

# Products and systems for the protection and repair of concrete structures — Test methods — Water absorption and resistance to alkali for hydrophobic impregnations

The European Standard EN 13580:2002 has the status of a  
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ICS 91.080.40

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### Summary of pages

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

The BSI copyright date displayed in this document indicates when the document was last issued.

### Amendments issued since publication

Amd. No.	Date	Comments

© BSI 18 September 2002

ISBN 0 580 40400 5

ICS 91.080.40

English version

Products and systems for the protection and repair of concrete structures - Test Methods - Water absorption and resistance to alkali for hydrophobic impregnations

Produits et systèmes pour la protection et la réparation des structures en béton - Méthodes d'essai - Absorption d'eau et résistance aux alcalis pour imprégnations hydrofuges

Produkte und Systeme für den Schutz und die Instandsetzung von Betontragwerken - Prüfverfahren - Wasseraufnahme und Alkalibeständigkeit für hydrophobierende Imprägnierungen

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## Foreword

This document (EN 13580:2002) has been prepared by Technical Committee CEN/TC 104 "Concrete and related products", the secretariat of which is held by DIN.

It has been elaborated by Subcommittee SC 8 "Products and systems for the protection and repair of concrete structures", the secretariat of which is held by 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of an identical text or by endorsement, at the latest by February 2003, and conflicting national standards shall be withdrawn at the latest by February 2003.

The Annexes A and B are 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, 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 specifies a test method to evaluate the effect of a hydrophobic impregnation. It deals with the rate at which treated concrete absorbs water and with the alkali resistance of that surface treatment. The method primarily relates to the protection of concrete structures.

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

EN 13579, *Products and systems for the protection and repair of concrete structures – Test methods – Drying test for hydrophobic impregnation.*

## 3 Symbols

Symbol	Explanation	Unit
$AR$	Absorption ratio	%
$AR_{(alk)}$	Absorption ratio after exposure to alkali	%
$C_m$	Mean consumption of impregnant during treatment	g/m <sup>2</sup>
$C_n$	Consumption of impregnant for each face of test cube during treatment	g/m <sup>2</sup>
$i_1$	Weight of a test cube at start of immersion test	g
$i_2$	Weight of a test cube at end of immersion test	g
$I_t$	Rate of increase in weight of a treated test cube	g/(m <sup>2</sup> · h <sup>0,5</sup> )
$I_{t(alk)}$	Rate of increase in weight of a treated test cube after exposure to alkali	g/(m <sup>2</sup> · h <sup>0,5</sup> )
$I_{ym}$	Mean rate of increase in weight of three treated test cubes	g/(m <sup>2</sup> · h <sup>0,5</sup> )
$I_{ym(alk)}$	Mean rate of increase in weight of three treated test cubes after exposure to alkali	g/(m <sup>2</sup> · h <sup>0,5</sup> )
$I_u$	Rate of increase in weight of an untreated test cube	g/(m <sup>2</sup> · h <sup>0,5</sup> )
$I_{um}$	Mean rate of increase in weight of three untreated test cubes	g/(m <sup>2</sup> · h <sup>0,5</sup> )
$M'_t$	Estimated moisture content of each test cube after conditioning	%
$M_m$	Mean saturated surface dry moisture content of 3 oven dry test cubes	%
$M_{ssd}$	Saturated surface dry moisture content of a test cube	%
$W'_{od}$	Estimated weight of a test cube in oven dry condition	g
$W_{od}$	Weight of a test cube in oven dry condition	g
$W_{ssd}$	Weight of a test cube in saturated surface dry condition	g
$W_t$	Actual weight of test cube after conditioning	g
$W_{t1}$	Weight of test cube immediately prior to treatment	g
$W_{t2}$	Weight of test cube immediately after treatment	g

## 4 Principle

Impregnants applied to the surface of the concrete reduce the ingress of water and salt solutions into concrete. The principle of the test method described in this standard is to compare rate of uptake of water of treated and untreated test cubes from the same batch of concrete. The ratio of the rates is defined as the absorption ratio. The long term durability is assessed by measuring the water absorption after a defined exposure to alkali.

## 5 Apparatus

- 5.1 Nine moulds for concrete cubes (100 mm x 100 mm x 100 mm).
- 5.2 Soft brush
- 5.3 Absorbent paper towel
- 5.4 Balance with an accuracy of 0,01 g.
- 5.5 Support for test cubes on bench in laboratory or in fume cupboard to allow air to circulate around all 6 faces.
- 5.6 Laboratory or chamber maintained at constant temperature  $(21 \pm 2) ^\circ\text{C}$  and relative humidity of  $(60 \pm 10) \%$
- 5.7 Forced air circulation oven to run at  $(105 \pm 5) ^\circ\text{C}$ .
- 5.8 Desiccator cabinet containing silica gel.
- 5.9 Fume cupboard.
- 5.10 Two suitable air tight boxes containing saturated potassium sulphate solution for storing specimens. Note that treated and untreated test cubes must be stored in separate boxes.
- 5.11 One 150 mm diameter petri dish with 2 spacers glued to bottom of dish to support the test cubes during treatment
- 5.12 Demineralised water (conductivity  $< 50 \mu\text{S}$ ).
- 5.13 Six 5 l beakers with suitable spacers to support test cubes.
- 5.14 Potassium-hydroxide solution (5,6 g/l).
- 5.15 Cling film.

## 6 Preparation of test specimens

Nine 100 mm concrete test cubes shall be cast from a single batch of Type C (0.45) concrete and cured for 28 days according to EN 1766. No oil or release agent will be permitted on the surface of the moulds (5.1). After removal from the curing tank, the test cubes shall be cleaned with tap water using a soft brush (5.2) to remove any loose material. The surface of the test cubes shall not be grit blasted. The test cubes shall be surface dried with an absorbent paper towel (5.3) and then weighed ( $\bar{W}_{ssd}$ ) using the balance (5.4).

Six test cubes (No. 1 - 6), suitably supported to allow air to circulate around each of the 6 faces (5.5), shall be conditioned on a bench in the laboratory (temperature  $(21 \pm 2) ^\circ\text{C}$  and relative humidity  $(60 \pm 10) \%$ ) (5.6) for 7 days and reweighed ( $W_i$ ). The remaining three test cubes (No. 7 - 9) shall be oven dried at  $(105 \pm 5) ^\circ\text{C}$  (5.7) for 7 days, cooled in a desiccator cabinet containing silica gel (5.8) and reweighed ( $W_{od}$ ).

The saturated surface dry moisture content ( $M_{ssd}$ ) of the 3 oven dry test cubes (No. 7 - 9), shall be calculated using the following formula :

$$M_{ssd} = \frac{W_{ssd} - W_{od}}{W_{od}} \cdot 100 \text{ in percentage by weight} \quad (1)$$

The estimated oven dry weight ( $W'_{od}$ ) of each of the remaining 6 test cubes (No. 1 - 6) shall be calculated using the formula :

$$W'_{od} = \frac{W_{ssd}}{1 + \left(\frac{M_m}{100}\right)} \text{ in grams} \quad (2)$$

where

$M_m$  is the mean saturated surface dry moisture content of the 3 oven dry test cubes (No. 7 - 9), in percentage by weight.

The estimated moisture content ( $M'_i$ ) of each of the test cubes after conditioning shall be calculated from the weight,  $W_i$

$$M'_i = \frac{W_i - W'_{od}}{W'_{od}} \cdot 100 \text{ in percentage by weight} \quad (3)$$

The test cubes (No. 1 - 6) shall be weighed daily during conditioning from the fourth day until the weight  $W_i$  obtained is equivalent to a moisture content of  $(5,0 \pm 0,5) \%$ .

## 7 Treatment

Three test cubes from the batch shall be treated in a fume cupboard (5.9) with the fan on immediately after the conditioning. The 3 untreated test cubes shall be placed in an airtight box (5.10) over a saturated solution of potassium sulphate until required for the absorption test.

Each cube shall be treated by dipping each face in the impregnant. Immediately prior to treatment of each face, the cube shall be weighed ( $W_{i1}$ ). 60 ml of the material shall be measured into a petri dish 150 mm in diameter (5.11).

One side of the cube, supported on the 2 mm plastic spacers, shall be dipped in the material for  $(120 \pm 5)$  s, and then removed. Excess liquid on the cube shall be allowed to drain back into the dish and the cube immediately reweighed ( $W_{i2}$ ). The excess material in the dish is then to be discarded. This procedure shall be repeated for first side of the other two cubes.

The consumption ( $C_n$ ) of the material for each face of the cube shall be calculated as follows :

$$C_n = \frac{W_{i2} - W_{i1}}{0,01} \text{ in grams by square meters} \quad (4)$$

The above procedure shall be repeated on the remaining faces of each of the cubes and the average consumption for each cube shall be calculated.

The mean consumption ( $C_m$ ) for the three test cubes shall be calculated.

If the consumption is below the manufacturer's recommended value the time of dipping can be extended.

If it is not practical to treat test cubes by this method, the treatment should be carried out in accordance with the manufacturer's instructions.



The cubes shall be stored, suitably supported to allow air to circulate around all 6 faces, in the fume cupboard (5.3) for  $(48 \pm 1)$  h after the start of treatment with the fan off. The treated cubes shall then be stored over a saturated potassium sulphate solution in an airtight box.

Note that it is essential that the treated and untreated cubes are stored in separate boxes.

## 8 Test procedure

The tests shall either be carried out on 3 treated and 3 untreated test cubes prepared as described in sections 6 and 7 above or on test cubes that have been used previously for the drying test as described in prEN 13579. In both cases, the absorption test shall commence 14 days after treatment.

Sufficient demineralised water (Conductivity < 50  $\mu\text{S}$ ) (5.12) shall be placed into each of the 6 beakers (5.13) so that each test cube supported on a spacer will be fully covered with a head of  $(25 \pm 5)$  mm. The three treated and the three untreated test cubes shall each be weighed ( $i_1$ ) and immersed in demineralised water. The treated and untreated test cubes shall be removed from the water after  $(24,0 \pm 0,1)$  hours and  $(1,00 \pm 0,02)$  hour respectively, surface dried with an absorbent cloth and reweighed ( $i_2$ ).

The rate of increase in weight for each treated test cube ( $I_t$ ) shall be calculated from the equation :

$$I_t = \frac{i_2 - i_1}{\sqrt{24} \cdot 0,06} \text{ in } \frac{\text{g}}{\text{m}^2 \cdot \text{h}^{0,5}} \quad (5)$$

and for each untreated test cube from the equation :

$$I_u = \frac{i_2 - i_1}{\sqrt{1} \cdot 0,06} \text{ in } \frac{\text{g}}{\text{m}^2 \cdot \text{h}^{0,5}} \quad (6)$$

The absorption ratio ( $AR$ ) shall be calculated :

$$AR = \frac{I_{tm}}{I_{um}} \cdot 100 \text{ in percentage} \quad (7)$$

where

$I_{tm}$  is the mean rate of weight gain of the three treated test cubes ; and

$I_{um}$  is the mean rate of weight gain of the untreated test cubes.

Immediately after the immersion test, the three treated test cubes shall be placed in individual beakers containing sufficient potassium hydroxide solution (5,6 g/l) (5.14) to fully cover a test cube supported on a spacer with a head of  $(25 \pm 5)$  mm. The beakers are securely covered with cling film (5.15) and left for  $(21 \pm 0,1)$  days. The test cubes shall be removed from the beakers and dried, suitably supported on a bench to allow air to circulate around each of the 6 faces in the laboratory, until their weight is within  $\pm 2$  g of their weight prior to the start of the immersion test ( $i_1$ ). A second immersion test shall be carried out and rate of increase in weight of each treated test cube after the alkali test  $I_{t(alk)}$  calculated. The absorption ratio ( $AR_{alk}$ ) shall be calculated by :

$$AR_{alk} = \frac{I_{tm(alk)}}{I_{um}} \cdot 100 \text{ in percentage} \quad (8)$$

where

$I_{tm(alk)}$  is the mean rate of weight gain of the three test cubes after immersion in alkali, in grams.

## 9 Test report

The test report shall contain at least the following information :

- a) a reference to this European standard ;
- b) name and address of the test laboratory ;
- c) identification number and date of the test report ;
- d) name and address of the manufacturer or supplier of the product(s) ;
- e) name and identification marks or batch number of the product(s) ;
- f) date of supply of the product ;
- g) date of preparation of the test specimens and any deviation from the prescribed method of preparation ;
- h) numbering of cubes ;
- i) details of the concrete mix design ;
- j) conditions of storage of prepared specimens prior to test ;
- k) the mean saturated surface dry moisture content of the test cubes ;
- l) the mean moisture content of the test cubes after conditioning ;
- m) the mean consumption of the impregnant ;
- n) the absorption ratio before and after exposure to alkali ;
- o) date of test and details of the test equipment used ;
- p) any deviation from the test method specified ;
- q) date of the report and signature ;
- r) any other observations.

## Annex A (informative)

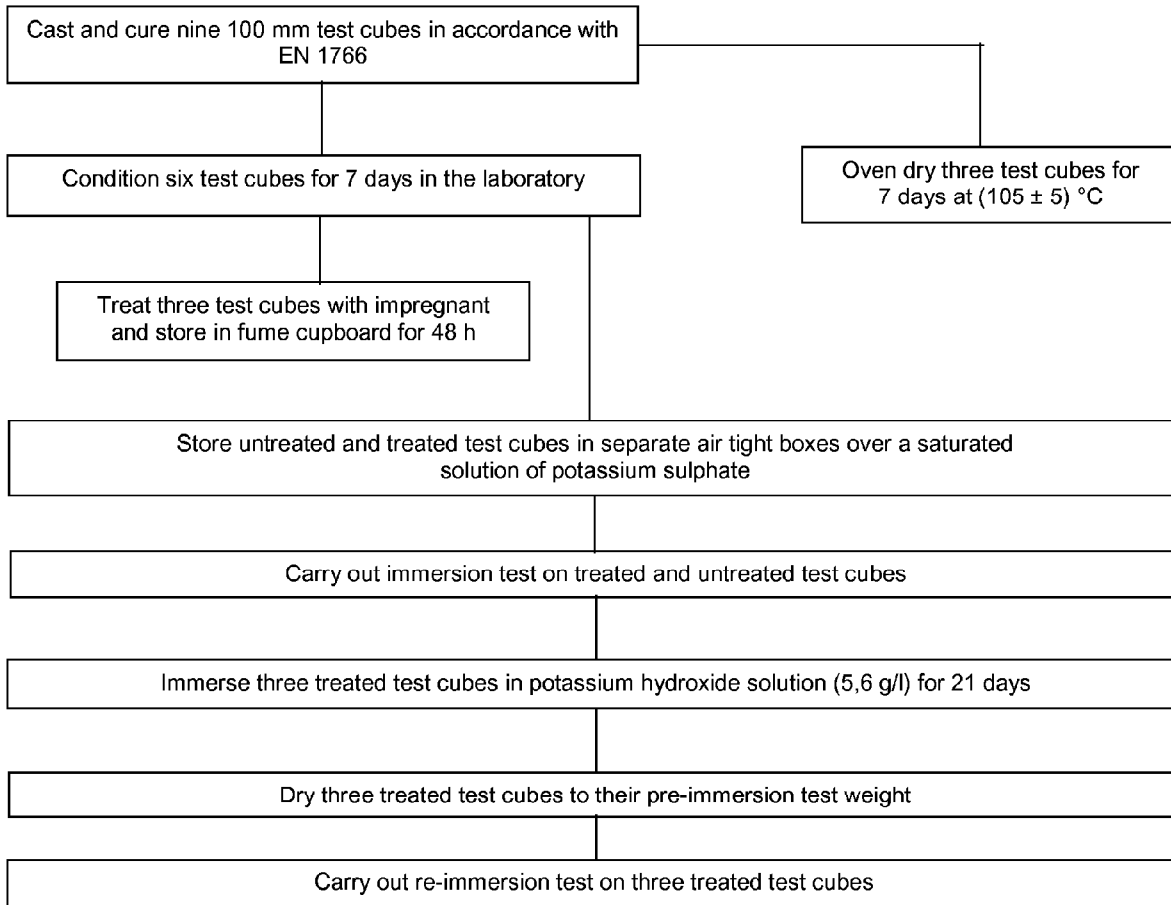


Figure A.1 : Flow chart of test procedure for absorption and resistance to alkali test

## Annex B (informative)

If all parties agree, the tests can be carried out on Type C (0,70) concrete as specified in EN 1766.

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