BRITISH STANDARD

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990:2002

Test methods for verification of corrosion protection of reinforcement in autoclaved aerated concrete and lightweight aggregate concrete with open structure

The European Standard EN 990:2002 has the status of a British Standard

ICS 91.100.30

National foreword

This British Standard is the official English language version of EN 990:2002. It supersedes BS EN 990:1996 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/523, Prefabricated components of reinforced autoclaved aerated concrete and lightweight aggregate concrete with open structure, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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English version

Test methods for verification of corrosion protection of reinforcement in autoclaved aerated concrete and lightweight aggregate concrete with open structure

Méthodes d'essai pour la vérification de la protection contre la corrosion des armatures dans le béton cellulaire autoclavé et le béton de granulats légers à structure ouverte

Prüfverfahren zur Überprüfung des Korrosionsschutzes der Bewehrung in dampfgehärtetem Porenbeton und in haufwerksporigem Leichtbeton

This European Standard was approved by CEN on 21 July 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.

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

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Foreword

This document (EN 990:2002) has been prepared by Technical Committee CEN /TC 177 "Prefabricated reinforced components of autoclaved aerated concrete or light-weight aggregate concrete with open structure", 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 March 2003, and conflicting national standards shall be withdrawn at the latest by March 2003.

This document supersedes EN 990:1995.

In order to meet the performance requirements as laid down in the product standards for prefabricated reinforced components of autoclaved aerated concrete or for prefabricated reinforced components of lightweight aggregate concrete with open structure a number of standardised test methods are necessary.

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.

1 Scope

This European Standard specifies the test methods for verification of the effectiveness of the corrosion protection of reinforcing steel embedded in components of autoclaved aerated concrete (AAC) according to prEN 12602 or in components of lightweight aggregate concrete with open structure (LAC) according to prEN 1520.

Tests according to this European Standard are not required for LAC-components if corrosion protection is achieved by embedding the reinforcing bars completely in a zone of concrete with closed structure according to prEN 1520:2002, 5.8.3.3.

Three different methods of short-term tests (methods 1 to 3) are provided.

The test methods can be used to examine the fundamental suitability of a corrosion protective system in combination with a defined manufacturing process for the production of reinforced components. They can also be used for current production control.

NOTE The specification of three different short-term test methods is based on historical reasons and established procedures rather than on technical needs.

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).

prEN 1520:2002, *Prefabricated reinforced components of lightweight aggregate concrete with open structure.*

prEN 12602, *Prefabricated reinforced components of autoclaved aerated concrete.*

3 Principle

Test specimens consisting of autoclaved aerated concrete (AAC) or lightweight aggregate concrete with open structure (LAC) with embedded reinforcing bars are cut from prefabricated reinforced components or manufactured separately. The test specimens are exposed to a defined corrosive environment for a specified series of exposure cycles. Immediately after the end of the corrosive exposure the concrete and the protective coating are removed from the embedded bars. The steel surface is examined visually for corrosion and the area of the corroded surface is determined and compared with the limits according to the relevant product standard prEN 1520 or prEN 12602.

4 Apparatus

a) Saw

A saw for cutting test specimens from reinforced components without excessive heating or vibrations.

b) Equipment for short-term test with alternate wetting with sodium chloride solution and drying in air (method 1):

1) a facility for wetting the test specimens for 2 h with sodium chloride solution (concentration 3 % by mass) by immersion in a tank or by continuous spraying;

2) a ventilated room or cabinet for drying the test specimens in air at (15 to 30) °C for 70 h. The relative humidity and the air movement shall be such that the rate of evaporation from a cylindrical beaker of (80 5) mm diameter initially filled with water to 20 mm from its top is (50 25) ml per 24 h.

c) Equipment for short-term test with alternate wetting with water and drying in warm air (method 2):

1) a facility for wetting the test specimens with water (water basin or water spray);

2) a ventilated room or cabinet capable of maintaining an air temperature of (40 5) °C and with provisions for circulating air into and out of the room during the drying period in a uniform manner. The relative humidity and the air movement shall be such that the rate of evaporation from a cylindrical beaker of (80 5) mm diameter initially filled with water to 20 mm from its top is (200 75) ml per 24 h.

NOTE To enable automation of the wetting and drying cycles it can be convenient to accommodate the wetting equipment according to 1) in the ventilated room or cabinet and to install an automatic temperature control system.

d) Equipment for short-term test with alternating temperature (method 3):

a humidity cabinet for the storage of the test specimens in moisture saturated air (relative humidity 95 %). The air temperature in the cabinet shall alternate every 3 h between (25 5) °C and (55 5) °C. The indicated temperatures shall be reached within approximately 1 h in each case and then be maintained constant during the rest of the 3 h period.

5 Test specimens

5.1 General

The test specimens shall be 400 mm long prismatic sections either cut from prefabricated reinforced components of current production (normal case) or especially manufactured for this purpose under conditions as close as possible to those of current production.

Each test specimen shall contain at least two reinforcing bars coated with the protective system to be tested. Where the test specimens are especially manufactured, the bars shall be free from corrosion before applying the protective system.

The width and the height (thickness) of the test specimens shall be such that the reinforcing bars are covered on all sides with at least the minimum nominal concrete cover required in the relevant product standard.

If the test specimens are cut from prefabricated reinforced components, their height shall extend over the full height (thickness) of the component.

In order to avoid damage due to the cutting operation the test specimens shall be cut from the reinforced components

¾ not less than 2 d after autoclaving in the case of AAC;

¾ not less than 7 d after casting in the case of LAC.

When the test specimens are manufactured separately, the concrete cover at the bottom shall be equal to the minimum value required in the product standards prEN 1520 or prEN 12602, respectively, and the cover at the top shall be at least equal to that value. Test specimens representing multilayer components shall have the same structure as the corresponding prefabricated components.

For each corrosion test at least three test specimens are required. Three additional companion specimens should be provided to enable comparison of the corrosion phenomena of the reinforcement of the exposed test specimens with that of the reinforcement of unexposed specimens. This is not necessary if it is certain that the steel surface has been free of any signs of corrosion before the protective system has been applied.

The companion specimens shall be stored in a non-corrosive environment (relative humidity of the air 70 %) until the end of the corrosion tests.

NOTE The purpose of the companion specimens is to enable to differentiate between the corrosion phenomena caused by the test conditions and the corrosion which possibly might have been present on the steel surface initially, before the beginning of the test, due to the use of reinforcement which had been corroded (to the permissible extent) before applying of the corrosion protective system. Only the (additional) amount of corrosion caused by the test conditions is of interest for the evaluation of the suitability of the corrosion protective system.

5.2 Sealing of the end faces and conditioning of the test specimens

Precautions shall be taken so that corrosion does not enter from the end faces of the test specimens into the interior, e. g. by application of an impermeable layer on the end faces.

For tests according to method 3 the test specimens shall be conditioned prior to the test by storing them for 2 h under water (tap water, approximately 20 °C) and subsequently in air at normal room temperature (15 to 30) °C and normal relative humidity (30 to 70) % for a period of 14 d.

The corrosion testing shall be started not less than 7 d after autoclaving in the case of AAC and not less than 28 d after manufacture in the case of LAC.

6 Corrosion tests

6.1 Short-term test with alternate wetting with sodium chloride solution and drying in air (method 1)

6.1.1 Exposure cycles

The test specimens shall be exposed to 10 exposure cycles. Each exposure cycle consists of

¾ 2 h wetting with sodium chloride solution with a concentration of 3 % by mass;

¾ 70 h drying in air under conditions indicated in 4.b 2).

The drying period may be extended to a total length of 7 d, if required, e. g. at weekends or holidays. Control of humidity and air movement in order to achieve the prescribed rate of evaporation is only necessary for a period of 70 h.

6.1.2 Examination of steel surface and evaluation of results

Immediately (not more than 4 d) after the last drying period the concrete and the protective cover are removed from the reinforcing bars, and the steel surface is examined visually from all sides.

For each test specimen the corroded area shall be determined by measurement and calculation and expressed as a percentage of the total surface area of the reinforcement calculated from the measured lengths and diameters of the bars. The end portions of the bars over a length of 50 shall be disregarded.

If applicable, the same procedure shall be done with the companion specimens, and the difference between the percentages of the corroded steel area of the test specimen and the corresponding companion specimen shall be calculated and reported.

Where a corrosion protective coating is used, which adheres to the steel surface so strongly that it is not possible to remove it in a way that the corrosion phenomena on the steel surface can be studied (such as epoxy coatings or certain emulsion systems) the presence or absence of visual signs of corrosion on the surface of the coating may be used for the evaluation of the suitability of the corrosion protective system.

6.2 Short-term test with alternate wetting with water and drying in warm air (method 2)

6.2.1 Exposure cycles

The test specimens shall be exposed to 30 exposure cycles of alternate wetting and drying.

Wetting shall be achieved by storing the test specimens for 2 h under water or by exposing them for 2 h to sprays of water such that the surface adjacent to the reinforcing bars is constantly kept wet. Tap water with a temperature of (20 5) °C shall be used. During the wetting period an air temperature of (15 to 30) °C shall be maintained.

After the wetting period the test specimens shall be dried for 21 h in air under conditions indicated in 4.c 2).

When the exposure cycles have to be interrupted, e. g. at weekends, holidays, or in the case of breakdown of the equipment, the test specimens shall be stored in air at (15 to 30) °C and any humidity. However this does not replace the prescribed drying period.

Alternatively, the normal drying procedure in circulated air at (40 5) °C may be extended up to 7 d.

If wetting and drying takes place in the same room or cabinet, it is not necessary to cool the air after the end of the drying period by artificial means. It is sufficient to turn the heating off so that temperature decreases by natural heat loss.

6.2.2 Examination of the steel surface and evaluation of results

See 6.1.2.

6.3 Short-term test with alternating temperature (method 3)

6.3.1 Exposure cycles

The test specimens shall be placed in the humidity cabinet according to 4 d) in moisture saturated air and exposed for a period of 28 d to four temperature cycles per day as indicated in 4 d).

When the temperature cycles have to be interrupted, e. g. at weekends, holidays or in the case of breakdown of the equipment, the test specimens shall be stored in moisture saturated air at (15 to 30) °C. If this period is at least 4 h, it may be taken to be equivalent to the regular (25 5) °C period. Otherwise it does not contribute to the exposure cycles.

6.3.2 Examination of the steel surface and evaluation of results

See 6.1.2.

7 Test report

The test report shall include the following:

a) identification of the product;

b) date of manufacture or other code;

c) date of sampling;

d) place and date of testing, testing institute and person responsible for testing;

e) date of beginning and end of corrosion test;

f) number and date of issue of this European Standard;

g) applied test method;

h) general appearance of the test specimens (defects, cracks);

i) type of corrosion protection;

j) percentage of corroded surface of the individual test specimens and of the companion specimens (if any) and mean values;

k) difference between the percentages of corroded areas of the individual test specimens and the corresponding companion specimens;

l) description of corrosion phenomena.

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