

Products and systems for the protection and repair of concrete structures — Test methods — Determination of thermal compatibility —

Part 2: Thunder-shower cycling (thermal shock)

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British Standard

ICS 91.080.40

National foreword

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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:

- 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;
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Foreword

This document EN 13687-2:2002 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of an identical text or by endorsement, at the latest by August 2002, and conflicting national standards shall be withdrawn at the latest by December 2002.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 Part of this European Standard describes a method of test for determining the thermal compatibility of grouts, mortars and concretes and surface protection systems applied to a standard concrete, by shock dousing in cold water at 12 °C followed by heating to 60 °C. It is one of a series of inter-related parts dealing with the thermal compatibility of repair products and systems. The other parts of this standard are :

EN 13687-1, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 1: Freeze-thaw cycling with de-icing salt immersion.*

EN 13687-3, *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.*

EN 13687-4, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 4: Dry thermal cycling.*

EN 13687-5, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of thermal compatibility - Part 5: Resistance to temperature shock.*

Annex A is normative.

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 standard is the second in a series of five parts to assess the thermal compatibility of repair products and systems, comprising grouts, mortars and concretes and surface protection systems, used for the repair and protection of concrete structures. The method measures the effect of shock cooling (thunder-shower) from an elevated temperature. The method is suitable for repair products and systems based on CC, PCC and PC binders and for surface protection systems.

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*.

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*.

prEN 1504-2, *Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 2: Surface protection systems*.

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*.

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

EN 1542, *Products and systems for the protection and repair of concrete structures - Test methods - Measurement of bond strength by pull-off*.

3 Terms and definitions

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

4 Principle

A layer of the repair product or system or surface protection system is applied to a reference concrete test specimen prepared according to EN 1766. After curing, the test specimen is subjected to thermal shock cycling between 60 °C and 12 °C. Following the temperature cycling, visible defects are recorded and the adhesion of the repair product or system to the concrete substrate is determined by pull-off test.

5 Apparatus

5.1 Laboratory maintained at the standard laboratory climate of $(21 \pm 2) ^\circ\text{C}$ and $(60 \pm 10) \% \text{RH}$ (see annex A).

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 test specimens, of dimensions of 300 mm x 300 mm x 100 mm to EN 1766 and type as specified in prEN 1504-2 or prEN 1504-3.

5.4 Core drilling machine with a diamond tool, internal diameter 50 mm as specified in EN 1542.

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

5.6 Equipment for thunder-shower simulation, comprising an open test cabinet with radiant surface heater (e.g. quartz beam) and water sprinkler system, such that the temperature on the specimen surface can be elevated to $(60 \pm 5) ^\circ\text{C}$ within (45 ± 15) min, verified by a thermocouple placed on the surface.

5.7 Water supply for the thunder shower cabinet (see 5.6) at $(12 \pm 3) ^\circ\text{C}$, capable of supplying at a minimum rate of 10 l/min per m^2 of specimen surface.

The temperature difference between the radiant heat temperature and the dousing water shall be $(48 \pm 5) ^\circ\text{C}$.

6 Preparation of test specimens

Three concrete test specimens (see 5.3) are required for each test, with one serving as a reference specimen. Prior to application of the repair product or system or surface protection system, all materials shall be stored in the standard laboratory climate (see 5.1) for at least 24 h. The repair grout, mortar or concrete and/or the surface protection system shall be prepared and applied to the concrete test specimens in accordance with manufacturers instructions at the standard laboratory climate (see 5.1) or such alternative environments as may be specified for the intended use.

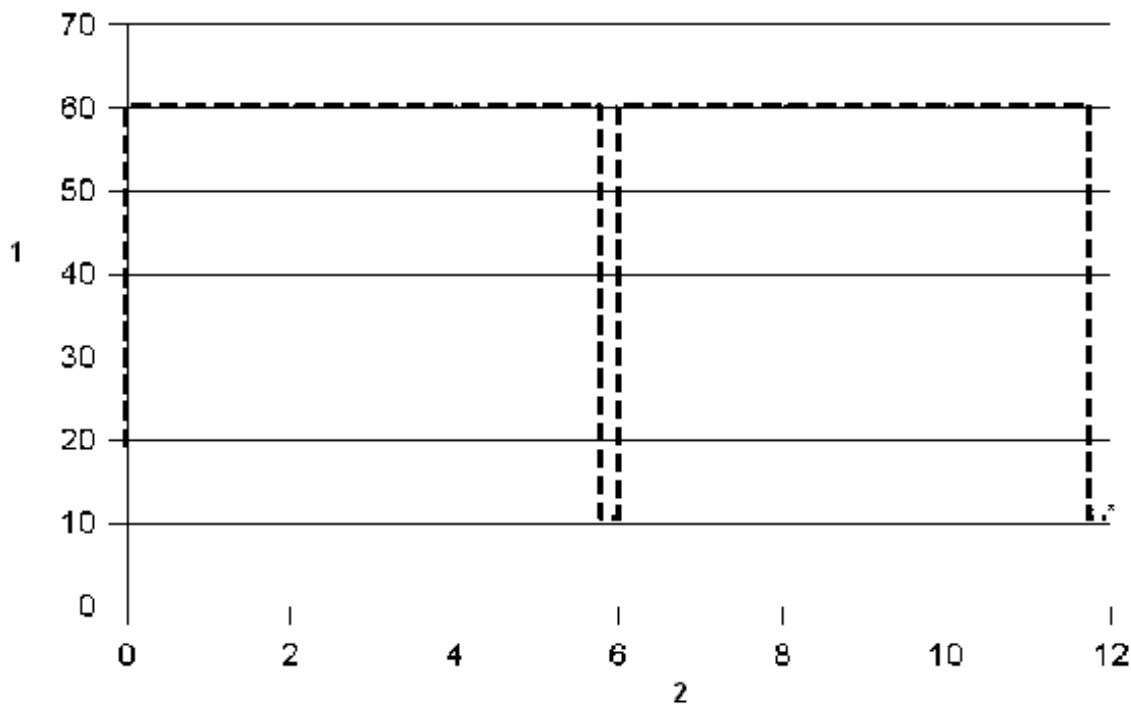
After application of the material under test, the samples shall be cured in accordance with the requirements of annex A.

7 Procedure

After completing the preparation, two of the test specimens shall be taken for test. A specimen shall be positioned in the thunder shower cabinet (see 5.6), with the test surface uppermost and positioned with a slight slope of the surface (approx. 3 degrees to the horizontal) so that the water can flow off rapidly. The 6 h test cycle shown in Figure 1 shall then start, comprising the following stages :

- storage under radiant heat at $(60 \pm 5) ^\circ\text{C}$ for 5 h and 45 min.
- dousing with water at a temperature of $(12 \pm 3) ^\circ\text{C}$ for 15 min.

The temperature difference between the radiant heat temperature and the dousing water shall be $(48 \pm 5) ^\circ\text{C}$.



Key

- 1 Temperature (deg °C)
- 2 Time (h)

Figure 1 — Thunder shower cycle

The thunder shower cabinet (see 5.6) shall be equipped with a sufficient source of radiant heat such that the surface of the specimen reaches the specified temperature. The dousing device shall ensure uniform sprinkling of water onto the surface of the specimens.

The complete six-hour cycle shall be repeated for the number cycles specified in prEN 1504-2 or prEN 1504-3. The reference specimen shall be stored in the standard laboratory climate.

8 Evaluation of results

After every ten cycles, the specimens shall be visually inspected :

- for scaling and/or cracking if a PC, PCC or CC 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 repair product or system applied to the reference specimen and the two test specimens shall be determined according to EN 1542 after conditioning at the standard climate conditions for not less than seven days after completion of cycling.

9 Test report

The test report shall include the following information :

- a) a reference to this European Standard, including the number, title and date of issue ;
- 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(s) of the product(s) ;
- f) date of supply of the product(s) ;
- g) date of preparation of the test specimens ;
- h) conditions of storage of prepared specimens prior to test ;
- i) date of test and details of test equipment used including the make, type and capacity and calibration details or identification number of the apparatus ;
- j) the total number of cycles carried out ;
- k) the results (single values, mean values and standard deviations) of the pull off test including individual forms of fracture, and any observed surface alterations after removal from the test cabinet ;
- l) the type and dimension of the concrete test specimens according to EN 1766 ;
- m) a description of the product, system or surface protection system under test and whether it is a single or multi layer system ;
- n) precision data ;
- o) date of test report and signature.

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 ± 2) °C for 27 days.

A.1.2 PCC (grouts, mortars and concretes)

- Prepare as EN 196, 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 ± 2) °C and (60 ± 10) % RH.

A.1.3 PC (grouts, mortars and concretes) and surface protection systems

- Cure for 7 days at (21 ± 2) °C and (60 ± 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 ± 2) °C and (60 ± 10) % RH.

A.2.2 Wet conditioning

- Immerse for 7 days at (21 ± 2) °C, or for CC take directly for test after 28 days of immersion ;
- remove all surface water by standing upright for 30 min before using for tests.

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