

Fibre-cement profiled sheets and fittings for roofing — Product specification and test methods

The European Standard EN 494 : 1994 with the incorporation of amendment
A1 : 1999 has the status of a British Standard

ICS 91.060.20; 91.100.40

Cooperating organizations

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United Kingdom	British Standards Institution

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National foreword

This British Standard has been prepared under the direction of Technical Committee B/542, Roofing and Cladding Products for Discontinuous Laying, and is the English language version of EN 494 : 1994 *Fibre-cement profiled sheets and fittings for roofing — Product specification and test methods*, including amendment A1 : 1999, published by the European Committee for Standardization (CEN).

EN 494 was produced as a result of international discussion in which the UK took an active part.

BS EN 494 supersedes BS 690 : Part 3 : 1973 which is withdrawn. BS 690 : Part 6 : 1976 *Asbestos cement slates and sheets Part 6. Fittings for use with corrugated sheets*, and section two of BS 4624 : 1981 *Methods of test for asbestos cement building products* are technically equivalent to EN 494 and will be withdrawn following publication of the EN concerned with lining sheets and panels, to which the aforementioned standards also apply.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 60, an inside back cover and a back cover.

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Fibre-cement profiled sheets and fittings for roofing — Product specification and test methods

(includes amendment A1 : 1999)

Plaques profilées en fibres-ciment et accessoires
pour couvertures — Spécification du produit et
méthodes d'essai
(inclut l'amendement A1 : 1999)

Faserzement-Wellplatten und dazugehörige
Formteile für Dächer — Produktspezifikation und
Prüfverfahren
(enthält Änderung A1 : 1999)

This European Standard was approved by CEN on 1994-02-11; amendment A1 was approved by CEN on 1999-01-08. 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

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Foreword

This European Standard has been prepared by CEN/TC 128, Roof covering products for discontinuous laying, the secretariat of which is held by ON.

A distinction has been made between product appraisal (test types) and routine quality control requirements (acceptance tests).

Attention is drawn to the need for observance of EC and/or EFTA Directives transposed into national legal requirements restricting the use of certain materials and to the related marking and labelling requirements.

The performance of a roof constructed with these products depends not only on the properties of the product as required by this standard, but also on the design, construction and performance of the roof as a whole in relation to the environmental and conditions of use.

Annex C is an informative annex and contains an A-Deviation.

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 August 1994, and conflicting national standards shall be withdrawn at the latest by August 1994.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, Switzerland, United Kingdom.

Foreword to amendment A1

This Amendment EN 494:1994/prA1:1999 to EN 494:1994 has been prepared by Technical Committee CEN/TC 128, Roof covering products for discontinuous laying and products for wall cladding, the Secretariat of which is held by IBN.

This Amendment to the European Standard EN 494:1994 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 1999, and conflicting national standards shall be withdrawn at the latest by November 1999.

This Amendment to the European Standard EN 494:1994 has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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 standard specifies the technical requirements and establishes methods of control and tests as well as acceptance conditions for fibre-cement profiled sheets and their fibre-cement fittings for roofing.

For the purpose of this standard fibre-cement profiled sheets are classified according to their height of corrugation and their mechanical characteristics. Examples of profiles are shown in figures 1 to 7.

NOTE: Some of these requirements can be applied, after agreement between manufacturer and purchaser, to curved sheets.

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 29001 : 1987 Quality systems - Model for quality assurance in design, development, production, installation and servicing

EN 29002 : 1987 Quality systems - Model for quality assurance in production and installation

ENV 197-1 : 1992 Cement - Composition, specifications and conformity criteria - Part 1: Common cements

ISO 390 : 1993 Fibre-cement products - Sampling and inspection.

ISO 2859-1 : 1989 Sampling procedures for inspection by attributes - Part 1: Sampling plans indexed by acceptable quality level (AQL) for lot-by-lot inspection.

ISO 3951 : 1989 Sampling procedures and charts for inspection by variables for percent nonconforming

3 DEFINITIONS

For the purposes of this standard the following definitions apply:

3.1 profiled sheet:

Component the cross section of which consists of corrugations as in the examples shown in figures 1 to 7. The corrugations are defined by their pitch a and their height h .

3.2 acceptance test:

Test to establish whether a batch of products conforms to a specification. The test is performed on samples drawn either from continuous production or from a consignment.

NOTE: Test methods, specification and limit values are specified in this standard. Sampling levels and acceptance criteria are given in 6.1.2.

3.3 type test:

Test carried out for the approval of a new product and/or when a fundamental change is made in formulation and/or method of manufacture, the effects of which cannot be predicted on the basis of previous experience.

The test is performed on the as delivered product and is required to demonstrate conformity of a generic product to a specification; it is not required for each production batch.

3.4 acceptance quality level (AQL):

In a sampling plan, the quality level which corresponds to a specified, relatively high probability of acceptance.

It is the maximum percent defective (or maximum number of defects per 100 units) that for purposes of sampling inspection can be considered satisfactory as a process average.

NOTE: A sampling scheme with an AQL of 4% means that batches containing up to 4% defective items have a high probability of acceptance.

3.5 as delivered:

The same condition as the producer intends to supply the product after completing all aspects of the process including maturing and, when appropriate, painting.

3.6 short sheet:

Sheet having a length less than or equal to 0,9 m.

3.7 long sheet:

Sheet having a length greater than 0,9 m.

3.8 upper face:

Face normally exposed to the weather.

4 SYMBOLS AND ABBREVIATIONS

- a*
 - 1. Pitch of the corrugations in millimetres
 - 2. One of the coefficients of the regression line (annex B)
- b*
 - 1. Dimension of the specimen parallel to the supports in either the breaking load test or the bending moment test in millimetres
 - 2. One of the coefficients of the regression line (annex B)
- d* Apparent density of the sheet in grams per cubic centimetres
- e* Thickness of the sheet in millimetres

f	Increase in deflection between applying 20% and 70% of the specified load in the breaking load test in millimetres
F	Load at rupture from either the breaking load test or the bending moment test in newtons
F_s	Load at rupture per metre width from the breaking load test in newtons
h	Height of the corrugations in millimetres
h_{od}	Height of the edge of the descending corrugation in millimetres
h_{om}	Height of the edge of the ascending corrugation in millimetres
l	Length of the sheet in millimetres
l_s	Clear span between the supports in the breaking load test or span between the centre of the supports in the bending moment test in millimetres
L_1	Upper estimate of the mean breaking load or bending moment at 95% confidence level
L_2	Lower estimate of the mean breaking load or bending moment at 95% confidence level
m	Mass of the specimen after drying in grams
M	Bending moment at rupture per metre length from the bending moment test in newtons metres per metre
R_L	Ratio of estimate L_2 to estimate L_1
s_1	Standard deviation of the specimens with mean X_1
s_2	Standard deviation of the specimens with mean X_2
V	Volume of the test specimen in cubic centimetres
x_o	Actual result obtained when dry testing
w	Width of the sheet in millimetres
X_1	Mean value of the test results (bending strength or bending moment) of the control specimens (first lot) for a type test
X_2	Mean value of the test results (bending strength or bending moment) of the specimens after a type test

- x_{std} Minimum value to be used as the specification for the dry method of test. This value is calculated at the 97,5% lower confidence level from the value y_{std} specified for the wet method of test in this standard
- y_o Value calculated from the value obtained from a specimen tested dry, which is the estimate at the 97,5% lower confidence level of the value expected from a specimen tested wet.
- y_{std} Minimum value specified in the standard for wet testing.

5 REQUIREMENTS FOR SHEETS

5.1 General requirements

5.1.1 Composition

Fibre-cement profiled sheets shall consist essentially of cement or a calcium silicate formed by chemical reaction of a siliceous and a calcareous material, reinforced by fibres. The cement shall comply with relevant national standards of CEN members and/or ENV 197-1.

Two types of fibre-reinforced cement profiled sheets are included in this standard:

Type AT (Asbestos Technology) for products the formulation of which contains chrysotile asbestos.

Type NT (Non-asbestos Technology) for products reinforced by other fibres and not containing asbestos.

The reinforcing fibres shall be one or more of the following forms:

- discrete elements randomly dispersed;
- continuous strands or tapes;
- nets or webs.

Process aids, fillers and pigments which are compatible with the composite may be added.

5.1.2 Appearance and finish

The sheets can be left with their natural colour, or colouring matters can be added in the composition; they can also receive adherent coloured or uncoloured coatings on their surface.

Variations of the surface appearance which do not impair the characteristics of the sheets as defined in this standard are permitted.

On exposure, the surface and/or its coating will be affected by weathering which may vary with site, location, aspect, pitch of roof and duration of exposure. Any deterioration in this respect shall not detract from the minimum mechanical and physical characteristics as specified in this standard or from the function of the sheet as a durable element.

Edges shall be straight and clean.

Sheets can have mitred or premitred corner(s) and/or can be predrilled for fixing.

5.2 Dimensions and tolerances

NOTE: See 6.1 for statistical interpretation.

5.2.1 General

The manufacturer shall specify the nominal dimensions.

NOTE: See 5.6 for designation and information.

5.2.2 Categorization by height of profile

The sheets are divided into five categories, depending on the nominal height of the corrugations (see figures 1 to 7).

Table 1: Categorization by height of profile

Category	h mm
A	15 to 30
B	25 to 45
C	40 to 80
D	60 to 120
E	90 to 150

5.2.3 Thickness

The thickness of the sheets shall either:

- be approximately constant across the width of the profile, as shown in figure 8a)
or
- vary regularly from the crowns and valleys to the flanks of the corrugations, as shown in figure 8b).

When measured in accordance with 7.2.3 the minimum individual thickness for each category shall be as specified in table 2.

Table 2: Minimum individual thickness

Category	h mm	Minimum individual thickness mm	
		length > 0,9 m	length ≤ 0,9 m
A	15 to 30	4,0	3,5
B	25 to 45	5,0	4,0
C	40 to 80	5,2	4,0
D	60 to 120	5,5	5,0
E	90 to 150	6,0	-

5.2.4 Tolerances on nominal dimensions

When measured in accordance with 7.2 the allowable dimensional variations shall be as follows:

a) on the pitch a :

	$a \leq 75 \text{ mm}$	$\pm 1,5 \text{ mm}$
75 mm	$< a \leq 180 \text{ mm}$	$\pm 2,0 \text{ mm}$
180 mm	$< a \leq 260 \text{ mm}$	$\pm 2,5 \text{ mm}$
260 mm	$< a$	$\pm 3,0 \text{ mm}$

b) on the height h :

15 mm	$\leq h \leq 45 \text{ mm}$	$\pm 2,0 \text{ mm}$
45 mm	$< h \leq 150 \text{ mm}$	$\pm 3,0 \text{ mm}$

c) on the length l : ± 10 mm

d) on the width w :
.
+ 10 mm
- 5

e) on nominal thickness e :

The average thickness measured in accordance with 7.2.3 shall be within $\pm 10\%$ and not more than $\pm 0,6$ mm of the nominal thickness.

f) on the squareness of the sheet:

Out of squareness $\leq 6,0$ mm.

g) on the height of edges:

This tolerance applies only for sheets having a rising edge on one side and a descending edge on the other side, and where it is required by the method of laying in order to ensure weathertightness and/or geometrical fit.

The producer shall use the tolerances specified in installation standards or regulations or if none are given, he shall specify them in his literature.

5.3 Physical requirements and characteristics

5.3.1 General

Mechanical and material properties are normally determined for products as delivered whenever practical. The results shall be identified as applying to coated or uncoated products.

NOTE: See 6.1 for statistical interpretation.

5.3.2 Apparent density

The manufacturer's literature shall specify the minimum apparent density of the sheets. The sheet shall have an apparent density equal to or greater than that specified by the manufacturer when tested in accordance with 7.3.1.

5.3.3 Mechanical characteristics

5.3.3.1 Breaking load

There are two classes for sheets of length greater than 0,9 m depending on the minimum breaking load for each category. For sheets in category C of length greater than 0,9 m and less than 1,25 m, there is a third class.

When tested in accordance with 7.3.2.1 the sheets shall have a breaking load, for a span of 1,1 m, at least equal to the values specified in table 3.

Table 3: Minimum breaking load

Category	<i>h</i> mm	Minimum breaking loads per metre width for a span of 1,1 m For sheets length > 0,9 m	
		Class 1 N/m	Class 2 N/m
A	15 to 30	1 400	1 250
B	25 to 45	2 500	2 000
C	40 to 80	4 250	3 500
D	60 to 120	7 000	5 500
E	90 to 150	12 500	8 500
NOTE: A special class 3 with a minimum breaking load per metre width of 2 200 N/m is allowed in category C for sheets of length greater than 0,9 m and less than 1,25 m.			

5.3.3.2 Deflection

When tested in accordance with 7.3.2.1 the increase in deflection of sheets of length greater than 0,90 m measured between applying 20% and 70% of the minimum load specified for their class (see figure 24) shall not exceed:

$$f = 0,7 \times 10^{-3} \times l_s^2/h$$

where:

f is the increase in deflection, in millimetres;

l_s is the clear span, in millimetres;
 h is the nominal height of corrugation, in millimetres.

5.3.3.3 Bending moment

When tested in accordance with 7.3.2.2, the minimum bending moment per metre length at rupture of the sheets, shall be as specified in table 4.

Table 4: Minimum bending moment

Category	h mm	Minimum bending moment per metre length at rupture		
		Length > 0,9 m		Length ≤ 0,9 m N m/m
		Class X N m/m	Class Y N m/m	
A	15 to 30	4 0	3 0	25
B	25 to 45	5 5	4 0	30
C	40 to 80	5 5	4 0	30
D	60 to 120	5 5	4 5	40
E	90 to 150	5 5	4 5	-

5.3.4 Water impermeability

When tested in accordance with 7.3.3, traces of moisture may appear on the under surface of the sheets, but in no instance shall there be any formation of drops of water.

5.3.5 Warm water

When tested in accordance with 7.3.4, after 56 days immersion at 60°C, the ratio R_L as defined in 7.3.4.4 shall not be less than 0,70.

5.3.6 Soak-dry

When tested in accordance with 7.3.5, after 50 soak-dry cycles, the ratio R_L as defined in 7.3.5.4 shall not be less than 0,70.

5.4 Climatic performance requirements

5.4.1 General

Climatic performance requirements are normally determined for as delivered products whenever practical. The results shall be identified as applying to coated or uncoated products. Performance of the coating in the tests specified in 5.4.2 and 5.4.3 shall not be considered in the assessment of the product.

5.4.2 Freeze-thaw

When tested in accordance with 7.4.1, after 100 freeze-thaw cycles, the ratio R_L as defined in 7.4.1.4 shall be not less than 0,70.

5.4.3 Heat-rain

When tested in accordance with 7.4.2, after 50 heat-rain cycles, any visible cracks, delamination or other defects in the sheets shall not be of a degree such as to affect their performance in use.



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5.5 Summary of characteristics and classification

5.5.1 Summary of characteristics

Table 5 gives the differences between acceptance characteristics for long sheets and short sheets.

Table 5: Acceptance characteristics

Category	Height of corrugations mm	Long sheets					Short sheets	
		Minimum thickness mm	Breaking load		Bending moment at rupture		Minimum thickness mm	Bending moment at rupture N m/m
			Class 1 N/m	Class 2 N/m	Class X N m/m	Class Y N m/m		
A	15 to 30	4,0	1 400	1 250	40	30	3,5	25
B	25 to 45	5,0	2 500	2 000	55	40	4,0	30
C	40 to 80	5,2	4 250	3 500	55	40	4,0	30
D	60 to 120	5,5	7 000	5 500	55	45	5,0	40
E	90 to 150	6,0	12 500	8 500	55	45	-	-
NOTE: A special class 3 with a minimum breaking load per metre width of 2 200 N/m in category C for sheets of length greater than 0,90 m and less than 1,25 m is allowed.								

5.5.2 Classification

5.5.2.1 Long sheets (length > 0,9 m)

The two types of long sheets are classified according to the following criteria:

- nominal height of corrugations: A, B, C, D, E
- class: Breaking loads 1, 2, 3
Bending moments X, Y

EXAMPLE 1: B 2Y means height of corrugations between 25 mm and 45 mm, minimum breaking load 2 000 N/m, minimum bending moment 40 N m/m.

EXAMPLE 2: C 1X means height of corrugations between 40 mm and 80 mm, minimum breaking load 4 250 N/m, minimum bending moment 55 N m/m.

5.5.2.2 Short sheets (length $\leq 0,9$ m)

Short sheets are classified according to the nominal height of corrugations in categories A, B, C and D.

5.6 Designation and information

The designation of the sheet shall include at least the following the following:

- type of product (see 5.1.1);
- name of the profile;
- class;
- category;
- size.

The manufacturer shall include the following in his literature:

- a) designation of the sheet as above;
- b) shape of the profile;
- c) number of complete corrugations;
- d) nominal values for
 - pitch,
 - height of corrugations,
 - thickness,
 - height of edges, where applicable,
 - length,
 - width;
- e) minimum apparent density;
- f) information relevant to the handling and installation.

6 QUALITY CONTROL

6.1 Factory quality control

6.1.1 Quality system

The manufacturer shall establish and maintain an effective documented quality control system so as to achieve compliance with this standard.

6.1.2 Acceptance tests

Each limit of specification shall be subject to an AQL of 4%. The sampling schemes provided in ISO 390, with an AQL of 4% and an inspection level S_3 , ensure that for large batches approximately 95% of the items fulfill the requirements.

If the quality system conforms to the Guidance paper no 7 (Construct 91/067) established by the Standing Committee of Construction (Directives 89/106) and issued by the EEC, then the inspection level can be lowered but the minimum sampling scheme for each control batch shall be at least in accordance with table 6.

Table 6: Minimum sampling schemes

Profiled sheets	
Pitch Height of corrugations Thickness Height of edge (where applicable) Length Width Apparent density	ISO 2859-1 : 1989 Inspection by attribute Double sampling AQL 4% Level S_1
Breaking load Bending moment	ISO 3951 : 1989 Inspection by variable; method σ or s AQL 4% Level S_3
Fittings	
Length Width Thickness	The same as for the dimensional characteristics for sheets

If the quality system of the factory is certified by an approved certification body according to EN 29001 or EN 29002, other methods may be applied in agreement with the approved certification body.