

Determination of steel stresses in unloaded reinforced components made of autoclaved aerated concrete

The European Standard EN 1738:1998 has the status of a
British Standard

ICS 91.100.30

National foreword

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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:

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Summary of pages

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ICS

Descriptors: concrete, cellular concrete, aggregates, reinforcing materials, reinforcing steels, tests, determination, stresses, modulus of elasticity, humidity

English version

Determination of steel stresses in unloaded reinforced components made of autoclaved aerated concrete

Détermination des contraintes de l'acier dans les éléments réalisés en béton cellulaire autoclavé armé, non chargés

Bestimmung der Stahlspannungen in unbelasteten bewehrten Bauteilen aus dampfgehärtetem Porenbeton

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CEN

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

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Ref. No. EN 1738:1998 E

Foreword

This European Standard 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.

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

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of an identical text or by endorsement, at the latest by October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.

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Contents

	Page
Foreword	2
1 Scope	3
2 Normative references	3
3 Principle	3
4 Apparatus	3
5 Test specimens	3
5.1 Sample	3
5.2 Shape and size of test specimens	3
5.3 Conditioning of test specimens	3
6 Testing procedure	3
6.1 Measuring of camber	3
6.2 Determination of steel strains	4
6.3 Determination of moisture content and modulus of elasticity of AAC	5
7 Test results	5
8 Test report	5
Annex A (informative) Determination of modulus of elasticity by means of a load test	6

1 Scope

This European Standard specifies a method of determining the steel stresses in longitudinal bars at midspan of unloaded reinforced components made of autoclaved aerated concrete (AAC) according to prEN 12602.

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.

EN 1352, *Determination of static modulus of elasticity under compression of autoclaved aerated concrete and of lightweight aggregate concrete with open structure.*

EN 1353, *Determination of moisture content of autoclaved aerated concrete.*

EN 1356:1996, *Performance test for prefabricated reinforced components of autoclaved aerated concrete or lightweight aggregate concrete with open structure under transverse load.*

EN 10002-2, *Metallic materials — Tensile testing — Part 2: Verification of the force measuring system of the tensile testing machines.*

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

3 Principle

At midspan of an unloaded reinforced component the concrete cover, the corrosion protective coating and part of the surrounding AAC are removed from at least three longitudinal bars, taking care to disturb the internal stresses as little as possible. Then strain gauges are glued to the surface of the bars. The steel stress is calculated from the difference of the strain gauge readings taken:

- when the bar is under stress while still being embedded in the component;
- when the bar is free from external stresses.

4 Apparatus

- Electrical strain gauges*, of any suitable type and with the same gauge factor.
- Glue*, of any suitable type by which the strain gauges can be reliably bonded to the steel surface;
- Any suitable data acquisition system*, by which the strain can be recorded with an accuracy of 0,01 mm/m.
- Tensile testing machine*, of class 2 or better according to EN 10002-2 (only for control of accuracy of test equipment).

The test equipment shall be checked when the type of strain gauges or glue is changed. The following procedure shall be applied.

- A pair of strain gauges are glued to a steel bar of the same type as normally used in the components.
- The steel bar is subjected to tension in a testing machine.
- The strain values of the strain gauges are determined at the stress levels of (50, 100 and 150) N/mm² which shall be maintained with an accuracy of 1 %.

The measured strain values shall not deviate by more than ± 5 % from those calculated from the loads indicated by the testing machine and from the cross-sectional area of the bar, assuming a modulus of elasticity of the steel of 200 000 N/mm².

The results of this test shall be recorded to be made available if required.

5 Test specimens

5.1 Sample

The sample for the preparation of the test specimens shall be taken in such a manner that it is representative of the product to be investigated. The direction of rise of the mass during manufacture shall be marked on the components.

NOTE For the subsequent evaluation of test results it is of great advantage if reliable data are available on the components to be tested and their load history, if relevant.

5.2 Shape and size of test specimens

The test specimens are full-size reinforced AAC-components.

5.3 Conditioning of test specimens

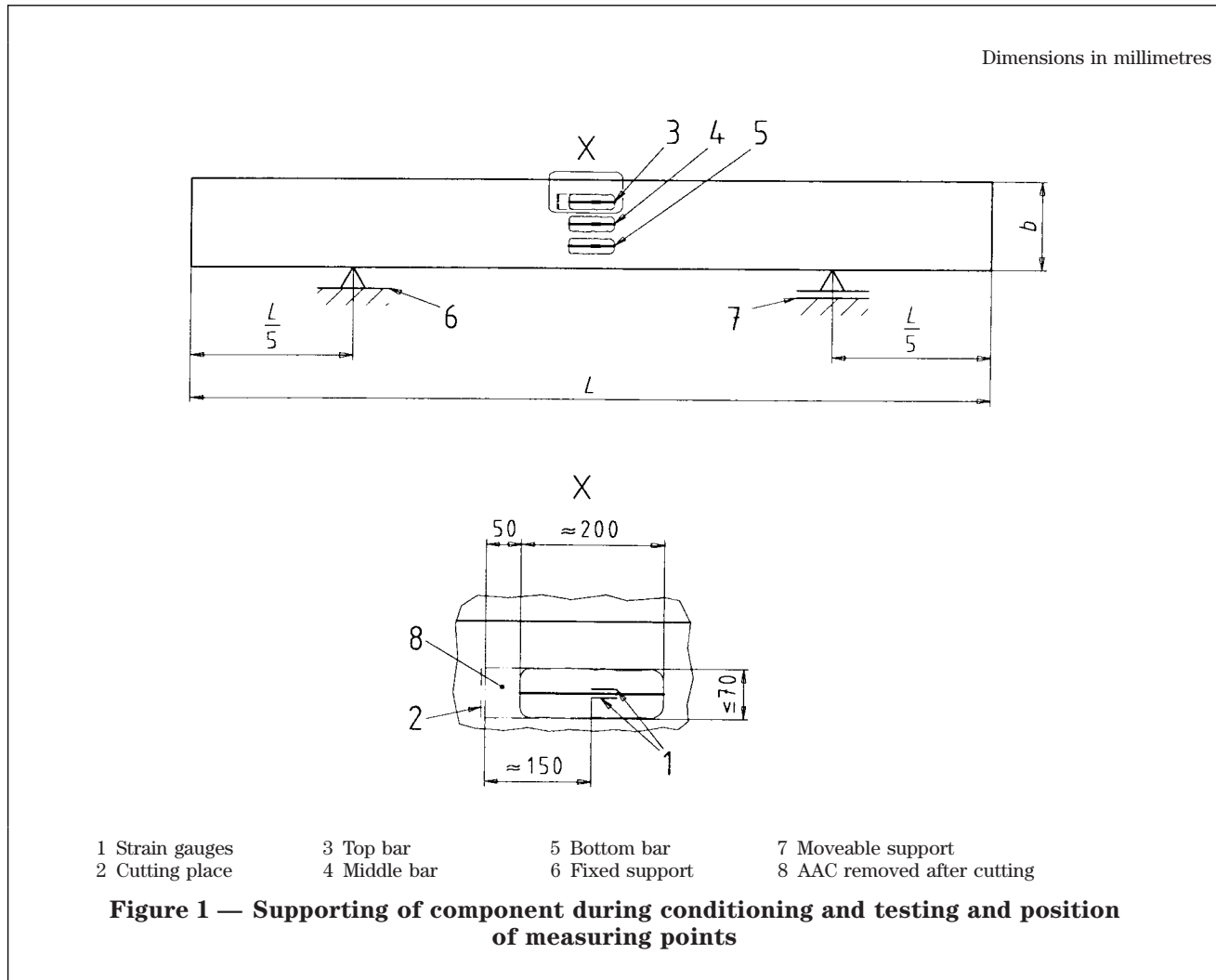
Prior to testing, the component shall be stored for at least seven days at a temperature of (15 to 30) °C and a relative humidity of (40 to 65) %. The storage conditions shall be as constant as possible.

During this time the component shall be placed on one of its longitudinal edges on two supports as shown in Figure 1, so that stresses due to its own weight are insignificant. One of the two supports shall be moveable in the longitudinal direction of the component (e.g. a loose roller) in order to avoid any longitudinal restraint.

6 Testing procedure

6.1 Measuring of camber

The camber of the unloaded component shall be measured at midspan, the component remaining in the same position as during the conditioning. Measurements shall be taken at both the upper and the lower edge. Any suitable method may be used (see e.g. EN 1356:1996, 5.2), provided that it allows an accuracy of ± 1 mm.



6.2 Determination of steel strains

During the whole procedure the component shall remain in the same position and under the same climatic conditions as during the conditioning. Normally, the steel strains are measured on three longitudinal bars at the same face of the component, representing the top, middle, and bottom positions during casting.

The bars shall be exposed at midspan over a length of about 200 mm (see Figure 1), and the necessary quantity of the surrounding AAC shall be taken away in order to allow the application of the strain gauges. The corrosion protective coating shall be also removed and the steel surface carefully cleaned.

Two diametrically opposite strain gauges shall be glued laterally onto each bar. When the glue has set, the first set of readings of the strain gauge values shall be taken. Then the steel bars are cut at one side, at a distance of about 150 mm from the end of the strain gauges (marked as cutting place in Figure 1), this is to prevent the cutting from inducing permanent deformations in the bar.

Then the remaining AAC around the bar between the cutting place and the strain gauges shall be carefully removed, and a second set of readings shall be taken, representing a state where the bars are free from external stresses.

6.3 Determination of moisture content and modulus of elasticity of AAC

Directly after the last strain gauge readings, samples shall be taken from the component in order to determine the moisture content and the modulus of elasticity of the AAC.

The moisture content of the AAC shall be determined according to EN 1353, taking care that the mass of the test specimens does not change by more than 0,3 % before being determined.

The modulus of elasticity of the AAC shall be determined according to EN 1352. Alternatively, provided that the component is and remains uncracked, the modulus of elasticity of the AAC may be derived from the load-deflection relationship achieved by means of a load test carried out during the conditioning period, at the day before the main test (see annex A).

7 Test results

The steel stress shall be calculated from the measured strain values according to equation (1):

$$\sigma_{s0} = (\varepsilon_1 - \varepsilon_2) \cdot E_s \quad (1)$$

where

- σ_{s0} is the steel stress of the considered bar in the unloaded component, in newtons per square millimetre (N/mm²);
- ε_1 is the mean value of the first reading of the two strain gauges of the considered bar;
- ε_2 is the mean value of the second reading of the two strain gauges of the considered bar;
- E_s is the modulus of elasticity of steel, usually taken as 200 000 N/mm².

8 Test report

The test report shall include the following:

- a) identification of the component(s);
- b) date of manufacture or other code;
- c) place and date of testing, testing institute and person responsible for testing;
- d) number and date of issue of this European Standard;
- e) description of the component(s) according to the product standard and, if available, background data on previous storage and loading conditions, and sampling;
- f) description of reinforcement including diameter and position of longitudinal and transverse bars, identification of tested bars, and steel properties;
- g) type of corrosion protective coating;
- h) camber (curvature) of the unloaded component at midspan;
- i) moisture content of AAC and temperature conditions at testing;
- j) type of strain gauges and type of glue;
- k) strain values at the first and the second reading for each individual strain gauge and mean value for each bar;
- l) calculated steel stresses of individual bars;
- m) compressive strength and dry density of AAC, if available;
- n) modulus of elasticity of AAC and test method applied;
- o) test results from the load-deflection test, if applicable;
- p) observations on the appearance of test specimens;
- q) (if appropriate) deviations from the standard method of testing;
- r) a declaration that the testing has been carried out in accordance with this European Standard except as detailed in 8q).

Annex A (informative)

Determination of modulus of elasticity by means of a load test

In general, the load test should be performed according to EN 1356, with the following modifications.

- The maximum bending moment should be (50 to 70) % of that corresponding to the specified load.
- The imposed load should be applied in not less than four approximately equal steps. The loading rate shall be such that the load increase from step to step takes about 2 min. After reaching the desired level, the load should be kept constant for (2 to 5) min, and then the midspan deflection should be measured.
- Directly after the load test, the component should be taken back to the “conditioning position”.

The following data should be collected and reported:

- date of load test;
- span;
- load-deflection readings;
- derived value of the modulus of elasticity of the AAC.

For two line loads applied normal to the longitudinal axis in the outer quarter points of the span the following equation (A.1) may be used for the calculation of E_c :

$$E_c = \frac{11 Fl^3}{384 If} \quad (\text{A.1})$$

where

- E_c is the modulus of elasticity of AAC, in newtons per square millimetre (N/mm²);
- F is the magnitude of each of the two equal line loads at the maximum load level, in newtons (N);
- l is the span, in millimetres (mm);
- I is the second moment of area of the section (reinforcement included), in millimetres to the fourth power (mm⁴);
- f is the midspan deflection corresponding to F , in millimetres (mm).

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