

**Draft for Public Comment**

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**Head office**

389 Chiswick High Road  
London W4 4AL  
Telephone: 0181 996 9000  
Fax: 0181 996 7400

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Responsible committee: B/517/8

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Title: Products and systems for the protection and repair of concrete structures — Test methods —Determination of thermal compatibility — Part 3: Thermal cycling without de-icing salt impact

(prEN 13687-3)

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**Responsible BSI committee Secretary:** M K Greenley

Direct tel: 0181-996-7232

E-mail address: malcolm\_greenley@bsi.org.uk

## Commenting on drafts

This draft standard is based on European discussions in which the UK took an active part. Your comments on this draft are welcome and will assist in the preparation of the consequent British Standard. If no comments are received to the contrary, then the UK will approve this draft and implement it as a British Standard. Comment is particularly welcome on national legislative or similar deviations that may be necessary.

Even if this draft standard is not approved by the UK, if it receives the necessary support in Europe, the UK will be obliged to publish the official English Language text unchanged as a British Standard and to withdraw any conflicting standard.

## Format

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Each comment shall make one point only, be clearly separated from the others and be structured as follows in clause order:

- clause/sub-clause;
- paragraph/table/figure number;
- type of comment (general, technical or editorial);
- comment (with rationale);
- proposed change.

## Submission

All comments should be submitted to the committee secretary at the Head Office address, preferably electronically via e-mail or on diskette (MS-DOS compatible, 1.44 megabytes). Comments should be compatible with Version 6.0 of Microsoft® Word for Windows™, if possible; otherwise comments in ASCII text format are acceptable. Any comments not submitted electronically should still adhere to the format requirements given above. No acknowledgement will normally be sent.

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Project no.: 1996/06202	DPC no.: 99/105691
Commentator:	Date:

Clause/ subclause	Paragraph/ Figure/ Table	Type of comment (General/ technical/ editorial)	Comment (with rationale)	Proposed change
Examples: 3.1	1st definition	Editorial	Definition is ambiguous and needs clarifying.	Amend to read '... so that the mains connector to which no connection ...'
6.4	2nd paragraph	Technical	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK, giving rise to misleadingly high results.	Delete reference to UV photometer.

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

**DRAFT**  
**prEN 13687-3**

July 1999

ICS

English version

Products and systems for the protection and repair of concrete  
structures - Test methods - Détermination of thermal  
compatibility - Part 3: Thermal cycling without de-icing salt  
impact

Produits et systèmes pour la protection et la réparation des  
structures en béton - Méthode d'essai - Détermination de la  
compatibilité thermique - Partie 3: Cycles thermiques sans  
immersion dans des sels déglaçants

Produkte und Systeme für den Schutz und die  
Instandsetzung von Betontragwerken - Prüfverfahren -  
Bestimmung der Wärmeverträglichkeit - Teil 3:  
Temperaturschockbeanspruchung ohne Tausalzangriff

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 104.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

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

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## Foreword

This document has been prepared by CEN /TC 104, "Concrete (performance, production, placing and compliance criteria)" (Secretariat DIN).

This document is currently submitted to the CEN Enquiry.

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

This part of the European Standard describes a method of test for determining the thermal compatibility of surface protection systems when applied to a standard concrete, by thermal cycling between 60 °C and -15 °C, including immersion in water but without immersion in de-icing salt solution.

## 1 Scope

This standard is the third of a series of five parts to assess the thermal compatibility of repair products and systems, or surface protection systems, for structural and non structural repair of concrete structures. The method measures the effect of thermal cycling without de-icing salt immersion upon surface protection systems used as part of a repair product or system.

## 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 1504-1, *Products and systems for the protection and repair of concrete structures - Part 1 : General scope and definitions.*

<sup>1)</sup>  
EN 1504-2, *Products and systems for the protection and repair of concrete structures - Part 2 : Surface protection systems.*

EN 1504-3<sup>1)</sup>, *Products and systems for the protection and repair of concrete structures -Structural and non-structural repair.*

EN 1504-4<sup>1)</sup>, *Products and systems for the protection and repair of concrete structures – Part 4 : Structural bonding.*

<sup>1)</sup>  
EN 1542, *Products and systems for the protection and repair of concrete structure - Test methods - Pull-off test.*

<sup>1)</sup>  
EN 1766, *Reference concrete for testing.*

## 3 Terms and definitions

For the purposes of this European Standard, terms and definitions contained in prEN 1504-1 apply.

## 4 Principle

The principle of the test method consists of applying the surface protection system to a reference concrete slab (prepared according to EN 1766). After curing of the surface protection system, the test specimen is subjected to thermal cycling without salt impact. Following the temperature cycling, visible defects (cracking, peeling, chalking etc) are recorded and the adhesion of the repair product or system to the concrete substrate is determined by pull-off test (according to EN 1542). Thermal cycling is carried out either continuously in a programmable climatic chamber or manually using a cooler, a water bath and an oven.

## 5 Apparatus

5.1 **Laboratory**, maintained at standard climate conditions (Annex A).

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<sup>1)</sup> At present at the draft stage

**5.2 Mixer**, for mixing the constituents of the mortar. Unless stated otherwise by the manufacturer, use a forced action pan mixer.

**5.3 Concrete slab test panels**, dimensions 300x300 x100 mm, of reference concrete to EN 1766 and type as specified in prEN 1504-2, 3 and 4.

**5.4 Core drilling machine** with a diamond tool, internal diameter 50 mm (according to EN 1542).

**5.5 Pull off Equipment**, for measuring the pull-off strength according to EN 1542.

**5.6 Programmable climatic chamber**, for thermal cycling, comprising an enclosed, insulated chamber with heating, cooling and flooding equipment. Adequate air and water motion for a homogenous temperature distribution in the chamber must be ensured. Inside shall be a temperature sensor to measure and record the temperature near the samples. The media temperature  $T$  in the chamber must be regulated in such a way that they are within the specified ranges at a distance of  $(10 \pm 2)$  mm from the centre of each coating surface throughout the test cycle. The climatic chamber shall have a controller for the heating, cooling, flooding and emptying.

**5.7 Alternative equipment**, comprising a cooler, adjustable at  $(-15 \pm 2)$  °C, a water bath, adjustable at  $(20 \pm 2)$  °C and an oven, adjustable at  $(60 \pm 2)$  °C.

## 6 Preparation of test specimens

The application of the repair product or system to the concrete slab specimens (5.3) shall be carried out at standard climate conditions (5.1) or such alternative environments as may be specified for the intended use.

Three concrete slab specimens (5.3) are required for each test, with one serving as a reference slab.

The top surface of the concrete slab specimens shall be prepared by grit blasting in accordance with EN 1766, followed by application of the repair product or system, or surface protection system, in accordance with manufacturers instructions, to form the test face according to EN 1542 clauses 5 and 6. Samples for wet and dry conditions according to Annex A shall be prepared. After application of the repair product or system, or surface protection system, the samples shall then be cured in accordance with the requirements of Annex A.

**IMPORTANT** Before immersion in water, all surfaces of the specimens except the test face are to be coated with thermosetting resin to prevent penetration of liquid into the side and rear of the concrete slab during the test.

## 7 Procedure

Thermal cycling then commences with two coated slabs. The reference slab is to be stored under laboratory conditions. Thermal cycling shall then be carried out by one of the following methods :

- a) in a programmable climatic chamber according to (5.6) or,
- b) manual cycling using the cooler, water bath and oven according to (5.7).

### 7.1 Thermal cycling in a programmable climatic chamber

Thermal cycling takes place in a programmable climatic chamber according to (5.6). After storing the coated concrete slabs as described in (6), the following cycle starts.

The coated concrete slabs are positioned upright, with a distance of a least 100 mm maintained between the slabs and of at least 50 mm from the slabs to the cabinet walls.

The test cycle is shown in Figure 1. One cycle lasts for 24 h and comprises the following stages :

- • 2 h water storage at  $T = (20 \pm 2)$  °C (including final emptying within a maximum of 15 min) ;



- • 3 h cooling with air at  $T = (-15 \pm 2) \text{ }^\circ\text{C}$  (maximum permissible deviation from the linear temperature curve between  $20 \text{ }^\circ\text{C}$  and  $-15 \text{ }^\circ\text{C}$  shall be  $3 \text{ }^\circ\text{C}$ );
- • 4 h storage at  $T = (-15 \pm 2) \text{ }^\circ\text{C}$ ;
- • 15 min heating with water at  $T = (20 \pm 2) \text{ }^\circ\text{C}$  (flooding within a maximum of 15 min);
- • 1 h 15 min water storage at  $T = (20 \pm 2) \text{ }^\circ\text{C}$  (including final emptying within a maximum of 15 min);
- • 1 h 30 min heating with air at  $T = (60 \pm 2) \text{ }^\circ\text{C}$  (permissible deviation from linear temperature curve between  $20 \text{ }^\circ\text{C}$  and  $60 \text{ }^\circ\text{C}$  shall be  $\pm 3 \text{ }^\circ\text{C}$ );
- • 10 h air storage at  $T = (60 \pm 2) \text{ }^\circ\text{C}$ ;
- • 15 min cooling with water at  $T = (20 \pm 2) \text{ }^\circ\text{C}$  (flooding within a maximum of 15 min);
- • 1 h 45 min water storage at  $T = (20 \pm 2) \text{ }^\circ\text{C}$ .

After every ten cycles, the positions of the test specimens in the chamber should be changed on a rotation basis, to compensate for any slight differences in temperature that might occur.

The complete 24 hour cycle shall be repeated for the duration specified in EN1504-2.

## 7.2 Thermal cycling by manual method

Thermal cycling takes place in a cooler, a water bath and an oven according to (5.7). After the storage described in (6) the following cycle starts.

The slabs are positioned upright, with a distance of at least 100 mm between the slabs and of at least 50 mm from the slabs to the walls.

The test cycle comprises the following steps :

- 2,0 h water storage at  $T (20 \pm 2) \text{ }^\circ\text{C}$ ;
- 4,0 h storage in air at  $T (-15 \pm 2) \text{ }^\circ\text{C}$ ;
- 2,0 h water storage at  $T (20 \pm 2) \text{ }^\circ\text{C}$ ;
- 16 h storage in air at  $T (60 \pm 2) \text{ }^\circ\text{C}$ .

Each cycle lasts 24 h. During an interruption of the cycle storage (over the weekend) the test specimens will be stored in the standard laboratory climate (5.1).

After every ten cycles, the positions of the test specimens in the storage tanks should be changed on a rotation basis, to compensate for any slight differences in temperature that might occur.

The complete four-hour cycle shall be repeated for the number of cycles specified in EN1504-2.

## 8 Evaluation of results

After each ten cycles, the coated test specimens are to be visually inspected :

- - for scaling and/ or cracking if a PC, PCC or HC repair product is tested
- - for surface alterations (cracks, peeling, blistering, delamination, bubbling or other surface defects) if a surface protection system is tested.

Cracks > 0,05 mm and any observed surface alterations shall be reported. The final visual inspection should be performed at least 16 h after the end of the cycling.

The pull-off strength of the reference slabs and the test specimens shall be determined according to prEN 1542 after conditioning at standard climate conditions for not less than seven days after completion of cycling.

## 9 Test report

The test report shall at least include the following information :

- a) a reference to this European Standard; title and date of issue ;
- b) any details necessary to identify the sample ;
- c) the type and dimensions of the concrete slabs according to EN 1766 ;
- d) a description of the surface protection system under test and whether it is a single coating or a multicoat system ;
- e) applied test method and apparatus used (i.e. manual or automatic cycling) ;
- f) the total number of cycles carried out ;
- g) any observed surface alterations after removal from the test cabinet ;
- h) a description of the pull-off equipment ;
- i) the results (single values, mean values and standard deviations) of the pull off test including individual forms of fracture ;
- j) any deviation from this standard ;
- k) the place, date and time of the test.

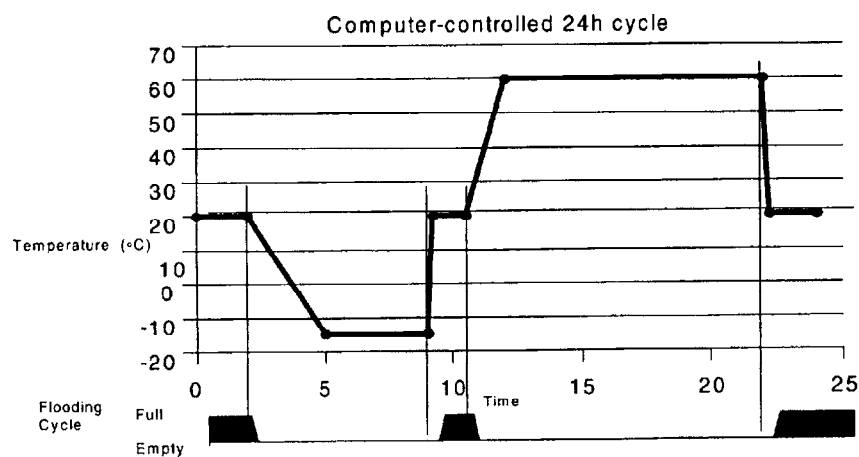


Figure 1 - Thermal cycling between  $-15 \pm 2^\circ\text{C}$ ,  $20 \pm 2^\circ\text{C}$  and  $60 \pm 2^\circ\text{C}$

## 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 HC (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 days.

##### 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 days in a standard laboratory climate of  $(21 \pm 2)$  °C and  $(60 \pm 10)$  % RH.

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

- • Cure for 7 days 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 days in a standard laboratory climate of  $(21 \pm 2)$  °C and  $(60 \pm 10)$  % RH.

##### A.2.2 Wet Conditioning :

- • immerse for 7 days at  $(21 \pm 2)$  °C, or for HC take directly for test after 28 days of immersion.
- • Remove all surface water by standing upright for 30 min before using for tests.