SLOVENSKI STANDARD
SIST EN 13295:2004

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Proizvodi in sistemi za zaġļ ito in popravilo betonskih konstrukcij - Preskusne metode ï Doloļ evanje odpornosti proti karbonatizaciji

Products and systems for the protection and repair of concrete structures - Test methods - Determination of resistance to carbonation

Produkte und Systeme für den Schutz und die Instandsetzung von Betontragwerken - Prüfverfahren - Bestimmung des Karbonatisierungswiderstands

Produits et systemes pour la protection et la réparation des structures en béton - Méthodes d'essai - Détermination de la résistance a la carbonatation

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91.080.40	Betonske konstrukcije	Concrete structures

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English version

Products and systems for the protection and repair of concrete structures - Test methods - Determination of resistance to carbonation

Produits et systèmes de protection et de réparation des structures en béton - Méthodes d'essai - Détermination de la résistance à la carbonatation

Produkte und Systeme für den Schutz und die Instandsetzung von Betontragwerken - Prüfverfahren - Bestimmung des Karbonatisierungswiderstands

This European Standard was approved by CEN on 24 March 2004.

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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 Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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Foreword

This document (EN 13295:2004) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by DIN.

It has been prepared by sub-committee 8 "Protection and repairs of concrete structures" (Secretariat 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 November 2004, and conflicting national standards shall be withdrawn at the latest by November 2004.

Annex A is normative.

This European Standard is one of a series dealing with products and systems for the protection and repair of concrete structures. It describes a method for determining the resistance to carbonation of a test specimen made from a repair product or system, excluding application of a protective coating system.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

This European Standard specifies an accelerated laboratory method for measuring the resistance against carbon dioxide penetration through repair products and systems, as defined in prEN 1504-3. The method is based on measurement of the depth of carbonation of the sample in a concentrated carbon dioxide atmosphere over a fixed time interval. The method is suitable for assessing the performance of repair grouts, mortars and concretes without a protective coating system applied.

The method does not measure the resistance to reduction in pH-value that may occur by absorption of other acidic gases (e.g. SO_2, HCl).

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 1504-1:1998, *Products and systems for the protection and repair of concrete structures — Definitions, requirements, quality control and evaluation of conformity — Part 1: Definitions.*

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

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

prEN 14630:2003, *Products and systems for the protection and repair of concrete structures — Test methods – Determination of carbonation depth in hardened concrete by the phenolphthalein method.*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 1504-1:1998 and the following apply.

3.1
Carbonation
alkaline components (e.g. calcium hydroxide) in the cement paste react with atmospheric carbon dioxide, after which the pH of the mortar or concrete is reduced.

3.2
Carbonation Depth
carbonation depth (d_k) is the average distance, measured in mm, from the surface of the concrete or mortar where the carbon dioxide (CO_2) has reduced the alkalinity of the hydrated cement to an extent such that an indicator solution based on phenolphthalein remains colourless.

4 Principle

The resistance of the repair product or system against carbonation is measured by an accelerated laboratory test, where samples are exposed to an atmosphere containing 1 % CO_2 at a temperature of (21 ± 2) °C and relative humidity (RH) of (60 ± 10) %.

NOTE The concentration of 1 % CO_2 in air develops the same reaction products with hydrated cement as a normal atmosphere at 0,03 % CO_2. The relative humidity of (60 ± 10) % results in the fastest rate of carbonation of CC and PCC materials.

The carbonation depth is measured by applying phenolphthalein indicator on a freshly broken piece of the specimen, following the procedure set out in clause 4.2 of prEN 14630:2003 The same specimen may be used several times to measure the increase in carbonation depth with time, by removing a small slice of the specimen for each measurement.

5 Equipment

5.1 Sealed cabinet for specimen exposure, with provision for gas inlets and outlets such that a uniform flow of CO_2 reaches all parts of the cabinet.

5.2 Gas supply of 1 % CO_2 in air, which should be supplied in a premixed bottled form.

5.3 Humidity controller designed to maintain (60 ± 10) % RH inside the cabinet in the presence of concrete samples that react with CO_2 to liberate extra moisture.

5.4 Phenolphthalein solution comprising 1 g of phenolphthalein indicator in a solution of 70 ml ethanol and 30 ml demineralised water.

5.5 Concrete cutting tools including a hammer and chisel for breaking pieces off the specimens.

5.6 Moulds for producing specimens made from non absorbent, rigid material, not attacked by cement paste or polymers.

5.7 Mortar mixer, in accordance with EN 196-1, or **forced action pan mixer**.

5.8 Compaction tools and equipment for repair grouts, mortars and concretes according to EN 196-1 or EN 1015-2.

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

5.9 Curing and conditioning room in accordance with annex A.

5.10 Measuring equipment, e.g. ruler or calliper.

6 Preparation

6.1 General

The test shall be carried out on rectangular specimens of various sizes. For a grout, mortar or concrete, a prism-shaped specimen to EN 196-1 40 mm x 40 mm x 160 mm shall be the minimum size used. For a concrete, with a maximum aggregate size of > 10 mm the minimum size of specimen shall be 100 mm x 100 mm x 400 mm.

The test is carried out on two parallel samples of repair product or system, and compared alongside two samples of control concrete.

6.2 Mixing and curing

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

For PCC and CC mortar, use the mortar mixer (**5.7**) set to a low speed, pouring the liquid into the bowl and adding the dry ingredients, mixing for a total period of two minutes.

For concrete mixes that contain coarse aggregates (> 4 mm), preparation shall be in accordance with EN 196-1, using a concrete mixer (**5.7**), or as otherwise instructed by the manufacturer. Where manufacturers' instructions preclude use of part bags of material, a concrete mixer (**5.7**) 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 concrete mixer (**5.7**).

Place the mixed material carefully into the moulds, compacting thoroughly. The specimens shall be finished flush with the sides of the mould using a steel float.

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

The specimens to be tested shall be compared against prisms of reference concrete type C (0,45), as defined in EN 1766. No air entraining admixture shall be used in the mix. The moulds shall be at least 100 mm x 100 mm x 400 mm and shall be filled and compacted on a vibrating table.

All specimens shall be stripped from their moulds and then cured in accordance with the requirements of annex A. The sides of the specimens shall be free from contaminants (e.g. demoulding agents or other materials), which could influence the carbonation rate.

6.3 Dry conditioning

The test specimens and concrete control specimens shall be brought to an even moisture content by storage in the standard laboratory climate defined in annex A, until the weight change is less than 0,2 % in a 24-hour period.

NOTE The necessary period of storage shall be at least 14 days.

7 Procedure

7.1 General

After preparation and conditioning, the specimens shall be placed on knife edge supports inside the sealed cabinet and exposed to the test gas, adjusting the flow rate to provide positive pressure.

NOTE The gas flow rate into the chamber will depend on the size of chamber and number of specimens behaving as CO_2 absorbers. The flow rate should be checked and verified as satisfactory by periodic sampling of the gas in representative areas of the cabinets, including likely still-air positions.

The depth of carbonation (d_k) shall be measured for both the test specimen and control concrete specimen at the end of the Dry conditioning period and then after 56 days in the cabinet.

The depth of carbonation shall be measured, using the procedure given in prEN 14630:2003 clause 4.2, on freshly broken faces from each prism. For each measurement a slice of 15 mm minimum thickness shall be broken off the prism using the chisel or bolster and the piece sprayed with the phenolphthalein indicator solution. Measurement of the depth of carbonation shall then be made (60 ± 5) min after spraying. The carbonation depth for the specimen (d_k) is the average depth on all four sides , measured in accordance with the following procedure, with Side 1 being the trowelled face.

7.2 Standard measuring procedure

7.2.1 General

The result should produce a level, pink coloration in the uncarbonated concrete on each side of the specimen except for the edges, which are rounded and should be ignored for the measurement.The standard result is termed shape A as shown in Figure 1a. The normal length (l) of level surface shall be not less than 30 mm.

NOTE Greater depths of carbonation occur in the corner areas of specimens, where carbon dioxide can penetrate from two sides at once. This effect should be omitted from the calculation.

For each surface in turn, the length of level surface (l) shall be divided into four equal parts, forming five points, as shown in Figure 1a. With the help of a ruler or calliper (**5.10**) the carbonation depth shall be measured at each point, determined perpendicular to the surface, to the nearest 0,1 mm. The average carbonation depth (e.g. d_{k1}) on that side of the specimen shall be calculated from the five individual values, rounded to the nearest 0,5 mm. The measurement shall then be repeated for the three remaining sides. The average of these four calculated values is the average carbonation depth (d_k) for the specimen.

The measurements shall then be repeated for the duplicate specimen. The carbonation depth on duplicate specimens should not differ by more than 20 %. If the difference is ≥ 20 %, both values should be reported. If the difference is < 20 %, report the average value.

If the edges of the uncarbonated area are rounded, reducing the length of the level portion on one or more sides (l) to less than 30 mm, then a shorter length may be used, to a minimum of 20 mm. The reduced length shall be divided into two equal parts, giving three measurement points, calculating the average carbonation depth (e.g. d_{k1}) from the three measurements (see Figure 1b) and then the average for all four sides (d_k).

If l < 20 mm, the test shall be halted and a larger prismatic specimen used.

If the carbonation front does not run as a straight line parallel to the surface, as shown in Figure 1, but is of uneven depth on one or more sides of the specimen, then the results for that side shall not be used in calculating the average result for the specimen and the depth of carbonation for that side (or sides) shall be determined in the following manner.