BRITISH STANDARD

BS EN 12269-1:2000

Determination of the bond behaviour between reinforcing steel and autoclaved aerated concrete by the "beam test" —

Part 1: Short term test

The European Standard EN 12269-1:2000 has the status of a British Standard

ICS 77.140.15; 91.100.30

National foreword

This British Standard is the official English language version of EN 12269-1:2000.

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 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.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 9 and a back cover.

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EUROPEAN STANDARD

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English version

Determination of the bond behaviour between reinforcing steel and autoclaved aerated concrete by the "beam test" - Part 1: Short term test

Détermination du comportement d'adhérence entre les barres d'armatures et le béton cellulaire autoclavé par la "méthode d'essai de poutre" - Partie 1: Essai de courte durée

Bestimmung des Verbundverhaltens zwischen Bewehrungsstahl und dampfgehärtetem Porenbeton mit Hilfe der "Balkenprüfung" - Teil 1: Kurzzeitprüfverfahren

This European Standard was approved by CEN on 10 March 2000.

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

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

Ref. No. EN 12269-1:2000 E

Contents

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.

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 2000, and conflicting national standards shall be withdrawn at the latest by October 2000.

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, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

The European Standard EN 12269 consists of the following parts:

- Part 1: Short-term test method;
- Part 2: Long-term test method.

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

1 Scope

This European Standard specifies a method of determining the bond behaviour between reinforcing bars and autoclaved aerated concrete (AAC) in prefabricated reinforced components according to prEN 12602:1996. The test method is conceived to obtain values for the short term bond strength, τ_{bm}, with different combinations of concrete type, bar shape and corrosion protection system.

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).

EN 678 Determination of the dry density of autoclaved aerated concrete.

EN 679 Determination of the compressive strength of autoclaved aerated concrete.

prEN 12602:1996 Prefabricated reinforced components of autoclaved aerated concrete.

3 Principle

The bond behaviour is investigated by means of a flexural test on a prismatic test specimen (beam) cut from a prefabricated reinforced AAC-component in such a way that it contains one single reinforcing bar situated on the longitudinal median plane near the bottom surface. The dimensions of the test beam are selected such that failure through bar slip is likely to occur.

The AAC is removed in the lower part of the cross-section (tension zone) at midspan, in order to form a type of "hinge", leaving the two adjacent portions of the beam being connected only by the remaining AAC in the compression zone and the steel bar in the tensile zone.

At both ends of the beam, the AAC is removed around the bar over a length of 100 mm in order to avoid a confinement effect above the supports and to reduce the bond length.

The beam is simply supported at its ends in the horizontal position and loaded at a steady deflection rate by means of two equal vertical loads acting equidistant from midspan in the central part of the span length.

The tensile force in the steel is calculated, according to Hooke's law, from the longitudinal steel strain measured at midspan, the E-modulus of the steel, and the cross-sectional area of the bar.

The bond stress is calculated by dividing the tensile force in the steel bar by the perimeter of the bar (without anti-corrosion coating) and the total bond length at the half of the beam considered.

Furthermore, the slip of the bar relative to the AAC is measured at both free ends and recorded as a function of the measured steel strain at midspan.

4 Apparatus

a) A saw for cutting test specimens from reinforced components;

b) A core drill with a diameter of the cutting edge of 200 mm to 300 mm, depending on the specimen height, for removing the AAC in the tensile zone of the cross-section in the midspan area of the beam;

c) A straight-edge and 0,1 mm-feeler gauges for checking the planeness of surface areas where loads and support reactions are transmitted;

d) A room or cabinet, capable of maintaining a temperature of (20 ± 2) ºC and a relative humidity of (55 ± 5) %, for conditioning of test beams prior to the test (see note);

e) A loading system with a capacity of approximately 30 kN, allowing the performance of a four point flexural test (see Figure 1) on a test beam with a span of 600 mm to 1 200 mm in deflection controlled mode. Deflections shall be determined at midspan by means of a transducer and shall be used for control of rate of movement of the platen of the testing machine or of the loading device;

The test beam shall rest on two supporting rollers through steel distribution plates having a width of (50 ± 2) mm and a thickness of ≥ 10 mm, extending over the full width of the test beam. At least one of the rollers shall be capable of being inclined in a plane perpendicular to the longitudinal axis of the test beam.

The supporting rollers shall be placed at a distance of 50 mm from the end surfaces of the test beam.

The load shall be applied equally to both beam parts, using a bridge profile resting on two rollers positioned perpendicularly to the longitudinal axis of the test beam with a distance of 200 mm. Between the rollers and the upper surface of the test beam steel distribution plates with a width of (30 ± 2) mm and a thickness of ≥ 10 mm, extending over the full width of the test beam, shall be inserted.

Both the supporting rollers and the load applying rollers shall be manufactured from steel and shall have a circular cross-section with a diameter between 15 mm to 40 mm. Their length shall be at least equal to the width of the test beam. The axes of all rollers shall be parallel to each other. Each roller, except one of the supporting ones, shall be capable of rotating around its longitudinal axis and of being inclined in a plane normal to the longitudinal axis of the test specimen. After correct centring in the testing machine, the axes of inclination of the three inclinable rollers shall be situated on a vertical plane which shall not deviate by more than ±1 mm from the axis of the compression force of the testing machine.

The middle axis between the loading rollers or the supporting rollers, respectively, shall not deviate from the vertical axis of the testing machine (axis of the vertical compression force) by more than ±1 mm.

f) A measuring system, capable of simultaneous measuring and registration of the following data:

- longitudinal strain in the bar (accuracy 2 %);
- slip of the bar at both ends relative to the end surface of the beam (accuracy 0,01 mm).

NOTE: For certain types of corrosion protective coatings it might be necessary to determine the bond behaviour at a temperature other than +20 ºC.

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.

5.2 Shape and size of test specimens

The test specimens shall be beams according to Figure 1 which are cut from a reinforced component in a way that the longitudinal bar, of which bond is to be tested, is disposed in the vertical centre plane of the beam with a cover of 15 mm to 30 mm with respect to the bottom face. If there are further longitudinal bars in the lower part (tension zone when tested) of the beam, they shall be cut at midspan. The beam shall contain no transverse reinforcement within the AAC.

For usual components the following dimensions shall be used:

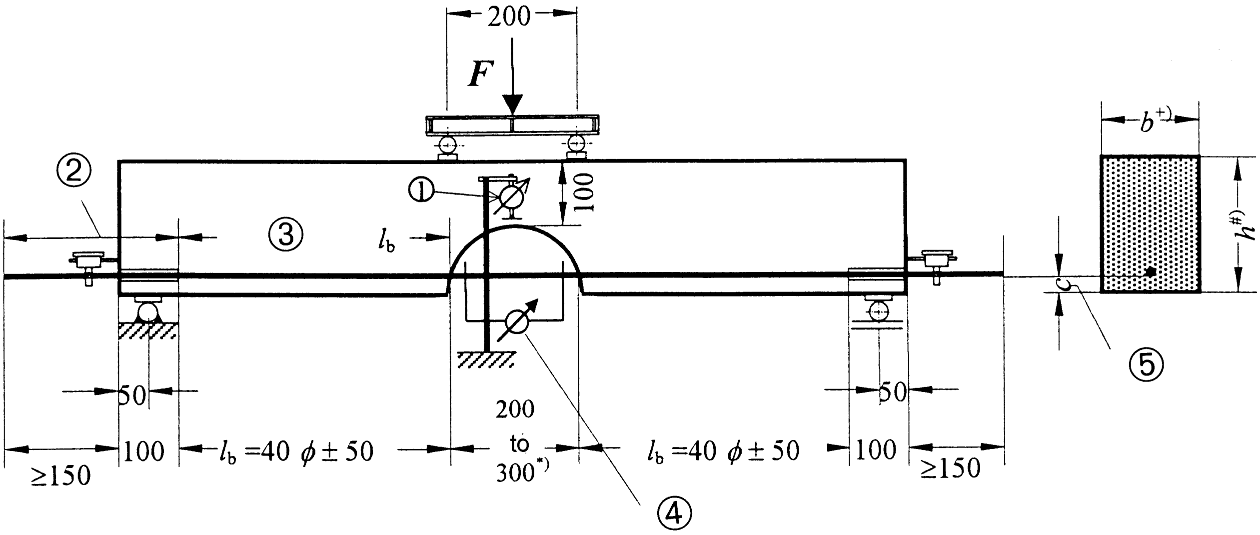
- total height: h = 200 mm;
- width: $b = 20\phi$, where ϕ is the diameter of the steel bar (not including protective coating), in millimetres;
- concrete cover: 15 mm ≤ c ≤ 30 mm.

The total length of the beam shall be chosen such that $l_b = 40\phi \pm 50$ mm on each side, where l_b is the bond length over which the bar is in contact with the AAC.

If, in exceptional cases, the cover of the longitudinal bar exceeds 30 mm, test specimens with a total height of h = 250 mm shall be used.

At both ends of the beam, the reinforcing bar to be tested shall protrude for at least 150 mm over the vertical end face of the AAC.

Dimensions in millimetres



Key

1) Transducer for vertical displacement
2) Free bar end
3) Bond length
4) Strain measuring base
5) Concrete cover

+) $b = 20\phi$, where ϕ is the diameter of the steel bar

#) h = 200 mm for concrete cover c = 15 mm to 30 mm and
h = 300 mm for concrete cover c > 30 mm

*) 200 mm to 250 mm for concrete cover c = 15 mm to 30 mm,
300 mm for concrete cover c > 30 mm

200 to 250 mm for concrete cover*)

Figure 1 – Test specimens and loading arrangement

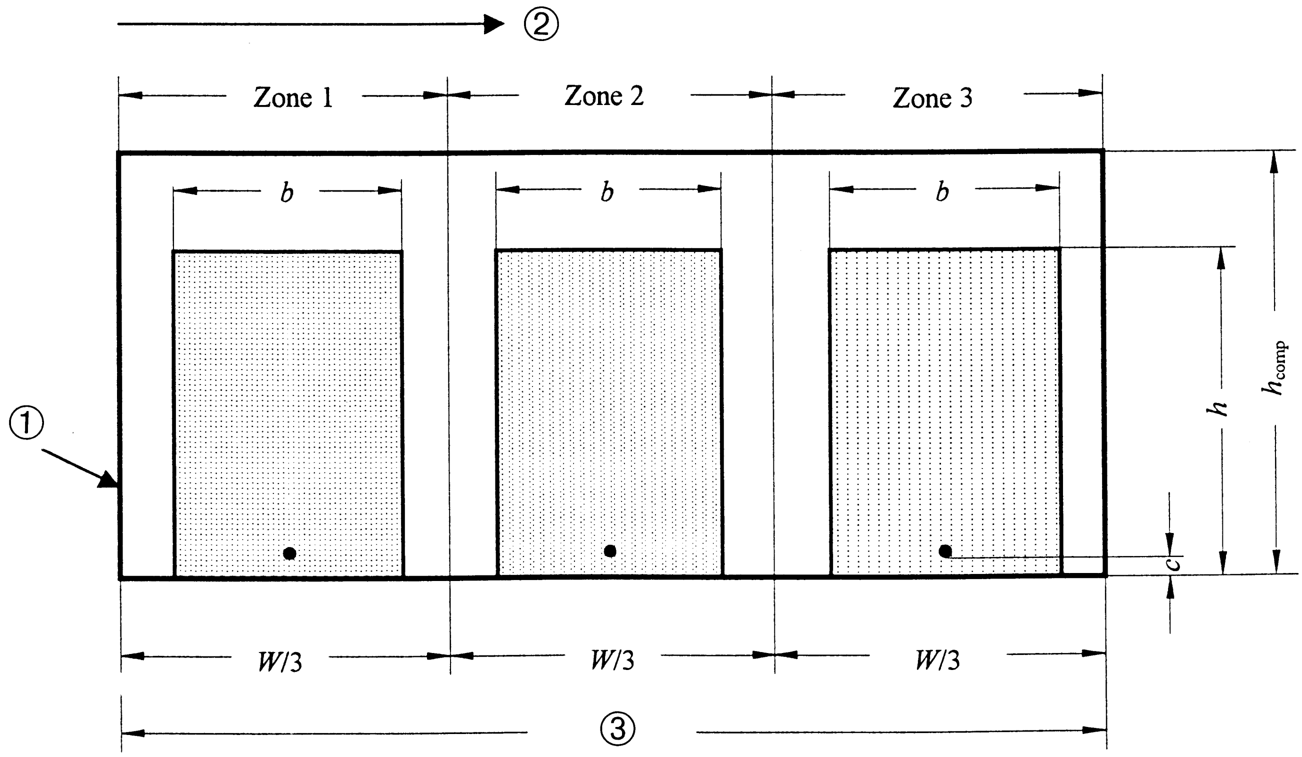
5.3 Number of test specimens

A test set shall consist of three test specimens.

Whenever possible, one test specimen shall be prepared from the upper third of the component, one from the middle and one from the lower third, in the direction of rise of the mass during manufacture (see Figure 2).

5.4 Preparation of test specimens

The test specimens shall be cut from the reinforced component, taking special care to avoid any early damage of bond. All surfaces shall be levelled sufficiently to ensure correct dimensions. The planeness of the surfaces shall be checked along the lines where the loading forces and the support reactions will be applied, by means of a straight edge and, if necessary, by means of feeler gauges. Deviations by more than 0,1 mm shall be corrected by grinding.



Key

1) Cross-section of component
2) Direction of rise
3) Width *W*

Figure 2 – Sampling scheme

At both ends of the beam, the AAC shall be removed from around the bar to be tested over a length of 100 mm in order to eliminate the influence of support pressure on bond.

At midspan the beam shall be provided with a semi-cylindrical hole, diameter 200 mm to 250 mm for beams with a total height of h = 200 mm (used for concrete cover c = 15 mm to 30 mm) and 300 mm for beams with a total height of h = 200 mm (used for concrete cover c > 30 mm). This hole is drilled horizontally (or cut out otherwise), perpendicularly to the longitudinal axis, leaving the bar free over a sufficient length in order to fix a strain measuring device. The corrosion protective coating shall be carefully removed by mechanical means from that part of the bar, where the strain measuring device is to be attached.

NOTE: Measuring of steel strains is necessary to determine the tensile force in the bar since this cannot be determined directly from the applied load by calculation, due to the fact that the lever arm of internal forces will vary with increasing load and deflection.

5.5 Conditioning of test specimens

Prior to the test, the test specimens shall be stored with enough free space around them enabling sufficient air circulation for a period of 14 days in a room with a constant temperature of (20 ± 2) ºC and a relative humidity of (55 ± 5) % (see note at the end of clause 4).

6 Testing procedure

After placing the test specimen on the supporting rollers, the transducers for measuring the slip at the bar ends shall be attached, and the strain measuring device shall be installed on the free part of the bar at midspan. After carrying out the necessary reference measurements (zero readings of slip and steel strain) the load applying system, consisting of a bridge profile, two rollers, and the respective distribution plates, is brought into position on the surface of the test specimen. The transducer for measuring midspan deflections used for control of loading rate is installed.

Subsequently, the load shall be applied, preferably in a manner that a constant deflection rate at midspan is achieved, leading to failure in about 5 min (see note 1). During loading, a graph slip versus steel strain shall be recorded for each bar end.

After having observed that the maximum load has been reached and failure has occurred at one side (see note 2), the beam shall be unloaded, and the protruding bar end at the failing side shall be anchored against the AAC in order to enable a second test where failure occurs on the other side.

Subsequently, loading shall be repeated until failure at the other side, and the graph slip versus steel strain shall be recorded again.

NOTE 1: For certain types of corrosion protective coatings it might be necessary to determine the bond behaviour at another loading rate.

NOTE 2: Failure can be caused by slip of the bar (bond failure) or by cracking of the AAC block (shear failure) or a combination of both.

7 Test results

Conventional bond strength at failure, τ_{bm}, shall be calculated, according to equation (1), assuming uniform distribution of bond stresses along the full embedded length of the bar in that half of the test beam where failure has occurred (see note).

$$\tau_{bm} = \frac{F_{su}}{\pi \times \phi \times l_b} \qquad ...(1)$$

where:

τ_{bm} is the conventional bond strength at failure, in newtons per square millimetre;

F_{su} $= \varepsilon_{su} \times E_s \times \pi\, \phi^2/4$, the tensile force in the reinforcing bar at failure, in newtons;

ϕ is the nominal bar diameter (without corrosion protective coating), in millimetres;

l_b is the measured bond length (length of embedment) in that half of the test specimen where failure has occurred, in millimetres;

ε_{su} is the measured steel strain at failure in the free central part of the bar, in millimetres per millimetre;

E_s is the modulus of elasticity of the steel, either taken as 200 000 N/mm² or determined by testing on companion bars, in newtons per square millimetre.

The bond strength τ_{bm} shall be expressed to the nearest 0,1 N/mm².

Next to the τ_{bm} values, it can be useful to determine the following data:

- slip corresponding to maximum load for both free ends of the bar;
- bond stress corresponding to a certain slip (e.g. 0,1 mm) at the free ends of the bar.

These values can be derived from the graphs slip versus steel strain.

NOTE: Usually two test results are obtained for each test beam (one for each end).

8 Test report

The test report shall include the following:

a) identification of the product;

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) dimensions of test specimens;

f)relative position and orientation of the test specimen in the original component;

g) dry density of the AAC according to EN 678;

h) compressive strength of the AAC according to EN 679;

j) diameter and surface conditions (plain smooth or ribbed) of the bar;

k) (if available) yield strength of the steel;

l) modulus of elasticity of the steel;

m) type of corrosion protective coating;

n) relative position of the bar with respect to the rise of the mass during manufacture of the component;

p) concrete cover of the bar;

q) graphs slip versus steel strain;

r)conventional values, τ_{bm}, of bond strength (individual values and mean value);

s) observations of failure mode (pure slip, cracking of AAC, etc.);

t) (if appropriate) deviations from the standard method of testing;

u) a declaration that the testing has been carried out in accordance with this European Standard, except as detailed in 8 t).

If determined, reporting of the following optional data can be useful:

v) slip at maximum load;

w) bond stress at a specified slip, e.g. 0,1 mm.

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