely affect the stones.

WARNING — This European Standard can involve hazardous materials and operations. Persons using this standard should be familiar with normal laboratory practice. This European Standard does not purport to address all the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any European and national regulatory conditions.

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.

EN 196-1:2016, *Methods of testing cement — Part 1: Determination of strength*

EN 459-2, *Building lime - Part 2: Test methods*

EN 1067, *Adhesives - Examination and preparation of samples for testing*

EN 12004-1, *Adhesives for ceramic tiles - Part 1: Requirements, assessment and verification of constancy of performance, classification and marking*

EN 14411, *Ceramic tiles - Definition, classification, characteristics, assessment and verification of constancy of performance and marking*

EN ISO 15605, *Adhesives - Sampling (ISO 15605)*

3 Sampling

Take at least 2 kg sample of the adhesive in accordance with EN ISO 15605 and EN 1067.

4 Test conditions

Standard conditions shall be (23 ± 2) °C and (50 ± 5) % relative humidity and the speed of air in the testing area less than 0,2 m/s.

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
6 h	±15 min
7 d	±3 h
14 d	±6 h
21 d	±9 h
28 d	±12 h

Testing shall be performed within the specified time window.

5 Test materials

5.1 General

Condition all test materials for at least 24 h under standard conditions.

The adhesive to be tested shall be within its shelf life, where this is specified.

5.2 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 8.

5.3 Test substrate

5.3.1 Concrete slab

The concrete slab shall be at least 35 mm thick, have a moisture content of less than 3 % by mass (carbide method) and have a water absorption at the surface after 4 h in the range of 0,5 cm^3 to 1,5 cm^3.

The tensile adhesion strength shall be at least 1,5 N/mm^2.

The test surface shall have a finish similar to that obtained by using a wooden float and be clean and dust-free at the time of the test.

A method for manufacturing a suitable concrete test slab and the procedures for measuring the performances are given in Annex A.

5.3.2 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 (8.1). When the result of > 0,5 N/mm^2 is achieved or cohesive failure occurs in the substrate, the requirement is considered satisfied.

6 Mixing of the adhesive

The amount of water and/or liquid admix required for preparing the cementitious adhesive shall be as stated by the manufacturer in parts by mass, 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 adhesive in a mixer of the type described in EN 196-1:2016, 4.4, using the slow speed settings (140 ± 5) rotations per min and (62 ± 5) revolution 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.

Let the adhesive mature as specified in the manufacturer's instructions, and then mix for a further 15 s.

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

7 Test report

The test report shall provide the following information:

a) the number and year of issue of this European Standard, i.e. EN 12004-2, and date of issue;

b) the place, date and time of sampling;

c) type of adhesive, commercial designation and manufacturer;

d) identification of test sample;

e) handling and storage of samples before testing;

f) test conditions;

g) date of test;

h) amount of water or liquid used for preparing the adhesive (for cementitious adhesives);

i) any other factor that could have influenced the result;

j) test results (individual and mean values and mode of failure where required):

   1) open time;

   2) slip;

3) tensile adhesion strength;

4) shear adhesion strength;

5) transverse deformation.

8 Test methods

8.1 Determination of open time

8.1.1 Test materials

8.1.1.1 Ceramic tiles

The tiles used for this method shall be glazed porous body tile complying with EN 14411, group BIII, of water absorption (15 ± 3) % by mass, with a thickness in the range 7 mm to 10 mm and a profile back pattern less than 0,25 mm deep, cut to facial dimensions of (50 ± 1) mm x (50 ± 1) mm.

8.1.1.2 Test substrate

The concrete slab shall comply with the requirements given in 5.3.1.

8.1.2 Apparatus

8.1.2.1 Notched trowel.

A notched trowel having 6 mm x 6 mm notches at 12 mm centres.

8.1.2.2 Weight (Mass).

A mass capable of exerting a force of (20 ± 0,05) N, with a cross-sectional area of less than 50 mm x 50 mm.

8.1.2.3 Pull-head plates.

Square metallic plates, with dimensions of (50 ± 1) mm x (50 ± 1) mm and a minimum thickness of 10 mm with a suitable fitting for connection to the test machine.

8.1.2.4 Test machine.

A test machine for direct pull tensile force test and with suitable capacity and sensitivity for the test. The machine shall be capable of applying the load to the pull-head plate at the rate of (250 ± 50) N/s through a suitable fitting that does not exert any bending force.

8.1.3 Procedure

Apply a thin layer of the adhesive, mixed in accordance with Clause 6, to the concrete slab with a straight edge trowel. Then apply a thicker layer and comb with the notched trowel (8.1.2.1).

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 drawn across the slab parallel to that edge (in a straight line).

After 5 min, 10 min, 20 min and 30 min place at least 10 test tiles (8.1.1.1) 50 mm apart, on the adhesive within 30 s. The tiles are placed on no more than four ribs for all adhesives. Load each tile with (20 ± 0,05) N for 30 s (8.1.2.2).

After 27 d storage under standard conditions, bond the pull-head plates (8.1.2.3) to the tiles with a suitable high strength adhesive (e.g. epoxide 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 ± 50) N/s.

8.1.4 Evaluation and expression of results

The individual tensile adhesion strengths are quoted to the nearest 0,1 N/mm² using the following formula:

$$A_S = L/A \quad (1)$$

where

A_S is the individual tensile adhesion strength in Newton per square millimetre;

L is the total tensile load in Newton;

A is the bonding area in square millimetre (2 500 mm²).

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

— determine the mean of the 10 values;

— discard the values falling outside the range of ± 20 % of the mean value;

— if five or more values remain, determine the new mean;

— if less than five values remain repeat the test;

— determine the mode of failure of the test units according to Annex B as the predominant mode.

The open time in minutes, is the maximum time interval at which the adhesive meets the tensile adhesion strength requirement defined in EN 12004-1.

8.1.5 Test report

The information listed in Clause 7, items a) to i) shall be provided plus item j) 1: open time in minutes.

8.2 Determination of slip

8.2.1 Test materials

8.2.1.1 Ceramic tiles

The tiles used for this method shall be dry pressed ceramic tile in accordance with EN 14411, group BI_a, with a water absorption ≤ 0,5 % by mass, unglazed, with plane adhering surface and with facial dimensions of (100 ± 1) mm x (100 ± 1) mm, a mass of (200 ± 10) g and a thickness in the range of 8 mm to 10 mm.

8.2.1.2 Test substrate

The concrete slab shall comply with the requirements given in 5.3.1.

8.2.2 Apparatus

8.2.2.1 Steel straight edge.

8.2.2.2 Clamps.

8.2.2.3 Masking tape.

A 25 mm wide masking tape.

8.2.2.4 Notched trowel.

A notched trowel having 6 mm x 6 mm notches at 12 mm centres.

8.2.2.5 Spacers.

Two (25 ± 0,5) mm x (25 ± 0,5) mm x (10 ± 0,5) mm thick spacers made from stainless steel.

8.2.2.6 Weight (Mass).

A mass capable of exerting a force of (50 ± 0,1) N with a cross-sectional area of less than (100 ± 1) mm x (100 ± 1) mm.

8.2.2.7 Vernier caliper.

A Vernier caliper accurate to 0,01 mm.

8.2.3 Procedure

Secure the steel straight edge (8.2.2.1), with the clamps (8.2.2.2), at the top of the concrete slab so that its bottom edge is horizontal when the slab is raised to its vertical position.

Position 25 mm wide masking tape (8.2.2.3) immediately below the steel straight edge and apply a thin layer of the adhesive mixed in accordance with Clause 6 to the concrete slab with a straight edge trowel.

Then apply a thicker layer of adhesive to the surface of the concrete slab so that it just overlaps the bottom edge of the masking tape. Comb the adhesive at right angles to the straight-edge with the notched trowel (8.2.2.4).

The trowel shall be held at an angle of approximately 60° to the substrate and parallel to the straight edge.

Immediately remove the masking tape, position 25 mm spacers (8.2.2.5) against the straight edge and after two minutes place the tile (8.2.1.1) against the spacers, as shown in Figure 1, and load with the mass of (50 ± 0,1) N (8.2.2.6).

Measure the gap between the straight edge and the tile, in three points, with the Vernier caliper (8.2.2.7) to within ± 0,1 mm.

After (30 ± 5) s remove the weight and the spacers and immediately and carefully lift the slab into a vertical position. After (20 ± 2) min re-measure the gap, as before, in the same three points.

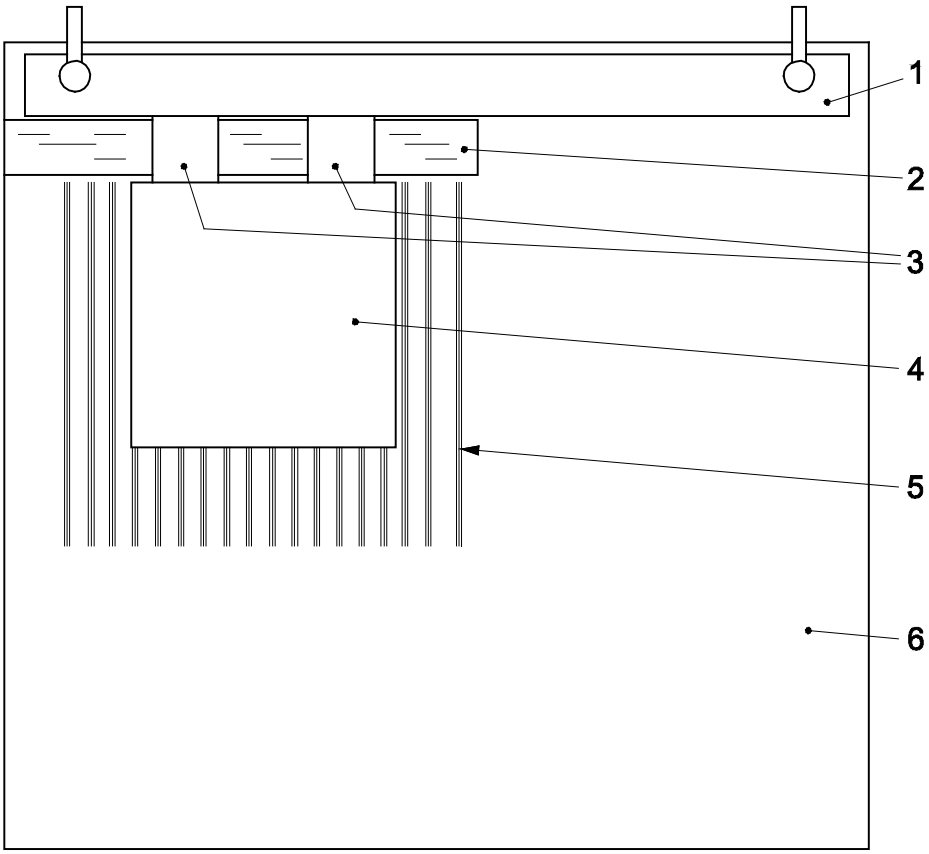
The maximum slip of the tile under its own mass is the difference between the two readings.

Carry out the test for each of 3 tiles, for each adhesive.

Report the results in millimetres and the mean value.

8.2.4 Test report

The information listed in Clause 7, items a) to i) shall be provided plus item j) 2: Slip in millimetre (individual and mean values).



Key

1 steel straight edge
2 masking tape 25 mm wide
3 25 mm x 25 mm x 10 mm thick spacers
4 tile: 100 mm x 100 mm
5 adhesive
6 concrete slab

Figure 1 — Slip test

8.3 Determination of tensile adhesion strength for cementitious adhesives (C)

8.3.1 Test materials

8.3.1.1 Ceramic tiles

The tiles used for this test shall be dry pressed ceramic tile in accordance with EN 14411, Group BI_a, fully vitrified, with a water absorption of ≤ 0,5 % by mass, unglazed and with a plain, matt, adhering surface, with facial dimensions of (50 ± 1) mm x (50 ± 1) mm.

8.3.1.2 Test substrate

The concrete test substrate shall conform to requirements given in 5.3.1.

8.3.2 Apparatus

8.3.2.1 Weight (Mass).

A mass capable of exerting a force of (20 ± 0,05) N, with a cross sectional area of less than 50 mm x 50 mm.

8.3.2.2 Pull head plate.

Square metallic plates, with dimensions of (50 ± 1) mm x (50 ± 1) mm and a minimum thickness of 10 mm with a suitable fitting for connection to the test machine.

8.3.2.3 Tensile testing apparatus.

A test machine for direct pull tensile force test and with suitable capacity and sensitivity for the test. The machine shall be capable of applying the load to the pull-head plate at the rate of (250 ± 50) N/s through a suitable fitting that does not exert any bending force.

8.3.2.4 Air circulating oven.

An air-circulating oven capable of controlling the temperature to within ± 3 °C.

8.3.2.5 Notched trowel.

A notched trowel having 6 mm x 6 mm notches at 12 mm centres.

8.3.3 Procedure

8.3.3.1 Preparation of test units

Apply a thin layer of the adhesive, mixed in accordance with Clause 6, to the concrete slab with a straight edge trowel. Then apply a thicker layer and comb with a notched trowel (8.3.2.5).

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 drawn across the slab parallel to that edge (in a straight line).

After 5 min place 10 tiles (8.3.1.1) on the adhesive at a distance apart of 50 mm and load each tile with (20 ± 0,05) N for 30 s.

8.3.3.2 Initial tensile adhesion strength

Prepare the test units in accordance with 8.3.3.1.

After 27 d storage under standard conditions bond the pull-head plates (8.3.2.2) to the tiles with a suitable high strength adhesive (e.g. epoxide).

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 ± 50) N/s.

If fast-setting properties of adhesives are to be tested, determine the tensile adhesion strength after six hours under standard conditions; the pull head plates shall be bonded a minimum of two hours before determining the tensile adhesion strength.

Report the results in Newton.

8.3.3.3 Tensile adhesion strength after water immersion

Prepare the test units in accordance with 8.3.3.1.

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

After 20 d remove the test units from the water, wipe with a cloth and bond the pull-head plates (8.3.2.2) to the tiles. After a further 7 h in standard conditions immerse the test units in water at the standard temperature.

The following day remove the test units from water and immediately carry out the tensile adhesion test in accordance with 8.3.3.2.

Report the results in Newton.

8.3.3.4 Tensile adhesion strength after heat ageing

Prepare the test units in accordance with 8.3.3.1.

Condition the test units under standard conditions for 14 d and then place the units in an air-circulating oven at (70 ± 3) °C for a further 14 d. Remove from the oven and bond the pull-head plates (8.3.2.2) to the tiles with a suitable high strength adhesive (e.g. epoxide).

Condition the test units for a further 24 h under standard conditions. Determine the tensile adhesion strength in accordance with 8.3.3.2.

Report the results in Newton.

8.3.3.5 Tension adhesion strength after freeze–thaw cycle

Prepare the test units in accordance with 8.3.3.1. In addition a layer of the adhesive approximately 1 mm thick shall be applied with a straight edged trowel to the back face of the tile (8.3.1.1) 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.

For each freeze–thaw cycle:

1) remove the test units from the water and place in a cold chamber to achieve a steady cabinet temperature of (−15 ± 3) °C within 2 h ± 20 min;

2) maintain the test units at (−15 ± 3) °C for 2 h ± 20 min;

3) immerse the test units in water at (20 ± 3) °C and raise the temperature to (15 ± 3) °C;

4) maintain the test units at (15 ± 3) °C for a minimum 2 h before commencing the next freeze–thaw cycle.

Repeat the cycle 25 times.

After the last cycle remove the test units from water, wipe with a cloth and bond the pull-head plates (8.3.2.2) to the tiles. Condition the test units for a further 24 h under standard conditions and determine the tensile adhesion strength in accordance with 8.3.3.2.

Report the results in Newton.

8.3.4 Evaluation and expression of results

The individual tensile adhesion strength shall be determined to an accuracy of 0,1 N/mm^2 using the following formula:

$$A_S = L/A \quad (2)$$

where

A_S is the individual tensile adhesion strength in Newton per square millimetre;

L is the total load in Newton;

A is the bonding area in square millimetre (2 500 mm^2).

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

— determine the mean of the 10 values;

— discard the values falling outside the range of ± 20 % from the mean value;

— if five or more than five values remain, determine the new mean value;

— if less than five values remain, repeat the test;

— determine the mode of failure of the test units according to Annex B as the predominant mode.

8.3.5 Test report

The information listed in Clause 7, items a) to i) shall be provided plus item j) 3): Tensile adhesion strength for each condition in Newton per square millimetre.

8.4 Determination of shear adhesion strength of dispersion adhesives (D)

8.4.1 Test materials

8.4.1.1 Ceramic tiles.

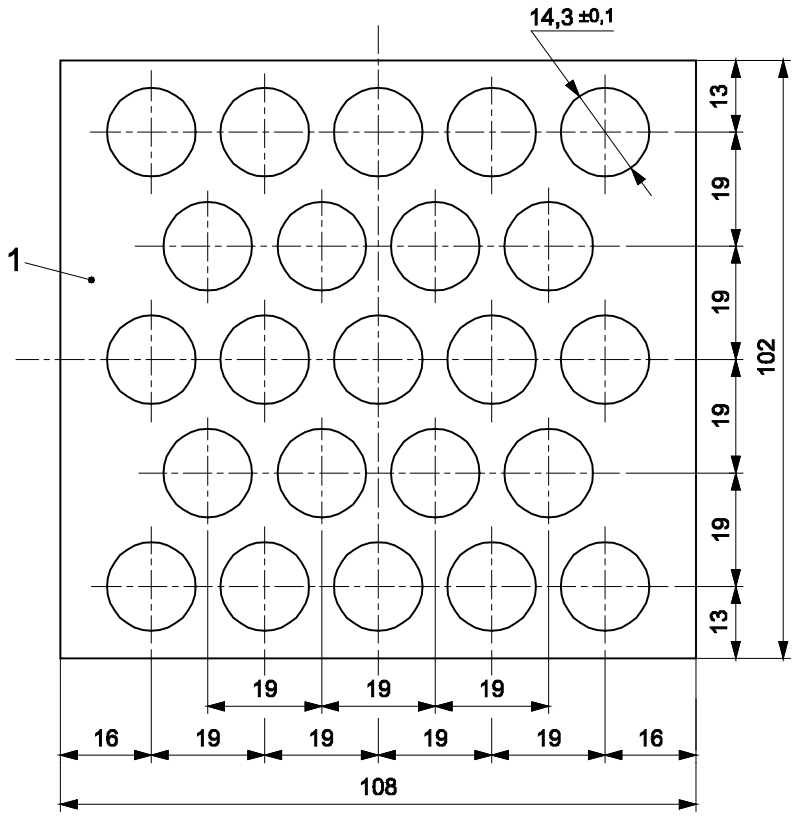
The tiles used for this method shall be glazed porous body tiles in accordance with EN 14411, group BIII, with a water absorption (15 ± 3) % by mass, with facial dimensions of (108 ± 1) mm x (108 ± 1) mm, a thickness in the range 7 mm to 10 mm and a profile back pattern less than 0,25 mm thick.

8.4.2 Apparatus

8.4.2.1 Template.

A smooth non absorbent frame (e.g. polytetrafluoroethylene) as shown in Figure 2.

Dimensions in millimetres



Key

1 material: PTFE or similar material with non-stick properties; hole diameter: (14,3 ± 0,1) mm; thickness: (1,5 ± 0,1) mm; conventional contact area: 5 508 mm^2

Figure 2 — Template (Dispersion adhesives)

8.4.2.2 Spacers.

Spacer rods 0,8 mm diameter, approximately 40 mm long.

8.4.2.3 Weight (Mass).

A mass of less than 100 mm x 100 mm cross sectional area capable of exerting a uniform force of (70 ± 0,15) N.

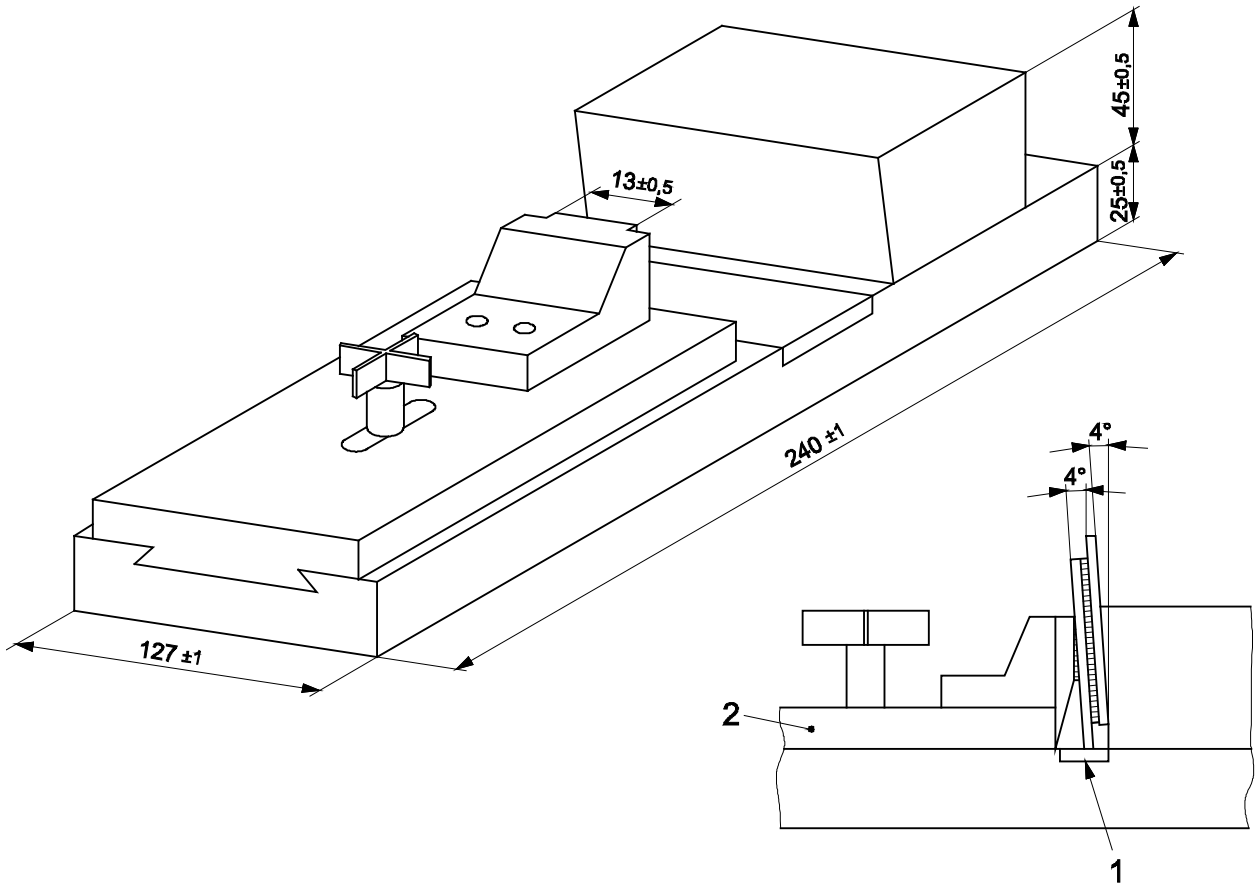
8.4.2.4 Test machine.

A 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 (8.4.2.5).

8.4.2.5 Shear test jig.

A suitable jig used for converting the compressive or tensile load exerted by the testing machine into a shear force. Examples of suitable jigs are shown in Figures 3 and 4.

Dimensions in millimetres



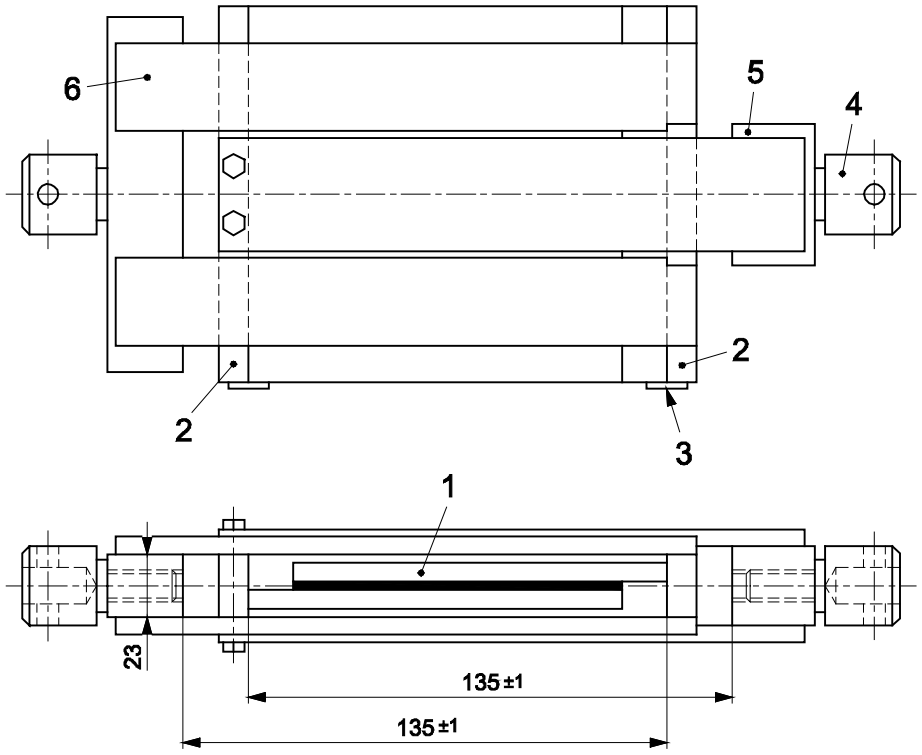
Key

1 hardened insert

2 adjustable jaws from 12 mm to 45 mm

Figure 3 — Jig for shear adhesion test using a compression machine

Dimensions in millimetres



Key

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

Figure 4 — Jig for shear adhesion test using a tensile machine

8.4.2.6 Air circulating oven.

An air circulating oven capable of controlling the temperature to within ± 3 °C.

8.4.3 Procedure

8.4.3.1 Preparation of test units

Each test unit shall be prepared with two tiles (8.4.1.1).

Draw a straight line on the porous side of one tile 6 mm from the tile edge. (To serve as a guide in overlapping of the tile as explained below.)

Place the template (Figure 2) 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.

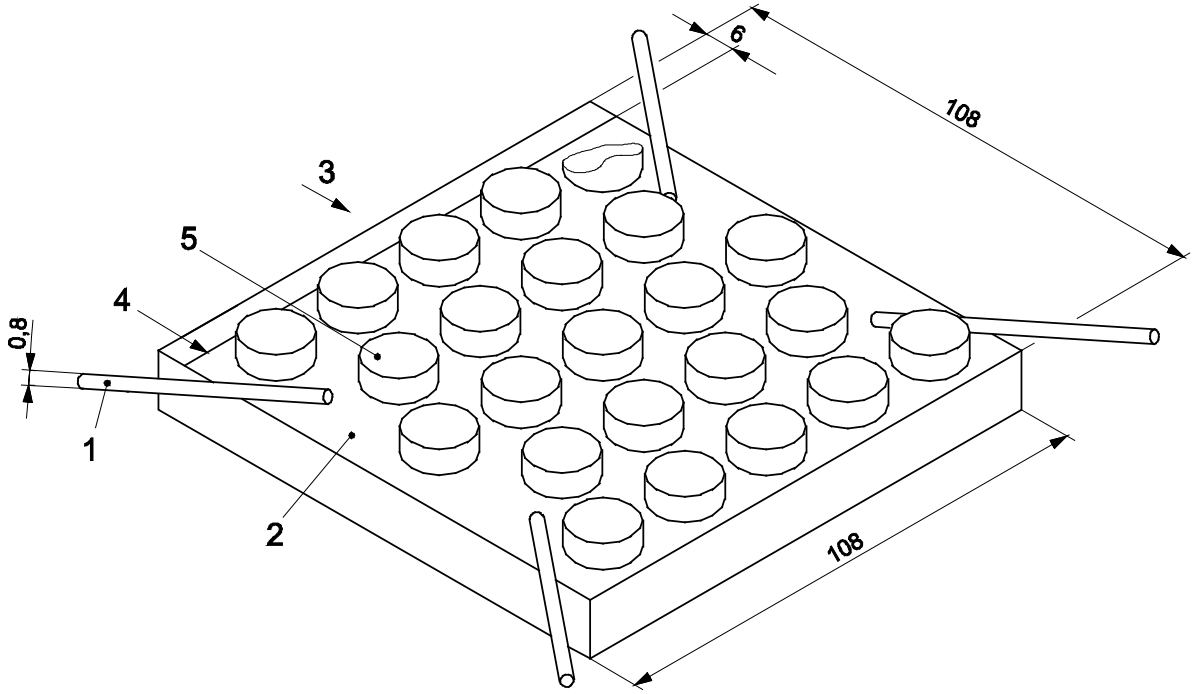
Carefully remove the template vertically (see Figure 5).

Place spacers rods (8.4.2.2) 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. Place it offset to provide an overlap between tiles with displacement of 6 mm, using the previously scribed line as a guide and ensuring that the edges of the tiles are parallel (Figure 5).

Place the test units on a plane surface and carefully load with (70 ± 0,15) N for 3 min. Carefully remove the spacer rods, without disturbing the relative position of the tiles in the test units.

Dimensions in millimetres



Key

1 spacer rods
2 ceramic test tile 108 mm x 108 mm
3 direction of application of load
4 guide line
5 adhesive

Figure 5 — Preparation of tile test unit (Dispersion adhesives)

A total of 10 test units are required for each test.

Condition the units according to the test requirements.

8.4.3.2 Initial shear adhesion strength

Condition 10 test units in standard test conditions for 14 d.

After conditioning has been completed, place the test units in a shear test jig (8.4.2.5) and apply a shear force by moving the crosshead at a speed of (5 ± 0,5) mm/min until failure occurs.

Report the results in Newton.

8.4.3.3 Adhesion strength after water immersion

Condition 10 test units in standard test conditions for 7 d, then immerse in water at standard temperature for 7 d. Remove the units and wipe with a cloth and test them as described in 8.4.3.2.

Report the results in Newton.

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

8.4.3.4 Shear adhesion strength after heat ageing

Condition 10 test units in standard conditions for 14 d and then place them in an air-circulating oven at (70 ± 3) °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 in standard conditions and test them as described in 8.4.3.2.

Report the results in Newton.

8.4.3.5 Shear adhesion strength at elevated temperature

Use the procedure described in 8.4.3.4 but test the tile adhesion within 1 min after removal of the test unit from the air circulating oven.

Report the results in Newton.

8.4.4 Evaluation and expression of results

Divide the individual values in Newton by the conventional area (5 508 mm^2) of adhesive contact. The individual values are quoted to 0,1 N/mm^2.

The shear adhesion strength is determined in the following way:

— determine the mean of 10 values;

— discard the values falling outside the range of ± 20 % from the mean value;

— if five or more values remain, determine the new mean value;

— if less than five values remain, repeat the test.

8.4.5 Test report

The information listed in Clause 7, items a) to i) shall be provided plus item j) 4: Shear adhesion strength for each condition in Newton per square millimetre.

8.5 Determination of shear adhesion strength of reaction resin adhesives (R)

8.5.1 Test materials

8.5.1.1 Ceramic tiles

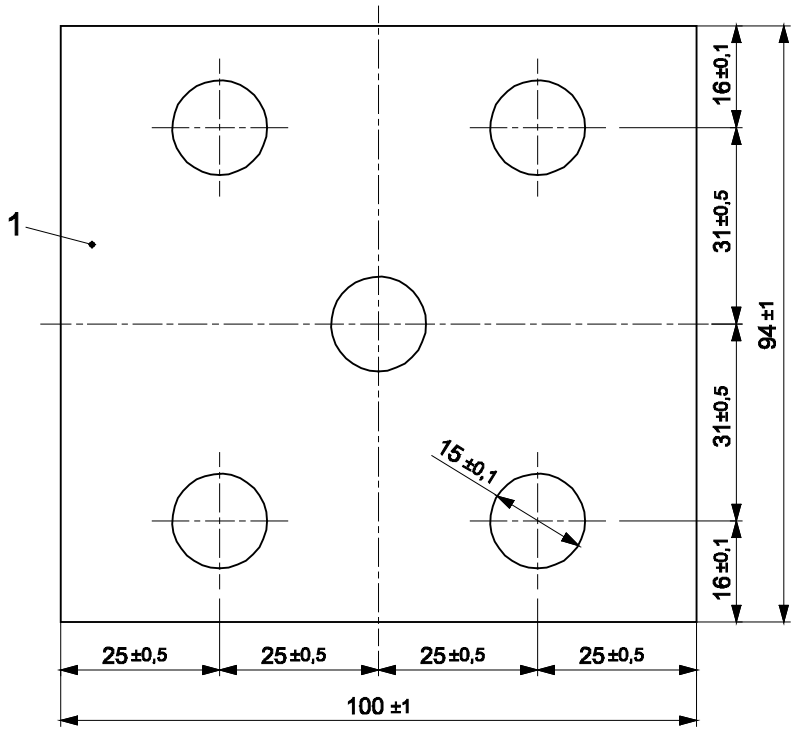
The tiles used for this method shall be fully vitrified tiles in accordance with EN 14411, group BI_a, with a water absorption ≤ 0,5 % by mass, unglazed and with plane adhering surface with facial dimensions of (100 ± 1) mm × (100 ± 1) mm and a thickness in the range 8 mm to 10 mm.

8.5.2 Apparatus

8.5.2.1 Template.

A smooth non-absorbent frame (e.g. polytetrafluoroethylene) in accordance with Figure 6.

Dimensions in millimetres



Key

1 material: PTFE or similar material with non-stick properties; hole diameter: (15,0 ± 0,1) mm; thickness: (1,5 ± 0,1) mm; conventional contact area: 1 660 mm^2

Figure 6 — Template for the preparation of tile test unit

8.5.2.2 Spacers.

Spacer rods 0,8 mm diameter, approximately 40 mm long.

8.5.2.3 Weight (Mass).

A mass of less than 100 mm x 100 mm cross sectional area capable of exerting a uniform force of (70 ± 0,15) N.

8.5.2.4 Test machine.

A 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 (8.5.2.5).

8.5.2.5 Shear test jig.

A suitable jig used for converting the compressive or tensile load exerted by the testing machine into a shear force. Examples of suitable jigs are shown in Figures 3 and 4.

8.5.2.6 Air circulating oven.

An air circulating oven capable of controlling the temperature to within ± 3 °C.

8.5.3 Procedure

8.5.3.1 Preparation of test units

Each test unit shall be prepared with two tiles (8.5.1.1).

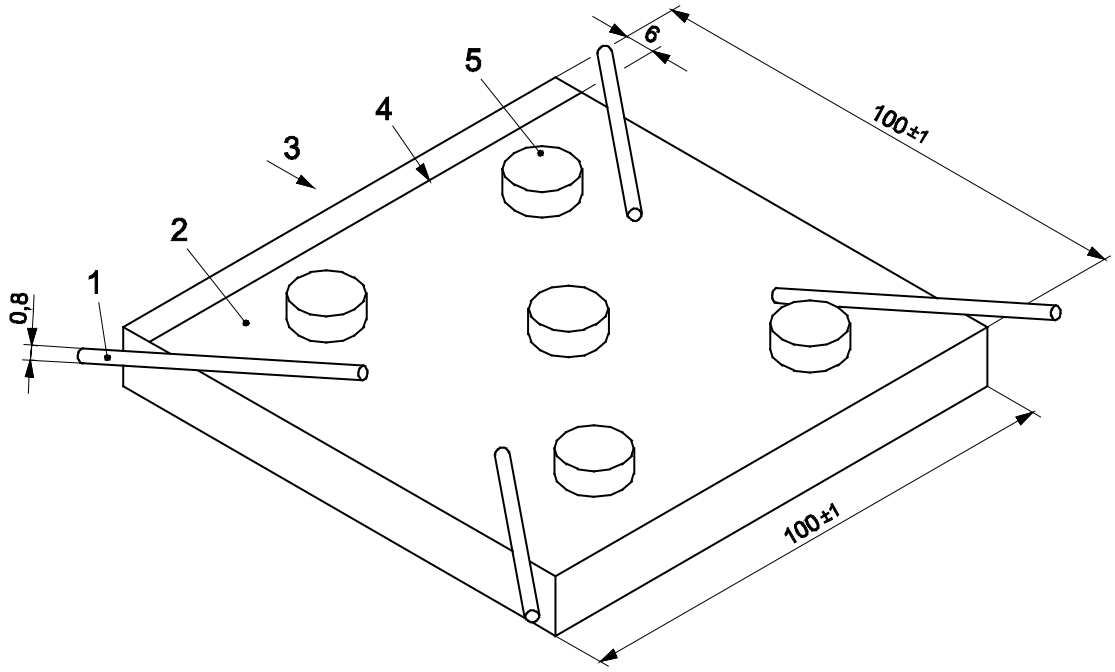
Draw a straight line on the porous side of one tile 6 mm from the tile edge. (To serve as a guide in overlapping of the tile as explained below.)

Place the template (Figure 6) 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 Figure 7).

Place spacers rods (8.5.2.2) at each corner of the first tile, approximately 20 mm over the tile.

Dimensions in millimetres



Key

1 spacer rods
2 ceramic test tile 100 mm x 100 mm
3 direction of application of load
4 guide line
5 adhesive

Figure 7 — Preparation of tile test unit

After 2 min place a second standard test tile over the coated tile. Place it offset to provide an overlap between tiles with displacement of 6 mm, using the previously scribed line as a guide and ensuring that the edges of the tiles are parallel (Figure 7).

Place the test units on a plane surface and carefully load with (70 ± 0,15) N for 3 min. Carefully remove the spacer rods, without disturbing the relative position of the tiles in the test units.

A total of 10 test units are required for each test.

Condition the test pieces in the standard test conditions for 7 d and then according to the test requirements.

8.5.3.2 Initial shear adhesion strength

Place the test pieces in the shear test jig (8.5.2.5) and apply a shear force by moving the crosshead at a speed of (5 ± 0,5) mm/min until failure occurs.

Report the results in Newton.

8.5.3.3 Shear adhesion strength after water immersion

Immerse the 10 test pieces in water at (23 ± 2) °C for 21 d. Remove the test pieces, wipe with a cloth and test them as described in 8.5.3.2.

Report the results in Newton.

8.5.3.4 Shear adhesion strength after thermal shock

Place the 10 test pieces in a waterbath maintained at (23 ± 2) °C for 30 min and then in a (100 ± 2) °C waterbath for a further 30 min.

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

Remove each test piece from the water, wipe off the excess water and test as described in 8.5.3.2.

Report the result in Newton.

8.5.4 Evaluation and expression of results

Divide the individual values in Newton by the conventional area (1 660 mm^2) of adhesive contact. The individual values are quoted to 0,1 N/mm^2.

The shear adhesion strength is determined in the following way:

— determine the mean of 10 values;

— discard the values falling outside the range of ± 20 % from the mean value;

— if five or more values remain, determine the new mean value;

— if less than five values remain, repeat the test.

8.5.5 Test report

The information listed in Clause 7, items a) to i) shall be provided plus item j) 4: Shear adhesion strength for each condition in Newton per square millimetre.

8.6 Determination of transverse deformation of cementitious adhesives (C)

8.6.1 Principle

The test described in this European Standard measures the transverse deformation of cementitious adhesives when subjected to a 3-point bending load, performed on test specimens of the stated dimension.

NOTE Transverse deformation is used to evaluate the deformability of the adhesive, i.e. its capacity to be deformed by stresses between the tile and the fixing surface without damage to the installed surface.

8.6.2 Test materials

8.6.2.1 Substrate.

A polyethylene film of minimum thickness 0,15 mm.

8.6.2.2 Plastic container.

A plastic container that is capable of being sealed to make it air tight, with an internal volume of (26 ± 5) I, e.g. a container with dimensions (600 ± 20) mm × (400 ± 10) mm × (110 ± 10) mm.

8.6.2.3 Support.

Rigid, smooth and flat support for the polyethylene film.

8.6.3 Apparatus

8.6.3.1 Anvil.

A metallic construction conforming to the dimensions of Figure 8.

8.6.3.2 Test jig.

Two metallic cylindrical supports, of diameter (10 ± 0,1) mm, spaced (200 ± 1) mm centre to centre, of length 60 mm minimum. See Figure 9.

8.6.3.3 Template A.

A smooth, rigid, non absorbent rectangular frame of internal dimensions (280 ± 1) mm × (45 ± 1) mm and thickness (5 ± 0,1) mm; e.g. made from polytetrafluoroethylene (PTFE) or metal.

A round hole of approximately 2 mm diameter drilled at each internal corner is recommended to ease production of the test piece. See Figure 10.

8.6.3.4 Template B.

A smooth, rigid, non-absorbent mould (see Figure 11) or similar device capable of producing a test specimen of dimensions (300 ± 1) mm × (45 ± 1) mm × (3 ± 0,05) mm.

8.6.3.5 Test machine.

The test machine shall be a press, capable of applying the anvil (8.6.3.1) to the test piece at a rate of 2 mm/min.

8.6.3.6 Flow table.

The flow table used for the compaction of (280 ± 1) mm × (45 ± 1) mm × (5 ± 0,1) mm specimen shall comply with EN 459-2.

Dimensions in millimetres

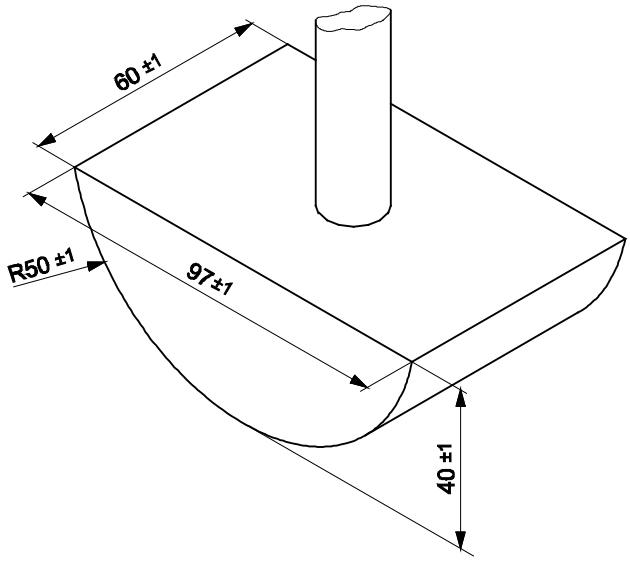
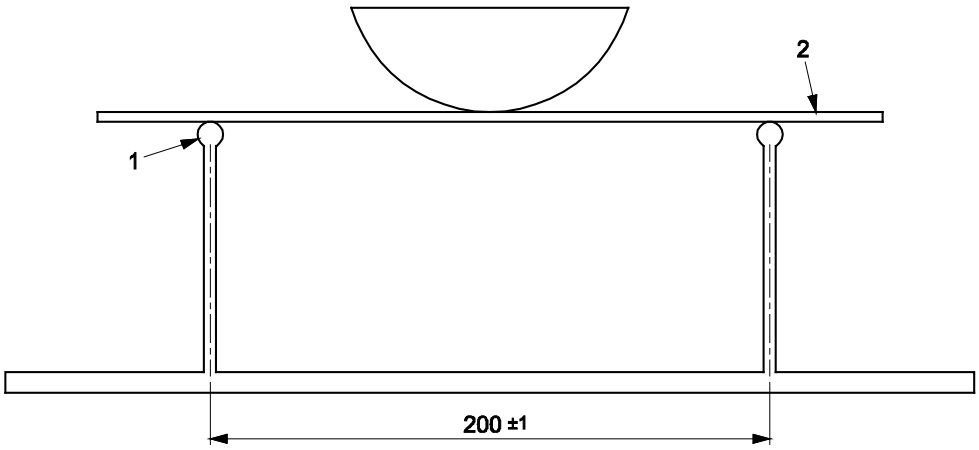


Figure 8 — Anvil

Dimensions in millimetres



Key

1 cylindrical support, diameter (10 ± 0,1) mm, length 60 mm minimum

2 adhesive (3 ± 0,1) mm thick

Figure 9 — Test jig

Dimensions in millimetres

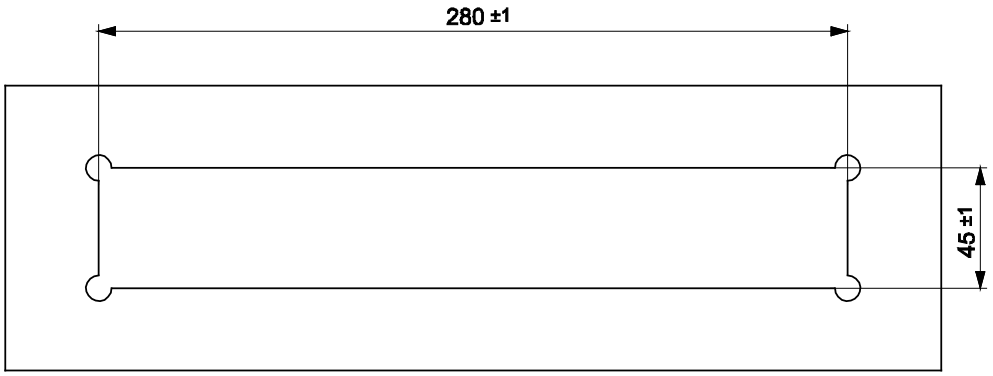


Figure 10 — Template A

Dimensions in millimetres

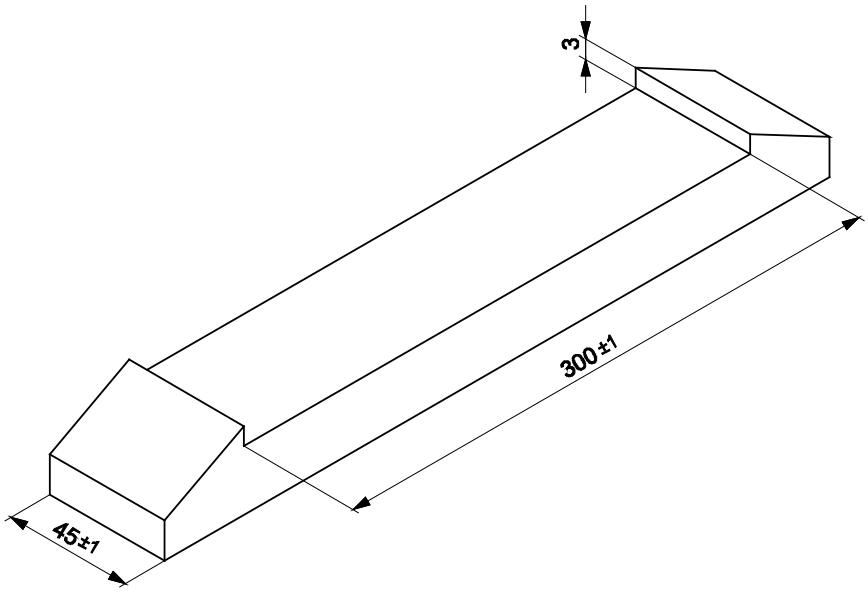


Figure 11 — Template B

8.6.4 Procedure

8.6.4.1 Preparation of substrate

Fix the polyethylene film (8.6.2.1) firmly to the rigid support (8.6.2.3), ensuring the surface, to which the adhesive is to be applied, is not distorted, e.g. without pleats or wrinkles.

8.6.4.2 Preparation of test units

Hold the template A (8.6.3.3) 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 the template B (8.6.3.4) and position it centrally over the specimen. Load the template with a weight capable of exerting a force of (100 ± 0,1) N and an approximate cross-sectional area of (290 × 45) 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 one hour later remove the weight.

After 48 h remove the template B.

Prepare six samples for each test.

Condition the units according to the test requirements.

8.6.4.3 Conditioning

Immediately after the removal of template B place six specimens, on the support, horizontally into the plastic container (8.6.2.2) and make it air tight.

Condition the test units at (23 ± 2) °C. After 12 d remove them from the plastic container and condition them for 14 d in air in standard conditions.

8.6.4.4 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 ± 1) mm from each end. If the three values fall within the required tolerance of (3,0 ± 0,1) 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 8.6.4.2, 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 shall otherwise fully meet the thickness criteria. Unless removed, the burr edges can create variation in test results.

Place the test sample on the test jig (Figure 9). 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 millimetre. When no cracking occurs, report the maximum force and deformation.

Repeat the test on the other test pieces. Test data from specimens with transverse deformation values that deviate by ± 20 % from the calculated average should be excluded. A minimum of 3 remaining test specimens is required.

8.6.4.5 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.

8.6.5 Test report

The information listed in Clause 7, items a) to i) shall be provided plus item j) 5: Transverse deformation in millimetres.

Annex A
(normative)

Concrete slab for test

A.1 General information

A concrete test slab suitable for the adhesive tests described in this standard may be manufactured and tested using these described procedures. Other concrete products meeting the requirements listed in 5.3 may be utilized.

A.2 Test conditions

Test conditions listed in Clause 4 shall apply.

A.3 Apparatus

A.3.1 Pull-head plates.

Square metallic (e.g. steel, aluminium) plates, with dimensions of (50 ± 1) mm x (50 ± 1) mm and a minimum thickness of 10 mm with a suitable fitting for connection to the tensile testing machine.

A.3.2 Tensile testing machine.

The machine shall be capable of applying the load to the pull-head plate at the rate of (250 ± 50) N/s, through a suitable fitting that does not exert any bending force.

A.3.3 Carsten-Röhrchen flask.

Carsten-Röhrchen flask or other suitable apparatus for measuring the water absorption at the surface of the concrete slab (see Figure A.1).

A.4 Concrete slab

A.4.1 Manufacture of the concrete slab

The specification (see 5.3.1) can be achieved by using the following procedure to manufacture the concrete slab:

— binder: Portland cement type CEM I 42,5 R in accordance with EN 197-1;

— aggregate: gravel sand, of 0 mm to 8 mm particle size, continuous grading curve between A and B (see Figure A.2);

— mix ratio binder and aggregate: 1:5 in proportion by mass;

— ultrafines content per cubic meter of ready mixed concrete: 500 kg/m^3 prepared concrete. The concrete shall contain ultrafines in order to be properly workable and have a closed structure; the ultrafines content consists of cement and aggregate particle size up to 0,125 mm;

— water/cement ratio: 0,5 by mass;

— manufacture: vertically or horizontally in moulds, avoid the use of any mould release agent;

— compaction: 90 s on a vibrating table at 50 Hz.

A.4.2 Conditioning of the concrete slab

The slabs shall be stored for 24 h under standard conditions, followed by six days water immersion at (20 ± 2) °C.

Before being tested the concrete slabs shall be stored separately, in vertical position, in a dry and ventilated environment, for at least three months and conditioned for 24 h under standard conditions.

A.4.3 Water absorption at the surface

Water absorption at the surface of the concrete slab shall be determined by the following method:

a) bond a graduated glass measuring tube (Carsten-Röhrchen flask) to the concrete slab by means of a suitable sealant;

b) after the sealant has cured, fill the measuring tube with water, to the upper level;

c) record the water level every 60 min during the 4 h of the test, and draw the absorption as a function of time;

d) perform at least 3 tests on a reference concrete slab from each batch.

A.4.4 Tensile adhesion strength

The tensile adhesion strength shall be determined by bonding at least five pull head plates (A.3.1) directly to the slab, e.g. with an epoxide resin, and determining the tensile adhesion strength by applying a force which increases at a constant rate of (250 ± 50) N/s.

A.4.5 Data recorded

The following items shall be recorded:

a) description of the concrete slab, and reference to the batch;

b) handling and storage of concrete slabs before testing;

c) water absorption of concrete slab, representative of the batch;

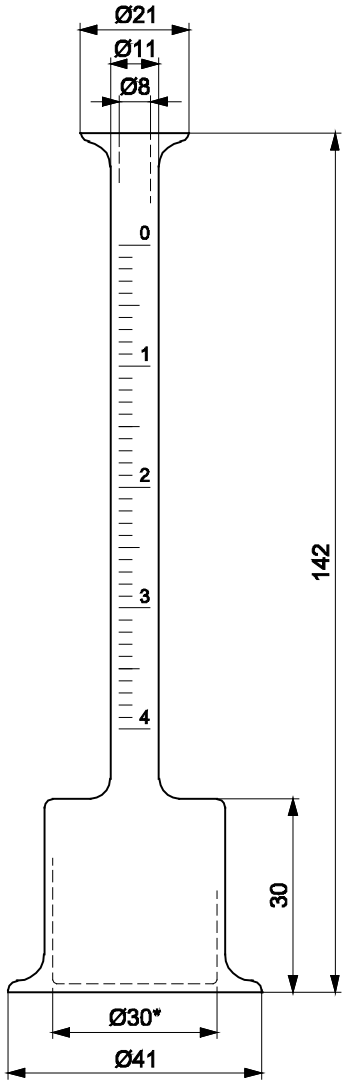
d) moisture content of the concrete slabs, representative of the batch;

e) tensile adhesion strength of concrete slab, representative of the batch;

f) any other factor that might have influenced the result;

g) date of the test.

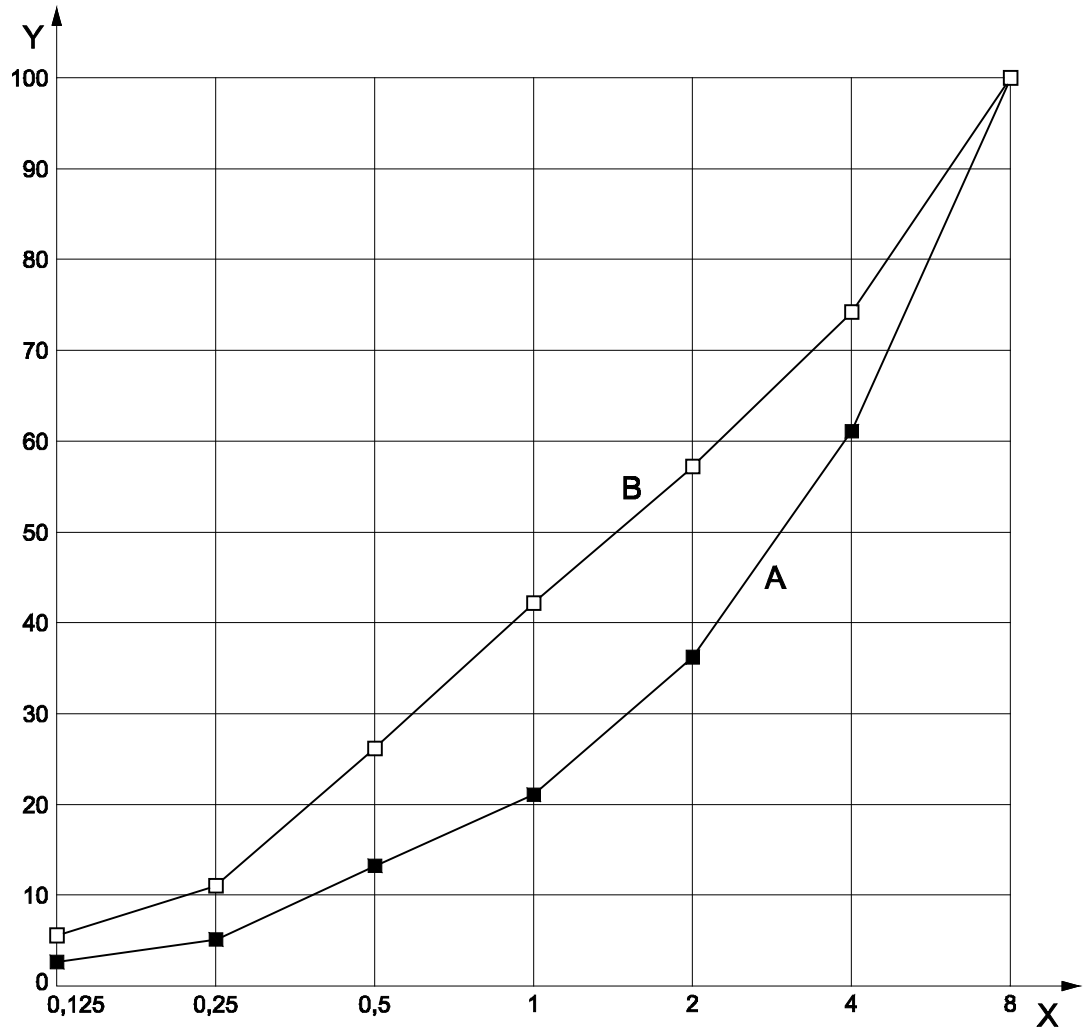
Dimensions in millimetres



Key

* area = 706,5 mm^2

Figure A.1 — Example of apparatus for evaluating water absorption



Key

X nominal opening size in millimetres

Y undersize as a percentage by mass

Figure A.2 — Grading curves for 8 mm maximum particle size

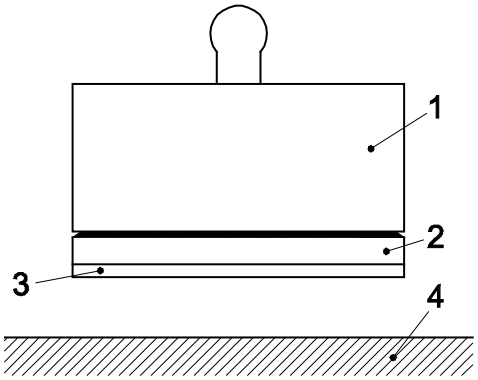
Annex B
(normative)

Failure patterns

B.1 Adhesion failure (AF-S or AF-T)

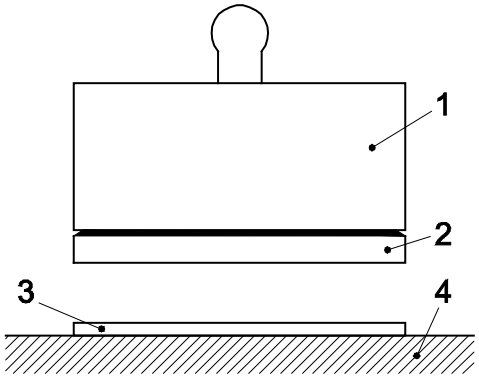
When failure occurs at the interface between adhesive and substrate the notation AF-S is used, when it occurs between tile and adhesive the notation AF-T is used and in both cases the test values equal the adhesion strength (see Figure B.1 and Figure B.2).

In some cases failure can occur in the adhesive layer between the tile and the pull-head plate. In this case the notation BT is used, see Figure B.3, and the adhesion strength is greater than the test value. The test should be preferably repeated.



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

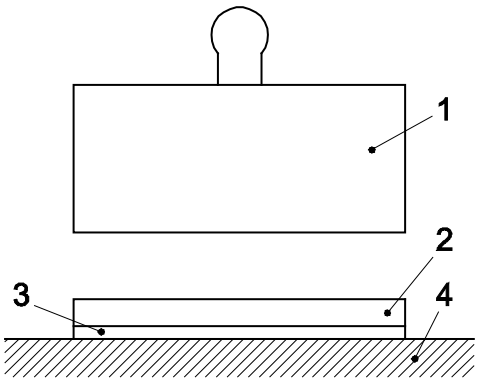
Figure B.1 — Adhesive failure between adhesive and substrate (AF-S)



Key

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

Figure B.2 — Adhesive failure between tile and adhesive (AF-T)



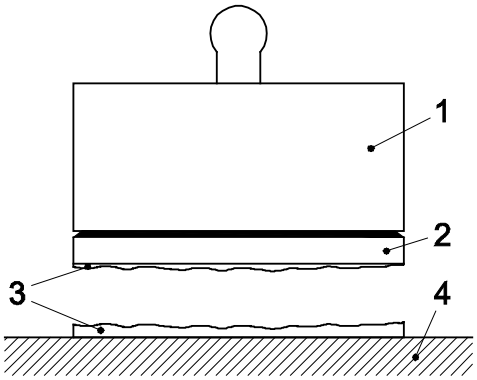
Key

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

Figure B.3 — Adhesive failure between tile and pull head plate (BT)

B.2 Cohesive failure within the adhesive (CF-A)

When failure occurs within the adhesive layer (see Figure B.4).



Key

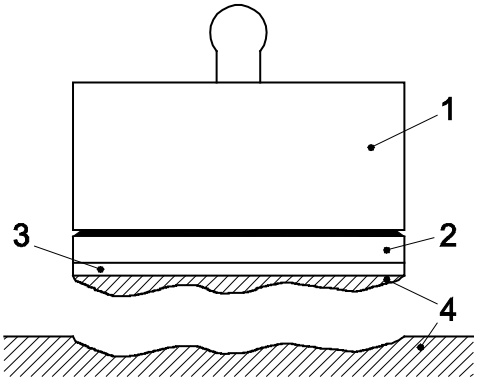
1 pull head plate
2 tile
3 adhesive
4 substrate (concrete slab)

Figure B.4 — Cohesive failure within the adhesive (CF-A)

B.3 Cohesive failure in the substrate or in the tile (CF-S or CF-T)

When failure occurs within the substrate the notation CF-S is used, see Figure B.5; when it happens within the body of the tile the notation CF-T is used (see Figure B.6).

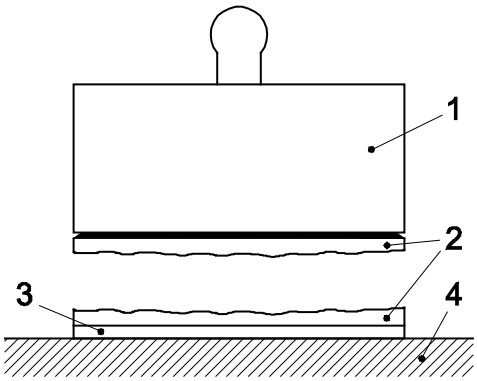
NOTE In this case the strength of the adhesive is greater than the test value.



Key

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

Figure B.5 — Cohesive failure within the substrate (CF-S)



Key

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

Figure B.6 — Cohesive failure within the tile (CF-T)

Bibliography

[1] EN 197-1, *Cement - Part 1: Composition, specifications and conformity criteria for common cements*

[2] ISO 6344 (all parts), *Coated abrasives — Grain size analysis*

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