SLOVENSKI STANDARD
SIST-TS CEN/TS 14038-2:2012

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Elektrokemična realkalizacija in postopki kloridne ekstrakcije za armirani beton - 2. del: Kloridna ekstrakcija

Electrochemical re-alkalization and chloride extraction treatments for reinforced concrete - Part 2: Chloride extraction

Elektrochemische Realkalisierung und Chloridextraktionsbehandlungen für Stahlbeton - Teil 2: Chloridextraktion

Traitements électrochimiques de réalcalinisation et d'extraction de chlorures applicables au béton armé - Partie 2: Extraction de chlorures

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Foreword

This document (CEN/TS 14038-2:2011) has been prepared by Technical Committee CEN/TC 219 “Cathodic protection”, the secretariat of which is held by BSI.

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

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Introduction

The purpose of chloride extraction is to rehabilitate a reinforced concrete part from corrosion activity and to provide long term corrosion protection of steel reinforcement in concrete which has been affected by chloride and to re-establish self protection ability. The duration of treatment is from several weeks up to as much as several months, depending on the amount of accumulated chloride, the permeability of the concrete, the lay-out of the reinforcement and other factors. The decision to terminate the application should be made according to the specific requirements detailed in this technical specification.

There are other electrochemical procedures that can be used to provide corrosion protection of steel in concrete structures. These include cathodic protection and re-alkalisation. There is a European standard for cathodic protection of steel in concrete (EN 12696) and a European Technical Specification for the re-alkalisation of carbonated concrete (TS 14038-1).

It has been assumed in the drafting of this Technical Specification that the execution of its provisions will be entrusted to appropriately qualified and competent people, for whose use it has been prepared.

1 Scope

This Technical Specification specifies a procedure for carrying out impressed current electrochemical chloride extraction from chloride bearing concrete in existing structures. It is applicable to atmospherically exposed parts of structures with ordinary reinforcement and/ or post-tensioned tendon ducts embedded in concrete. In the latter case, it is essential to verify that there is no risk of hydrogen embrittlement, if necessary by conducting trials and installing monitoring during the treatment.

This Technical Specification does not apply to pretensioned concrete, which may suffer hydrogen embrittlement on the stressing bars during chloride extraction, or to concrete containing epoxy-coated or galvanised reinforcement.

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 1504-2:2004, *Products and systems for the protection and repair of concrete structures: Definitions, requirements, quality control and evaluation of conformity - Part 2: Surface protection systems for concrete*

EN 1504-9, *Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 9: General principles for the use of products and systems*

EN 12696, *Cathodic protection of steel in concrete*

EN 14629, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of chloride content in hardened concrete*

EN 14630, *Products and systems for the protection and repair of concrete structures - Test methods - Determination of carbonation depth in hardened concrete by the phenolphthalein method*

EN ISO 8044:1999, *Corrosion of metals and alloys — Basic terms and definitions (ISO 8044:1999)*

3 Terms and definitions

For the purposes of this Technical Specification, the terms and definitions given in EN ISO 8044:1999 and EN 1504-2:2004 and the following apply.

3.1
chloride extraction
electrochemical treatment for providing a low chloride content and developing a high pH value to concrete, which surrounds reinforcing bars, corresponding to sound, carbonated or non-carbonated concrete.

4 Principle

Chloride extraction of reinforced concrete is performed by applying an electric field between the steel reinforcement embedded in the concrete and an anode surrounded by an alkaline electrolyte solution containing hydroxyl ions temporarily placed on the concrete surface. Dissolved, negatively charged ions – such as chloride - will be moved from the reinforcement to the external electrode. This is mainly a physical process.

Coincidentally, the electrochemical reactions occurring at the steel surface provide the evolution of hydroxyl ions by the reduction of oxygen and water. This process alkalises the concrete in the vicinity of the rebar as described in CEN/TS 14038-1.

NOTE 1 The chloride content cannot be reduced to zero; an usual target content is an average profile of 0.4 %, related to the cement mass. To achieve this, the driving voltage between reinforcement and external anode should be set as high as possible – usually ranging between 30 V and 40 V.

NOTE 2 The chloride extraction effect is not limited to the zone between concrete surface and next reinforcement layer, but can be triggered in greater depths of concrete, as long as reinforcement is present and is connected with the upper reinforcement layer. In such a case a multi-stage treatment is required. Even treatments from the opposite side of a concrete slab are possible, but require an extended time of application.

NOTE 3 If the reinforcement surface is covered by corrosion products, these oxides have to be reduced prior to the possible reduction of oxygen and water. During this period, which may consume theoretically up to 700 Ah/m², few if any hydroxyl ions can be developed. In such a case, hydrogen evolution is likely just as in the later stages of the chloride extraction treatment.

NOTE 4 Details of the principle underlying this process are given in the European Federation of Corrosion report [1].

NOTE 5 Some electrolyte materials may change the surface appearance of the concrete.

5 Assessment and repair of the structure

5.1 General

Prior to undertaking chloride extraction, an assessment of the structure, including its physical condition, its structural integrity and the nature and extent of any repairs which might be needed, shall be performed in accordance with EN1504-9.

The investigations specified in 5.2 to 5.8 shall be carried out in order to:

a) determine the suitability of the structure for chloride extraction;

b) provide information for design and time of treatment.

5.2 Review of records

All available drawings, specifications, records and notes shall be reviewed for information on the location, quantity, nature (e.g. mild or high strength steel, smooth or deformed bar, galvanised, epoxy-coated) and continuity of the reinforcement, as well as the constituents and quality of the concrete.

NOTE The possible sensitivity to reduction of bond strength should be evaluated in the case of smooth reinforcement.

5.3 Inspection

An inspection shall be carried out to ascertain the type, causes and extent of defects and any features of the structure or of its surrounding environment, which could influence the application and effectiveness of chloride

extraction. All areas of the structure which require chloride extraction shall be checked for delamination of the concrete cover. Defects such as delaminations, cracks, honeycombing or poor construction joints which could permit significant water penetration, or prevent current flow and thereby impair the effectiveness of the chloride extraction treatment, shall be recorded.

NOTE 1 In areas which have been previously repaired, the repair methods and materials should be identified, as far as possible. If the concrete behind the repair is to be treated with chloride extraction, the deviating electrical resistivity and porosity of the repair media should be considered.

The cause of any deterioration which is not attributable to corroding reinforcement shall be determined.

NOTE 2 If any signs of structural distress are evident, an assessment of both the load bearing capacity of the structure and the need for temporary or permanent strengthening or support should be made.

5.4 Determination of chloride content

The chloride content of the concrete shall be determined as a proportion of the mass of cement or concrete in accordance with EN 14629. Concrete samples shall be taken from areas expected to have the highest possible chloride content in order to ascertain whether chloride contamination is present and the profile from the surface through the cover to behind the reinforcement.

5.5 Carbonation depth measurement

Carbonation depth shall be measured in accordance with EN 14630. Carbonation depth shall be measured at several locations to ascertain its distribution.

NOTE In selecting locations for concrete sampling, the objective is to identify areas with various carbonation depths for comparison with post treatment data.

5.6 Concrete cover thickness and reinforcement location measurements

Concrete cover thickness and reinforcement location measurements shall be carried out in order to enable a determination to be made of comparative current flow though areas of thick and thin cover, and to identify regions of varying reinforcement density. Any features that could impair the effectiveness of chloride extraction, such as shielding of the reinforcement, caused by embedded metal mesh, metal fibres, metal plates, plastic sheets or non-conductive repair materials shall be identified. Points at which short circuits between the reinforcing steel and the anodes could occur shall be noted.

5.7 Alkali aggregate reaction

If the concrete of the structure which is to be treated with chloride extraction contains aggregates which may be sensitive to alkali, the risk of provoking an alkali aggregate reaction (AAR) should be considered prior to any treatment.

5.8 Reinforcement continuity and size

The reinforcement continuity shall be proven on site by measuring the electrical resistance between reinforcing bars in mutually remote locations across the structure and between all reinforcing bars exposed during concrete repairs (see 5.9.3) or other works following the method and acceptance criteria given in EN 12696., . These measurements shall include the following:

a) continuity between elements of the structure within each chloride extraction zone;

b) continuity of metallic items, other than reinforcement, with the reinforcement itself.

Reinforcement size shall be identified from drawings when available and shall be verified by direct measurements.