BRITISH STANDARD

BS EN
1170-5 : 1998

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

Part 5. Measuring bending strength, 'Complete bending test' method

The European Standard EN 1170-5 : 1997 has the status of a British Standard

ICS 91.100.30

National foreword

This British Standard is the English language version of EN 1170-5 : 1997 published by the European Committee for Standardization (CEN).

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.

This standard, together with BS EN 1170 : Parts 1 to 4, 6 and 7, supersedes BS 6432 : 1984 which is withdrawn.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.

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, 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

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English version

Precast concrete products — Test method for glass-fibre reinforced cement — Part 5: Measuring bending strength — 'Complete bending test' method

Produits préfabriqués en béton — Méthode d'essai des composites ciment-verre — Partie 5: Mesure de la résistance en flexion — Méthode dite 'Essai complet de flexion'

Vorgefertigte Betonerzeugnisse — Prüfverfahren für Glasfaserbeton — Teil 5: Bestimmung der Biegezugfestigkeit — Vollständige Biegezugprufung

This European Standard was approved by CEN on 29 October 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.

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.

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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 1170-5 : 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, Switzerland and the United Kingdom.

Contents

1 Scope

This European Standard specifies a test method for identifying the stress and deformation performance, at the limit of proportionality and on failure, of a GRC composition subjected to bending.

It is also used to establish, for a given composition of GRC, the relationship between the conventional strength at 28 days and the strength at 7 days (see EN 1170-4).

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*
EN 1170-4	*Precast concrete products — Test method for glassfibre reinforced cement — Part 4 : Measuring bending strength — 'Simplified bending test' method*

3 Symbols and abbreviation

3.1 Symbols

b	width of test piece, in millimetres;
d	thickness of test piece in millimetres;
F_{LOP}	load at limit of proportionality, in newtons;
F_{MOR}	failure load, in newtons;
l	length of test piece, in millimetres;
L	span, in millimetres;
M_d	mass of test piece after drying, 'dry mass', in grams;
M_W	mass of test piece before drying, 'wet mass', in grams;
W	water content, in percentage by mass;
Δ_{LOP}	deflection at limit of proportionality, in millimetres;
Δ_{MOR}	deflection at failure in millimetres;
ε_{LOP}	stress at limit of proportionality;
ε_{MOR}	deformation at failure
σ_{LOP}	stress at limit of proportionality, in megapascals;
σ_{MOR}	stress at failure, in megapascals.

3.2 Abbreviation

GRC: glassfibre reinforced cement.

4 Apparatus

The apparatus comprises :

– *a bending test machine*, of accuracy meeting the class 2 requirements specified in ISO 7500-1. It is provided with a four-point bending device (minimum diameter of supports: 6 mm) and a displacement sensor (accurate to 0,01 mm) located preferably in the transverse axis of symmetry of the test device. The test device shall be fitted with a system for plotting the load/deflection curve, either on-line or off-line ;

– *two flat, easy to clean, smooth material plates*, of approximately (500 × 800) mm. In the case of a 'pouring' production, provide for a frame having a thickness equal to that of the product being manufactured;

– *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

Consecutively make sample panels on the two flat boards, with no facing layer (solid GRC only) under the same conditions as for the actual production they represent: spray or premix.

After 24 h, demould and store the two sample panels under the same conditions as for the actual production they represent for 6 days.

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

Cut out by sawing in each panel, at $\left(50\,^{+\,1}_{\ 0}\right)$ mm from the edges, eight test pieces from the positions illustrated in figure 1.

Mark the test pieces as shown in figure 1.

Dimensions of the test pieces:

– width : (50 ± 2) mm ;

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

The variations in thickness of the test pieces shall not exceed 5 % and shall be limited to 0,5 mm. e.g. by grinding

NOTE. The thickness of the test piece may need to be changed to meet this requirement.

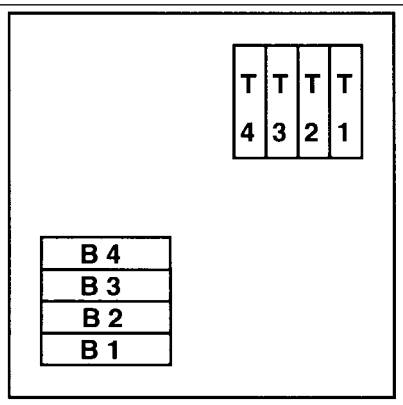

Figure 1. Position and identification of test pieces

Table 1. Length of test pieces as a function of their thickness

Dimensions in millimetres

Thickness d	$\leq$ 6,7	6,8 to 10	10,1 to 12,5	$\geq$ 12,6
Length l, with a tolerance of $^{+25}_{0}$ mm	160	225	275	325

Storage of the test pieces :

a) test pieces from the first panel :

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

b) test pieces from the second panel :

When the test pieces have been aged for six days, keep them in the laboratory at a temperature of (20 ± 3) °C and relative humidity of (60 ± 5) % for 21 days so that they have been aged for 27 days. Then immerse them in water at (20 ± 2) °C for 24 h for the test at 28 days.

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

After removal from the water and prior to the test, wipe the test pieces with a damp cloth to remove any surface water.

5.2 Test method

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

Position the test pieces in the testing machine, as shown in figure 2, on the two bottom supports with a span L between them determined in accordance with table 2. For each test panel, the test pieces marked '1' and '3' are tested with the 'mould' face down on the two bottom supports and those marked '2' and '4' with the 'mould' face in contact with the top supports.

To start the test, adjust the rate of application of the load :

– automatic control by load: (10 ± 0,3) N/s ;

– automatic control by displacement: (0,03 ± 0,003) mm/s.

NOTE. In order to evaluate correctly the limit of proportionality, the load and displacement sensors should be zeroed at the moment the test piece is in contact with the top supports.

Continue the test until complete failure of the test piece.

Stop recording at 0,9 F_{MOR}.

Measure the thickness and width of the test piece in the failure zone to the nearest 0,1 mm.

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

After failure, place the test pieces in the ventilated drying oven adjusted to (105 ± 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 %.

Table 2. Span of test pieces as a function of their length

Dimensions in millimetres

Length l	160	225	275	325
Span L	135	200	250	300

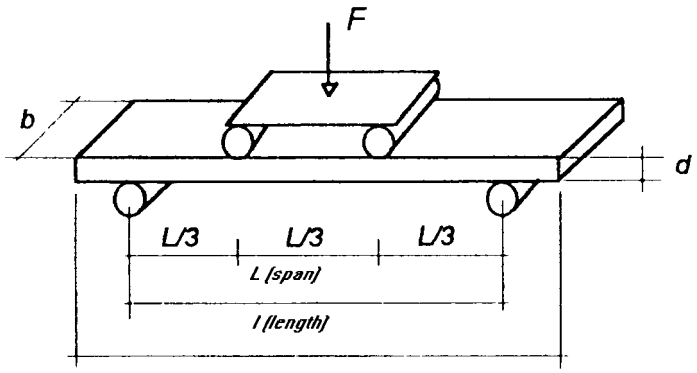

Figure 2. Position of test pieces in testing machine

6 Expression of results

6.1 Deflection and load at the limit of proportionality

The deflection Δ_{LOP} and load F_{LOP} at the limit of proportionality are assessed by considering the load/deflection curve.

They correspond to the point where the linearity of the two characteristics changes.

NOTE. To evaluate the limit of proportionality in the best possible way, it is desirable that the choice of scales on the load/deflection graph produces a slope of approximately 45 °C.

6.2 Deflection and load on failure

The deflection Δ_{MOR} and load F_{MOR} on failure correspond to the maximum load value recorded.

NOTE. The determination of the ultimate value of the deflection may be difficult. However, examination of the descending section of the curve is important because this gives supplementary information on the ductility of the material.

6.3 Deformation and stress

The deflection and the load depend on the geometry of the test piece. In order to compare the mechanical behaviour of the different test pieces it is necessary to express the results in form of deflection and stress (of the extreme fibres of the bottom face).

The deformation (ε_{LOP} and ε_{MOR}) and stress (σ_{LOP} and σ_{MOR}) values at the limit of proportionality and on failure are given by the following equations :

$$\varepsilon_{LOP} = \frac{108}{23} \times \frac{\Delta_{LOP} \times d}{L^2} \qquad \varepsilon_{MOR} = \frac{108}{23} \times \frac{\Delta_{MOR} \times d}{L^2}$$

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

NOTE 1. The two equations shown above for calculating ε_{LOP} and ε_{MOR} are applicable when the displacement sensor for measuring the deflection is placed in the middle of the axis of symmetry of the test device. If the sensor is placed normal to the bottom support, the constant $\frac{108}{23}$ should be replaced by $\frac{27}{5}$ in the two equations.

NOTE 2. These four equations are only applicable theoretically in the case of linear isotropic elastic materials. However, the values calculated using them are sufficiently approximate for GRC material.

NOTE 3. The conversion formulae are:

ε_{MOR} (subserviance by moving) = 0,70 σ_{MOR} (subserviance by loading) + 2,26

σ_{MOR} (subserviance by loading) = 1,34 σ_{MOR} (subserviance by moving) − 2,22

6.4 Water content

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

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

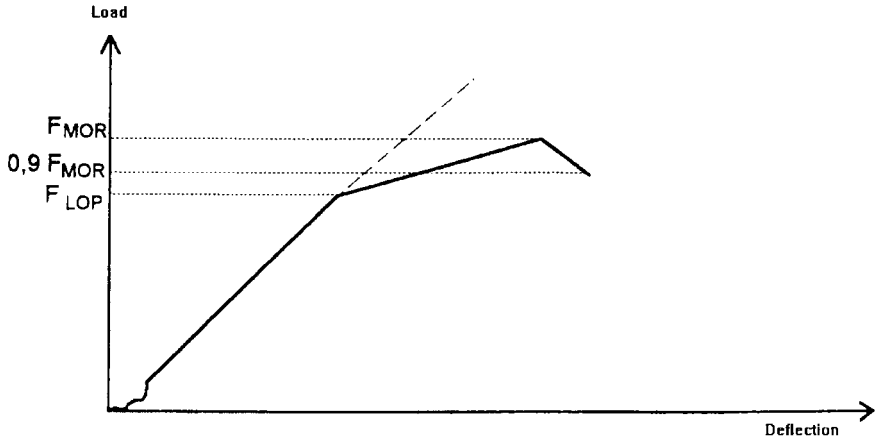

Figure 3. Example of load/deflection curve

7 Test report

The test report shall contain the following information:

– the identification of the laboratory (especially the characteristics and accuracy of the test machine, name of the test supervisor);

– the complete identification of the test pieces (especially their origin, marking, date of manufacture of the panels);

– all individual results : dimensions, wet mass, dry mass, loads, stress, deflection and deformation at limit of proportionality and on failure, water content;

– the load/deflection curves;

– the mean average values at 7 and 28 days: ε_{LOP}, σ_{LOP}, ε_{MOR}, σ_{MOR} and W;

– the relationships between the mean stresses on failure ($_{MOR}$) of the identified test pieces $\frac{T_1 + T_2 + T_3 + T_4}{B_1 + B_2 + B_3 + B_4}$, $\frac{T_1 + T_3}{T_2 + T_4}$ and $\frac{B_1 + B_3}{B_2 + B_4}$;

– the curing conditions if different to those specified in the standard;

– all comments useful for interpreting the results;

– the reference to this standard;

– the date of test.

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