BRITISH STANDARD

BS EN
1170-4 : 1998

Precast concrete products — Test method for glass-fibre reinforced cement

Part 4. Measuring bending strength — 'Simplified bending test' method

The European Standard EN 1170-4 : 1997 has the status of a British Standard

ICS 91.100.30

National foreword

This British Standard is the English language version of EN 1170-4 : 1997.

The UK participation in its preparation was entrusted to Technical Committee B/524, Precast concrete products, 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.

The UK voted against this standard at the CEN Formal Vote stage but the analysis of voting, in accordance with CEN/CENELEC Internal Regulations Part 2 : *Common rules for standards work*, resulted in a positive vote. In consequence, the document was accepted as a European Standard.

This standard, together with BS EN 1170 : Parts 1 to 3 and 5 to 7, supersedes BS 6432 : 1984 which is withdrawn.

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

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or by using the 'Find' facility of the BSI Standards Electronic Catalogue.

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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.

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 March 1998

ISBN 0 580 29185 5

Amendments issued since publication

Amd. No.	Date	Text affected

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1170-4

November 1997

ICS 91.100.30

Descriptors: Concrete products, prefabricated elements, composite materials, cements, glass, verification, conformity tests, bend tests, measurements, breaking strength

English version

Precast concrete products — Test method for glass-fibre reinforced cement — Part 4: Measuring bending strength — 'Simplified bending test' method

Produits préfabriqués en béton — Méthode d'essai des composites ciment-verre — Partie 4: Mesure de la résistance en flexion — Méthode dite 'Essai simplifié de flexion'

Vorgefertigte Betonerzeugnisse — Prüfverfahren für Glasfaserbeton — Teil 4: Bestimmung der Biegezugfestigkeit — Einfache Biegezugprüfung

This European Standard was approved by CEN on 29 September 1997.

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.

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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

Ref. No. EN 1170-4 : 1997 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 229, Precast concrete products, the secretariat of which is held by AFNOR.

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 1998, and conflicting national standards shall be withdrawn at the latest by May 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.

Contents

1 Scope

This European Standard specifies a test method, applicable to glass-fibre reinforced cement, for verifying conformity to the bending strength specification, for evaluating the uniformity of the production process and for checking the homogeneity of the compaction.

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.

ISO 7500-1	*Metallic materials — Verification of static uniaxial testing machines — Part 1: Tensile testing machines*
prEN 1169	*Performance criteria for glass-fibre reinforced cement — Manufacture control plan*

3 Symbols and abbreviation

3.1 Symbols

b	width of test piece, in millimetres;
d	thickness of test piece (to the nearest 0,1 mm), in millimetres;
F_{MOR}	failure load, in newtons;
l	length of test piece, in millimetres;
L	span, in millimetres;
m_w	mass of test piece before drying, 'wet mass', in grams;
m_d	mass of test piece after drying, 'dry mass', in grams;
W	water content, in percentage by mass;
σ_{MOR}	stress at failure by bending, in megapascals.

3.2 Abbreviation

GRC	glass-fibre reinforced cement.

4 Apparatus

The apparatus comprises:

– *a bending test machine*, of accuracy meeting the class 3 requirements specified in ISO 7500-1. It is provided with a 4-point bending device, the diameter of the supports being not less than 6 mm and the distance between the supports being fixed (span: 200 mm) or adjustable;

– *a flat board*, of approximatively (500 × 800) mm made of smooth, easy to be cleaned material. In the case of Premise cement, a frame with the same thickness as the product;

– *a flat-bottomed tank*, of approximately (500 × 200 × 100) mm filled with water maintained at (20 ± 2) °C;

– *a rule*, accurate to 0,5 mm;

– *a calliper*, accurate to 0,1 mm;

– *a ventilated drying oven*, adjusted to (105 ± 5) °C;

– *a scale*, with a measuring range 0 kg to 2 kg accurate to 0,1 g.

5 Procedure

5.1 Test pieces

Make a sample panel with no facing layer (i.e. made entirely of GRC),on the flat board, under the same conditions as the actual production it represents: spray or premix.

After 24 h, demould and store the sample panel until the age of 6 days, under the same conditions as for the actual production it represents.

Cut out by sawing at 50^{+1}_{0} mm from the edges, eight test pieces from the positions illustrated in figure 1.

NOTE. The test pieces can also be cut out on the day of demoulding.

Mark the test pieces as shown in figure 1.

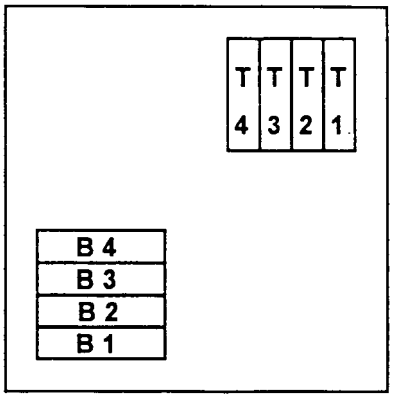

Figure 1. Position and identification of test pieces

Dimensions of the test pieces:

a) for a testing machine with fixed distance between supports:

– width: (50 ± 2) mm;

– length: 225^{+25}_{0} mm;

b) for a testing machine with adjustable distance between supports;

– width (50 ± 2) mm;

– length as a function of the thickness, in accordance with table 1.

Table 1. Length of test pieces as a function of their thickness				
Dimensions in millimetres				
Thickness d with a tolerance of $\pm$ 0,5 mm	$\leq$ 6,7	6,8 to 10,0	10,1 to 12,5	$\geq$ 12,6
Length l with a tolerance of $^{+25}_{0}$ mm	160	225	275	325

When the eight test pieces have been aged for six days, immerse them in the tank filled with water at (20 $\pm$ 2) °C for 24 h so that they have been aged for seven days at the time of the tests.

The test shall be carried out no more than 1/2 h after the test pieces have been removed from the water.

5.2 Test method

Measure the length of each test piece to the nearest millimetre.

Position the test pieces[1)] in the testing machine, as shown in figure 2, on the two bottom supports with a span L determined in accordance with table 2.

Table 2. Span of the test pieces as a function of their length				
Dimensions in millimetres				
Length l	160	225	275	325
Span L	135	200	250	300

Apply the load smoothly at a rate of (10 $\pm$ 1) N/s.

Record the failure load F_{MOR}, which is the maximum value read off the machine pressure gauge.

After failure, measure to the nearest 0,1 mm the thickness and width of the test piece at or near the failure location.

Weigh each test piece, i.e. determine m_w (in grams).

After the failure, place the test pieces in the ventilated drying oven adjusted to (105 $\pm$ 5) °C until a constant mass m_d is attained, i.e. until the difference between two weighing results 24 h apart is less than 0,1 %.

6 Expression of results

The stress on failure by bending σ_{MOR}, expressed in megapascals, is given by the following equation:

$$\sigma_{MOR} = \frac{F_{MOR} \times L}{b \times d^2}$$

The water content W, expressed as a percentage by mass, is determined by the following equation:

$$W = \frac{m_w - m_d}{m_d} \times 100$$

NOTE. In quality control it is not essential to measure the water content systematically (see prEN 1169).

7 Interpreting the test

The specified value of the ultimate bending stress is determined as a function of the use of the GRC product. It is defined during the consideration of the suitability.

NOTE. The variability of the production process can be evaluated in accordance with annex A.

8 Test report sheet

The test report sheet shall comprise the following elements:

– the date of test;
– the identification of manufacturer;
– the dimensions of test pieces;
– the intermediate results: failure load; if necessary, wet mass and dry mass;
– the results: stress on failure; if necessary, water content;
– the curing conditions if different from those specified in the standard.

NOTE. An example of the test report sheet is given in annex B.

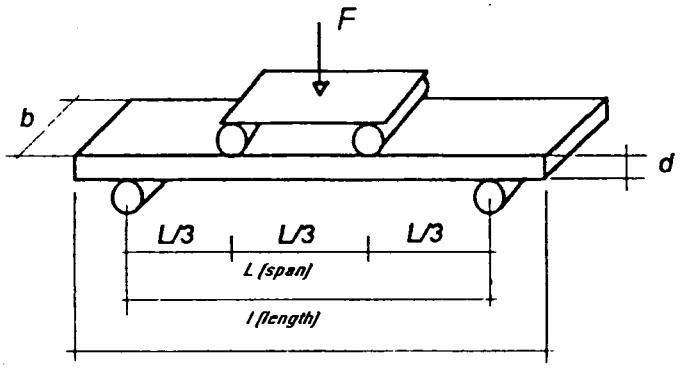

Figure 2. Position of test pieces in testing machine

[1)] Test pieces T_1, T_3, B_1 and B_3 are placed 'mould' face down on the two bottom supports; test pieces T_2, T_4, B_2 and B_4 are placed with the 'mould' face up in contact with the top supports.

Annex A (informative)

Variability of the production process

As in all industrial processes, the final result depends on five large families of parameters:

NOTE. Annotations above — delete 'Value and dispersion' and substitute 'Value and its variability'.

In the case of glass-fibre reinforced cement, experience has shown that the important variables are:

– materials: length and type of fibres, granulometry of the sand, nature and class of cement;

– methods: fibre content, formulation of the mortar, water/cement ratio;

– equipment: fibre content and orientation;

– workmanship: quality of compaction, spraying distance;

– ambient conditions: hardening temperature and duration of curing.

The relationship between the stresses on failure by bending (σ_{MOR}) obtained from the eight test pieces $\left(\frac{T_1 + T_2 + T_3 + T_4}{B_1 + B_2 + B_3 + B_4} \text{ and } \frac{T_1 + T_3 + B_1 + B_3}{T_2 + T_4 + B_2 + B_4}\right)$ is an indication of the 'workmanship and equipment'.

For a valid evaluation of the quality and uniformity levels, it is useful:

– to make a graph of the evolution of mean values and varibilities;

– and to proceed with a statistical analysis (calculation of mean and standard deviation) every five series of tests.

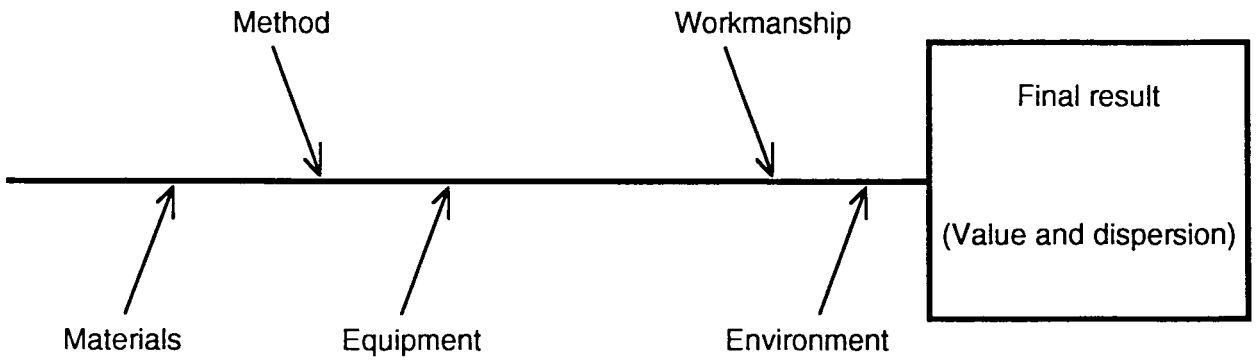

Figure A.1 Families of parameters

Annex B (informative)
Example of test report sheet

Company: ..... **Plant**: .....

Test performed by: .....

Date of production: .....

Order and marking of products made on that day:

Tests carried out: consistency: yes - no
fibre output: yes - no

d (mm)	l (mm)	L (mm)
2,5 to 6,7	160	135
6,8 to 10	225	200
10 to 12,5	275	250
≥ 12,6	325	300

$$\text{Stress (MPa)} = \frac{\text{Load (N)} \times \text{span (mm)}}{\text{Width (mm)} \times \text{thickness}^2\ \text{(mm)}} \qquad \sigma_{MOR} = \frac{F_{MOR} \times L}{b \times d^2}$$

PRODUCTION CONTROL ON HARDENED GRC (WITHOUT FACING LAYER)

Resistance to bending

TEST: at 7 days on: .....
(prior immersion in water for 24 h)

Test pieces	T_1	T_3	B_1	B_3	T_2	T_4	B_2	B_4
Orientation of 'mould' face	Down				Up			
Width (mm) b								
Thickness (mm) d								
Length (mm) l								
Failure load (N) F_{MOR}								
Stress on failure (MPa) σ_{MOR}								
Relationship of individual stresses on failure for $\frac{T_1 + T_2 + T_3 + T_4}{B_1 + B_2 + B_3 + B_4}$								
Relationship of individual stresses on failure for $\frac{T_1 + T_3 + B_1 + B_3}{T_2 + T_4 + B_2 + B_4}$								

Wet mass: (g) m_w								
Dry mass: (g) m_d								
Water content (%) W								
Mean value (%)								

*) Taking into account the influence of the thickness on the value of the stress, it is recommended to record the results to the nearest 0,1 mm.

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