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SIST-TS CEN/TS 12390-9:2006

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Testing hardened concrete - Part 9: Freeze-thaw resistance - Scaling

Prüfung von Festbeton - Teil 9: Frost- und Frost-Tausalz-Widerstand - Abwitterung

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ICS:

91.100.30	Beton in betonski izdelki	Concrete and concrete products

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TECHNICAL SPECIFICATION

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English Version

Testing hardened concrete - Part 9: Freeze-thaw resistance - Scaling

Prüfung von Festbeton - Teil 9: Frost- und Frost-Tausalz-Widerstand - Abwitterung

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The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

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EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This Technical specification (CEN/TS 12390-9:2006) has been prepared by Technical Committee CEN/TC 51 "Cement and building limes", the secretariat of which is held by IBN.

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

Introduction

Concrete structures exposed to the effects of freezing and thawing need to be durable, to have an adequate resistance to this action and, in cases such as road construction, to freezing and thawing in the presence of de-icing agents. It is desirable, especially in the case of new constituents or new concrete compositions, to test for such properties. This also applies to concrete mixes, concrete products, precast concrete, concrete members or concrete in situ.

Many different test methods have been developed. No single test method can completely reproduce the conditions in the field in all individual cases. Nevertheless, any method should at least correlate to the practical situation and give consistent results. Such a test method may not be suitable for deciding whether the resistance is adequate in a specific instance but will provide data of the resistance of the concrete to freeze-thaw-attack and freeze-thaw-attack in the presence of de-icing agents.

If the concrete has inadequate resistance then the freeze-thaw attack can lead to two different types of damage, namely to scaling (surface weathering) and to internal structural damage. This part of this standard covers only testing for scaling resistance.

This Technical Specification has one reference method and two alternative methods. For routine testing either the reference method or one of the two alternative methods may be used with the agreement of the parties involved. In case of doubt, and if there is no such agreement, the reference method is used.

The application of limiting values will require the establishment of the correlation between laboratory results and field experience. Due to the nature of the freeze-thaw action, such correlation would have to be established in accordance with local conditions.

1 Scope

This Technical Specification describes the testing of the freeze-thaw scaling resistance of concrete both with water and with sodium chloride solution. It can be used either to compare new constituents or new concrete compositions against a constituent or a concrete composition that is known to give adequate performance in the local environment or to assess the test results against some absolute numerical values based on local experiences.

Extrapolation of test results to assess different concretes i.e. new constituents or new concrete compositions, requires an expert evaluation.

NOTE In some cases the test methods may not be suitable for testing special concretes e.g. high strength concrete or permeable concrete. In these cases the result is to be treated with caution. These tests may not identify aggregates that are subject to occasional 'pop-outs'.

There is no established correlation between the results obtained by the three test methods. All tests will clearly identify poor and good behaviour, but they differ in their assessment of marginal behaviour

There are two types of concrete deterioration when a freeze-thaw attack occurs, scaling and internal structural damage. Test methods on internal structural damage are described in a CEN Technical Report CEN/TR 15177 "Testing the freeze-thaw resistance of concrete - Internal structural damage".

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12390-2, *Testing hardened concrete — Part 2: Making and curing specimens for strength tests.*

ISO 5725 (all parts), *Accuracy (trueness and precision) of measurement methods and results.*

EN 60751, *Industrial platinum resistance thermometer sensors (IEC 60751:1983 + A1:1986).*

3 Terms and definitions

For the purposes of this Technical Specification, the following terms and definitions apply.

3.1
Freeze-thaw resistance
resistance against alternating freezing and thawing in the presence of water alone

3.2
Freeze-thaw resistance with de-icing salt
resistance against alternating freezing and thawing in the presence of de-icing salt

3.3
Scaling
loss of material at the surface of concrete due to freeze-thaw attack

3.4
Internal structural damage
cracks inside concrete which cannot be seen on the surface, but which lead to an alteration of concrete properties, e. g. reduction of the dynamic modulus of elasticity

4 Making of test specimens

Except where details are specified in Clauses 5, 6 and 7 (e. g. the curing) prepare the test specimens in accordance with EN 12390-2. Concrete that requires vibrating for compaction is compacted on a vibrating table. The prestorage conditions concerning temperature and moisture are documented.

The maximum aggregate size Dmax is restricted to one third of the mould length.

5 Slab test (reference method)

5.1 Principle

Slab specimens, sawn from concrete test specimens (Figure 1), are subjected to freeze-thaw attack in presence of a 3 mm deep layer of de-ionised water or 3% sodium chloride (NaCl) solution. The freeze-thaw resistance is evaluated by the measurement of mass scaled from slab after 56 freeze-thaw cycles.

5.2 Equipment

5.2.1 Equipment for making 150 mm concrete cubes according to EN 12390-2.

5.2.2 Climate controlled room or chamber with a temperature of (20 ± 2) °C and an evaporation of (45 ± 15) g/(m² h). Normally this is obtained with a wind velocity ≤ 0,1 m/s and a relative humidity of (65 ± 5) %. The evaporation is measured from a bowl with a depth of approximately 40 mm and a cross section area of (225 ± 25) cm^2. The bowl is filled up to (10 ± 1) mm from the brim.

5.2.3 Diamond saw for concrete cutting.

5.2.4 Rubber sheet, (3 ± 0,5) mm thick which is resistant to the salt solution used and elastic down to a temperature of –27 °C.

5.2.5 Adhesive for gluing the rubber sheet to the concrete specimen. The adhesive is resistant to the environment in question.

NOTE Contact adhesive has proved to be suitable.

5.2.6 Expanded Polystyrene cellular plastic, (20 ± 1) mm thick with a density of (18 ± 2) kg/m^3 or alternative thermal insulation with at least a heat conductivity of 0,036 W/(m·K).

5.2.7 Polyethylene sheet, 0,1 mm to 0,2 mm thick.

5.2.8 Freezing medium, consisting either of 97 % by mass of tap water and 3 % by mass of NaCl (for test with de-icing salt) or of de-ionised water only (for test without de-icing salt).

5.2.9 Freezing chamber with temperature and time controlled refrigerating and heating system with a capacity such that the time-temperature curve presented in Figure 4 can be followed for every position where a specimen is placed. The freezer has a good air circulation. The open-mesh shelves in the freezer are level. No deviation from the horizontal plane shall exceed 3 mm per metre in any direction.

5.2.10 Thermocouples, or an equivalent temperature measuring device, for measuring the temperature in the freezing medium on the test surface (see Figure 3) with an accuracy within ± 0,5 K.

5.2.11 Vessel for collecting scaled material. The vessel is suitable for use at temperatures up to 120 °C without mass loss and is resistant to attack by sodium chloride.

5.2.12 Suitable paper filter for collecting scaled material, optional.

5.2.13 Brush, with short (about 20 mm), stiff bristles for brushing off material that has scaled.

5.2.14 Spray bottle, containing tap water for washing off scaled material.

5.2.15 Drying cabinet, controlled at a temperature of (110 ± 10) °C.

5.2.16 Balance, with an accuracy within ± 0,05 g.

6.2.17 Vernier callipers, with an accuracy within ± 0,1 mm.

5.3 Preparation of test specimens

The test requires four specimens, one from each of four cubes.

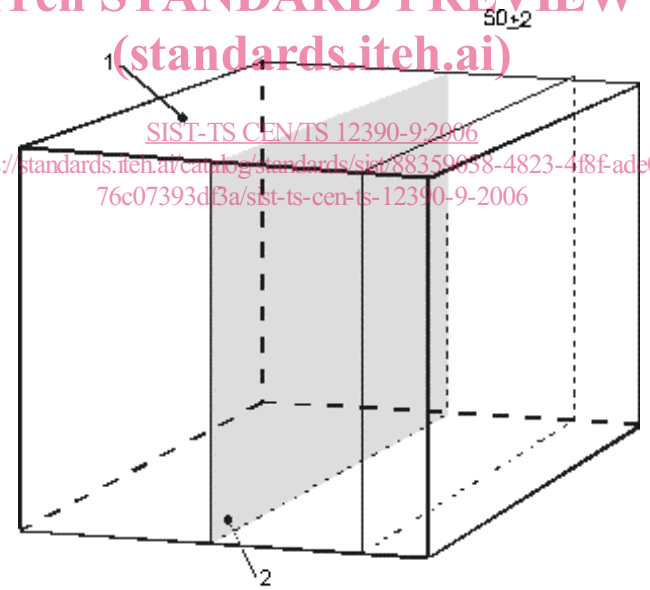
During the first day after casting the cubes are stored in the moulds and protected against drying by use of a polyethylene sheet. The air temperature is (20 ± 2) °C.

After (24 ± 2) h, the cubes are removed from the moulds and placed in a bath with tap water having a temperature of (20 ± 2) °C.

When the cubes are 7 days old, they are removed from the water bath and placed in the climate chamber (5.2.2), where they are stored until the freeze-thaw testing starts.

At 21 days a (50 ± 2) mm thick specimen is sawn from each cube perpendicular to the top surface so that the saw cut for the test surface is located in the centre of the cube, see Figure 1. The range in mean thickness of a specimen shall not exceed 2 mm.

Dimensions in millimetres



Key
1 Top surface at casting
2 Test surface

Figure 1 — Location of test specimen and test surface in sawn cube

Directly after sawing, wash the specimen in tap water and wipe off the excess water with a moist sponge. Measure all dimensions of the specimen to an accuracy of ± 0,5 mm by using vernier callipers (5.2.17). Without delay, return it to the climate chamber ensuring that the test surface is vertically with a space between the specimens of at least 50 mm.

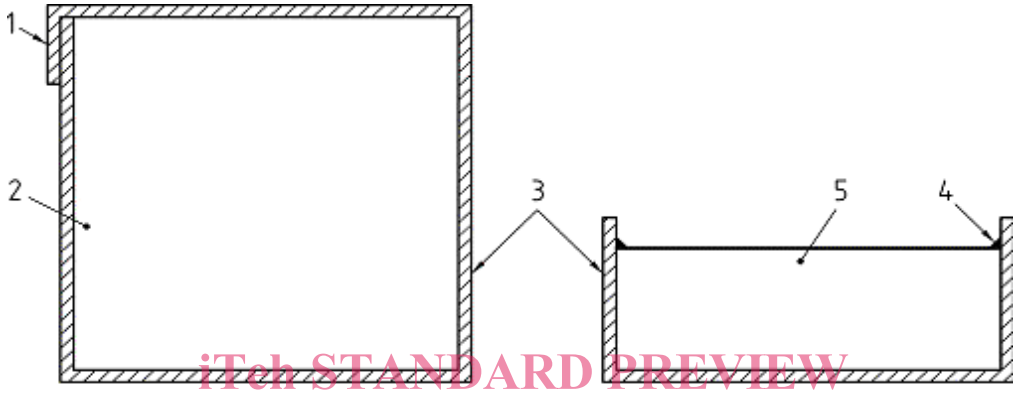
When the concrete is (25 ± 1) days old, rubber sheet is glued to all surfaces of the specimen except the test surface. Place a string of glue or silicone rubber around the test surface in the join between the concrete and the rubber. The surface area remaining after the application of the glue string shall be not less than 90 % of the original surface area of the specimen. The edge of the rubber sheet reaches (20 ± 1) mm above the test surface. After fixing the rubber sheet the specimen is returned to climate chamber.

NOTE 1 The adhesive is normally spread on the concrete surfaces as well as on the rubber surfaces. The manner of gluing the rubber sheet illustrated in Figure 2 has been proved suitable.

When the concrete is 28 days old, pour a layer about 3 mm deep of de-ionised water at a temperature of (20 ± 2) °C on the top surface. This resaturation continues for (72 ± 2) h at (20 ± 2) °C during which time the layer is to be maintained at about 3 mm.

NOTE 2 For a specimen with the test area of 150 mm x 150 mm, 67 ml de-ionised water gives an approximately 3 mm thick layer.

Before the test, all surfaces of the specimen except the test surface are thermally insulated with (20 ± 1) mm thick polystyrene cellular plastic (5.2.6) according to the test set-up in Figure 3. Another material or thickness providing equivalent thermal insulation can be used instead.



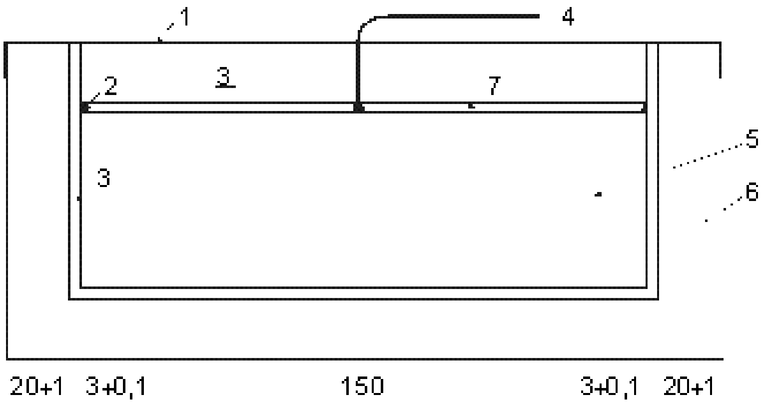
Key

1 Overlap
2 Test surface
3 Rubber sheet
4 Glue string
5 Specimen

Figure 2 — Sealing the test specimen

Start the test when the specimens are 31 days old. Not earlier than 15 min before the specimens are placed in the freezing chamber (5.2.9), replace the de-ionised water on the test surface with 67 ml of the freezing medium (5.2.8), to obtain an average thickness of 3 mm, at a temperature of (20 ± 2) °C.

Dimensions in millimetres



Key

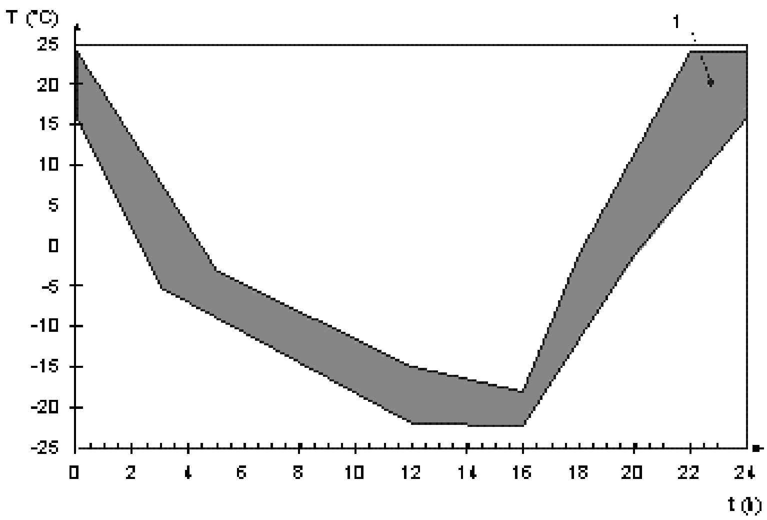
1 Polyethylene sheet
2 Glue string
3 Rubber sheet
4 Temperature measuring device in contact with the test surface
5 Specimen
6 Thermal insulation
7 Freezing medium

Figure 3 — The test set-up used for the freeze-thaw test

The freezing medium is prevented from evaporating by applying a nearly flat, horizontal polyethylene sheet (5.2.7) as shown in Figure 3. The polyethylene sheet remains flat throughout the test so that the distance between the sheet and the surface of the freezing medium is at least 15 mm.

5.4 Test procedure

To begin the test, place the specimens in the freezing chamber at the cycle phase time (0 ± 30) min according to Figure 4. After the specimens have been placed in the freezing chamber, subject them to repeated freezing and thawing. Monitor the temperature continuously in the freezing medium at the centre of the test surface for at least one specimen in the freezing chamber. During the test, the temperature in the freezing medium shall fall within the shaded area shown in Figure 4. The temperature shall exceed 0 °C during each cycle for at least 7 h but not more than 9 h. The air temperature in the freezer shall never fall below –27 °C.



Key

1 Temperature range at the centre of the test surface

Figure 4 — The time (*t*) -temperature (*T*) cycle in the freezing medium at the centre of the test surface