BRITISH STANDARD

BS EN
12618-2:2004

Products and systems for the protection and repair of concrete structures — Test methods —

Part 2: Determination of the adhesion of injection products, with or without thermal cycling — Adhesion by tensile bond strength

The European Standard EN 12618-2:2004 has the status of a British Standard

ICS 91.080.40

National foreword

This British Standard is the official English language version of EN 12618-2:2004.

The UK participation in its preparation was entrusted by Technical Committee B/517, Concrete, to Subcommittee B/517/8, Protection and Repair of Concrete Structures, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 12, an inside back cover and a back cover.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 9 July 2005

ISBN 0 580 44410 4

Amendments issued since publication

Amd. No.	Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12618-2

August 2004

ICS 91.080.40

English version

Products and systems for the protection and repair of concrete structures - Test methods - Part 2: Determination of the adhesion of injection products, with or without thermal cycling Adhesion by tensile bond strength

Produits et systèmes pour la protection et la réparation des structures en béton - Méthodes d'essai - Partie 2: Détermination de l'adhérence des produits d'injection, après cycles thermiques ou non - Procédé d'adhérence par traction

Produkte und Systeme für den Schutz und die Instandsetzung von Betontragwerken - Prüfverfahren - Teil 2: Bestimmung der Haftzugfestigkeit von Rissfüllstoffen mit oder ohne thermische Behandlung - Haftzugfestigkeit

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Ref. No. EN 12618-2:2004: E

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Foreword

This document (EN 12618-2:2004) has been prepared by Technical Committee CEN /TC 104, "Concrete and related products", the secretariat of which is held by DIN.

It has been drafted by Sub-Committee 8 "Products and systems for the protection and repair of concrete structures" (Secretariat AFNOR).

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 February 2005, and conflicting national standards shall be withdrawn at the latest by February 2005.

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1 Scope

This document describes a test method to determine the adhesion to hydraulic concrete of injection products. The test can be applied to polymer and cementetious injection products.

The injection may be performed upon cracks in the dry, damp, wet or with water flowing through them. The tensile bond test should always be carried out after the appropriate period of curing under the standard conditions of test detailed below, but may additionally be performed upon a further set of specimens after a period of artificial ageing by thermal cycling.

The test can provide an opportunity for subjective assessment of injectability.

2 Normative references

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

EN 1504-1:1998, *Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 1: Definitions.*

prEN 1504-5:2001, *Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 5 - Concrete injection.*

EN 1766, *Products and systems for the protection and repair of concrete structures - Test methods - Reference concretes for testing.*

EN 13687-3, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility – Part 3: Thermal cycling without de-icing salt impact.*

EN 24624:1992, *Paints and varnishes - Pull-off test (ISO 4624:1978)*

3 Terms and definitions

For the purposes of document, the terms and definitions given in EN 1504-1:1998, prEN 1504-5:2001 and EN 24624:1992 apply.

4 Tests methods

4.1 Principle

The principle of this test is the tensile testing of composite specimens in the form of a sandwich, concrete/injection product/concrete.

These composite specimens are obtained by sawing or coring a composite test piece prepared by injecting the product into an artificial crack whose moisture content is controlled (dry, damp, wet or under water). The artificial crack is formed by placing two concrete slabs face to face.

NOTE This artificial crack is preferred to natural crack obtained by splitting, due to a better control of the contact area between injection grout and concrete substrate, which is of importance in the measured load.

The standard conditions of test shall be (21 ± 2) °C and (60 ± 10) % R.H.

4.2 Equipment

4.2.1 Tensile test machine

Pull off test equipment according to EN 24624 with a pulling capacity sufficient to cause tensile bond failure of the specimen. The accuracy shall be within ± 2 %. A capacity of 10 kN is sufficient for most applications.

The pull off equipment shall be capable of applying the load according to EN 24624 and shall be provided with a measurement device which displays the exerted force by an analogue or digital system. The measurement device shall retain the reading of maximum force exerted, the so called failure load.

4.2.2 Loading fixtures (dollies)

Circular dollies with a diameter of (50 ± 0,5) mm or square dollies of (50 x 50 ± 0,5) mm.

The dollies are made of steel with a thickness of at least 20 mm or of aluminium with a thickness of at least 30 mm.

On the side which the adhesive is to applied, the dolly shall be flat with a tolerance of 0,1 mm per 50 mm length.

The dollies shall be provided with a means for attaching the pull-off test equipment (4.2.1) that ensures the load can be applied normal to the surface under test, without bending or shear forces being applied to the test area.

4.2.3 Adhesive for bonding the dollies to the composite test piece and for bonding the three side "b", "c" and "d" (Figures 1 and 2) of the slabs. Two components epoxy, polyester or acrylic adhesives have been found suitable.

4.2.4 Connections for attaching the dollies to the testing machine. These shall be of the self-aligning type, that is they shall be attached to the fixed and moving members respectively in such a way that they will move into self alignment as soon as any load is applied, so that the axis of the test specimen will coincide with the line of force supplied through the centre line of the connection assembly.

4.2.5 Diamond core drill, and barrel that enable the drilling of (50 ± 0,5) mm cores.

The core barrel should have a cutting edge which stands proud of the cylinder by (1,5 ± 0,5) mm (to minimise lateral forces being applied to the test area).

Or,

4.2.6 Saw for cutting specimens. The saw shall have a diamond or silicon carbide cutting edge and shall be capable of cutting specimens which conform to the prescribed dimensions without excessive heating or shock.

4.2.7 Conditioning chamber or cabinet capable of maintaining the composite test piece and the test specimens at the specified temperature and relative humidity, and, if required, (for test specimens only) to achieve the thermal ageing cycle specified in 4.7 below.

4.2.8 Injection equipment, including mixer, pressure pot or injection pump (manual or powered injection hoses, injection nipples/packers).

4.2.9 Caulking or sealing compound for sealing the side "a" (Figure 1) where the injection takes place, and for fitting any injection nipples, shall be chosen by the supplier of the injection product.

4.2.10 Concrete slabs, (1 000 x 500 x 40) mm cast from concrete specified in EN 1766, type MC 0,45. The bottom faces shall be planar, sufficient to ensure that the gap width can be maintained within the permitted 30 % tolerance.

4.2.11 Pressure gauges

The injection unit shall be equipped with a nozzle pressure gauge, to measure the injection pressure. The pressure gauge shall be constructed so that grout does not enter the gauge.

4.2.12 Grinding equipment, for cleaning adhesive from the used dollies.

4.2.13 Vernier calipers accurate to not less than 0,1 mm.

4.3 Procedure

4.3.1 Preparation of the composite test piece

The bottom faces, as cast, of the concrete slabs shall be lightly grit-blasted to a surface roughness index between 0,20 and 0,25 according to EN 1766. The slabs shall be clamped together with their grit-blast sides face to face, using inert plastics spacers to achieve the required recommend crack width to a tolerance of ± 30 %. This is normally of the order 0,2 mm to 1 mm, but the material supplier may nominate any alternative crack width.

The two concrete slabs shall be bonded together on sides "b", "c" and "d" (Figure 1), apart from the final 100 mm of side "b" 50 mm from side "c", which shall be left unbounded as a vent. Steel clamps shall be fixed as shown in Figures 2 and 3.

The crack remaining open at side "a" shall be prepared for injection by the procedure recommended by the supplier of the product under test. This may include the fitting of injection nipples and vents as inlet and outlet ports.

NOTE Special care should be taken when handling the composite test piece, weighing approximately 92 kg plus clamping apparatus ; appropriate tools (two wheeled trolley) should be used to promote safely handling.

4.3.2 Conditioning

The composite test piece and the components of the product system shall be maintained under the standard test conditions or other selected and declared conditions, (e.g. 5 °C or 35 °C) for at least 48 h before proceeding. The specimen should be kept upright.

Then :

— for injection into a dry crack: no further conditioning required;

— for injection into a damp crack : the crack shall be kept filled with tap water for 30 min, then emptied and allowed to drain for 10 min before proceeding with injection;

— for injection into a wet crack : soak crack as above, but proceed with injection immediately after emptying without any period of draining;

— for injection into a water filled crack : fill the crack with water for 30 min, as above. Then proceed with injection without emptying the water. If required to prove that the system can be injected against a head of water, a water supply at the desired supply at the desired pressure may be connected to the outlet port.

4.4 Injection

The components of the injection product shall be mixed in accordance with the instruction of the supplier and then introduced into the crack via the tubes by the method specified by the supplier. The pressure at the inlet shall be measured (see 4.2.11). The injection is complete when unadulterated injection product is seen to emerge from the outlet port in side "b" adjacent to side "c".

4.5 Curing

The injected test piece shall be maintained in the conditioning environment for 7 days, then at the standard test conditions for a further 7 days for resin injection systems, or a further 21 days for cementitious injection systems.

4.6 Assessment of crack filling

After curing, test piece shall be cut up and specimens shall be taken, according to the plan shown in Figure 4.

Test specimens are ∅ 50 mm cores. If the adherence is deteriorated by coring (which is the case for ductile products with adherence lower than 0,5 N/mm^2), the test specimens are taken by sawing (50 x 50) mm blocs.

The specimens and sawn pieces shall be visually examined and an estimate made of the percentage of fulfilled cracks.

Only specimens with fulfilled cracks shall be tested for tensile bond strength.

4.7 Artificial ageing

Six specimens shall be placed in a programmable environmental cabinet and subjected to 24 cycles of the regime described in EN 13687-3.

4.8 Measurement of tensile bond strength

4.8.1 Selection

Specimens N° 1, 8, 3, 10, 5, 12 shall be tested without artificial ageing and, if required specimens N° 7, 2, 9, 4, 11, 6 shall be tested after artificial ageing (see Figure 4).

4.8.2 Loading fixtures shall be glued to the specimens in accordance with the procedure recommended by the adhesive supplier, taking appropriate measures to ensure parallelism of the flat surfaces of the dollies and their coaxiality.

The specimens, with loading fixtures attached, shall be fitted in turn into the tensile test machine, ensuring that their axis is aligned with an imaginary line joining the points of attachment to the test machine.

4.8.3 Load testing. Each specimen shall be pulled to failure at such a rate that the increase in load shall be (0,1 ± 0,05) N/mm^2/s. The maximum load sustained by the specimen shall be recorded together with the proportion of the fracture surface attributable to the following modes of failure:

— A : Failure in the injection product (cohesive failure);

— B : Failure at the interface between the concrete and the injection product (adhesive failure);

— C : Failure in the concrete (substrate failure).

5 Calculation

The adhesive bond strength shall be calculated by expressing the failure load in N as a function of the cross-sectional area of the specimen in mm^2. It shall be calculated to the nearest 0,1 N/mm^2. The failure mode shall be reported. If there is a mix of these modes of failure make a visual assessment to determine the surface area percentage mode of failure.

6 Test report

The test report shall include the following:

a) complete identification of the injection product or system tested, including type, source, manufacturer's code numbers and history;

b) reference to this document;

c) type of reference concrete used for casting the slabs;

d) date and place of injection of the composite test piece;

e) ambient conditioning during the injection of the composite test piece (including whether the crack was dry, damp or wet);

f) width of the crack;

g) the method of injection (gravity or force feed) and the final pressure;

h) percentage of filling of the specimens and sawn pieces;

i) date of tensile bond test;

j) failure load of each specimen;

k) tensile bond strength and proportional fracture mode of each specimen;

l) mean tensile bond strength of each set of specimens prepared and tested under the same conditions;

m) the failure mode of each specimen.

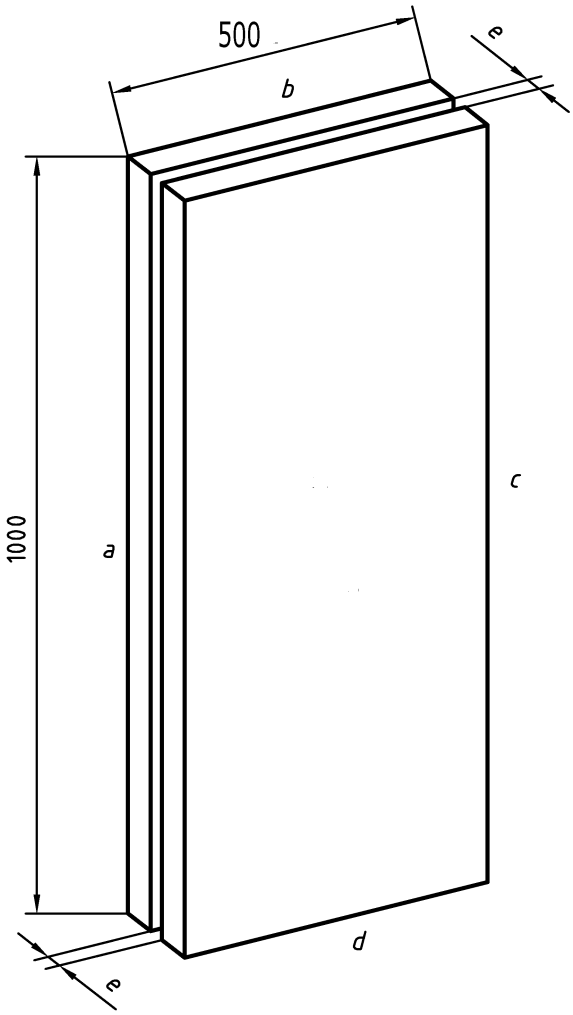
7 Reproducibility

The coefficient of variation of the obtained individual results by different laboratories shall not exceed 30 %.

8 Repeatability

The coefficient of variation of the obtained individual results shall not exceed 25 %.

Dimensions in millimetres



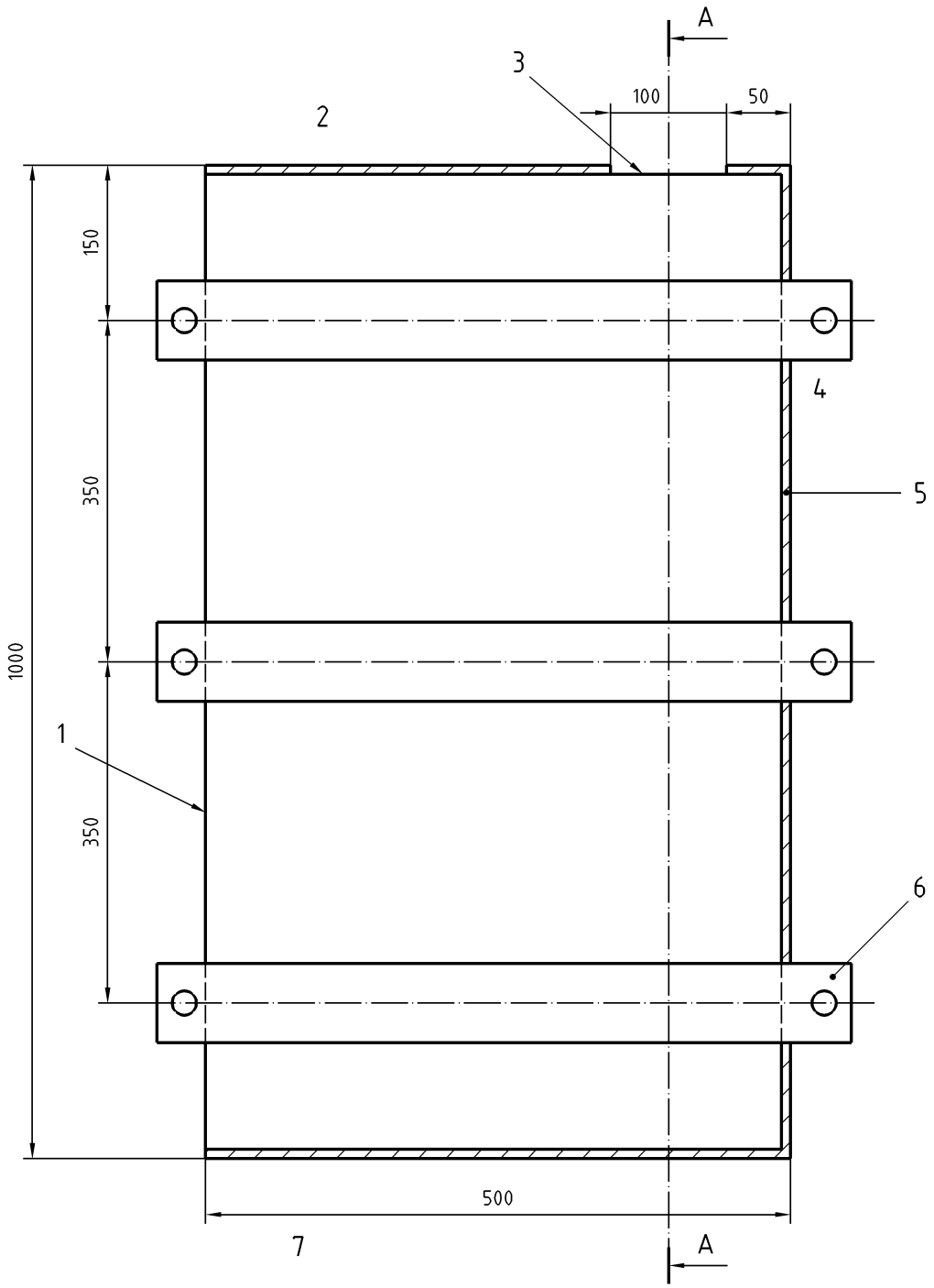
Key

Sides c, d : closed
Side b : partially closed
Side a : injection side

$0{,}2 < e < 1$ mm

Figure 1 — Shape and geometry of composite test piece

Dimensions in millimetres

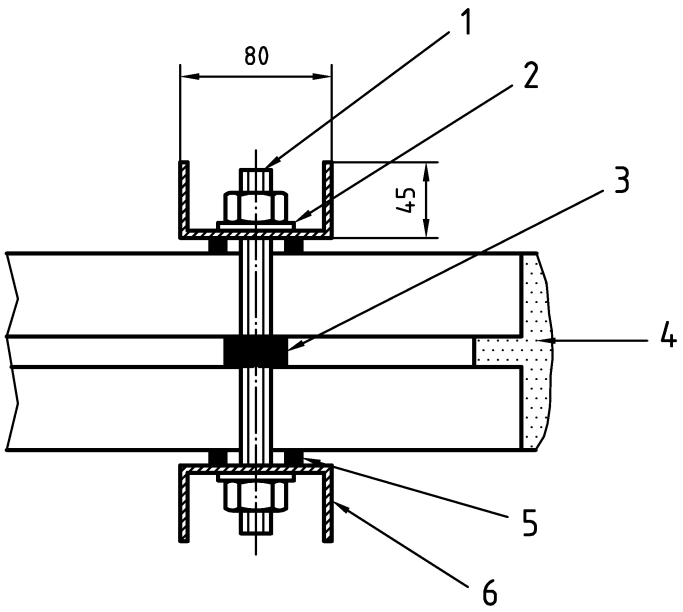


Key

1 Injection periphery
2 Side b
3 Unbonded area
4 Side c
5 Expoxy bonding
6 Steel channel
7 Side d

Figure 2 — Composite test piece assembling device (upper view)

Dimensions in millimetres

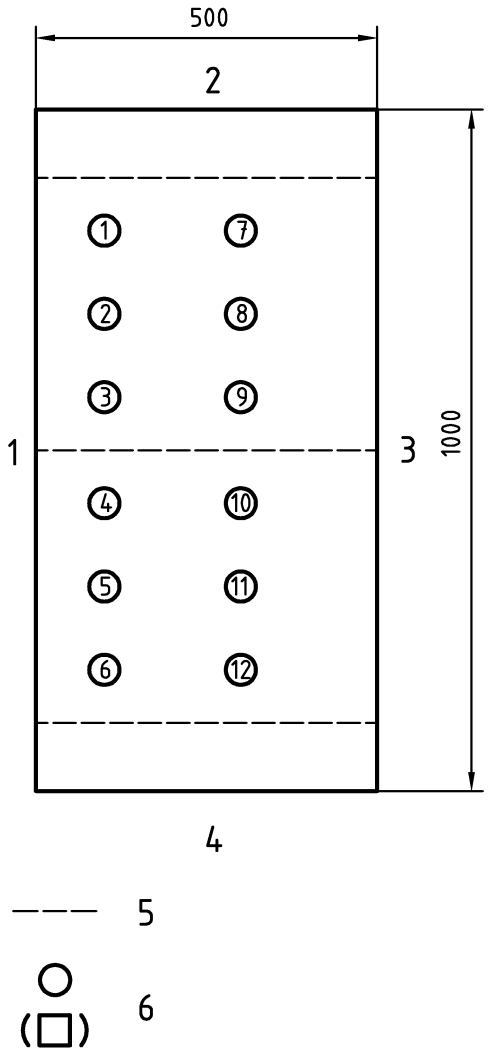


Key

1 Thread rod of 10 mm
2 Locking washer
3 PE spacer
4 Epoxy bonding
5 Rubber gasket
6 Steel channel

Figure 3 — Assembly device (side view)

Dimensions in millimetres



Key

1 Side a
2 Side b
3 Side c
4 Side d
5 Saw direction
6 Test specimen — core 50 mm; square 50 mm x 50 mm

Figure 4 — Composite test piece (plan of cutting up)

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