BRITISH STANDARD

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12636:1999

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

The European Standard EN 12636:1999 has the status of a British Standard

ICS 91.080.40

National foreword

This British Standard is the English language version of EN 12636:1999.

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

— aid enquirers to understand the text;

— present to the responsible 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.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 11 and a back cover.

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English version

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

Produits et systèmes pour la protection et la réparation des structures en béton — Méthodes d'essais — Détermination de l'adhérence béton sur béton

Produckte für den Schutz und die Instandsetzung von Betontragwerken — Prüfverfahren — Bestimmung der Verbundwirkung Beton-Beton

This European Standard was approved by CEN on 16 April 1999.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 12636:1999 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 104, Concrete (performance, production, placing and compliance criteria), the Secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by November 1999, and conflicting national standards shall be withdrawn at the latest by November 1999.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

It has been prepared by sub-committee 8, Products and systems for the protection and repair of concrete structures, (Secretariat AFNOR).

Contents

1 Scope

This European Standard describes methods for the measurement of the adhesion of structural bonding agents between fresh or hardened concrete and a hardened concrete substrate.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

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

EN 1542:1999, *Products and systems for the protection and repair of concrete structures — Test methods — pull-off test*.

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

EN 12189, *Products and systems for the protection and repair of concrete structures — Test methods — Determination of open time*.

3 Test method

3.1 Hardened concrete to hardened concrete

The adhesion between hardened concrete substrates is measured using the results from tensile bending tests performed on pairs of concrete test prisms which have been bonded using the bonding agent under test.

For satisfactory performance of the bonding agent, the tensile bending test should result in fracture in the concrete. When fracture occurs within the bond line it is considered that the structural bonding agent has not performed satisfactorily.

Alternatively, the tensile bending test can be performed in the presence of a longitudinal clamping force where the intended use involves the application of longitudinal prestress.

3.2 Fresh concrete to hardened concrete

The method for the determination of the bond strength of fresh concrete adhesively bonded to hardened concrete involves coring through the fresh concrete overlay beyond the bonded surface and into the hardened concrete substrate, and then performing a pull-off test.

For satisfactory performance of the bonding agent the pull-off test should result in fracture in the concrete. When fracture occurs within the bond line it is considered that the structural bonding agent has not performed satisfactorily.

4 Hardened concrete to hardened concrete

4.1 Equipment

4.1.1 *Steel moulds*, for producing concrete test pieces of size 40 mm × 40 mm × 160 mm conforming to EN 196-1.

4.1.2 *Concrete mixer*, as in prEN 1766.

4.1.3 *Grit blasting equipment*.

4.1.4 *A stop clock*, calibrated in minutes to a maximum of 120 min.

4.1.5 *A suitable frame,* for clamping the concrete test pieces together, for example, see Figure 1 of EN 12189.

4.1.6 *Testing machine*, capable of gradually applying a force of up to 20 kN during the tensile bending test.

4.1.7 *Steel support frame*, *support rollers*, *loading rollers and spreader beam*, as shown in Figure 1 for four point bending test on bonded concrete prisms.

4.1.8 *Steel wire brush*.

4.2 Test procedure

4.2.1 ***Sampling material***

The bonding agent to be tested shall be taken from one production batch.

4.2.2 ***Number of test specimens***

Tensile bending tests shall be conducted on a minimum of three pairs of bonded concrete prisms.

4.2.3 ***Concrete prisms***

Concrete test prisms, measuring 40 mm × 40 mm × 160 mm and using reference concrete type MC (0,40) shall be manufactured and cured in accordance with prEN 1766. The test prisms shall be removed from the water and cut in half to form two prisms, each measuring 40 mm × 40 mm × 80 mm. Saw cutting shall be carried out on a suitable bench such that the flatness of the surface is to within a tolerance of 0,5 mm and spalling of the cut edges does not exceed 1 % of the bonded area. The sawn concrete surfaces to be bonded shall be cleaned in running water using a steel wire brush and then grit blasted in accordance with prEN 1766. The test pieces shall then be conditioned as defined below depending upon whether bonding is to be carried out on a dry or wet hardened concrete substrate.

4.2.4 ***Conditioning***

The resin and hardener component of the bonding agent shall be conditioned before mixing to the test temperature of (21 ± 2) °C.

a) Dry surface

   Condition test components for 48 h at (21 ± 2) °C and a RH of (60 ± 10) %. Dust shall be removed by brushing immediately prior to application of the bonding agent.

b) Wet surface

   Condition test components by immersion in water at room temperature for 48 h. The area to be bonded shall be placed in a vertical position for 15 min at (21 ± 2) °C and a RH of (60 ± 10) % to allow free water to drain off before application of the bonding agent.

c) Extreme temperatures

   For testing at extremes of environmental conditions, alternative conditioning and test temperatures as specified by the supplier shall be used.

4.2.5 *Specimen preparation*

The components of the bonding agent shall be mixed at the test temperature and applied in a layer 1 mm thick, to the prepared concrete end faces of both prisms in each pair all in accordance with the manufacturer's instructions. Appropriate spacers shall be used to control the thickness of the bonding agent.

Immediately, the corresponding faces of the two concrete prisms in each pair shall be placed against the coated face and the two prisms clamped together to achieve a 1 mm to 2 mm thick bond line with no entrapped air voids. The complete assemblies shall then be cured at the test temperature for seven days or such other time that may be specified.

4.2.6 *Measurement*

At the end of the specified curing period the bonded concrete prisms shall be positioned within the testing machine over a span of 150 mm as shown in Figure 1. The load shall then be applied vertically at the third span points by means of the spreader beam and increased smoothly at the rate of (50 ± 10) N/s until fracture.

Alternatively, the tensile bending test may be performed on the pair of bonded concrete prisms in the presence of a longitudinal clamping force, as described in EN 12189.

The load at failure and the position of the failure plane shall be recorded for each pair of prisms.

4.3 Test report

The report shall include the following information:

a) identification of all the constituents in the adhesive mix including manufacturer's name, code numbers if applicable, type description and date of production;

b) the conditioning and test temperature;

c) the substrate surface condition, dry or wet;

d) curing period in days between bonding and testing;

e) the method of clamping the concrete test pieces together;

f) for each pair of bonded prisms:

- the elapsed time interval between application of the bonding agent and closing of the joint;
- the longitudinal clamping force imposed during the tensile bending test;
- the failure load recorded in the tensile bending test;
- the position of the failure plane;

g) date of the test;

h) reference to this European Standard.

5 Fresh concrete to hardened concrete

5.1 Equipment

The equipment can be divided in two parts depending on choice of test method, i.e. circular bonded dollies or friction grip.

Friction grip should be used when the thickness of the top layer exceeds 40 mm.

5.1.1 ***Adhesively bonded dollies method*** *(see Figure 2)*

a) *mixer* for the repair material as recommended by the manufacturer;

b) *climatic chambers* for the conditions studied;

c) *vernier callipers* accurate to not less than 0,1 mm;

d) *adhesive, rapid hardening two component epoxy or similar*;

e) *grinding equipment*;

f) *steel wire brush*;

g) *cleaning solvent*;

h) *diamond core drilling bit*, internal diameter of (51 ± 1) mm. The core bit should have a cutting edge which protrudes from the cylinder by 1 mm to 2 mm (to minimize lateral forces being applied to the test area);

i) *pull-off test equipment,* according to EN 1542 with a pulling capacity of at least 10 kN. The accuracy shall be within ±2 %.

The pull-off equipment shall be capable of applying the load according to EN 1542, **3.1**, 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. The level of the failure load should be recorded;

j) *cylindrical steel dollies*, with a diameter of (50 ± 0,5) mm and a height of at least 25 mm. On the side on which the adhesive is to be applied, the dolly shall be flat with a tolerance of ±0,1 mm per 50 mm length.

5.1.2 ***Friction grip method***

a) *climatic chambers* for the conditions studied;

b) *vernier callipers* accurate to not less than 0,1 mm;

c) *diamond core drill* with a diameter depending on friction grip used. The core bit should have a cutting edge which protrudes from the cylinder by 1 mm to 2 mm (to minimize lateral forces being applied to the test area);

d) *a steel grip* (see Figure 3) suitable for gripping cores of the specified diameter. It shall have an attachment for the pull-off test equipment, so that an axial tensile force may be smoothly applied to the core. The internal depth of the grip, i.e. the length of the core which can be accommodated above the annular clamp, shall be at least three times the nominal size of the largest aggregate in the composition being gripped, at least 1/3 of the thickness of the bonded layer and at least 1/4 of the diameter of the core;

e) *pull-off test equipment* according to EN 1542 with a pulling capacity of at least 10 kN. The accuracy shall be within ±2 %.

The pull-off equipment shall be capable of applying the load according to EN 1542:1999, **3.1**, 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. The level of the failure load should be recorded with a precision of ±5 %.

5.2 Test procedure

5.2.1 ***Sampling material***

The bonding agent to be tested shall be taken from one production batch.

5.2.2 ***Number of test pieces***

A minimum of one base concrete test piece, enabling five separate bond tests as shown in EN 1542:1999, Figure 1, is required for each surface condition and test temperature.

5.2.3 ***Base concrete***

The dimensions of the hardened concrete base test pieces shall be 300 mm × 300 mm with a thickness of at least 50 mm. They shall be manufactured using reference concrete type MC (0,40) and cured in accordance with prEN 1766. The surface of the hardened concrete to be bonded shall be grit blasted in accordance with the requirements of prEN 1766.

The base concrete test specimens shall then be conditioned as defined below depending upon whether bonding is to be carried out on a dry or wet hardened concrete substrate.

5.2.4 ***Conditioning***

The resin and hardener component of the bonding agent shall be conditioned before mixing to the test temperature of (21 ± 2) °C.

a) Dry surface

Condition test components for 48 h at (21 ± 2) °C and a RH of (60 ± 10) %. Dust shall be removed by brushing immediately prior to application of the bonding agent.

b) Wet surface

Condition test components by immersion in water at room temperature for 48 h. The area to be bonded shall be placed in a vertical position for 15 min at (21 ± 2) °C and a RH of (60 ± 10) % to allow free water to drain off before application of the bonding agent.

c) Extreme temperatures

For testing at extremes of environmental conditions, alternative conditioning and test temperatures shall be specified in accordance with the manufacturer's instructions.

5.2.5 ***Specimen preparation***

The components of the bonding agent shall be mixed at the test temperature and applied in a layer 2 mm thick to the prepared top surface of the hardened base concrete test piece all in accordance with the manufacturer's instructions. The fresh concrete applicable to the intended use shall then be cast to the appropriate thickness approximately at the middle of the open time of the bonding agent. Compact the fresh concrete by placing on a suitable vibrating table.

The bonded test pieces shall be removed from the mould 24 h after the bonding agent has been applied and cured for 28 days in water at 20 °C ± 2 °C before testing, or as otherwise specified.

5.2.6 *Measurement*

When using adhesively bonded dollies the bond strength test shall be conducted in accordance with EN 1542:1999, clause **7**.

The pull-off force should be fixed so that its direction will not diverge by more than the value stated in Table 1 from the axial direction of the test specimen.

Table 1 — Maximum allowable divergence between loading direction and the axial direction of test specimen

d_d^D/D	**Angle of divergence** (degrees)
<0,5	2,5
0,5 to 2,0	1,0
≥2,0	0,5
[1)] d_d is the thickness of the fresh concrete overlay, in millimetres; D is the diameter of the test specimen, in millimetres.	

NOTE There are different types of equipment to apply and control the direction of the load, for example the friction equipment shown in Figure 3.

If the surface is uneven a drill with double drill cutter heads, as in Figure 4a), could be used. The inner cutter head corresponds to the diameter of the test specimen. When using double cutter head equipment two notches are drilled so that the outer notch reaches a depth of about 20 mm. After that, the outer cutter head is taken away and the inner notch drilled down to the necessary depth as in Figure 4b). The loading equipment is then placed in the outer notch and the attachment plate applied, see Figure 3.

5.3 Test report

The report shall include the following information:

a) identification of all the constituents in the adhesive mix including manufacturer's name, code numbers if applicable, type description and date of production;

b) the conditioning and test temperature;

c) the substrate surface condition, dry or wet;

d) the composition of the fresh concrete;

e) curing period in days between bonding and testing;

f) for each pull-off test:

- the elapsed time interval between application of the bonding agent and pouring the fresh concrete;
- the calculated bond strength;
- the failure load;
- the type of failure.

g) date of the test;

h) reference to this European Standard.

Annex A (informative)
Bibliography

[1] SS 13 72 43, Concrete testing — Hardened concrete, shotcrete and plaster adhesion strength.

[2] FIP/9/2, Proposal for a standard for acceptance tests and verification of epoxy bonding agents for segmental construction. Fédération Internationale de la Précontrainte, March 1978.

Dimensions in millimetres

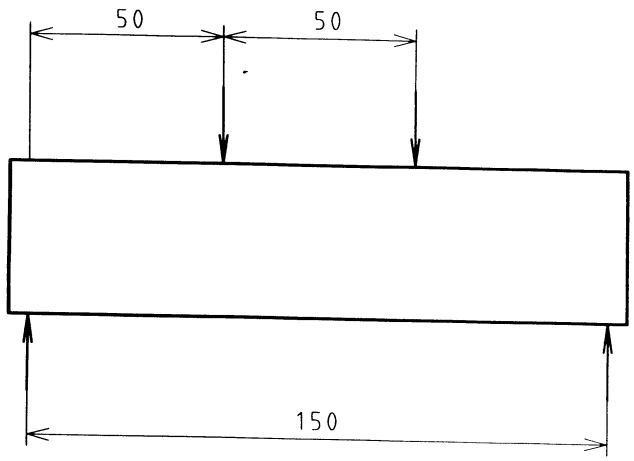


Figure 1 — Clamping frame and loading arrangement in four point bending

Dimensions in millimetres

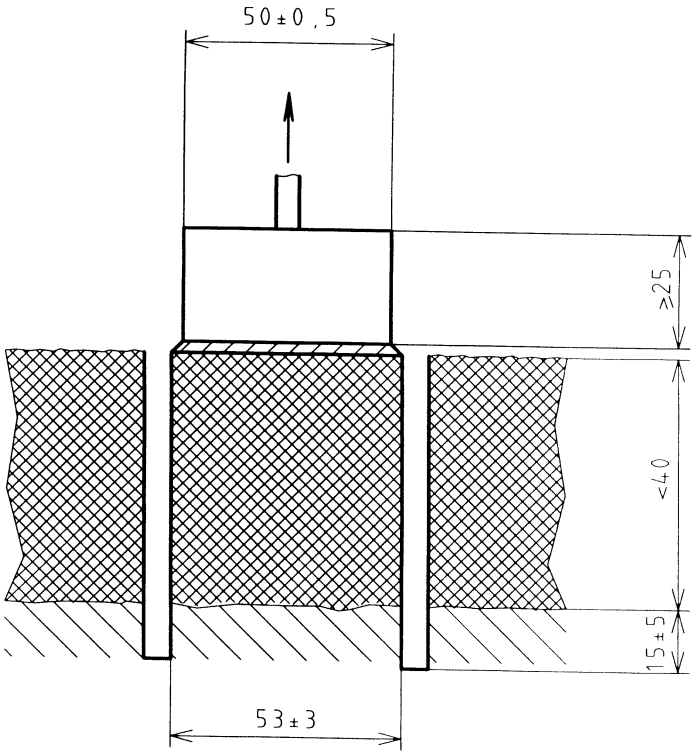


Figure 2 — Example of adhesively bonded dollies

Dimensions in millimetres

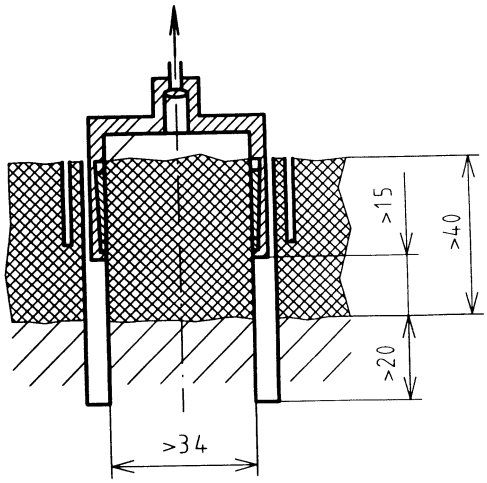
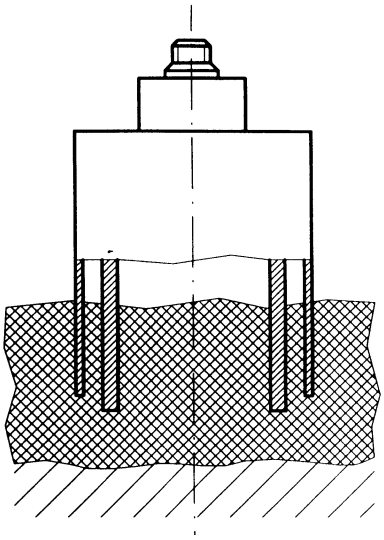
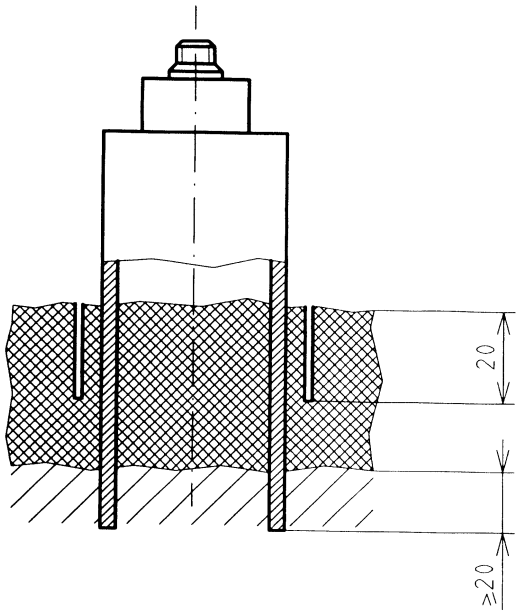


Figure 3 — Example of placing of test equipment to measure the bond strength — Mechanical tensile arrangement with friction grasp



a) Example of double drill cutter, gives notches for placing of the loading equipment and for inner drill core bit

Dimensions in millimetres



b) Example of single drill cutter head to drill inner core down to necessary depth

Figure 4

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