
Proizvodi in sistemi za zaščito in popravilo betonskih konstrukcij - Preskusne metode - 4. del: Določevanje krčenja in nabrekanja

Products and systems for the protection and repair of concrete structures - Test methods - Part 4: Determination of shrinkage and expansion

Produkte und Systeme für den Schutz und die Instandsetzung von Betontragwerken - Prüfverfahren - Teil 4: Bestimmung des Schwindens und Quellens

Produits et systèmes de protection et de réparation des structures en béton - Méthodes d'essai - Partie 4: Détermination du retrait et de l'expansion

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Products and systems for the protection and repair of concrete structures - Test methods - Part 4: Determination of shrinkage and expansion

Produits et systèmes de protection et de réparation des structures en béton - Méthodes d'essai - Partie 4: Détermination du retrait et du gonflement

Produkte und Systeme für den Schutz und die Instandsetzung von Betontragwerken - Prüfverfahren - Teil 4: Bestimmung des Schwindens und Quellens

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

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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Foreword

This document EN 12617-4:2002 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of an identical text or by endorsement, at the latest by November 2002, and conflicting national standards shall be withdrawn at the latest by December 2002.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 was 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.

This European Standard describes two methods for determining the dimensional stability of repair products and systems subject to conditions of drying and immersion. The first method measures the unrestrained shrinkage and expansion, while the second method measures the effects of restraint on the unrestrained shrinkage and expansion.

It is one of a series of inter-related parts dealing with dimensional stability of repair products and systems. The other parts are:

prEN 12617-1, *Products and systems for the protection and repair of concrete structures - Test methods – Part 1: Determination of linear shrinkage.*

prEN 12617-2, *Products and systems for the protection and repair of concrete structures - Test methods – Part 2: Determination of volumetric shrinkage.*

EN 12617-3, *Products and systems for the protection and repair of concrete structures - Test methods - Part 3: Determination of early age linear shrinkage for structural bonding agents.*

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.

EN 12617-4:2002 (E)

1 Scope

This European Standard specifies a method for measuring the dimensional stability (i.e. the shrinkage and expansion movement) due to changes in the moisture content of hydraulic mortars or concretes (CC) or polymer hydraulic cement mortars or concretes (PCC) as defined in EN 1504-1. Two methods are proposed, namely a procedure for unrestrained movement and a procedure for restrained movement.

The provisions of the standard are applicable to grout, mortar or concrete products or systems with a maximum aggregate size of 10 mm.

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 196-1:1994, *Methods of testing cement - Part 1: Determination of strength*.

EN 1015-2, *Methods of test for mortar for masonry – Part 2: Bulk sampling of mortars and preparation of test mortars*.

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 1504-3¹, *Products and systems for the protection and repair of concrete structures - Part 3: Structural and non-structural repair*.

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

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

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

3 Terms and definitions and symbols

3.1 Terms and definitions

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

3.2 Symbols

The following list of symbols is used in this standard.

c	is the specific length variation, in % ;
m	is the specific mass change, in % ;
L	is the initial length of test specimen at time of release from mould, in mm ;

¹ Under preparation.

L_g	is the gauge length ($L_g = L$ only for type 2 studs), in mm ;
L_0	is the initial reading in the measuring apparatus, taken after 24 h, in mm ;
ΔL	is the length variation in relation to the initial length, in mm ;
M_0	is the initial mass of the test specimen at time of release from the mould, in g ;
ΔM	is the mass variation in relation to the initial mass, in g.

4 Principle

The shrinkage or expansion determination comprises two methods of test for CC and PCC repair products and systems.

The first method is for measuring the unrestrained linear movement arising from immersion in water (expansion) or drying conditions (shrinkage) of prismatic specimens 40 mm × 40 mm × 160 mm in size from 24 h to 56 days after casting.

The second method is for measuring the loss of adhesion and the tendency to crack, when applied to a 300 mm × 300 mm × 100 mm reference concrete substrate and subjected to immersion in water (expansion) or drying conditions (shrinkage).

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5 Apparatus

5.1 Unrestrained movement mould

Moulds, complying with the requirements of 4.5 of EN 196-1:1994 except that there shall be a minimum of three compartments, allowing simultaneous preparation of test specimens. Each compartment shall be provided a hole at the centre of each end face to hold a measurement stud that is to be embedded in the specimen.

5.2 Measurement studs

Studs made of stainless steel, or other hard material that does not react with the mortar. Typical designs for Type 1 recessed stud and Type 2 projecting stud are shown in Figures 1 and 2 respectively.

NOTE The design of the studs and the embedment method need to be compatible with the measuring apparatus used (see 5.3).

5.3 Measuring apparatus

Apparatus used to measure the length of the test specimens. It shall be adjustable to give sufficient length to measure the minimum specimen length ± 5 mm and have an accuracy of measurement of ± 0,001 mm. It shall have suitable fittings to receive the measurement studs (see 5.2).

5.4 Calibration rod

A rod made of invar metal or other material that has a similar coefficient of expansion over the range of test temperatures. The calibration rod shall be (160 ± 1) mm in length and with ends of the same shape as the measurement studs (see 5.2).

NOTE It is recommended that a second identical rod be available to serve as check for wear on the first rod and the seatings of the measuring apparatus (see 5.3), by comparing their apparent lengths at three-monthly intervals.

EN 12617-4:2002 (E)**5.5 Tampers**

Tampers consisting of sound, non-absorbent rods, of (38 ± 1) mm and (15 ± 1) mm in diameter and (200 ± 10) mm in length. The tamping face of each rod shall be flat and at right angles to the length of the tamper, the mass of the larger tamper shall be (250 ± 15) g and the smaller tamper (40 ± 5) g.

5.6 Concrete slab test panels

Concrete panels prepared in accordance with the method of EN 1542 with dimensions $300 \text{ mm} \times 300 \text{ mm} \times 100 \text{ mm}$, made using reference concrete to EN 1766 and of a type as specified in prEN 1504-3².

5.7 Standard laboratory climate

Storage room in accordance with the requirements of annex A.

5.8 Mortar mixer

Mixer in accordance with EN 196-1, or forced action pan mixer.

5.9 Compaction tools and equipment

Tools and equipment for compacting repair grouts, mortars and concretes according to EN 196-1 or EN 1015-2.

5.10 Water baths

Baths containing potable water for complete immersing the test specimens at a temperature of (21 ± 2) °C, as defined in annex A.

5.11 Triangular support grid

A grid onto which the specimens are supported in the standard laboratory climate or water bath, to achieve a minimum 5 mm clearance.

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6 Procedure for unrestrained movement**6.1 General**

Unless specified to the contrary, not less than six prism specimens shall be prepared and tested, from which three specimens shall be used for measuring the average shrinkage and three specimens shall be used for measuring the average swelling.

6.2 Preparation of specimens

All materials shall be conditioned in the standard laboratory climate (see annex A) 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 (see 5.8) set to a low speed, pouring the gauging liquid into the bowl and adding the dry ingredients, mixing for a total period of two minutes.

² Under preparation.

Where the manufacturer's instructions preclude use of part bags of material, a forced action pan mixer (see 5.8) 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 (see 5.8).

NOTE 2 The air content (see EN 1015-7, pressure method) and the compressive strength and density (see EN 12190) of the CC and PCC mixes should normally be determined to characterise the mortar under test.

If type 1 measuring studs are to be used, these shall be attached to the mould using a bolt that passes through the hole in the centre of each end face and locates on the threaded stud, ensuring the stud is positioned centrally.

If type 2 measuring studs are to be used, these shall be inserted into the holes in the end faces of the moulds so that they are up against the conical part of the hole, in so doing, care shall be taken that the studs are not displaced during specimen preparation.

NOTE 3 To hold the measuring studs securely, the holes of the mould can be filled with a moulding compound into which the studs are pressed, carefully removing any moulding compound expelled.

The repair product or system shall be carefully compacted into the moulds, using the smaller diameter tamper (see 5.5) to work the material around the portion of stud projecting into the mould, thereby ensuring full compaction. The compaction method shall be in accordance with the manufacturer's instructions.

NOTE 4 As there is a risk of breakage during removal of the mould and subsequent handling, it is recommended that additional specimens are cast and tested alongside the minimum number of three specimens.

The repair product or system shall then be cured in the standard laboratory climate (see annex A) for 24 h.

6.3 Initial measurement

6.3.1 General

Before undertaking initial measurement, all measuring equipment (see 5.3 and 5.4) shall be brought to the test temperature for at least 24 h.

After (24 ± 1) h from mixing, the specimens shall be carefully removed from the moulds.

NOTE If retarded, accelerated or expansive products or systems are being tested, the manufacturer's advice should be sought.

Before taking the first measurement, the adhesion of the measuring studs shall be checked. If this is inadequate, either the measuring studs shall be secured with a suitable adhesive or the affected specimens shall be rejected.

The reading on the measuring apparatus (see 5.3) shall first be checked with the calibration rod (see 5.4), using the general measuring technique (see 6.3.2). The specimens shall then be marked with a unique identifier, and then the initial mass (M_0) and the initial length (L) recorded. An initial reading (L_0) shall then be taken on the measuring apparatus (see 6.3.2). After completion of a series of initial measurements, the reading for the calibration rod shall be taken again.

6.3.2 Method of measurement

The position of the specimen in the measuring apparatus shall be the same for each measurement. To ensure this is achieved, an alignment point shall be marked on each specimen at the time of the first reading.

When the calibration rod (see 5.4) or test specimens are rotated about their axis in the measuring apparatus (see 5.3), the reading on the apparatus shall not change by more than $\pm 0,001$ mm. Where excess movement occurs, the measuring apparatus shall be checked for function and the measuring studs in the specimens checked for fixity and cleanliness and the readings repeated.