

Products and systems  
for the protection and  
repair of concrete  
structures —  
Test methods —  
Determination of  
resistance of capillary  
absorption

The European Standard EN 13057:2002 has the status of a  
British Standard

ICS 91.080.40

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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:

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l'absorption capillaire

Produkte und Systeme für den Schutz und die  
Instandsetzung von Betontragwerken - Prüfverfahren -  
Bestimmung der kapillaren Wasseraufnahme

This European Standard was approved by CEN on 4 January 2002.

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## Foreword

This document EN 13057:2002 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of an identical text or by endorsement, at the latest by November 2002, and conflicting national standards shall be withdrawn at the latest by December 2002.

It has been prepared by sub-committee 8 "Products and systems for the protection and repair of concrete structures", the secretariat of which is held by AFNOR.

This European Standard is one of a series dealing with products and systems for the protection and repair of concrete structures. It gives definitions, requirements, quality control and attestation of conformity for the structural and non-structural repair of concrete structures.

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, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

## 1 Scope

This European Standard is one of a series dealing with products and systems for the protection and repair of concrete structures. It specifies a method for determining the resistance to water absorption of repair products and systems, as defined in prEN 1504-3<sup>1</sup>.

The method is based on measuring the increase in weight due to capillary absorption of water over a fixed time interval. The weight of water absorbed is expressed as a coefficient, indicating the tendency of the specimen to imbibe water by capillary action without external pressure applied.

## 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 (including amendments).

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

prEN 1504-3, *Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 3: Structural and non-structural repair*.

ISO 554, *Standard atmospheres for conditioning and/or testing – Specifications*.

ISO 556, *Conditioning and testing - Standard atmospheres - Definitions*.

## 3 Principle

The method of test is applicable to repair grout, mortar or concrete specimens. Hereafter the term mortar specimen refers equally to concrete, unless stated to the contrary.

Resistance to capillary absorption is measured on the trowelled upper face of 100 mm diameter cylindrical specimens of mortar, with a thickness of at least 20 mm or three times the maximum aggregate size, whichever is the greater. As an alternative, the cut face of 100 mm diameter cores of repair mortar may be used.

## 4 Equipment

4.1 Standard laboratory climate in accordance with the requirements of annex A.

4.2 Moulds for producing specimens made from non absorbent, rigid material, not attacked by cement paste or polymers, of  $(100 \pm 5)$  mm internal diameter and  $(25 \pm 0,5)$  mm depth, or other depth necessary to satisfy the requirement of being three times the maximum aggregate size.

Suitable moulds may be prepared from rigid polypropylene pipe, cut to the appropriate length. It shall be ensured that around the circumference, the length of pipe is within  $\pm 0,5$  mm of the target depth of the specimen.

4.3 Flat bottomed, rigid tray and cover, into which the specimens are placed, resting on knife-edge supports to achieve a depth of water immersion of  $(2,0 \pm 1,0)$  mm. The area of the tray should be at least twice the area of the test specimen(s) to be stood in the tray with a cover to enclose fully the tray.

4.4 Demineralised water.

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<sup>1</sup> Under preparation.

- 4.5 Balance with a minimum resolution of 0,01 g.
- 4.6 Stopwatch accurate to 1 second.
- 4.7 Mortar mixer, in accordance with EN 196-1, or forced action pan mixer.
- 4.8 Compaction tools and equipment in accordance with EN 196-1.

NOTE The compaction method shall be in accordance with the manufacturer's instructions.

- 4.9 Ventilated oven operating at  $(40 \pm 2)$  °C.

## 5 Method of test

The determination of water uptake is carried out on three specimens.

### 5.1 Preparation of specimens

All materials shall be conditioned in the standard laboratory climate (4.1) for a period of not less than 24 h prior to mixing.

Unless otherwise instructed by the manufacturer, use the following mixing technique for preparing the specimens.

For PCC and CC mortar, use the mortar mixer (4.7) set to a low speed, pouring the gauging liquid to the bowl and adding the dry ingredients, mixing for a total period of two minutes.

*For concrete mixes which contain coarse aggregates (> 5 mm), preparation shall be by forced action pan mixer (4.7), or as otherwise instructed by the manufacturer.*

For PC mortar, combine the component parts of the mortar, mixing until fully blended and streak-free.

Where manufacturer's instructions preclude use of part bags of material, a concrete mixer (4.7) or other method recommended by the manufacturer shall be used.

NOTE 1 It has been found that certain types of repair mortar can foam excessively under the action of the mortar mixer specified in EN 196-1. An alternative is to use a forced action pan mixer (4.7).

Place the mixed material carefully into the cylindrical moulds, compacting thoroughly by vibro-compaction or as otherwise instructed by the manufacturer. Release of the mortar shall be achieved by lining the base of the mould with a suitable film, which does not react with the repair product or system. A light smearing of mould oil may be used on the sides of the mould before assembling the base plate.

The specimens shall be finished flush with the sides of the mould using a steel float, with this trowelled surface being the test face.

NOTE 2 The air content, strength and density of the CC and PCC mixes should normally be determined to characterise the mortar under test.

### 5.2 Alternative preparation method

With the approval of the manufacturer, longer test specimens may be prepared than the 100 mm required under (clause 3), trimming the excess repair material once the sample has cured to leave the required length. In this case, the specimen shall be prepared in accordance with (5.1) above, ensuring the thickness is within the manufacturer's recommended maximum value. The cut face shall be the test face.

### 5.3 Curing and conditioning

Cure the specimens using the standard conditions given in annex A, or as otherwise agreed with the manufacturer, taking care to protect the test face from contamination.

Where required, trim the specimens after curing to give the specified length, using a diamond-bladed concrete saw. The cut face shall be parallel with the moulded test face, with the thickness at any point within  $\pm 1$  mm of the length specified in (clause 3).

After the required curing period, bring the specimens to a low and even moisture level by drying in the oven (4.9) for a minimum of seven days at  $(40 \pm 2)$  °C until constant weight is achieved, defined as a weight change of not greater than 0,2 % in 2 h.

Condition the specimens and the test equipment for at least 24 h under the dry conditions defined in annex A.

### 5.4 Test procedure

Carry out the test in the standard laboratory climate (4.1). Before testing, weigh the specimens and record the dimensions. Mark eight equi-spaced axial lines around the perimeter of the test face using an indelible marker, to the full height of each specimen.

Place the test face of each specimen on supports in the shallow tray (4.3) containing the water such that the depth of immersion up the sides of each specimen is  $(2 \pm 1)$  mm (see Figure 1). Start the stopwatch (4.6) immediately and place the cover over the tray to prevent air movement around the specimen under test.

Determine the water uptake into the specimen at testing intervals appropriate to the rate of water uptake into the specimen, with at least six readings required. A reading shall always be taken after 2 h in any case.

NOTE Intervals of 12 min, 30 min, 1 h, 2 h, 4 h and 24 h are appropriate in most cases.

Remove the specimen from the tray and wipe it with absorbent paper to remove surplus water. Determine the mass of the specimen using the balance (4.5) to an accuracy of 0,01 g. Record the location of the wet front after 2 h by marking the position on the eight axial lines. Return the specimen to the tray immediately and replace the cover. It shall be ensured that the removal, drying, weighing and marking of the specimen and its return to the tray are complete within two minutes.

## 6 Expression of results

The water uptake per unit area ( $i$ ) shall be calculated for each time increment from the absorbed weight of water (kg) divided by the surface area of the test face ( $m^2$ ).

### 6.1 Sorption Coefficient

Using a graph, plot  $i$  against the square root of the time of immersion ( $h$ ). Determine the gradient of the resulting line, which should be linear, as shown in Figure 2. The gradient of the line is defined as the sorption coefficient  $S$  ( $kg/(m^2 h^{0,5})$ ).

NOTE 1 The sorption coefficient can also be expressed in units of  $(m/h^{0,5})$ , calculating the volume of water absorbed from the weight, using a density for water of 1 000  $kg/m^3$ .

Two special cases may exist:

- a) Flat end portion - as shown in Figure 3, where the specimen reaches full saturation before the end of the test period. In this case, the gradient shall be calculated from the initial linear portion of the graph.

NOTE 2 In the case where one or more specimens from a set of three has less than three readings taken before the front has reached the top of the specimen, the results are to be discarded and the test repeated using a specimen thickness which is at least twice that of the discarded specimens.



b) Non-linear graph - as shown in Figure 4, caused by variation in the properties of the mortar with depth or change in the system with time. In this case, the gradient shall be calculated as the slope from the intercept to the last reading (i.e. 24 h).

## 6.2 Resistance coefficient

An optional calculation of the resistance coefficient ( $R$ ) may be made using the equation:

$$R = \frac{t_c}{X^2} \quad (1)$$

where

$R$  is the resistance coefficient, ( $\text{h/m}^2$ );

$t_c$  is the time to completion of capillary saturation (h);

$X$  is the thickness of the specimen (m).

Where the water front reaches the top of the specimen during the 24 h test period, determine the time at which the specimen became saturated by capillary absorption ( $t_c$ ) at the point of deviation from the linear portion of the graph, as shown in Figure 3.

**NOTE** The resistance coefficient  $R$  in equation (1) is a measure of the depth to which water will penetrate into the specimen at a given time. In this way the resistance coefficient reflects the fineness of the capillary pore system and because of this can give a correlation with the ratio of water to cementitious binder.

For mortars with a low water uptake, accurate definition of the resistance coefficient may not be possible. This is because the time to reach saturation may not be achieved during the test period. In this case, determine the average height rise after 2 h from the position of the wet front, as marked on the axial lines on the sides of the specimens, measured to the nearest 0,5 mm. The wet front can become diffuse after 2 h under test, making it difficult to mark the position of the height rise after this period.

## 7 Test report

The test report shall include the following information:

- a) a reference to the test method standard;
- b) name and address of the test laboratory;
- c) identification number and date of the test;
- d) name and address of the manufacturer or supplier of the product;
- e) name and identification marks or batch number of the product;
- f) date of supply of the product;
- g) date of preparation of the test specimens and any deviation from the prescribed method of preparation, including the maximum aggregate size and the thickness of the specimen ( $X$ );
- h) conditions of storage of prepared specimens prior to test;
- i) date of test and details of the test equipment used, including the make, type and capacity and the calibration details or the identification number of the apparatus and a description of the test face, (i.e. trowelled or saw-cut face);

- j) the test results, including a graph of the form shown in Figures 2 - 4, single and average values of the sorption coefficient ( $S$ ) for test slices and control concrete, rounding to two significant figures;
- k) optional result - single and average values of the resistance coefficient ( $R$ ) for test specimens and control specimens, rounding to two significant figures, along with the time period to saturation ( $t_c$ );
- l) precision data;
- m) date of test report and signature.

Key

- |   |                           |   |                         |
|---|---------------------------|---|-------------------------|
| 1 | Tray                      | 4 | Water level             |
| 2 | Knife edge support        | 5 | Axial lines on specimen |
| 3 | Mortar or concrete sample |   |                         |

Figure 1 — Typical arrangement of test specimen

Key

- 1 Water uptake ( $\text{kg/m}^2$ )
- 2 Gradient
- 3 Time under test ( $\text{h}^{0,5}$ )

Figure 2 — Linear graph

Key

- 1 Water uptake ( $\text{kg/m}^2$ )
- 2 Gradient
- 3 Capillary saturation ( $v_c$ )
- 4 Time under test ( $\text{h}^{0,5}$ )

Figure 3 — Specimen fully saturated

Key

- 1 Water uptake ( $\text{kg/m}^2$ )
- 2 Gradient
- 3 Time under test ( $\text{h}^{0,5}$ )

Figure 4 — Non-linear graph

## Annex A (normative)

### Summary of temperatures and humidities for the curing, conditioning and testing of repair products and systems

#### A.1 Curing

##### A.1.1 CC (grouts, mortars and concretes)

Prepare as EN 196-1, cover in film for 24 h.

Demould after 24 h.

Cure under water at  $(21 \pm 2)$  °C for 27 d.

##### A.1.2 PCC (grouts, mortars and concretes)

Prepare as EN 196-1, cover in film for 24 h.

Demould after 24 h and wrap in film for 48 h.

Unwrap and cure for 25 d in a standard laboratory climate of  $(21 \pm 2)$  °C and  $(60 \pm 10)$  % RH.

##### A.1.3 PC (grouts, mortars and concretes)

Prepare as ISO 554.

Cure for 7 d at  $(21 \pm 2)$  °C and  $(60 \pm 10)$  % RH.

#### A.2 Conditioning and testing

For specific applications, the following definitions apply:

##### A.2.1 Standard laboratory climate (Dry conditioning)

Take from the curing/storage environment and condition for 7 d in a standard laboratory climate of  $(21 \pm 2)$  °C and  $(60 \pm 10)$  % RH.

## Bibliography

EN 206-1, *Concrete – Specification, performance, production and conformity.*

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

EN 1015-7, *Methods of test for mortar for masonry - Part 7: Determination of air content of fresh mortar.*

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

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