BRITISH STANDARD

BS EN
12504-3:2005

Testing concrete in structures —

Part 3: Determination of pull-out force

The European Standard EN 12504-3:2005 has the status of a British Standard

ICS 91.100.30

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 12504-3:2005. No British Standard is superseded. General guidance on non-destructive methods of test for hardened concrete, including the pull-out test, is given in BS 1881-201:1986.

The UK participation in its preparation was entrusted by Technical Committee B/517, Concrete, to Subcommittee B/517/1, Concrete production and testing, 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 subcommittee can be obtained on request to its secretary.

The UK National Annex NA attached to this Standard provides additional information on pull-out testing.

Cross-references

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2005

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 10, the Annex NA page and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 33426 0

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12504-3

March 2005

ICS 91.100.30

English version

Testing concrete in structures - Part 3: Determination of pull-out force

Essais pour béton dans les structures - Partie 3: Détermination de la force d'arrachement

Prüfung von Beton in Bauwerken - Teil 3: Bestimmung der Ausziehkraft

This European Standard was approved by CEN on 4 September 2003.

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Ref. No. EN 12504-3:2005: E

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Foreword

This document (EN 12504-3:2005) 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 2005, and conflicting national standards shall be withdrawn at the latest by September 2005.

This European Standard is based on ISO/DIS 8046 "Concrete hardened — Determination of pull-out strength".

This standard is one of a series of methods for testing concrete in structures.

A draft standard was submitted in 1996 to CEN enquiry as prEN 12399. It was one of a series of individually numbered test methods for fresh or hardened concrete. For convenience it has now been decided to combine these separate draft standards into three new standards with separate Parts for each method, as follows:

— Testing fresh concrete (EN 12350)

— Testing hardened concrete (EN 12390)

— Testing concrete in structures (EN 12504)

This series EN 12504 includes the following Parts where the brackets give the numbers under which particular test methods were submitted to CEN enquiry:

EN 12504 Testing concrete in structures —

— *Part 1: Cored specimens — Taking, examining and testing in compression (former prEN 12504:1996)*

— *Part 2: Non-destructive testing — Determination of rebound number (former prEN 12398:1996)*

— *Part 3: Determination of pull-out force (former prEN 12399:1996)*

— *Part 4: Determination of ultrasonic pulse velocity (former prEN 12396:1998)*

The Annex A of this standard is informative.

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

Introduction

A range of different methods of measuring pull-out force are available. ISO/DIS 8046 only refers to embedded inserts. This document has been extended to include similar inserts which can be inserted into the hardened concrete and expanded, but which do not create sideways stresses in the concrete.

There are methods which rely on gluing or on the production of sideways stresses to secure an insert, but it is not yet clear whether these give the same results as the methods included in this part.

The measurement can be used to estimate in-situ strength, to determine when post tensioning can proceed, when forms and props can be removed, when winter protection and curing can be terminated, or for comparative testing.

1 Scope

This document specifies a method for the determination of the pull-out force of hardened concrete using a cast-in disc insert and rod, or a similar device installed afterwards by drilling into the hardened concrete.

NOTE The test method is not intended as an alternative for the determination of the compressive strength of concrete, but with suitable correlations it can provide an estimate of in situ strength.

2 Normative references

Non applicable.

3 Principle

A small metal disc, with a rod fixed centrally on one side is installed into concrete, so that the rod protrudes from the surface of the concrete. The force required to pull the disc out of the concrete is measured.

4 Apparatus

4.1 Disc and rod device cast into the concrete (see Figure 1, a))

4.1.1 The disc shall have a circular head of diameter (25 ± 0,1) mm;

4.1.2 The rod shall have a diameter not more than 0,6 times that of the disc;

4.1.3 The length of the rod, measured from the surface of the concrete to the nearest surface of the disc, shall be equal to the diameter of the disc;

4.1.4 The sides of the rod shall be smooth and tapered, with the largest diameter nearest to the surface of the concrete, to minimize friction during testing;

4.1.5 The device may be coated with a release agent to prevent bonding to the concrete and may be notched to prevent rotation in the concrete if the rod is to be unscrewed. Disc and rod device installed after the concrete has hardened

4.2 Disc and rod device installed after the concrete has hardened (see Figure 1, b))

4.2.1 Special devices, drills and under-reaming equipment are required to install the device into the hardened concrete.

NOTE These equipment is available from proprietary manufacturers.

4.2.2 The device shall conform to 4.1.1 and 4.1.3, except that 4.1.1 shall apply after the disc has been mechanically expanded.

4.3 Bearing ring, that can be placed on the concrete surface symmetrically around the protruding rod and having an inside diameter of (55 ± 0,1) mm and an outside diameter of (70 ± 1) mm.

4.4 Loading system

4.4.1 The loading system shall be capable of applying a tensile force to the insert with the reaction being transmitted to the concrete surface through the bearing ring.

4.4.2 The loading system shall ensure that the bearing ring is concentric with the rod and that the load is applied perpendicularly to the plane of the insert.

4.4.3 The calibrated loading system shall include a means of indicating the maximum force applied to a tolerance deviation of ± 2 %. The dial, scale or display shall have a device, that records of the maximum applied force.

5 Test area

5.1 Specimen location

The centres of test positions shall be at least 200 mm apart.

The centres shall be 100 mm from the edge of the concrete.

The inserts shall be placed so that all reinforcement is outside the expected conical failure surface by at least one bar diameter, or the maximum aggregate size, whichever is the greater.

The minimum thickness of the concrete to be tested shall be 100 mm.

5.2 Number of tests

The number of tests required to represent an area or part of a structure depends upon:

a) the expected variability of the concrete;

b) the purpose of the test and the accuracy required.

NOTE Care should be exercised to avoid averaging individual results, if the differences between them reflect real differences in strength, due to factors such as variations in location curing conditions or batches of concrete.

6 Procedures

6.1 Installation of inserts

Securely fix cast-in devices to the formwork or locating device at the required test positions.

NOTE 1 A small separately removable panel may be incorporated inter the formwork when the test is being used to determine the formwork stripping time.

NOTE 2 It is important to ensure that the rods are disconnected from the formwork before its removal.

Drill and under-ream holes for other types of devices and assemble the devices according to the manufacturer's instructions.

6.2 Loading

Do not apply the test to frozen concrete.

First remove the tapered rod of a cast-in device and then connect the loading system to the disc in accordance with the manufacturer's instructions.

Apply the load and increase it at a steady rate of (0,5 ± 0,2) kN/s, without shock, until fracture occurs.

NOTE The insert can be loaded to fracture if the strength is to be estimated, or a proof load can be applied to check that the concrete has achieved a predetermined minimum strength.

Record the maximum indicated force.

7 Expression of results

The maximum indicated force shall be expressed to the nearest 0,05 kN.

NOTE If there is a requirement to determine the pull-out strength, then the procedures given in informative Annex A should be followed.

8 Test report

The report shall include:

a) unambiguous identification of the test location/area(s);

b) description of the concrete tested (if appropriate);

c) details of curing of the concrete (if appropriate and known);

d) age of the concrete at time of test (if known);

e) surface moisture condition of the concrete at time of test;

f) date of test;

g) type of apparatus (cast-in or installed);

h) whether the concrete was loaded to rupture or proof loaded;

i) individual force measurement(s) recorded;

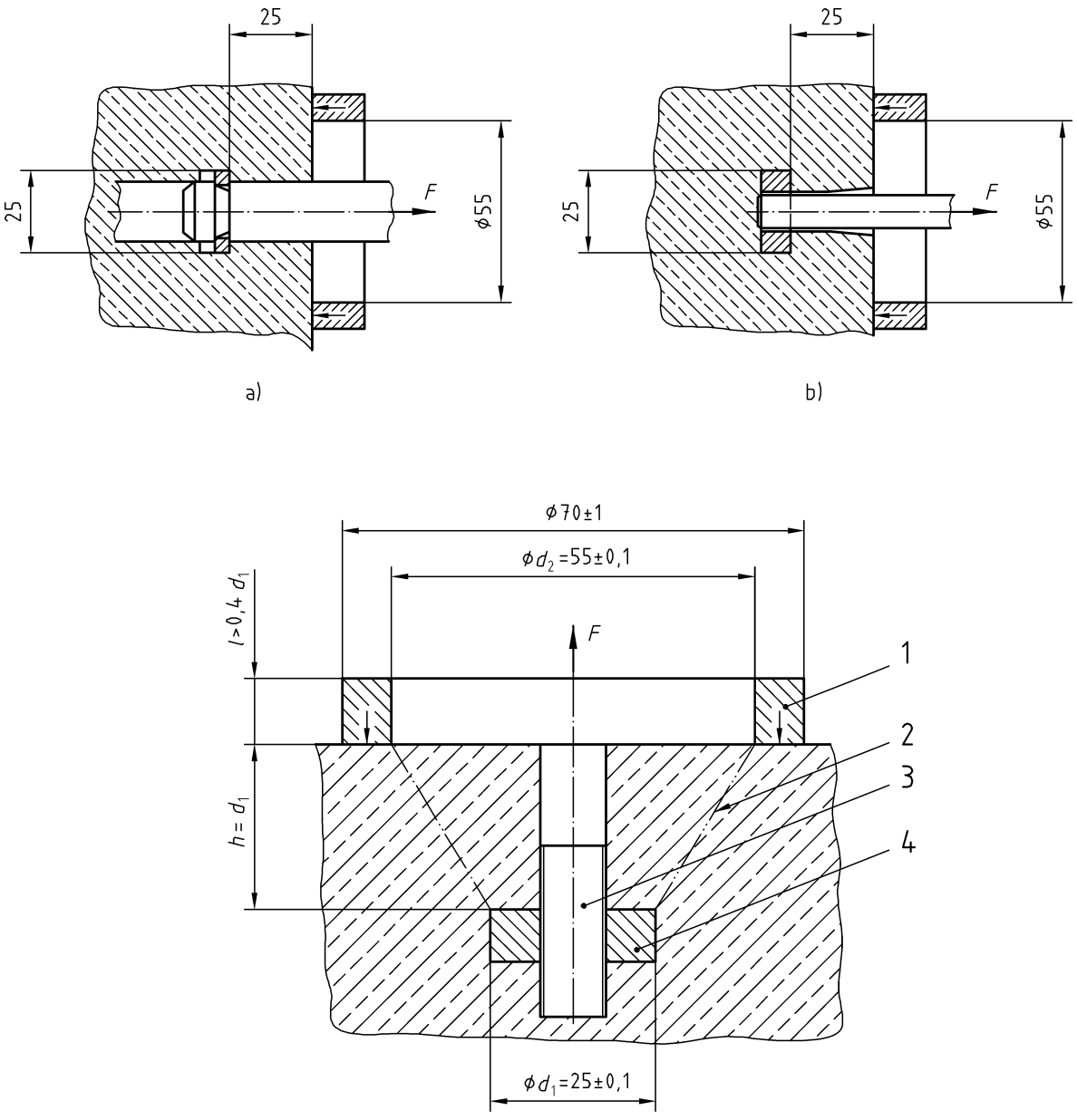
j) any deviations from the standard test method;

k) a declaration by the person technically responsible for the test that it was carried out in accordance with this document, except as noted in item j).

9 Precision

There is no precision data currently available.

Dimensions in millimetres



Key

a) Installed disc insert system
b) Cast-in insert system
c) Scheme of pull-out test

1 Bearing ring
2 Assumed conic fracture
3 Pull-out insert rod
4 Pull-out insert disc

Figure 1 — Pull-out test arrangements

Annex A
(informative)

Relationship between pull-out force and in-situ strength of concrete

The pull-out force can be empirically related to the in-situ strength of the concrete as determined in accordance with EN 12504-1.

The correlation between strength and pull-out force for the apparatus being used should be established experimentally.

It has been shown that for a given type of apparatus the relationship between pull-out force and compressive strength is similar over a wide range of concretes and that a general correlation can be used with reasonable accuracy. Greater accuracy can, however, be achieved if a specific correlation is obtained for the type of concrete under investigation.

Special correlations are required for lightweight concretes or other concretes with less common constituents.

When a general correlation is used, estimates of compressive strength are unlikely to have 95 % confidence limits better than ± 20 % of the mean of four valid results. When a specially prepared correlation for the type of concrete is available, estimates can be within ± 10 %.

The pull-out strength may be calculated by the formula:

$$f_{\mathrm{p}} = \frac{F}{A} \tag{A.1}$$

where:

f_{p} is the pull-out strength in MPa or N/mm²;

F is the pull-out force, in N;

A is the surface area, in mm², of the fracture, given by the formula:

$$A = \frac{1}{4}\pi(d_2 + d_1)\left[4h^2 + (d_2 - d_1)^2\right]^{\frac{1}{2}} \tag{A.2}$$

where:

d_1 is the diameter, in mm, of the head of the pull-out insert (25 mm);

d_2 is the internal diameter, in mm, of the bearing ring (55 mm);

h is the distance, in mm, from the pull-out insert head to the concrete surface.

Bibliography

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

National annex NA (informative)
Additional information on pull-out testing

Pull-out testing is an established method for determining in situ strength. In particular, it is recommended for the assessment of formwork striking times and for determining the time when post-tensioning may commence [1].

Formwork striking times are often expressed in terms of the characteristic strength required from test cubes of equal maturity to the structure. As the pull-out test is a test directly on the structure, the characteristic strength required for pull-out testing may be up to 15 % less. However, it is not possible to make a reliable estimate of the characteristic strength from a few pull-out test results and consequently a suitable margin should be introduced to cover the difference between the mean pull-out force and the required characteristic in situ strength, see CIRIA Report 136 [2].

When used for these purposes, the devices should be located in the least mature face of the element in areas that were the last to be placed. The upper face of a slab is normally the least mature face. Due to water movements during vibration, it is also the weaker face, all other factors being equal. Consequently, the pull-out devices should be located on the upper surface of the slab. If they have been placed on the soffit, an allowance should be made for the possible differences between readings taken in this zone and the weakest areas of the slab.

Establishing a correlation between the pull-out force and cube strength for the particular concrete in use is strongly recommended. Casting devices into a series of test cubes and testing these specimens in conjunction with normal cubes at different ages provides an effective means for determining the correlation between pull-out force and cube strength.

The test causes some damage to the surface and is best used on faces that will not be seen. Where proof testing is undertaken, consideration should be given to the long-term effects of leaving these devices in the structure, e.g. whether they will corrode and create a problem.

National bibliography

[1] CONSTRUCT. *Guide to flat slab formwork and falsework*. The Concrete Society, Crowthorne, 2003.

[2] CIRIA. *Formwork striking times — Criteria, prediction and methods of assessment*. Report 136, CIRIA, London, 1995.

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