



SLOVENSKI STANDARD SIST EN 990:2001

01-april-2001

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

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

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 a structure ouverte

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Ta slovenski standard je istoveten z: EN 990:1995

ICS:

91.100.30 Beton in betonski izdelki Concrete and concrete products

SIST EN 990:2001 en

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EUROPEAN STANDARD

EN 990

NORME EUROPÉENNE

EUROPÄISCHE NORM

May 1995

ICS 91.080.40; 91.100.30

Descriptors: concrete, cellular concrete, armatures, steels, corrosion prevention, corrosion tests, verification, effectiveness

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

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Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart, 36 B-1050 Brussels

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Ref. No. EN 990:1995 E



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Foreword	

This European Standard has been prepared by the Technical Committee CEN/TC 177 "Prefabricated reinforced components of autoclaved aerated concrete or light-weight aggregate concrete with open structure", of which the secretariat 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 November 1995, and conflicting national standards shall be withdrawn at the latest by November 1995.

In order to meet the performance requirements as laid down in the product standard for prefabricated components of lightweight aggregate concrete with open structure a number of standardized test methods are necessary.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies methods for verification of the effectiveness of the corrosion protection of reinforcing steel embedded in autoclaved aerated concrete (AAC) components¹⁾ or components of lightweight aggregate concrete with open structure (LAC) according to prEN 1520.

Tests according to this 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 4.4.3.3 of prEN 1520.

Three different methods of short-term tests (methods 1 to 3) and a long-term test (method 4) are provided. The corrosion protection system is considered to be suitable for reinforced components²⁾ within the range of application in accordance with prEN 1520 if it passes

- at least one of the short-term tests, the choice of which is free

or

- the long-term test.

In cases of doubt the results of the long-term test are decisive (reference test method).

The test methods may 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 may also be used for current quality control.

NOTE: The specification of three different short-term test methods is based on historical reasons and established procedures rather than on technical needs. Since all three short-term tests are more severe than the long-term test (reference test methods) manufacturers are free to choose the one with which they are familiar or which seems to be the most convenient or practical. Experience has shown that protection systems which pass one of the short-term tests will always pass the long-term test, too.

¹⁾A standard about "Prefabricated reinforced components of autoclaved aerated concrete" is in preparation at CEN



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.

prEN 1520 Prefabricated components of lightweight aggregate concrete with open structure

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 (short-term test) or for a specified period of time (long-term test). Immediately after the end of the corrosive exposure the concrete and the protective coating are removed from the embedded bars, and the steel surface is examined visually for corrosion. The amount of rust present on the steel bars taken from the test specimens is recorded and compared with admissible limits.

4 Apparatus

a) Saw

A saw for cutting test specimens from reinforced components without excessive heating, vibration or shock.

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

- 1) 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) Room or cabinet for drying the test specimens in air at 15°C 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 mm diameter initially filled with water to 20 mm from the top is (75 ± 25) ml per 24 h.

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

- 1) Facility for wetting the specimens with water (water basin or water spray);
- 2) 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 so that the rate of evaporation specified in 6.2.1 is attained everywhere.

NOTE: To enable automation of the wetting and drying cycles it may be convenient to accommodate the wetting equipment according to 1) in the ventilated room 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 $\geq 95\%$). The air temperature in the cabinet shall alternate every 3 h between (25 ± 5) °C and (55 ± 5) °C. The indicated temperature shall be reached within approximately 1 h and then be maintained constant during the rest of the 3 h period.

e) Equipment for long-term test (method 4)

A humidity cabinet for the storage of the test specimens in air at a relative humidity of $\geq 95\%$ and at normal room temperature of 15°C to 30°C for a period of 1 a.

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 bars are covered on all sides with at least the minimum nominal concrete cover.

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

- not less than 2 d after autoclaving in the case of AAC;
- not less than 7 d after manufacture in the case of LAC.

If the test specimens are manufactured separately the concrete cover at the bottom shall be equal to the minimum cover required in the product standard prEN 1520 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 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 on the surface of the exposed bars with that of unexposed bars unless it is beyond doubt that the steel surface has been free of any signs of corrosion before the protection system has been applied.

The companion specimens shall be stored in a non-corrosive environment (relative humidity of the air not exceeding 70 %) until the end of the corrosion tests.

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 and method 4 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 of 15 °C to 30 °C and normal humidity of 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

The test specimens shall be exposed to 10 cycles consisting of

- 2 h wetting with sodium chloride solution with a concentration of 3 % by mass;
- 70 h drying in air under conditions indicated in 4.b 2).

NOTE: 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 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. The end portions of the bars over a length of 50 mm shall be disregarded.

The protective system is considered suitable for the intended purpose

- if the steel surface is free from corrosion or if only first signs of corrosion (no flaky rust or pitting) are visible in separate places which are approximately uniformly distributed over the bars and cover not more than 5 % of the surface

or

- if the corrosion is not more than that observed on the bars of unexposed companion specimens (reference bars) which were stored in a non-corrosive atmosphere under the conditions indicated in 5.1.

NOTE 1: In some countries the effect of the corrosion test is judged by the reduction of the rust grade according to the European Scale for degree of rusting. The rust grade of the reference bars and that of the exposed bars are determined. The reduction in rust grade number is calculated by subtracting the rust grade of the exposed bars from that of the reference bars. The effect of the protective system is assumed to be satisfactory if the reduction of the rust grade number is not greater than 1.

NOTE 2: Where protective coatings are used which adhere very strongly to the steel surface (such as epoxy coatings or modern emulsion systems) it can be very difficult to uncover the steel surface without disturbance of the corrosion phenomena. In such cases the protective system may be considered suitable if no signs of corrosion are visible on the surface of the coating.

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

6.2.1 Exposure

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

Wetting shall be achieved by storing the test specimen under water for 2 h by exposing them to sprays of water such that 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 °C to 30 °C shall be maintained.

After the wetting period the test specimens shall be dried for 21 h in circulated air at (40 ± 5) °C. The air movement along the surfaces of the test specimens shall be such during the drying period that the rate of evaporation from a cylindrical beaker of 80 mm diameter initially filled with water to 20 mm from the top is (250 ± 50) ml per 24 h.

When the 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 °C to 30 °C and any humidity. However this does not replace the prescribed drying procedure.

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

NOTE: 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

The test specimens shall be placed in the humidity cabinet according to 4 d) in moisture saturated air and exposed for 28 d every 24 h to four temperature cycles as indicated in 4 d).

When the 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°C 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 may not contribute to the cycles.

6.3.2 Examination of the steel surface and evaluation of results

See 6.1.2.

6.4 Long-term test (method 4)

6.4.1 Exposure

The test specimens shall be placed in the humidity cabinet according to 4e) for a period of 1a.

6.4.2 Examination of 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 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);
- j) type of corrosion protection;
- k) percentage of corroded surface of the individual test specimens and of the reference specimens (if any) and mean values
(Alternatively: Reduction in rust grade of each individual test specimen and mean value.);
- l) description of corrosion phenomena.