BRITISH STANDARD

BS EN
14488-4:2005
+A1:2008

# Testing sprayed concrete —

## Part 4: Bond strength of cores by direct tension

ICS 91.100.30



BSI
British Standards

# National foreword

This British Standard is the UK implementation of EN 14488-4:2005+A1:2008. It supersedes EN 14488-4:2005 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by ⟨A1⟩ ⟨A1⟩.

The UK participation in its preparation was entrusted by Technical Committee B/517, Concrete, to Subcommittee B/517/10, Sprayed concrete.

A list of organizations represented on this subcommittee 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.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 6 September 2005



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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 14488-4:2005+A1

March 2008

ICS 91.100.30

Supersedes EN 14488-4:2005

English Version

# Testing sprayed concrete - Part 4: Bond strength of cores by direct tension

Essais pour béton projeté - Partie 4: Adhérence en traction directe sur carottes

Prüfung von Spritzbeton - Teil 4: Haftfestigkeit an Bohrkernen bei zentrischem Zug

This European Standard was approved by CEN on 17 April 2005 and includes Amendment 1 approved by CEN on 21 January 2008.

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Ref. No. EN 14488-4:2005+A1:2008: E

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# Foreword

This document (EN 14488-4:2005+A1:2008) has been prepared by Technical Committee CEN/TC 104 "Concrete and related products", 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of an identical text or by endorsement, at the latest by September 2008 and conflicting national standards shall be withdrawn at the latest by September 2008.

This document includes Amendment 1, approved by CEN on 2008-01-21.

This document supersedes EN 14488-4:2005.

The start and finish of text introduced or altered by amendment is indicated in the text by tags ⟨A1⟩ ⟨A1⟩.

This European Standard is part of a series concerned with testing sprayed concrete.

This series EN 14488 *Testing sprayed concrete* includes the following parts:

— Part 1: Sampling fresh and hardened concrete

— Part 2: Compressive strength of young sprayed concrete

— Part 3: Flexural strengths (first peak, ultimate and residual) of fibre reinforced beam specimens

— Part 4: Bond strength of cores by direct tension

— Part 5: Determination of energy absorption capacity of fibre reinforced slab specimens

— Part 6: Thickness of concrete on a substrate

— Part 7: Fibre content of fibre reinforced concrete

⟨A1⟩ *deleted text* ⟨A1⟩

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

## 1 Scope

This European Standard describes a means of determining the tensile bond between sprayed concrete and substrate of concrete or rock tested in a laboratory as a direct tension test. Bond strength is defined as the capacity to transfer tension between two layers. Bond strength is calculated as the ultimate tensile force divided by the stressed cross-sectional area of a core, drilled out of a sprayed concrete layer together with a portion of the substrate concrete or rock.

〚A1〛 Alternative in situ test methods for determining bond strength are allowed provided they meet all the requirements of this European Standard. In case of dispute, the method described in this European Standard is the reference test method. 〚/A1〛

## 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 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test at ambient temperature*

EN 12390-1, *Testing hardened concrete — Part 1: Shape, dimensions and other requirements for specimens and moulds*

EN 12504-1, *Testing concrete in structures — Part 1: Cored specimens — Testing, examining and testing in compression*

## 3 Principle

A core with a diameter ($d$) of 50 mm–100 mm and a length of more than 2 $d$ is drilled through the sprayed concrete layer and the concrete or rock substrate. The core is cross-cut so that the bonding zone is near to the middle of the test specimen and the length is 2 $d$, after which steel dollies are glued onto the ground end surfaces of the core and the test specimen is subjected to increasing stress until it fractures. The values obtained are assessed with regard to the nature of the fracture, and classified as belonging to one of two types:

a) Fracture in the bonding zone which gives the actual bond strength. This also includes the special case in which no bonding between the layers is obtained.

b) Fracture where the fracture surface is not entirely in the bonding zone, which means that the bond strength is greater than the value of ultimate stress obtained in this case.

## 4 Apparatus

**4.1 Tensile testing machine** of class 2 or better, in accordance with EN 10002-1 which makes it possible to measure the stress within ± 2 % accuracy, and to regulate the increase in stress within the range of (0,05 ± 0,01) MPa/s.

**4.2 Stone saw and surface grinder**

**4.3 Steel dollies** (two for each test specimen), with diameters equal to the core diameter (± 1 mm) and a thickness of at least 0,4 times the dolly diameter. The surface to be glued shall be flat to within ± 0,05 mm.

The other surface is to be fitted with a device which permits application of an axial load at right angles to the surface of the dolly. Alternatively, one steel dolly may be used provided that it is attached to the testing machine by a universal joint.

**4.4 Adhesive** for gluing steel to concrete.

**4.5 Water container** which is thermostatically controlled: (20 ± 2) °C.

# 5 Test procedures

## 5.1 Obtaining cores

The test samples shall be obtained from the sprayed concrete in accordance with EN 12504-1.

## 5.2 Preparation of test specimen

The diameter ($d$) of the specimen, see Figure 1, shall be chosen so that:

a) it is at least 4 times the nominal maximum particle size of the sprayed concrete;

b) the height ($h$) of the finished specimen shall equal 2 $d$;

c) it is not greater than 4 times the thickness of the layer; and

d) average distance to the bond surface is at least 0,5 $d$ from either end of the specimen.

〚A1〛 NOTE The requirements referring to flatness of the end of the end surface of the cored specimen and its height may not be satisfied in case of partially cored pull-off tests. The requirements regarding gluing of dollies are not relevant where the sample is clamped rather than glued.

However, in all cases, the requirement concerning the axiality of loading and load rate in 5.3 shall be satisfied. 〈A1〛

The end surface of the core shall be ground so that the demands for flatness according to EN 12390-1 are fulfilled. The dollies are glued, in accordance with the manufacturers instructions, to the ends of the core so that the centre of the dollies coincides with the centre of the core ± 1 mm.

If not specified otherwise, the specimens shall be water cured, only interrupted by necessary work to prepare the joint and gluing on the steel dollies. During this work the specimens should be protected against drying with wet hessian or an alternative method.

## 5.3 Testing

The test shall not be carried out until the sprayed concrete layer has reached an age of at least 28 days, unless otherwise specified.

The following procedure is to be carried out for each test specimen:

The cross sectional area of the test specimen shall be determined in accordance with measurements as described in EN 12390-1. The specimen shall be axially loaded to a precision of ± 1 mm.

The tensile force shall be applied continuously at a speed of (0,05 ± 0,01) MPa/s. The maximum tensile load is recorded. If the fracture takes place in the glue joint, the value is noted and the test specimen reglued as described in 5.2 above.

The proportion of the fracture extending into the bonding zone shall be estimated to the nearest 10 %.

The bond strength shall be calculated as the maximum load divided by the cross sectional area.

## 6 Results

If more than 80 % of the fracture goes through the bonding zone, the value shall be recorded to be the bond strength. Otherwise, it should be considered to be the lower limit of the bond strength.

## 7 Report

The report shall include:

a) name and address of test laboratory

b) date and identification number of report

c) identification of the test specimens

d) any deviation from the standard test method

e) details of adjustment by grinding

f) date of test

g) age

h) the maximum tensile load to the nearest 0,01 kN

i) the cross-sectioned area to the nearest 1 $mm^2$

j) the tensile bond strength to the nearest 0,05 MPa

k) the estimated bonded area to the nearest 10 %, and the failure mode (substrate, bond or sprayed concrete)

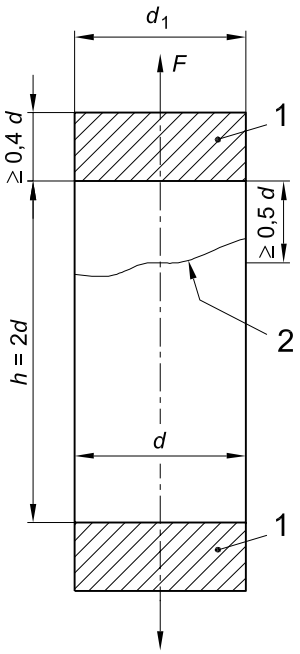
l) test results, mean and individual values

m) other information which may influence the assessment of results

n) declaration from the person technically responsible for the test that the testing was carried out in accordance with this standard

## 8 Precision

There are currently no precision data for this test.




**Key**

*h* Height of core

$d_1$ dolly diameter = $d \pm 1$ mm

*d* Core diameter

*F* Load applied axially, ± 1 mm core centroid

1 Dolly

2 Bond surface

**Figure 1 — Vertical cross-section of test specimen geometry**

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