BRITISH STANDARD

BS EN
1741:1998

# Determination of shear strength for out-of-plane forces of joints between prefabricated components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure

The European Standard EN 1741:1998 has the status of a British Standard

ICS 91.100.30

# National foreword

This British Standard is the English language version of EN 1741:1998.

The UK participation in its preparation was entrusted to Technical Committee B/523, Prefabricated components of reinforced autoclaved aerated concrete and lightweight aggregated 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.

**Cross-references**

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**Summary of pages**

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

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EUROPEAN STANDARD
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EUROPÄISCHE NORM

# EN 1741

April 1998

ICS

Descriptors: Concrete, cellular concrete, aggregates, reinforcing materials, prefabricated elements, joints, mechanical tests, shear tests, determination, shear strength, test specimen

English version

# Determination of shear strength for out-of-plane forces of joints between prefabricated components made of autoclaved aerated concrete or lightweight aggregate concrete with open structure

Détermination de la résistance au cisaillement des jonctions entre les éléments préfabriqués réalisés en béton cellulaire autoclavé ou en béton de granulats légers à structure ouverte, sous l'effet de forces agissant en dehors du plan des éléments

Bestimmung der Schubtragfähigkeit von Fugen zwischen vorgefertigten Bauteilen aus dampfgehärtetem Porenbeton oder haufwerksporigem Leichtbeton bei Belastung rechtwinklig zur Bauteilebene

This European Standard was approved by CEN on 25 March 1998.

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, Czech Republic, 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**



Ref. No. EN 1741:1998 E

## 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, 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.

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.

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## 1 Scope

This European Standard specifies a method of determining the shear strength for out-of-plane forces of joints between prefabricated components made of autoclaved aerated concrete (AAC) according to prEN 12602 or lightweight aggregate concrete with open structure (LAC) according to prEN 1520.

## 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 678, *Determination of dry density of autoclaved aerated concrete.*

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

EN 992, *Determination of dry density of lightweight aggregate concrete with open structure.*

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

EN 1354, *Determination of compressive strength of lightweight aggregate concrete with open structure.*

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

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

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

## 3 Principle

The shear strength of longitudinal joints between prefabricated AAC- or LAC-components for forces acting perpendicular to the plane of the components is determined by applying a vertical line load along the middle-axis on top surface of a horizontally positioned section of a component. The loaded section is supported at both longitudinal edges. At least one of these longitudinal supports consists of an adjacent component section connected to the loaded section by a joint of the type to be tested. The load is increased continuously or in steps until failure of the joint occurs.

The test can be carried out without lateral restraints (case A) or with lateral restraints preventing in-plane displacements normal to the joint (case B).

## 4 Apparatus

a) *Saw*, for cutting components and test specimens;

b) *Testing machine or jack*, capable of applying a vertical compressive load without shock continuously or in steps. The precision of the machine or jack and of the load indication shall be such that the failure load can be determined to an accuracy of $\pm 3$ %. The measuring range shall be such that the failure load is higher than one-tenth of the range used;

c) *Callipers and/or a rule*, capable of reading the dimensions of the test specimens and the joints to an accuracy of 1 mm;

d) *Devices*, according to Figures 1, 2, and 3 for loading and supporting the test specimen;

e) *Weighing equipment*, capable of determining the mass of the sections to an accuracy of 5 kg;

f) *Steel plates and rollers*, according to Figures 1, 2 and 3;

g) *Device for measuring the relative vertical displacement between the joined sections* (optional).

## 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. In the case of AAC, the direction of rise of the mass during manufacture shall be marked on the components.

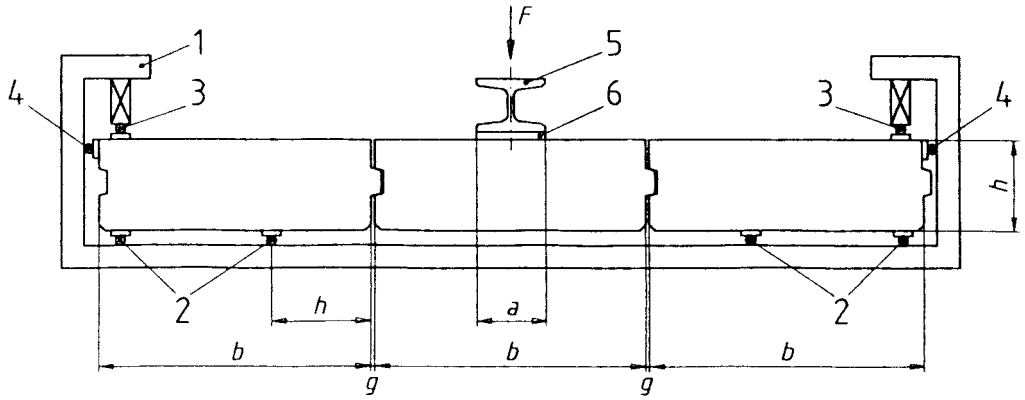
### 5.2 Shape and size of test specimens

A test specimen normally consists of an arrangement of three sections taken from prefabricated components with standard width and thickness which shall be joined in the intended manner (see Figure 1). The length of the sections shall be equal to their width. For certain investigations test specimens consisting of two sections may be used (see Figures 2 and 3).

### 5.3 Number of test specimens

A test set shall consist of at least three test specimens, each normally made of three sections taken from the same component (see Figure 1).

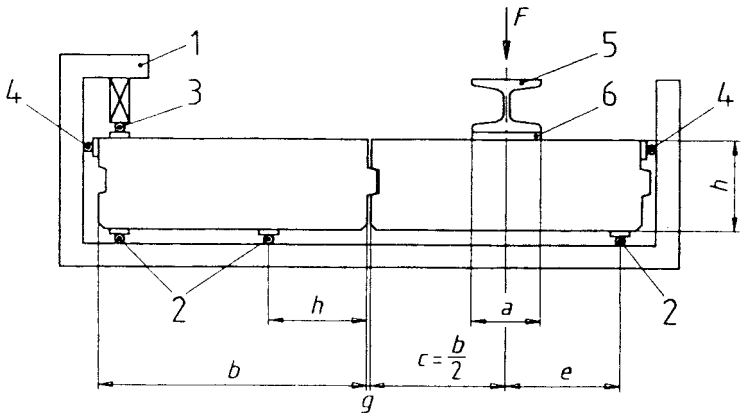
When testing an asymmetric joint between two sections, two test sets with different arrangements of the sections with respect to loading and supports shall be carried out (see Figures 2 and 3).




$a = b - 2h \geq 100$ mm is the maximum permitted gap
$g$ is the maximum permitted gap

1 Support frame
2 Moveable support rollers
3 Upper supports
4 Lateral supports (only in case B)
5 Load distribution beam
6 Soft fibreboard or equalizing layer

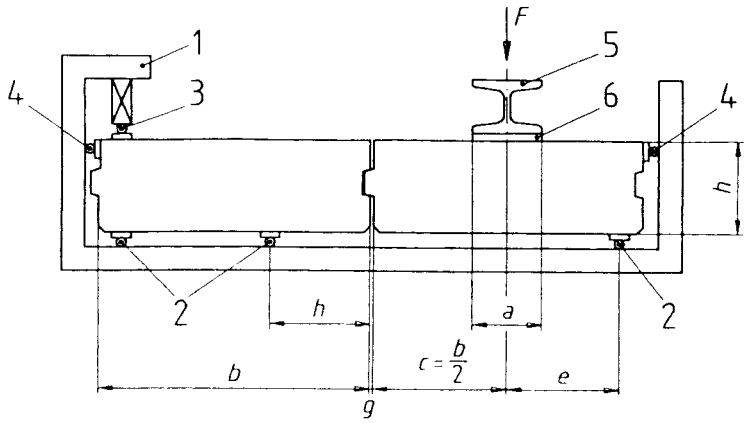
**Figure 1 — Arrangement of standard shear test**




$a = b - 2h \geq 100$ mm

1 Support frame
2 Moveable support rollers
3 Upper supports
4 Lateral supports (only in case B)
5 Load distribution beam
6 Soft fibreboard or equalizing layer

**Figure 2 — Arrangement of one-sided shear test (type 1)**




1 Support frame
2 Moveable support rollers
3 Upper supports
4 Lateral supports (only in case B)
5 Load distribution beam
6 Soft fibreboard or equalizing layer

**Figure 3 — Arrangement of one-sided shear test (type 2)**

### 5.4 Preparation of test specimens

AAC components shall be allowed to cool for at least 2 d after autoclaving before being assembled.

LAC components shall be at least 21 d old before being assembled and at least 28 d at testing.

The sections shall be cut to length from the components by means of a saw.

Before jointing, length, thickness, and width of the sections shall be measured. The shape and dimensions of the longitudinal faces adjacent to the joint (e.g. tongue and groove) shall also be determined.

If the components or sections are frozen or cold, they shall be stored with sufficient space between each other at room temperature for at least 2 d before jointing.

The sections shall then be arranged on a support frame according to Figure 1, 2 or 3. Each support consists of a roller with a diameter of 20 mm or more and a steel plate between the roller and the section. The supports shall extend over the full length of the test specimen. The steel plates shall have a width of $(50 \pm 2)$ mm and a thickness of at least 10 mm. The section on which the load is applied shall be weighed prior to being jointed.

The gap between the assembled sections shall have the maximum width permitted by the manufacturer.

If a dry jointing system is used (e.g. tongue and groove joint), the sections shall be simply laid together without additional fixing.

In the case of joints to be grouted with mortar or concrete, the sections shall be placed in position and fixed temporarily together in at least two places before grouting. After hardening of the grouting material the restraint shall be removed.

Grouting shall be performed according to the instructions of the manufacturer of the components. The grouting procedure (including e.g. any prewetting of the concrete adjacent to the joint), the recipe, consistency, and the temperature of the grouting material shall be recorded in the test report.

A grouted joint shall be protected against moisture loss under plastic foil immediately after grouting and cured at room temperature for at least 7 d before the test.

### 5.5 Conditioning of test specimens

The test specimens shall be kept at room temperature before and during testing. The mass-related moisture content of the concrete at testing shall be at least 10 % for AAC and at least 5 % for LAC. This shall be checked after the shear test (see **6.2**).

NOTE When in doubt about the moisture content, this can be estimated in advance by testing related samples of material.

## 6 Testing procedure

### 6.1 Shear test

The load shall be applied as line load acting in a vertical direction parallel to the joints and along the longitudinal axis of the section to be loaded. It shall be uniformly distributed over the whole length of the test specimen and have a width equal to the width of the loaded section less twice its thickness, but not less than 100 mm, by means of a distribution beam and an intermediate layer of soft fibre board.

The load shall be applied continuously or in steps until failure of a joint. In the case of incremental loading, the size of the load steps shall not exceed 1/10 of the estimated failure load. For each step the load may be increased rapidly, but without shock. After reaching the intended load level, the load shall be kept constant for 1 min before the next load step is applied. The total duration of the shear test should be approximately 10 min. The formation of cracks or irregularities and the rupture load shall be noted in the test report. If required, the relative vertical displacement between the joined sections should be measured.

### 6.2 Investigations after shear test

Observations on the extent of filling of grouted joints shall be indicated in the test report.

Samples shall be taken from the sections in the vicinity of the joint to check the moisture content of the concrete. In the case of AAC this shall be done in accordance with EN 1353. In the case of LAC the procedure described in EN 1356:1996, **7** may be used.

Additional samples shall be taken in order to determine the compressive strength and the dry density of the concrete. They shall be extracted from undamaged parts of the sections tested or from a component or block from the same mould or mixer batch as used for the components of the shear test. The compressive strength shall be determined according to EN 679 (AAC) or EN 1354 (LAC). The dry density shall be determined according to EN 678 (AAC) or EN 992 (LAC).

Samples of mortar dowels or of the grouting material shall be taken for the determination of the density, the moisture content and the compressive strength. These properties shall be tested in accordance with the relevant or most appropriate EN test methods.

If it is not possible to determine the compressive strength of the grouting material on test specimens taken from the joints, this shall be done on prisms or cubes cast in moulds using material from the same batch as used for grouting of the joints.

## 7 Test results

The shear strength of the joint shall be expressed as ultimate shear force per unit length 1 m and shall be determined from equation (1) or equation (2), respectively, where equation (1) is valid for test specimens consisting of three sections (standard shear test according to Figure 1) and equation (2) is valid for test specimens consisting of two sections (one-sided shear test according to Figure 2 or 3).

$$V_R = \frac{F_u}{2l} \quad (1)$$

$$V_R = \frac{F_u}{l} \times \frac{e}{c+e} \quad (2)$$

where

$V_R$ is the conventionally defined value of shear strength, in kilonewtons per metre (see NOTE);

$F_u$ is the failure load, in kilonewtons;

$l$ is the length of the broken joint, in metres;

$c$ is the distance of the line load from the joint, in metres ($c = b/2$, $b$ being the width of the section as shown in Figure 2 or Figure 3, not including the width of any tongue);

$e$ is the distance of the line load from the vertical support of the loaded section, in metres.

The shear strength shall be rounded to the nearest 0 or 5 in the third significant figure (e.g. 4,05 kN/m or 11,0 kN/m).

NOTE In the case of grouted joints or other fixed jointing systems, equation (2) is only an approximation due to the unknown bending moment in the joint.

## 8 Test report

The test report shall include the following:

a) identification of the components;

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) preparation of test specimens;

f) drawing of joint, jointing system, and load application device, showing also the direction of rise in the case of AAC;

g) recipe and properties of fresh grouting material, if applicable;

h) shear strength of individual test specimens and mean value of each test set;

i) relative vertical displacement between the joined sections as a function of the shear force (if measured);

j) moisture content of AAC or LAC, respectively;

k) density of AAC or LAC, respectively;

l) compressive strength of AAC or LAC, respectively;

m) properties of hardened grouting material if determined (compressive strength, moisture content, density);

n) observations during and after the test;

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

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

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