BRITISH STANDARD

BS EN
1521 : 1997

Determination of flexural strength of lightweight aggregate concrete with open structure

The European Standard EN 1521 : 1996 has the status of a British Standard

ICS 91.100.30

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee B/523, Prefabricated concrete and lightweight aggregate concrete with open structure, upon which the following bodies were represented:

Aggregate Concrete Block Association
Autoclaved Aerated Concrete Products Association
British Masonry Society
British Precast Concrete Federation Ltd.
Department of the Environment (Building Research Establishment)
Institution of Structural Engineers
Local Authority Organizations

This British Standard, having been prepared under the direction of the Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 15 August 1997

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Contents

National foreword

This British Standard has been prepared by Technical Committee B/523 and is the English language version of EN 1521 : 1996 *Determination of flexural strength of lightweight aggregate concrete with open structure*, published by the European Committee for Standardization.

Cross-reference

Publication referred to	Corresponding British Standard
EN 992 : 1995	BS EN 992 : 1996 *Determination of the dry density of lightweight aggregate concrete with open structure*

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, an EN title page, pages 2 to 6, an inside back cover and a back cover.

EUROPEAN STANDARD
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EN 1521

November 1996

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Descriptors: Prefabricated elements, armatures, components, concrete, aggregates, mechanical tests, bend tests, determination, tensile strength

English version

Determination of flexural strength of lightweight aggregate concrete with open structure

Détermination de la résistance à la flexion du béton de granulats légers à structure ouverte

Bestimmung der Biegezugfestigkeit von haufwerksporigem Leichtbeton

This European Standard was approved by CEN on 1996-10-19. CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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.

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 Central Secretariat has the same status as the official versions.

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

CEN

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

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

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 177, Prefabricated reinforced components of autoclaved aerated concrete or lightweight 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 May 1997, and conflicting national standards shall be withdrawn at the latest by May 1997.

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 national standards organizations of 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.

Contents

1 Scope

This European Standard specifies a method of determining the flexural (tensile) strength of lightweight aggregate concrete with open structure (LAC) according to prEN 1520 by means of prismatic test specimens taken from prefabricated components.

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 992	*Determination of dry density of lightweight aggregate concrete with open structure*
prEN 1520	*Prefabricated components of lightweight aggregate concrete with open structure*

3 Principle

The flexural strength is determined by applying a uniform bending moment in the middle third of the span of a simply supported prismatic test specimen by means of two-point loading. The maximum load sustained is recorded, and the flexural strength is calculated.

4 Apparatus

a) *any saw*, suitable for wet cutting reinforced LAC components;

b) *calipers*, capable of reading the dimensions of test specimens to an accuracy of 0,1 mm;

c) *a straight-edge*, with a length of approximately 450 mm, feeler gauges (0,2 mm, 0,5 mm, 1,0 mm, and 3 mm) and a square, for checking the planeness and the squareness of test specimens;

d) *a balance*, capable of determining the mass of test specimens to an accuracy of 0,1 %;

e) *a testing machine*, capable of applying a vertical compressive load at the required uniform rate without shock or interruption. The precision of the machine and the load indication shall be such that the ultimate load can be determined with an accuracy of ± 2 %. The measuring range shall be such that the ultimate load is higher than one tenth of the range used.

f) *a loading device*, according to figure 1, for transmitting the load of the testing machine to the test specimen.

The device for applying the loads shall consist of two supporting rollers and two loading rollers. The rollers shall be manufactured from steel and shall have a circular cross-section with a diameter between 15 mm and 40 mm; they shall be at least 10 mm longer than the width of the test specimen. 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 the hinges 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 axis of the testing machine (axis of the vertical compression force) by more than ± 1 mm.

The centre distance, l, between the supporting rollers (i.e. the span length) shall be equal to $3h$, where h is the nominal height of the test specimen (normally 100 mm).

The loading rollers shall be equally spaced between the supporting rollers as shown in figure 1.

All rollers shall be adjusted in their correct position with all distances having an accuracy of ± 1 mm.

g) *a room or cabinet*, capable of maintaining a temperature of (20 ± 5) °C, for storage of the test specimens;

h) *a ventilated drying oven*, capable of maintaining temperatures of (45 ± 5) °C and (105 ± 5) °C.

i) *a water storage tank*, for conditioning of test specimens. Provision of automatic control of water temperature to (20 ± 5) °C shall be made where the tank is located in a room not having temperature controlled within that range.

5 Test specimens

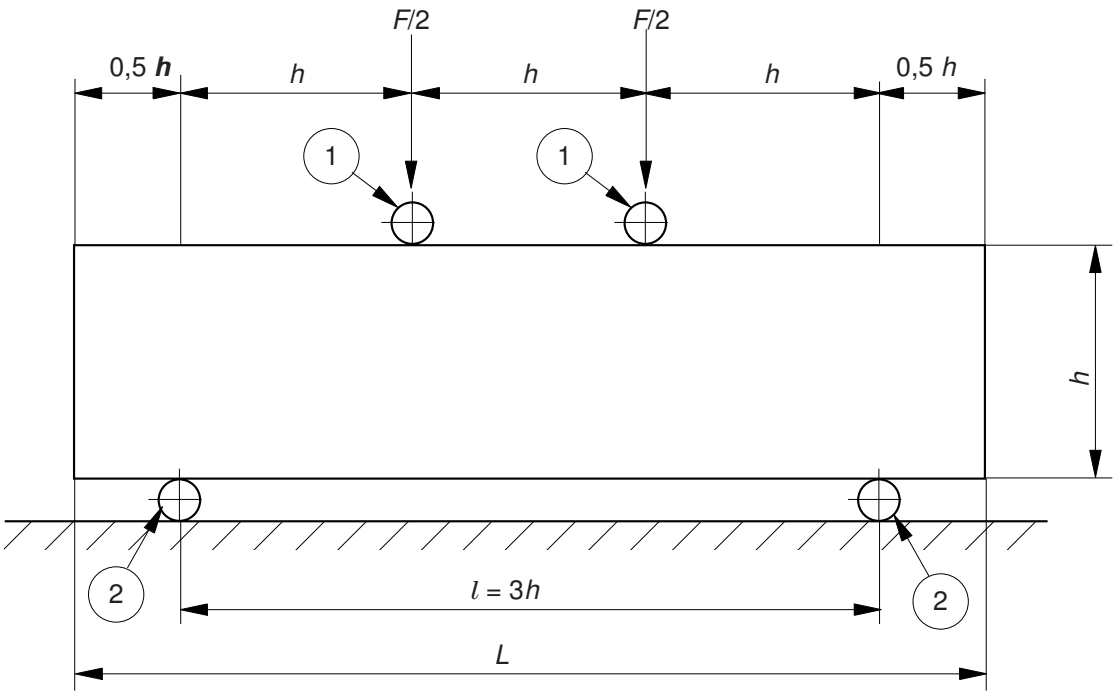
5.1 Sample

The sample for the preparation of the test specimens (usually a prefabricated reinforced component) 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 reference test specimens shall be prisms cut from prefabricated components, with a height $h = 100$ mm, a width $b = 100$ mm, and a length of $L = 400$ mm.

Test specimens of other sizes may be used, provided that the flexural strength determined on such test specimens can be directly related to the flexural strength determined on prisms
100 mm × 100 mm × 400 mm.



1. Loading rollers (capable of rotation and of being inclined independently of each other)
2. Supporting rollers (one fixed and the other capable of rotation and of being inclined)

Figure 1. Loading arrangement

5.3 Number of test specimens

A test set shall consist of three test specimens.

5.4 Preparation of test specimens

The test specimens shall be taken from the central area near the longitudinal axis of the component in such a way that their longitudinal axis is parallel to the longitudinal axis of the component and that one of the longitudinal surfaces coincides with that surface of the component, where the maximum flexural stresses are expected to occur under service conditions.

The test specimens shall be cut from the component at an age of 2 d if possible. They shall contain no reinforcing bars. The surfaces of the test specimens shall be plane and perpendicular to each other.

The planeness of the surfaces shall be checked along both of their diagonals and 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 3,0 mm along the diagonals and by more than 0,2 mm along the lines where the loading forces and the support reactions will be applied shall be corrected by grinding or cutting.

The angle between adjacent longitudinal faces of the test specimens shall also be checked, using a square and, if necessary, a 1 mm feeler gauge. Deviations from squareness by more than 1 mm per 100 mm ($\approx 0{,}6^{\circ}$) shall be corrected by grinding or cutting.

Alternatively, if the surfaces in contact with the loading rollers or support rollers depart from a plane by not more than 0,5 mm, rubber or leather strips may be used as a load distributing intermediate layer between the rollers and the bearing surfaces, instead of grinding these areas.

The rubber or leather strips shall be of uniform thickness (approximately 5 mm), 25 mm in width, and shall extend over the full width of the test specimen.

5.5 Examination of test specimens and determination of their dimensions and volume

The test specimens shall be examined visually, and any abnormalities shall be reported.

The dimensions of the test specimens shall be measured to an accuracy of 0,1 mm, using calipers. Measurements may be taken before or after conditioning according to **5.6**.

The width b and the height h shall be measured at both ends (b_1 and b_3 or h_1 and h_3, respectively) and at midspan (b_2 or h_2, respectively), each value being the mean value of a total of two individual measurements, taken at two opposite longitudinal faces.

The total length L shall be measured along the middle axes of two opposite longitudinal surfaces.

The volume V of the individual test specimens shall be calculated by multiplying the arithmetic mean value of length measurements by the geometric mean value of width measurements $(b_1 + 2b_2 + b_3)/4$ and the geometric mean value of height measurements $(h_1 + 2h_2 + h_3)/4$.

5.6 Conditioning of test specimens

After cutting, the test specimens shall be allowed to dry for $(1 \pm 0{,}5)$ h in air with the temperature of (20 ± 5) °C. Immediately afterwards they shall be sealed in vapour proof sealing and cured for 14 d at the above temperature. After this curing period the sealing shall be removed, and the test specimens shall be stored in a ventilated drying oven at a temperature of (45 ± 5) °C until constant mass is attained. The mass of the test specimens is considered constant if after 24 h of further drying it has not changed by more than 0,2 %.

Directly after removal from the drying oven, the test specimens shall be immersed in water of drinking water quality at (20 ± 5) °C for a period of 7 d.

Then the test specimens shall be allowed to drip dry for $(1 \pm 0{,}5)$ h before determination of the flexural strength.

Immediately before testing, the moist mass m_{hum} of the test specimens shall be determined to an accuracy of 0,1 %.

NOTE. The purpose of the drying and wetting procedure specified in this clause is simulation of unfavourable conditions with respect to flexural strength due to possible shrinkage cracking and strength reduction due to water saturation.

6 Testing procedure

6.1 Flexural test

All testing machine bearing surfaces shall be wiped clean and any loose material shall be removed from the surfaces of the test specimen that will be in contact with the rollers.

The loading device shall be correctly centred in the compression testing machine (see **4**f).

The test specimen shall be placed on the support rollers of the loading device in the testing machine, correctly centred and aligned perpendicular to the rollers and supported on the surface corresponding to the surface of the component from which the test specimen has been taken and where the maximum tensile stresses are expected to occur in the component when in use.

The longitudinal axis of the test specimen shall not deviate by more than ± 1 mm from the (theoretical) plane of the hinges of the inclinable rollers (see **4**f).

The load shall not be applied before all loading and supporting rollers are resting evenly against the test specimen.

Subsequently, the load may be applied rapidly, but without shock, up to approximately 50 % of the anticipated breaking load. Thereafter without halt, the load shall be increased continuously until rupture occurs, at a uniform rate which constantly increases the stress in the extreme fibres at approximately 0,02 N/mm^2 per s, when calculated in accordance with clause **7** (see note).

When using a manually controlled testing machine, any tendency for the selected rate of loading to decrease, as test specimen failure is approached, shall be corrected by appropriate adjustment of the controls.

When using an automatically controlled testing machine, the rate of loading shall be periodically checked to ensure that the rate is constant and at the required level.

The maximum load indicated shall be recorded.

NOTE. The required loading rate of the testing machine for test specimens with square cross-section is given by equation (1):

$$R = sh^2/3 \qquad (1)$$

where:

- R is the required loading rate, in newtons per second;
- s is the specified stress rate ($s = 0{,}02$), in newtons per square millimetre per second;
- h is the nominal height of the test specimen, in millimetres.

For reference test specimens with square section 100 mm × 100 mm and a span length of 300 mm the specified stress rate is achieved by increasing the testing machine load by approximately 70 N/s.

6.2 Examination and measurement of test specimens after the test

The fractured test specimen shall be examined and the appearance of the LAC and type of fracture shall be recorded if these are unusual.

Height h_{fr} and width b_{fr} of the cross-section at the location of fracture shall be measured to the nearest 0,1 mm, each vlaue being the mean value of a total of two individual measurements, taken at two opposite longitudinal faces.

Subsequently, the test specimens shall be dried at (105 ± 5) °C in order to determine the dry density of the LAC on the basis of EN 992 and to check its moisture content. Care shall be taken that no LAC is lost before the final weighings have been taken.

7 Test results

The flexural strength of the test specimen shall be calculated from equation (2):

$$f_{cf} = \frac{Fl}{b_{fr}h_{fr}^2} \quad (2)$$

where:

f_{cf}	is the flexural strength, in newtons per square millimetre;
F	is the maximum load (see note), in newtons;
l	is the span length, in millimetres;
b_{fr} and h_{fr}	are the cross-sectional dimensions of the test specimen at the location of fracture, in millimetres (see figure 1).

The flexural strength of each individual test specimen and the mean value shall be expressed to the nearest 0,01 N/mm^2.

The dry density of the LAC shall be calculated from equation (3):

$$\rho = \frac{m_d}{V} \quad (3)$$

where:

ρ	is the dry density, in kilograms per cubic metre;
m_d	is the dry mass of the broken test specimen according to **6.2**, in kilograms;
V	is the volume of the test specimen according to **5.5**, in cubic metres.

The dry density of each individual test specimen and the mean value shall be indicated to the nearest 10 kg/m^3.

The moisture content of the LAC shall be calculated from equation (4):

$$\mu_m = 100\ \frac{m_{hum} - m_d}{m_d} \quad (4)$$

where:

μ_m	is the mass related moisture content, in percent;
m_{hum}	is the mass of the test specimen in the moist state according to **5.6**, in kilograms;
m_d	is the dry mass of the broken test specimen according to **6.2**, in kilograms.

The mass related moisture content of each individual test specimen and the mean value shall be indicated to the nearest 0,1 %.

NOTE. The weight of the test specimen is not included. Depending on the testing machine and the loading arrangement the weight of the loading arrangement or parts thereof is not always included in the indicated maximum load. It may be necessary, therefore, to take this into account when calculating the flexural strength.

8 Test report

The test report shall include the following:

a) identification of the product;

b) date of manufacture or other code;

c) age of the sample at the time of preparation of test specimens;

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

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

f) size and relative position of the test specimens in the component;

g) flexural strength of each individual test specimen and mean value;

h) dry density of each individual test specimen and mean value;

j) moisture content of each individual test specimen and mean value;

k) (if unusual) observations on the appearance of the test specimens before and after the flexural test, appearance of the fracture surface, location of fracture outside the loading rollers;

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

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

List of references

See national foreword.

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