

Australian Standard[®]

AS 1012.24:2015

Methods of testing concrete

Method 24: Determination of the tensile bond strength of concrete—Repairs and strengthening systems

1 SCOPE

This Standard describes a procedure for the determination of the tensile bond strength of concrete repairs, which use mortars, grouts, concretes and other products. This method also applies for the determination of the tensile bond strength of concrete strengthening systems such as fibre reinforced polymer (FRP) composites.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1580 Paints and related materials—Methods of test

1580.408.5 Method 408.5: Adhesion—Pull-off test

3 PRINCIPLE

The method requires the exertion of a tensile force on a steel dolly bonded to the surface of the repair material or strengthening system. The test area is defined by coring through the surface of the repair material or strengthening system and into the concrete substrate below. The strength of the bond at the interface of the repair material or strengthening system and the concrete substrate is measured and the type of failure reported.

The test method is based on the broad processes used in AS 1580.408.5.

4 APPARATUS

4.1 Pull off test equipment

A commercially available pull off adhesion tester (as per AS 1580.408.5—2006, Clause 5.1). A capacity of 10 kN is sufficient to cause tensile bond failure of the specimen for most applications.

The pull-off tester shall be calibrated at zero load and over the range of interest, and shall be accurate within $\pm 10\%$ of the set reading and with a pulling capacity sufficient to cause tensile bond failure of the specimen. The measurement device shall retain the reading of maximum force exerted.

NOTE: The pull-off equipment may be provided with a measurement device that displays the exerted force by an analogue or digital system.

4.2 Test dollies

Test dollies of circular cross-section with a diameter of 50 ± 0.5 mm and with a thickness of at least 20 mm for steel dollies and 30 mm for aluminium dollies. The gluing surface of the dollies shall be flat to within 0.2 mm over the 50 mm diameter.

The dollies shall be so designed to ensure that the tensile load can be applied normal to the surface under test, and not to induce any shear force.

The method used for attaching the dolly to the pull-off test equipment shall incorporate a spherical seat, or otherwise the spherical seat or gripping mechanism shall be within the pull-off test equipment.

4.3 Adhesive

A high strength solventless adhesive, usually a two-pack epoxy, for securing the dolly to the surface.

4.4 Grinding apparatus

Grinding apparatus for use in cleaning the surface of the repair and adhesive from used dollies.

4.5 Solvents

Solvents for use in cleaning the surface of the repair and adhesive from used dollies.

4.6 Brushes

Steel wire brush and soft-bristled brush.

4.7 Core drill

Diamond core drill and barrel that enable the drilling of a (50 ± 1.0) mm cylinder through the repair material or strengthening system and into the concrete substrate below. The core barrel shall have a cutting edge that stands proud of the cylinder by (1.5 ± 0.5) mm.

4.8 Vernier calipers

Vernier calipers accurate to at least 0.1 mm.

4.9 Digital camera

Digital camera suitable for recording the failure surface conditions.

5 NUMBER OF TEST SITES

The test sites shall be selected as specified or as agreed by the relevant parties. At least three test sites shall be selected for a bond test for an individual repair or strengthening system.

6 PROCEDURE

6.1 Core drilling

The site of the core drilling shall be examined, so as to avoid the presence of any steel reinforcement, thoroughly clean the surface and photograph prior to drilling.

Commence drilling with the diamond coring barrel with an axis normal to the surface and continue to drill through the repair material or strengthening system to a depth of at least 15 mm beyond the repair and into the concrete substrate below. Carefully remove the diamond coring barrel without damaging the core and leaving it intact with an annulus around the core.

NOTE: The total drill-in depth is—

$$D1 = dd + 15 \text{ mms}$$

where

$D1$ = the total drill in depth, in millimetres

dd = the thickness of the mortar layer, in millimetres.

6.2 Applying the dolly

Clean the surface of the repair core face to remove loose material prior to applying the dolly.

Clean the dolly using the grinding equipment as necessary, then degrease and dry the side of the dolly onto which the adhesive is to be applied. Apply a thin layer of adhesive to the surface of the specimen so that the adhesive will form a uniform layer between the dolly and the outer surface of the core. Be particularly careful to ensure that no adhesive shall penetrate into the annulus clearance made by the coring barrel.

NOTE: A paper towel or fine rag may be used to temporarily protect the annulus space from adhesive.

Place the dolly on the core face so that the centre of the dolly coincides with the centre of the core. Apply sufficient pressure to the dolly to expel air, carefully and immediately removing any extruded adhesive. Allow the adhesive to harden in accordance with the adhesive manufacturer's instructions.

6.3 Setting the pull-off equipment

The pull off equipment and its accessories shall be used in accordance with the manufacturer's instructions.

Place the pull-off equipment concentrically over the dolly and normal to the cored surface. Secure the equipment in such way that its position will not change during the test.

6.4 Applying the load

Increase the load continuously at an even rate not greater than 10 N/s until failure occurs.

Record the load at failure and then determine the mean diameter of the specimen at the failure face as the average result of two measurements taken perpendicularly to each other, across the core, using the vernier calipers.

6.5 Determination of the type of failure

Photograph the failure surface.

From a visual assessment, determine and report the type of failure of the specimens categorized as follows:

- (a) a = tensile failure in the concrete substrate.
- (b) b = tensile failure in the repair.
- (c) a/b = bond failure at the interface between the substrate and the repair material or at the interface between the substrate and the strengthening system.
- (d) c = bond failures between layers of the strengthening system.
- (e) y = tensile failure in the adhesive layer.
- (f) z = failure of dolly or apparatus.
- (g) y/z = bond failure between the adhesive layer and the dolly.

If there is a combination of these types of failure, a visual inspection shall be made of the failure face to assess and report the percentage of each type of failure, based on the surface area, to nearest 10%.