

Australian Standard™

Ceramic tiles—Products for installation

Part 2: Adhesives—Test methods



This Australian Standard was prepared by Committee BD-044, Fixing of Ceramic Tiles. It was approved on behalf of the Council of Standards Australia on 28 March 2003. This Standard was published on 4 June 2003.

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Australian Chamber of Commerce and Industry
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Ceramic tiles—Products for installation

Part 2: Adhesives—Test methods

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PREFACE

This Interim Standard was prepared by the Standard Australia Committee BD-044, Fixing of Ceramic Tiles.

This Standard incorporates Amendment No. 1 (July 2005). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Interim Standard is to provide methods for testing the compliance of ceramic tile adhesives.

This Interim Standard is based on ISO draft 13007 Part 2.

This Standard is Part 2 in a series of Standards on products for the installation of ceramic tiles, as follows:

AS

4992 Ceramic tiles—Products for installation

4992.1 Part 1: Adhesives—Definitions and specifications

4992.2 Part 2: Adhesives—Test methods (this Standard)

Other parts in preparation are as follows:

AS

4992.3 Part 3: Grouts—Definitions and specifications

4992.4 Part 4: Grouts—Test methods

Standards Australia invites comment on this Interim Australian Standard from persons and organizations concerned with the subject of the Standard. The expiry date of comment is 2 years from the date of publication, at which time this Standard will be confirmed, withdrawn or revised in the light of public comment received.

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Interim Australian Standard

Ceramic tiles—Products for installation

Part 2: Adhesives—Test methods

1 SCOPE

This Standard sets out methods for determining characteristics for adhesives used in the installation of ceramic tiles, as follows:

- (a) Determination of open time.
- (b) Determination of slip.
- (c) Determination of shear adhesion strength.
- (d) Determination of tensile adhesion strength.
- (e) Determination of transverse deformation.
- (f) Determination of chemical resistance.

2 REFERENCED DOCUMENTS

AS	
2701	Methods of sampling and testing mortar for masonry constructions (all methods)
4662	Ceramic Tiles—Definitions, classification, characteristics and marking
4992	Ceramic tiles—Products for installation
4992.1 (Int)	Part 1: Adhesives—Definitions and specifications
ISO	
1512	Paints and varnishes — Sampling
1513	Examination and preparation of samples for testing

3 GENERAL TEST CONDITIONS AND PROCEDURES

3.1 Sampling

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

3.2 Test conditions

Standard conditions shall be $23 \pm 2^\circ\text{C}$ and $50 \pm 5\%$ relative humidity and a circulation of air in the testing area less than 0.2 m/s. Other test conditions may be specified in Clause 4. The tolerance in the time of conditioning for all test specimens shall be as follows:

Conditioning	Tolerance, h
24 h	± 0.5
7 d	± 3
14 d	± 6
21 d	± 9
28 d	± 12

3.3 Test materials

3.3.1 Preparation

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

3.3.2 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 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. Where a range of values is given, the average shall be used.

A minimum quantity of 2 kg of the adhesive powder and the recommended quantity of liquid shall be used to prepare the adhesive, using a mixer planetary type (see Figures 1 and 2), running at the slow speed settings 140 ± 5 rotation per min and 62 ± 5 rotation per min planetary movement.

The procedure shall be as follows:

- (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.
- (g) 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)/Reaction resin adhesive (R)

Where 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 ± 5 mm thick, have a moisture content of less than 3% by mass and have a water absorption at the surface after 4 h of testing in the range of 0.5 cm^3 to 1.5 cm^3 . The cohesive strength shall be at least 1.5 N/mm^2 .

NOTE: A method for manufacturing a suitable concrete test slab and the procedures for measuring the cohesive strength and surface water absorption is given in Appendix A.

3.5.2 Other substrates (optional)

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 described in Clause 4.1. When the 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 that occurs at the interface between adhesive and substrate (AF-S) or between tile and adhesive (AF-T). The test value equals the adhesive strength (see Figures 3(a) and (b)). In some cases the 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).

When 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)

When 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.

3.6.4 Modes of failure that may be a combination of any of the above

An approximate percentage of each shall be recorded.

3.7 Test report

The following shall be reported:

- (a) Date of test.
- (b) Type of adhesive, commercial designation and manufacturer's name.
- (c) Source, date obtained and complete identification of test sample.
- (d) Handling and storage of samples before testing.
- (e) Test conditions.
- (f) Amount of water or liquid used for preparing adhesive.
- (g) Test results (individual and mean values and mode of failure where required).
- (h) Full description of test substrate.
- (i) Any other factor that could have affected the result.
- (j) Reference to this Australian Standard, i.e., AS 4992.2(Int).

4 TEST METHODS

4.1 Determination of open time

4.1.1 General

Open time shall be tested in accordance to the general test conditions and procedures given in Clause 3 and the specific conditions and procedures give in Clauses 4.1.2 to 4.1.5.

4.1.2 Ceramic tiles

The tiles used for this test shall be Group B III porous body tiles complying with AS 4662, of water absorption $15 \pm 3\%$ by mass, and cut to facial dimensions of $50 \pm 1 \text{ mm} \times 50 \pm 1 \text{ mm}$.

4.1.3 Test substrate

The mandatory concrete test substrate shall conform to requirements given in Clause 3.5.1.

4.1.4 Apparatus

4.1.4.1 Mass

A mass of less than 50 mm × 50 mm cross-sectional area, capable of exerting a uniform force of 20 ± 0.05 N.

4.1.4.2 Pull-head plates

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

4.1.4.3 Test 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.

4.1.5 Procedure

Apply a thin layer of the adhesive, mixed in accordance with Clause 3.4, to the concrete slab with a straight edged trowel. Then apply a thicker layer and comb with a notched trowel having 6 mm × 6 mm notches at 12 mm centres for cementitious adhesives and 4 mm × 4 mm notches at 8 mm centres for dispersion adhesives and reaction resin adhesives. Hold the trowel at an angle of approximately 60° to the substrate at a right angle to one edge of the slab and draw across the slab parallel to that edge (in a straight line).

After 5, 10, 20, 30 or more minutes place at least ten test tiles 50 mm apart on the adhesive within 30 s. Tiles are placed on no more than 4 ribs for C adhesives and no more than 6 ribs for D adhesives. Load each tile with 20 ± 0.05 N for 30 s.

After 27 days storage under standard conditions, bond the pull-head plates 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.

4.1.6 Evaluation and expression of results

The individual tensile adhesion strengths shall be quoted to 0.1 N/mm² using the following equation:

$$A_s = L / A \quad \dots 1$$

where

A_s = the individual tensile adhesion strength in newtons per square millimetre (2500 mm²)

L = the total tensile load; in newtons

A = the bonding area, in square millimetres

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

- Determine the mean of the ten values.
- Discard the values falling out of 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 (see Clause 3.6).

The open time, in minutes, is the maximum time interval at which the adhesive meets the tensile adhesion strength requirement defined in AS 4992.1(Int) for open time.

4.1.7 Test report

The following shall be reported:

- (a) Date of test.
- (b) Type of adhesive, commercial designation and manufacturer's name.
- (c) Source, date obtained and complete identification of test sample.
- (d) Handling and storage of samples before testing.
- (e) Test conditions.
- (f) Amount of water or liquid used for preparing adhesive.
- (g) Test results (individual and mean values and mode of failure where required).
- (h) Full description of test substrate.
- (i) Any other factor that could have affected the result.
- (j) Open time, in minutes.
- (k) Reference to this Australian Standard, i.e., AS 4992.2(Int).

4.2 Determination of slip

4.2.1 General

Slip shall be tested in accordance with the general test conditions and procedures given in Clause 3 and the conditions and procedures given in Clause 4.2.2 to 4.2.6.

4.2.2 Ceramic tiles

The tiles used for this method shall be Group BI fully vitrified tile in accordance with AS 4662, with a water absorption $\leq 0.2\%$ by mass, unglazed, and with facial dimensions of 100 ± 1 mm $\times$ 100 ± 1 mm and weight of 200 ± 10 g.

4.2.3 Concrete test substrate

The concrete test substrate shall conform to requirements given in Clause 3.5

4.2.4 Apparatus

The following shall be required:

- (a) *Steel straightedge*
- (b) *Clamps*
- (c) *Masking tape* A 25 mm wide masking tape.
- (d) *Spacer* Two 25 ± 0.5 mm $\times$ 25 ± 0.5 mm $\times$ 10 ± 0.5 mm thick spacers made from stainless steel.
- (e) *Mass* A mass capable of exerting force of 50 ± 0.1 N with a cross sectional area of less than 100 ± 1 mm $\times$ 100 ± 1 mm.
- (f) *Vernier calliper* A Vernier Calliper accurate to 0.01 mm

4.2.5 Procedure

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

Then immediately 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 straightedge with a notched trowel having 6 mm × 6 mm notches at 12 mm centres, for cementitious adhesives and 4 mm × 4 mm notches at 8 mm centres for dispersion adhesives and reaction resin adhesives.

Hold trowel held at an angle of 60° to the substrate and parallel to the straight edge. Immediately remove the masking tape, position 25 mm spacers or the spacing bar as shown against the straightedge and after two minutes place a type BI_a tile against the spacers, as shown in Figure 4 and load with a weight of 50 ± 0.1 N for 30 ± 5 s. Remove the spacers and measure the gap between the straightedge and the tile with the Vernier calliper to within ± 0.1 mm. Immediately and carefully lift the slab into a vertical position. After 20 ± 2 min remeasure 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 3 tiles, for each adhesive. Report the results in millimetres and the mean value.

4.2.6 Test report

The following shall be reported:

- (a) Date of test.
- (b) Type of adhesive, commercial designation and manufacturer's name.
- (c) Source, date obtained and complete identification of test sample.
- (d) Handling and storage of samples before testing.
- (e) Test conditions.
- (f) Amount of water or liquid used for preparing adhesive.
- (g) Test results (individual and mean values and mode of failure where required).
- (h) Full description of test substrate.
- (i) Any other factor that could have affected the result.
- (j) Slip, in millimetres (individual and mean values).
- (k) Reference to this Australian Standard, i.e., AS 4992.2(Int)

4.3 Determination of shear adhesion strength (D, R)

4.3.1 General

Shear adhesion strength shall be tested in accordance with the general test conditions and procedures given in Clause 3 and the conditions and procedures given in Clauses 4.3.2 to 4.3.11.

4.3.2 Ceramic tiles

The tiles for this test shall be as follows:

- (a) *Dispersion adhesives (D)* Group BIII glazed porous body tiles in accordance with AS 4662, with a water absorption of 15 ± 3% by mass, facial dimensions of 108 ± 1 mm × 108 ± 1 mm and at least 6 mm thick
- (b) *Reaction resin adhesives (R)* Group BI_a fully vitrified tiles in accordance with AS 4662, with a water absorption ≤ 0.2% by mass, unglazed with plane adhering surface and facial dimensions of 100 ± 1 mm × 100 ± 1 mm.

4.3.3 Apparatus

The following shall be required:

- (a) *Template* A smooth non-absorptive frame (e.g., polytetrafluoroethylene in accordance with Figures 5(A) and 5(B) for D adhesives and Figures 6(A) and 6(B) for R adhesives).
- (b) *Spacers* Spacer rods 0.8 mm diameter approximately 40 mm long.
- (c) *Mass* A mass of less than 100 mm × 100 mm cross sectional area capable of exerting a uniform force of 70 ± 0.15 N.
- (d) *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.
- (e) *Shear test jig* Any suitable jig used to transfer into shear from the compression or tensile load exerted by the testing machine. Examples of suitable jigs are shown in Figures 7 and 8.
- (f) *Air-circulating oven* An air-circulating oven capable of controlling the temperature to within $\pm 2^\circ$.

4.3.4 Procedure

Each test unit shall be prepared with two Group BIII tiles for D adhesives or Group BI_a tiles for R adhesives.

Draw a straight line on the porous 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(A) and 5(B) and 6(A) and 6(B)) over the unglazed back of the first test tile. Trowel sufficient adhesive across the template and then screed clean so as to neatly and completely fill the holes in the template. Carefully remove the template vertically (see Figures 5(B) and 6(B)).

Place spacers 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 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 (see Figures 5(B) and 6(B)).

Place the test units on a plane surface and carefully load with 70 ± 0.15 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.

4.3.5 Adhesion strength (D,R)

Condition 10 test units in standard test conditions for 7 days for R adhesives or 14 days for D adhesives.

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 ± 0.5 mm/min until failure occurs.

Report the results in Newtons.

4.3.6 Adhesion strength after water immersion (D, R)

Condition 10 test units in standard conditions for 21 days for adhesives (D2) or 7 days for rapid drying adhesives (D2F) and reaction resin adhesives (R). Then immerse in water at $23 \pm 2^\circ\text{C}$ for 21 days for reaction resin adhesives or 7 days for dispersion adhesives (D2; D2F). Remove the units and wipe with a cloth.

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 ± 0.5 mm/min until failure occurs.

Report the results in Newtons.

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

4.3.7 Adhesion strength after heat aging (D)

Condition 10 test units in standard conditions for 14 days and then place them in an air-circulating oven at $70 \pm 2^\circ\text{C}$ for a further 14 days, ensuring that air is free to circulate around each test unit.

Condition the units for a further 24 h in standard conditions, place the test units in a shear test jig 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 Newtons.

4.3.8 Adhesion strength at elevated temperature (D)

Condition 10 test units in standard conditions for 14 days and then place them in an air-circulating oven at $70 \pm 2^\circ\text{C}$ for a further 14 days, ensuring that air is free to circulate around each test unit.

One minute after removal of test unit from air-circulating oven, place the test units in a shear test jig 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 Newtons.

4.3.9 Adhesion strength after thermal shock (R)

After conditioning 10 test units in standard conditions for 7 days, place the test pieces in water bath maintained at $23 \pm 2^\circ\text{C}$ for 30 min and then in a 100°C waterbath for a further 30 min. Repeat the cycle for a total of four times and then place the test pieces in the $23 \pm 2^\circ\text{C}$ bath for approximately 30 min for cooling.

Remove each test piece from the water, wipe off the excess water, place the test units in a shear test jig 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.

4.3.10 Evaluation and expression of results

Divide the individual values, in Newtons, by the conventional area of adhesive contact. (D 5480 mm², R 1660 mm²)

Determine the shear adhesion strength as follows:

- (a) Determine the mean of 10 values.
- (b) Discard the values falling out of the range of $\pm 20\%$ from the mean value.
- (c) If five or more values remain, determine the new mean value.
- (d) If less than five values remain, repeat the test.

4.3.11 Test report

The following shall be reported:

- (a) Date of test.
- (b) Type of adhesive, commercial designation and manufacturer's name.
- (c) Source, date obtained and complete identification of test sample.
- (d) Handling and storage of samples before testing.