SLOVENSKI STANDARD
SIST EN 12390-18:2021

01-julij-2021

Preskušanje strjenega betona - 18. del: Določanje koeficienta migracije klorida

Testing hardened concrete - Part 18: Determination of the chloride migration coefficient

Prüfung von Festbeton - Teil 18: Bestimmung des Chloridmigrationskoeffizienten

Essai sur béton durci - Partie 18: Détermination du coefficient de migration des chlorures

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ICS:

91.100.30	Beton in betonski izdelki	Concrete and concrete products

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Testing hardened concrete - Part 18: Determination of the chloride migration coefficient

Essais pour béton durci - Partie 18 : Détermination du coefficient de migration des chlorures

Prüfung von Festbeton - Teil 18: Bestimmung des Chloridmigrationskoeffizienten

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

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European foreword

This document (EN 12390-18:2021) has been prepared by Technical Committee CEN/TC 104 “Concrete and related products”, the secretariat of which is held by SN.

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of an identical text or by endorsement, at the latest by September 2021, and conflicting national standards shall be withdrawn at the latest by September 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

A list of all parts in the EN 12390 series, published under the general title “Testing hardened concrete”, can be found on the CEN website.

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

1 Scope

This document specifies the procedure for obtaining the non-steady-state chloride migration coefficient of specimens of hardened concrete at a specified age (see Annex A). The test procedure does not take into account any interaction of concrete with the saline solution over time. The test result is a durability indicator with respect to the resistance of the concrete investigated against chloride penetration.

The test procedure does not apply to concrete specimens with surface treatments such as silanes.

If the aggregate or any other embedded elements (such as metallic fibres or conducting particles) are electrically conductive, this will influence the magnitude of chloride migration. This fact is taken into account when establishing threshold values. It prevents comparison of chloride migration values between concretes if the aggregates induce a difference of half an order of magnitude (higher or lower) of chloride migration.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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*

EN 14488-1, *Testing sprayed concrete - Sampling fresh and hardened concrete*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
migration cell
apparatus for holding a cylindrical test specimen with a lateral sealing of non-conductive material enabling the test specimen to be exposed on two parallel surfaces to test solutions

3.2
migration test set-up
test container with a migration cell support, migration cell test solutions, sleeve, sleeve clamps, electrodes and electronics

3.3
migration
movement of ions under the action of an external electrical field

3.4
chloride migration coefficient
transport property which reflects the resistance against chloride penetration under the action of an externally applied electrical field

4 Symbols

c_d Chloride concentration at which a colour change occurs, c_d = 0,07 mol·l^{-1}

c_0 Chloride concentration of the potassium hydroxide solution (catholyte) [mol·l^{-1}]

d, h Diameter and height, respectively, of the cylindrical specimen [m]

M_{nss} Chloride migration coefficient (non steady-state) [× 10^{-12} m^2·s^{-1}]

E Voltage gradient [V·m^{-1}]

erf^{-1} Inverse Error Function

F Faraday Constant, F = 9,649 · 10^4 J · (V·mol)$^{-1}$

m_w Mass of the water-saturated test specimen [kg]

R Gas constant, R = 8,314 J · (K·mol)$^{-1}$

t Duration of the migration test with an external voltage over the test specimen applied [s]

T Absolute, mean temperature of both test solutions during the migration test [K]

U Absolute value of the applied voltage [V]

x_d Mean penetration depth of chloride ions of the two halves of the split test specimen

x_{max} Maximum penetration depth

z Ionic charge, for chloride ions z = 1

5 Principle

A specimen of concrete or mortar is placed between a chloride free and a chloride containing alkaline solution and an electric voltage is applied between two external electrodes to drive the chloride ions into the concrete specimen. After a given period of time, the specimen is split and the penetration depth of the free chloride ions is determined by using a suitable colour indicator solution. The chloride migration coefficient is calculated based on the measured depth of penetration, the magnitude of the applied voltage and other parameters.

NOTE This procedure can also be applied for testing products according to EN 1504-3 [1], EN 14487-1 [2].

6 Apparatus and equipment

Laboratory room with an air temperature of (20 ± 2) °C:

1) scale with an instrumental measurement uncertainty not exceeding ± 0,05 g;

2) vernier calliper gauge with an instrumental measurement uncertainty not exceeding ± 0,05 mm;

3) ruler with an instrumental measurement uncertainty not exceeding ± 0,05 mm;

4) water bath for storing the test specimens under water at (20 ± 2) °C;

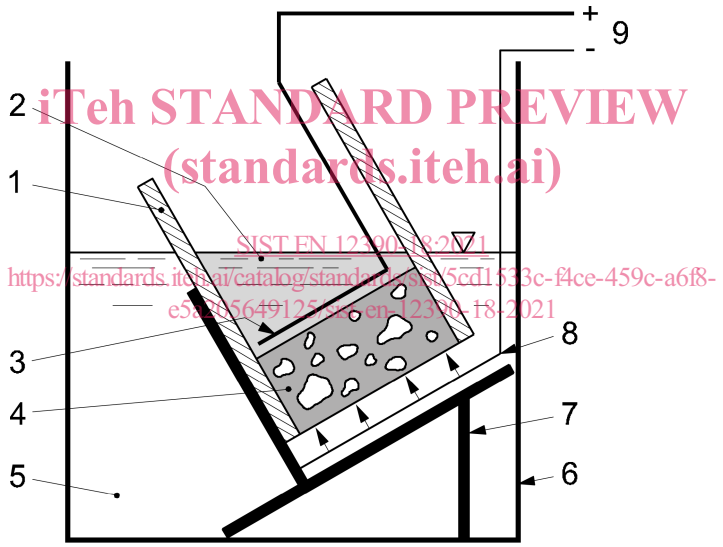
5) thermometer with an instrumental measurement uncertainty not exceeding ± 0,5 °C;

6) drying oven with ventilation and adjustable temperature;

7) migration set-up comprising (also see Figure 1 to Figure 4):

- migration cell for test specimens with a diameter between 50 mm and 110 mm (fabric-reinforced, electrically non-conductive rubber sleeve [see Figure 2] and, depending on the construction of the cell, stainless steel sleeve clamps [see Figure 4]);
- migration cell support made from non-corrosive and electrically non-conductive material;
- rectifier with voltage regulator (up to 40 V);
- voltmeter, ammeter with an instrumental measurement uncertainty not exceeding ± 1 V or ± 1 mA;
- stainless steel electrodes;
- catholyte reservoir: non-corroding and electrically non-conductive material.

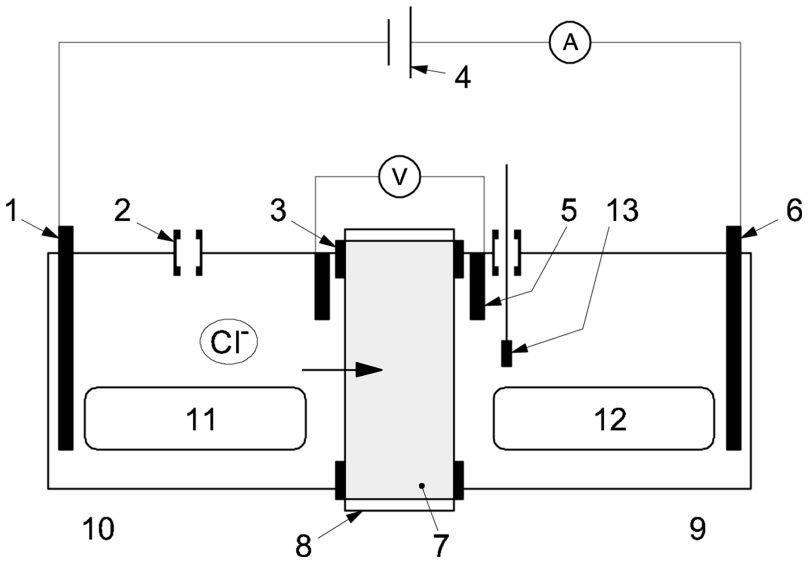
NOTE Similar setups for the determination of the migration coefficient might be allowed according to national provisions, provided in particular that the increase in temperature under the test (Joule effect) does not exceed 3 °C.



Key

1	rubber sleeve	6	catholyte reservoir
2	anolyte	7	migration cell support
3	anode	8	cathode
4	test specimen	9	rectifier
5	catholyte		

Figure 1 — Schematic illustration of a migration test set-up



Key

1	cathode	8	waterproof protection
2	filler opening	9	downstream cell
3	joints	10	upstream cell
4	power supply	11	anolyte solution
5	electrode	12	catholytic solution
6	anode	13	temperature probe
7	concrete specimen		

Figure 2 — Schematic illustration of an alternative migration test set-up

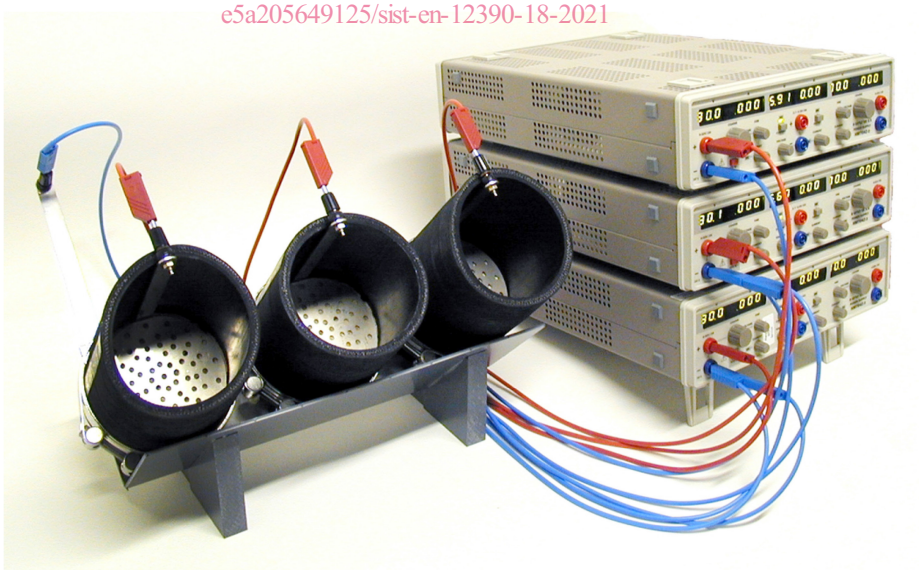


Figure 3 — Photograph of a migration test set-up

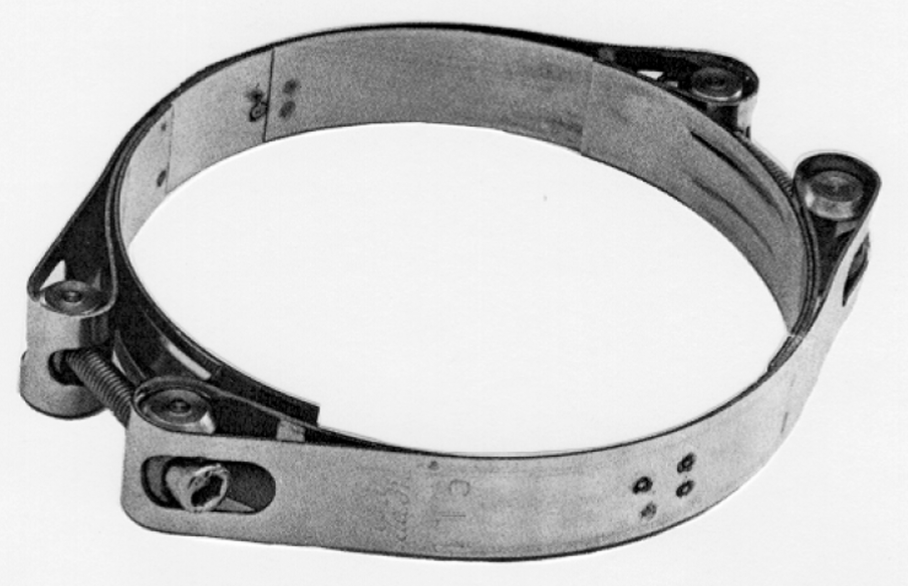


Figure 4 — Stainless steel sleeve clamp

8) Test solutions:

— Anolyte: 0,2 N KOH (11,2 g KOH to be filled up to 1 000 ml with distilled or demineralized water) or 0,3 N NaOH (12,0 g NaOH to be filled up to 1 000 ml with distilled or demineralized water);

— Catholyte: 5 % NaCl (50 g NaCl on 950 g 0,2 N KOH) (the reference solution) or (50 g NaCl on 950 g 0,3 N NaOH);

If specified or agreed, other NaCl concentrations between 3 % and 10 % may be utilized. This shall be explicitly noted in the test documentation and audit reports, and taken into account in the calculation of the migration coefficient.

Where KOH is used to prepare the anolyte, KOH shall also be used to prepare the catholyte.

— 0,1 N Silver nitrate solution;

— 5 % Potassium dichromate solution (optional).

7 Preparation of specimens

7.1 Preparing sub-specimens

For cores with a diameter between 50 mm and 110 mm a minimum of two cubical sub-specimens are prepared with at least 150 mm edge length, or a minimum of three cylindrical sub-specimens with a diameter of 100 mm and a height of 200 mm. For cores with a diameter of 50 mm a minimum of two cubical sub-specimens are necessary. The preparation and compaction of the sub-specimens shall be executed in accordance with EN 12390-2. The troweled surfaces shall be protected from drying with close fitting polythene sheeting or equivalent.

The cubical or cylindrical sub-specimens shall be de-moulded according to EN 12390-2.

After de-moulding, the sub-specimens shall be stored in water in accordance with EN 12390-2 until extracting the cylindrical specimens.

7.2 Preparing test specimens

A test series comprises at least five cylindrical specimens with a diameter of (50 ± 1) mm or at least three cylindrical specimens with a diameter of (100 ± 1) mm (diameters between 50 mm and 110 mm are allowed). The specimens shall have a height of (50 ± 2) mm. The diameter d and the height h of each specimen shall be determined and the result recorded to the nearest 0,1 mm. The diameter of the cores should not be less than three times the maximum aggregate size.

The preparation should commence not earlier than 10 days before the test starts. If not otherwise regulated, the test shall start 28 days after specimen casting.

For cubical specimens, the cores shall be extracted by drilling perpendicular to the troweled surface. The upper side of the cores should have a distance of at least 50 mm from the troweled surface. For cylindrical specimens, the first 50 mm layer from the troweled surface shall be sawn and discarded.

Visible spalls and holes on the test specimen face in contact with the NaCl solution (catholyte) ≤ 5 mm in diameter can be filled with sealing material. Depending on the size and number of defects, the sealed surface area should be less than 3 % of the test surface area. If there are spalls and holes > 5 mm in diameter on the test surface, a 5 mm to 10 mm layer containing the above defects shall be sawn and discarded.

Subsequently, the test specimens are to be cut parallel to the test surface to obtain a height of (50 ± 2) mm. The sawn surfaces should be plano-parallel with a maximum deviation of 1 mm, determined at quarter points. If necessary, the test surface may be ground.

8 Procedure

8.1 Installation of the test specimens in the migration cell

The test specimens prepared in accordance with 7.2 shall be taken from the water storage immediately prior to testing and installed in the rubber sleeve as shown in Figure 1 or Figure 2.

Two stainless steel sleeve clamps (see Figure 3) shall be fitted tight to the curved surface of the specimen to prevent lateral penetration of the test solution. Thereupon, the test specimens shall be flush mounted with the perforated stainless steel anode.

8.2 Installation of the migration cell in the migration apparatus

The migration cells are positioned in the migration chamber in such a way as shown in Figure 1 or Figure 2 to let the test surface parallel to the stainless steel cathode with a distance of 10 mm to 15 mm so as to enable the resulting gas bubbles to escape.

Each migration cell should be filled with approximately 300 ml for a test specimen diameter of 100 mm and 75 ml for a test specimen diameter of 50 mm of the anolyte solution. If a set-up as illustrated in Figure 1 is used, the migration cell shall be installed tilted to approx. 30° from the horizontal to ensure unhindered escape of the emerging gas bubbles.

The migration chamber is filled with chloride solution (e.g. for the reference solution 5 % NaCl in 0,2 N KOH) to the meniscus of the anolyte solution in the migration cell (see Figure 1 or Figure 2). The solutions shall not be mixed.