BS ISO 10904:2011

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Fibre-cement corrugated sheets and fittings for roofing and cladding

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National foreword

This British Standard is the UK implementation of ISO 10904:2011.

The UK participation in its preparation was entrusted to Technical Committee B/3, Ad hoc co-ordination group for fibre reinforced cement products.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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INTERNATIONAL STANDARD

ISO 10904

First edition
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Fibre-cement corrugated sheets and fittings for roofing and cladding

Plaques ondulées en fibrociment et leurs accessoires pour couvertures et revêtements

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10904 was prepared by Technical Committee ISO/TC 77, *Products in fibre reinforced cement*.

This first edition of ISO 10904 cancels and replaces ISO 9384:1991 and ISO 9933:1995, which have been technically revised.

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Introduction

The performance of a roof or another building part constructed with the products covered by this International Standard depends not only on the properties of the products as required by this International Standard, but also on the design, construction and installation of the components as a whole relative to the environment and the conditions of use.

This International Standard does not include calculations with regard to works, design requirements, installation techniques, wind uplift or rain proofing of the installed sheets.

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Fibre-cement corrugated sheets and fittings for roofing and cladding

1 Scope

This International Standard specifies technical requirements and methods for the inspection and testing of straight short and long fibre-cement profiled sheets and their fibre-cement fittings designed to provide the weather-exposed surfaces on roofs and internal and external walls of buildings.

Products covered by this International Standard can be used for other purposes, provided they comply with the appropriate national or international application code or standard.

Some of the requirements of this International Standard can apply, after agreement between manufacturer and purchaser, to curved profiled sheets.

The type tests described in this International Standard are not intended to evaluate the performance of the coating in isolation (colour-fastness, adhesion, etc.). Specific performance requirements for coatings are referenced in other International Standards or national standards.

This International Standard does not apply to fibre-cement profiled sheets and fittings reinforced with asbestos fibres.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 390:1993, *Products in fibre-reinforced cement — Sampling and inspection*

ISO 2602:1980, *Statistical interpretation of test results — Estimation of the mean — Confidence interval*

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO 3951-1, *Sampling procedures for inspection by variables — Part 1: Specification for single sampling plans indexed by acceptance quality limit (AQL) for lot-by-lot inspection for a single quality characteristic and a single AQL*

ISO 12468-1, *External exposure of roofs to fire — Part 1: Test method*

ISO 12468-2, *External fire exposure to roofs — Part 2: Classification of roofs*

EN 15057, *Fibre cement profiled sheets — Impact resistance test method*

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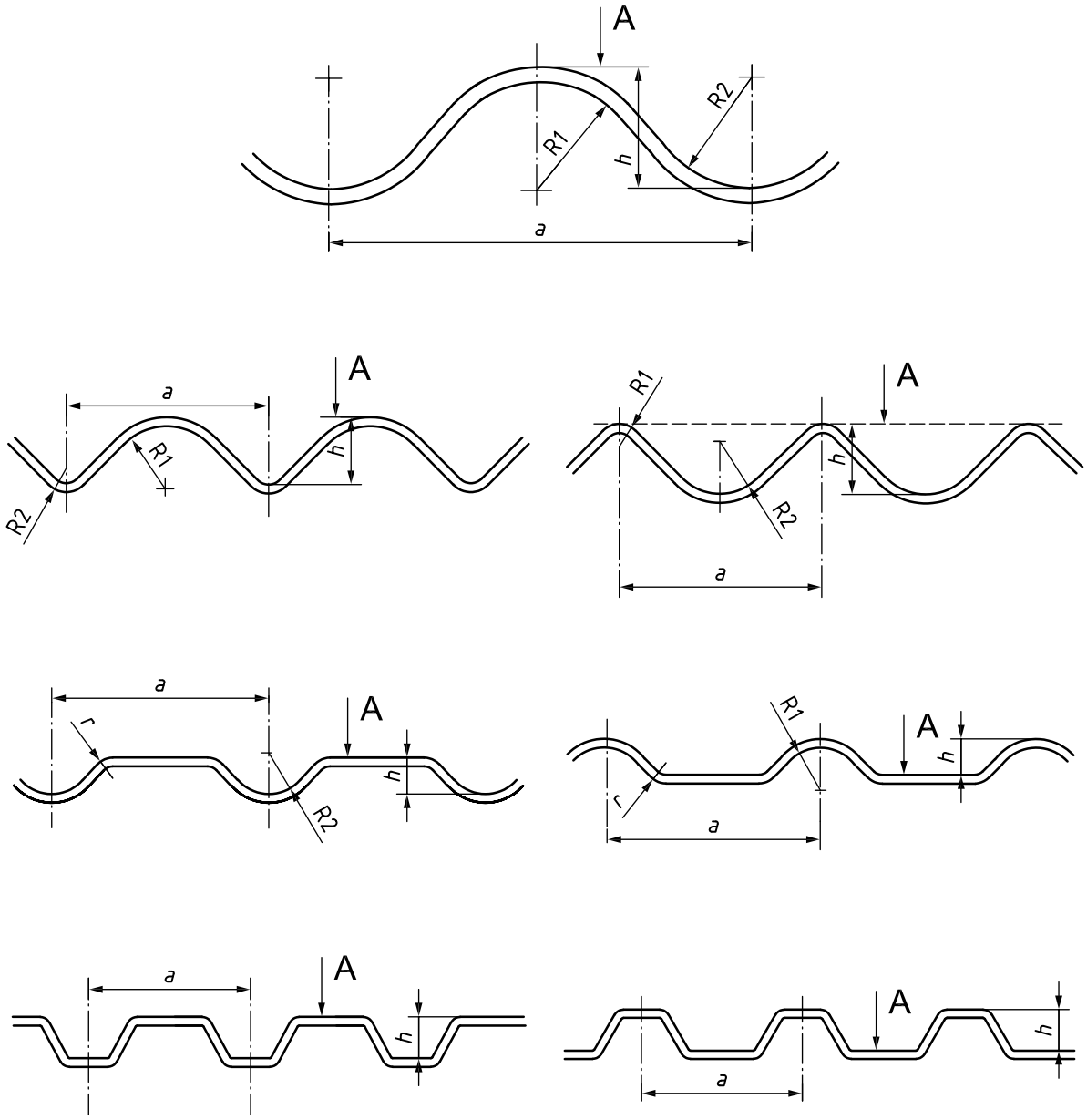
3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1
profiled sheet
component whose cross-section consists of corrugations

NOTE 1 Examples are shown in Figure 1.

NOTE 2 The corrugations are defined by their pitch, a, and their height, h.



Key
A upper face

Figure 1 — Examples of categorization by height of profile

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3.2
side corrugation
corrugation at the extreme end(s) of a cross section normally having a different pitch and height, normally used for side overlapping

3.3
acceptance test
test to establish whether a batch of products conforms to a specification

NOTE 1 The test is performed on samples drawn from continuous production or from a consignment.

NOTE 2 Test methods, specifications and limit values are specified in this International Standard. Sampling levels and acceptance criteria are specified in 6.3.

NOTE 3 See ISO 390.

3.4
type test
test performed to demonstrate conformity with the requirements of this International Standard or 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

NOTE The test is performed on the as-delivered product, but is not required for each production batch.

3.5
acceptable quality level
AQL
maximum percent defective (or maximum number of defects per 100 units) that can be considered satisfactory as a long-term average quality level in a sampling plan

NOTE When a manufacturer's process satisfies a sampling scheme with an AQL of 4 %, this indicates that 96 % of the inspected product exceeds the specification. This type of specification provides the consumer with a clearly defined lower quality boundary; this does not occur if acceptance is based solely on the average value of the measured property. Examples of sampling schemes can be found in ISO 390, ISO 2859-1 and ISO 3951-1.

3.6
as delivered
in the same condition as that in which the producer intends to supply the product after completing all aspects of the process, including maturing and, when appropriate, painting

3.7
reinforcement fibres
organic or inorganic reinforcement fibres for the manufacture of fibre-cement profiled sheets and fittings complying with this International Standard

NOTE See 5.1.

3.8
apparent density
dry mass per unit volume based upon the volume of the sample calculated by water displacement or equivalent

NOTE This is an average density of the material and pores, coated or uncoated (as delivered).

3.9
breaking load
maximum load achieved during the bending test and representing the load-bearing capacity of the sheets at the test span

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3.10
bending moment at rupture
moment at mid-span calculated from the maximum load during the bending test

3.11
short sheet
sheet with a length less than or equal to 0,9 m

3.12
long sheet
sheet with a length greater than 0,9 m

3.13
upper face
face normally exposed to the weather

3.14
under face
reverse of the upper face

3.15
ambient laboratory conditions
atmosphere for testing or storing and conditioning of samples, defined for the purpose of this International Standard as a temperature of 23 °C ± 10 °C and a relative humidity of 50 % ± 20 %

3.16
fitting
components with particular shapes that are fitted to profiled sheets and complete, for instance, the roofing at the verge, ridge and eaves, or perform functions such as ventilation, daylight-admission, etc.

3.17
bending modulus
modulus of elasticity derived from the load-deflection data recorded during the breaking load test

4 Symbols, abbreviations and units

For the purposes of this document, the following symbols and abbreviations are used.

a pitch of the corrugation, expressed in millimetres

b dimension of the specimen parallel to the supports in either the breaking load test (called width of the specimen) or the bending moment test (called length of the specimen), expressed in millimetres

e thickness of the sheet, expressed in millimetres

E_m bending modulus, expressed in newtons per square millimetre, in the breaking load test

$f_{0,15}$ deflection, expressed in millimetres, at approximately 15 % of the maximum load in the breaking load test

$f_{0,55}$ deflection, expressed in millimetres, at approximately 55 % of the maximum load in the breaking load test

F load at rupture in the breaking load test or bending moment test, expressed in newtons

F_s load at rupture per metre width from the breaking load test, expressed in newtons per metre

$F_{0,15}$ load, expressed in newtons, at 15 % of the maximum load in the breaking load test

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$F_{0,55}$ load, expressed in newtons, at 55 % of the maximum load in the breaking load test

h height of the corrugation, expressed in millimetres

h_{od} height of the edge of the descending corrugation, expressed in millimetres

h_{om} height of the edge of the ascending corrugation, expressed in millimetres

I moment of inertia of the section around a horizontal axis through the centre of gravity, expressed in millimetres

l length of the sheet, expressed in millimetres

l_s clear span between the supports in the breaking load test or the bending moment test, expressed in millimetres

L_1 upper estimation at 95 % confidence level of the result X_1

L_2 lower estimation at 95 % confidence level of the result X_2

m mass of the specimen, expressed in grams, after drying, when determining the apparent density

M bending moment at rupture per metre length from the bending moment test, expressed in newton-metres per metre

R_L ratio of the estimation L_2 to the estimation L_1

s_1 standard deviation of the specimens with average X_1

s_2 standard deviation of the specimens with average X_2

V apparent volume, expressed in cubic centimetres, of the specimens for the apparent density test

w width of the sheet, expressed in millimetres

x_o actual result obtained when dry-testing

$\bar{X}_1$ mean value of the bending test results of the control specimens (the first lot) for a type test

$\bar{X}_2$ mean value of the bending test results of the specimens (the second lot) after a type-test exposure

x_{std} minimum value for use 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 International 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 this International Standard for wet testing

α one of the coefficients of the regression line defined in Annex E

β one of the coefficients of the regression line defined in Annex E

ρ apparent density of specimen, expressed in grams per cubic centimetre

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5 Product requirements

5.1 General

5.1.1 Composition

5.1.1.1 Fibre-cement profiled sheets and fittings shall consist essentially of cement or a calcium silicate formed by the chemical reaction of a siliceous and a calcareous material, reinforced by fibres. The cement shall comply with the relevant national standards in the country of manufacture.

Process aids, fillers, aggregates and pigments that are compatible with the fibre-reinforced cement may be added.

5.1.1.2 Reinforcement may be one or a combination of the following materials:

— cellulose fibre;

— synthetic organic and/or inorganic fibre;

— glass fibre.

5.1.1.3 These materials may have one or more of the following forms:

— discrete elements randomly dispersed;

— continuous strands or tapes;

— nets or webs.

5.1.2 Manufacture

Fibre-cement profiled sheets may be formed either with or without pressure and cured either under natural or accelerated conditions, to meet the specified requirements. The fibre-cement fittings may be formed by either hand- or machine-moulding techniques.

5.1.3 Appearance and finish

The profiled sheets may be left with their natural color, or coloring matter may be added in the composition. They may also receive adherent colored or uncolored coatings or impregnations on their surfaces. The upper face shall have a generally smooth finish. Variations of the surface appearance that do not impair the characteristics of the sheets as defined in this International Standard are permitted.

Edges shall be straight and clean and the sheets shall be square. Sheets may have one or more corners pre-mitred or prepared for mitring and/or may be pre-drilled for fixing.

The fittings shall have a general appearance and finish compatible with the sheets with which they are being used.

5.2 Categorization and classification

5.2.1 According to nominal height of corrugations

The fibre-cement profiled sheets are divided into five categories depending on the nominal height, h, expressed in millimetres, of their corrugations, in accordance with Table 1. Examples of profiles are shown in Figure 1.

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Table 1 — Categories of fibre-cement profiled sheets

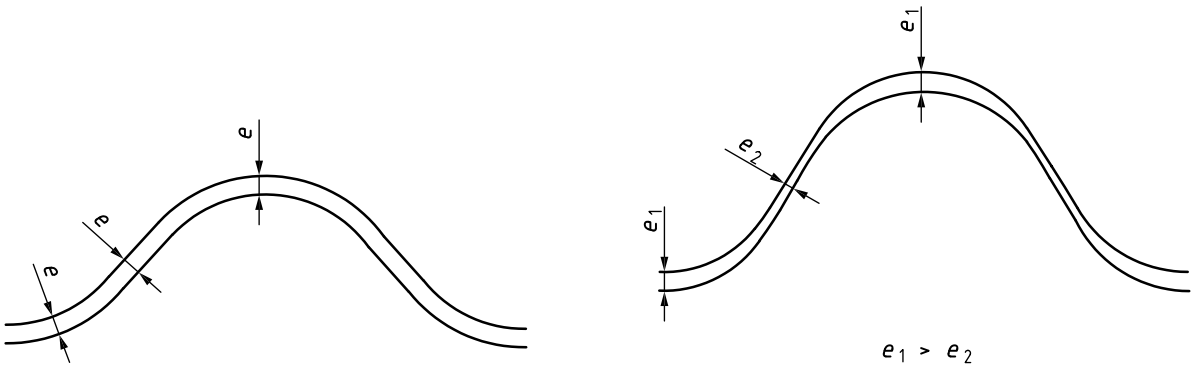
Category	Height h mm	
	Long sheets length > 0,9 m	**Short sheets** length ≤ 0,9 m
A	$15 \leq h \leq 30$	$15 \leq h \leq 30$
B	$25 \leq h \leq 45$	$25 \leq h \leq 45$
C	$40 \leq h \leq 80$	$40 \leq h \leq 80$
D	$60 \leq h \leq 120$	$60 \leq h \leq 120$
E	$90 \leq h \leq 150$	—

5.2.2 According to thickness

The thickness of the sheets may be

— either approximately constant throughout the width of the profile (type A sheets); see Figure 2 a); or

— vary regularly between the valley and the crown for corrugated sheets or between the lower part and the upper part of ribs for asymmetrical section sheets, in the same cross-section (type B sheets); see Figure 2 b).



a) Constant thickness **b) Variable thickness**

Figure 2 — Profiled sheet

5.2.3 According to minimum breaking load in bending for long sheets

For sheets with a length greater than 0,9 m (long sheets), each category of sheet is subdivided into classes according to the value of the minimum breaking load in bending; see Table 3.

5.2.4 According to minimum bending moment at rupture for long and short sheets

For long and short sheets, each category of sheet is subdivided into classes according to the value of the minimum bending moment at rupture; see Table 4.

National standards may choose one or more classes depending on the local conditions in the area of use.

National standards may specify, in addition of the minimum breaking load (in newtons per metre width), the unit flexural strength (in newtons per square millimetre) provided that the manufacturer defines the profile,

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including the side corrugations, and consequently indicates how to calculate the moment of inertia for the specific corrugated surface section.

5.3 Dimensions and tolerances on nominal dimensions

5.3.1 General

The manufacturer shall specify the nominal dimensions, shapes and configuration of the edges of the fibre-cement profiled sheets.

Fittings shall have nominal dimensions and shapes determined by the manufacturer and appropriate to the corresponding fibre-cement profiled sheets with which the fittings are used.

5.3.2 Minimum thickness of profiled sheets

Each individual thickness measured according to B.5 shall be no less than the values in Table 2.

Table 2 — Minimum individual thickness of profiled sheets

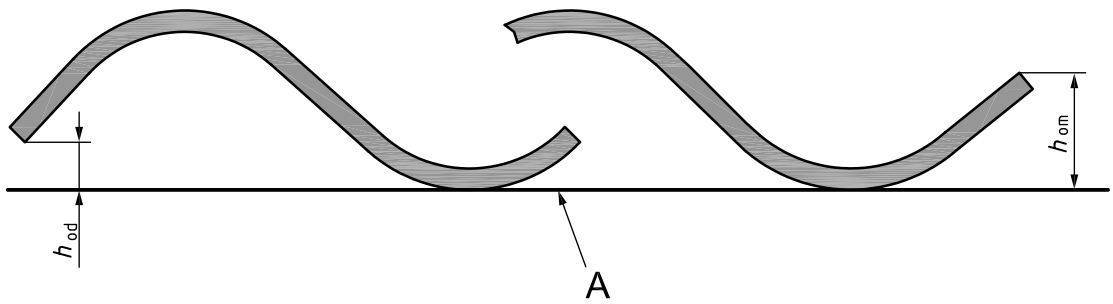
Category	Height h mm	Minimum individual thickness e mm	
		Long sheets length > 0,9 m	**Short sheets** length ≤ 0,9 m
A	$15 \leq h \leq 30$	3,0	3,0
B	$25 \leq h \leq 45$	4,0	4,0
C	$40 \leq h \leq 80$	4,5	4,5
D	$60 \leq h \leq 120$	5,5	5,5
E	$90 \leq h \leq 150$	6,0	—

5.3.3 Number of corrugations

The number of corrugations considered for designation is the number of complete corrugations of the sheet.

5.3.4 Height of edges

The nominal height of edges of both the ascending and descending edges (see Figure 3) shall be specified in national standards. This requirement applies only for sheets having an ascending corrugation on one side and a descending corrugation on the other side.



Key

A reference plane (control surface)

Figure 3 — Measurement of the height of edges

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5.3.5 Tolerances on nominal dimensions for sheets

The following tolerances shall apply to nominal dimensions given by the manufacturer:

a) tolerance on pitch, a, expressed in millimetres:

$a \leq 75$	± 1,5
$75 < a \leq 180$	± 2
$180 < a \leq 260$	± 2,5
$260 < a$	± 3

b) tolerance on height of corrugation, h, expressed in millimetres:

$15 \leq h \leq 45$	± 2
$45 < h \leq 150$	± 3

c) tolerance on length: ± 10 mm;

d) tolerance on width: $^{+10}_{-5}$ mm;

e) tolerance on thickness, e: the average thickness shall be within ± 10 %, but no more than ± 0,6 mm of the nominal thickness;

f) out-of-squareness of sheet: ≤ 6 mm;

g) tolerance on height of edges: applies only for sheets having an ascending (rising) edge on one side and a descending edge on the other side, and where it is required by the installation technique in order to ensure weather tightness and/or geometrical fit; the manufacturer shall use the tolerances specified in installation standards or regulations or, if none are given, he shall specify them in his literature.

5.3.6 Tolerances on nominal dimensions for fittings

The following tolerances shall apply to nominal dimensions given by the manufacturer:

a) tolerance on length: ± 10 mm;

b) tolerance on width: ± 10 mm;

c) tolerance on average thickness: ± 1 mm.

National standards may specify tolerances tighter than the ones specified in 5.3.5 and 5.3.6.

5.4 Physical requirements and characteristics

5.4.1 General

Mechanical and physical properties are normally determined on product as delivered. The results shall be identified as applying to coated or uncoated material. Failure of the coating does not constitute non-compliance of the product with this International Standard.

Testing of mechanical characteristics is performed with the upper face in compression. If required to establish a relationship between upper and under face testing, where significant differences are expected or if required for design purposes, the load shall be applied on the under face. Results obtained for under face testing are not relevant for classification.

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5.4.2 Mechanical characteristics

5.4.2.1 General

For non-roofing and cladding applications, alternative mechanical characteristics may be agreed between the manufacturer and purchaser.

5.4.2.2 Minimum breaking load

When tested wet as specified in 7.3.2, using the method given in Annex C, long sheets shall have a minimum breaking load at least equal to the values specified in Table 3.

5.4.2.3 Bending modulus — Modulus of elasticity

The manufacturer's literature may specify the minimum bending modulus (modulus of elasticity) of the profiled sheets. When tested wet as specified in 7.3.2, using the method given in Annex C, the modulus of elasticity, E_m, between 15 % of the maximum load, $F_{0,15}$, and 55 % of the maximum load, $F_{0,55}$, in the breaking load test (see Figure C.2) shall not be less than the specified value.

Table 3 — Long sheets — Minimum breaking load per metre width

Category	**Minimum breaking load (BL), wet, by class of long sheet** (length > 0,9 m) N/m										
	BL1	BL2	BL3	BL4	BL5	BL6	BL7	BL8	BL9	BL10	BL11
A	600	1 250	1 400	—	—	—	—	—	—	—	—
B	—	1 250	1 400	2 000	2 500	3 500	—	—	—	—	—
C	—	—	1 400	2 000	2 500	3 500	4 250	—	—	—	—
D	—	—	—	—	—	3 500	4 250	5 500	7 000	—	—
E	—	—	—	—	—	—	—	—	—	8 500	12 500

5.4.2.4 Minimum bending moment

When tested wet as specified in 7.3.3, using the method given in Annex D, long sheets and short sheets shall have a minimum bending moment at rupture per metre length of sheet at least equal to the values specified in Table 4.

Table 4 — Long sheets and short sheets — Minimum bending moment per metre of length

Category	**Minimum bending moment (BM), wet, by class of long sheet** (length > 0,9 m) **or short sheet** (length ≤ 0,9 m) Nm/m						
	BM1	BM2	BM3	BM4	BM5	BM6	BM7
A	12[a]	20	25	30	40	—	—
B	—	20	25	30	40	45	55
C	—	—	25	30	40	45	55
D	—	—	—	30	40	45	55
E	—	—	—	—	40	45	55

[a] Applies to short sheets only.

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5.4.3 Apparent density

The manufacturer's literature shall specify the minimum apparent density of the profiled sheets. When tested in accordance with 7.3.4, using the method given in Annex F, the density shall not be less than the specified value.

5.4.4 Water permeability

When tested for water permeability in accordance with 7.3.5, using the method given in Annex G, traces of moisture may appear on the underface of the specimen, but in no instance shall there be any formation of water drops.

NOTE Some national testing methods and performance requirements for the water permeability can differ from those given in this International Standard.

5.4.5 Freeze-thaw performance

5.4.5.1 Long and short sheets

This test shall be carried out if local climatic conditions justify it or national standards specify it.

When freeze-thaw testing is required, profiled sheets are tested in accordance with 7.3.6, using the test method given in Annex H. The ratio, R_L, of the lower versus the upper estimate mean values of the bending moments for the exposed and unexposed specimens, determined at the 95 % confidence level after 100 freeze-thaw cycles, shall not be less than 0,70.

Any visible cracks, delamination or other visible alteration shall not be of such a degree as to affect the performance in use.

5.4.5.2 Fittings

This test shall be carried out if local climatic conditions justify it or national standards specify it.

When freeze-thaw testing is required, fittings are tested in accordance with 7.3.7, using the test method given in Annex H. Any visible cracks, delamination or other visible alteration after 100 freeze-thaw cycles shall not be of such a degree as to affect the performance in use.

5.4.6 Heat-rain performance

When tested in accordance with 7.3.8, using the test method given in Annex I, after 50 heat-rain cycles, any visible cracks, delamination or other defects in the sheets shall not be of such a degree as to affect their performance in use. In case of doubt, a water-permeability test shall be performed on the sheet considered to have the highest incidence of defects after heat-rain exposure. When a product has successfully passed this water-permeability test, it shall be considered to comply with the requirement of heat-rain performance .

5.4.7 Warm water performance

When tested in accordance with 7.3.9 or 7.3.10, using the test method given in Annex J, the ratio, R_L, of the lower versus the upper estimate mean values of the breaking load (for long sheets) or the bending moment (for short sheets) for the exposed and unexposed specimens, determined at the 95 % confidence level after 56 d at 60 °C, shall not be less than 0,70.

5.4.8 Soak-dry performance

When tested in accordance with 7.3.11 or 7.3.12, using the test method given in Annex K, the ratio, R_L, of the lower versus the upper estimate mean values of the breaking load (for long sheets) or the bending moment (for short sheets) for the exposed and unexposed specimens, determined at the 95 % confidence level after 50 soak-dry cycles, shall not be less than 0,70.

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5.5 Requirements concerning fire behavior

For the purpose of conformity with national regulations, products can be required to satisfy specific product or system fire tests. The details of the specifications and acceptance criteria shall be defined by national standards and/or regulations. Where no standard or performance requirement has been established, the product shall be tested in accordance with ISO 12468-1 and the results classified in accordance with ISO 12468-2.

5.6 Product performance

The categories and classes of fibre-cement profiled sheets defined in this International Standard might not be considered to give an indication of the service life of the product. Product service life is influenced by factors such as the geographical location, location of the product on the structure, type and method of installation and applied surface coatings. This International Standard defines only minimum physical performance requirements and does not prescribe material formulations. Therefore, it cannot be presumed that the service life of fibre-cement profiled sheets of similar category and class made by various manufacturers are similar. Service life can be estimated only for clearly specified product applications and products in defined climate zones.

5.7 Requirements concerning impact resistance

For the purpose of conformity with national regulations, roof assemblies may be required to satisfy specific requirements related to non-fragility in an effort to reduce the risk of people falling through roofs. The details of the test specifications and acceptance criteria shall be defined by national standards and/or regulations. In case information is required on the performance of the products used in the construction of such roof assemblies, fibre-cement profiled sheets shall be tested by soft-body impact in accordance with the test method in EN 15057.

6 Evaluation of conformity

6.1 General

The conformity of fibre-cement profiled sheets and fittings with the requirements of this International Standard shall be demonstrated by

— type testing, and

— quality control by the manufacturer.

6.2 Type testing

6.2.1 General

Type tests shall be performed on products as delivered. If the same composition and production method is used to produce sheets of various nominal sizes and thicknesses, it is necessary to perform type tests only on one size of each nominal thickness.

Table 5 lists the characteristics that shall be subject to type testing, with the minimum performance requirements and methods of test. All characteristics listed in Table 6 shall be subject to initial type testing.

6.2.2 Initial type testing

Initial type testing shall be performed to demonstrate conformity with this International Standard. Tests that have been carried out previously on a product having the same physical characteristics and satisfying similar conformity requirements and using the same test method and sampling procedure specified in this International Standard may be taken into account.

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