SRI LANKA STANDARD 1593: 2018

(ISO 8336: 2017)

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FIBRE CEMENT FLAT SHEETS PRODUCT SPECIFICATION AND TEST METHODS

SRI LANKA STANDARDS INSTITUTION

SRI LANKA STANDARD FIBRE - CEMENT FLAT SHEETS – PRODUCT SPECIFICATION AND TEST METHODS

SLS 1593: 2018
(ISO 8336: 2017)

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SRI LANKA STANDARDS INSTITUTION
17, Victoria Place
Elvitigala Mawatha
Colombo - 08
Sri Lanka.

Sri Lanka Standards are subject to periodical revision in order to accommodate the progress made by industry. Suggestions for improvement will be recorded and brought to the notice of the Committees to which the revisions are entrusted.

This Standard does not purport to include all the necessary provisions of a contract

SRI LANKA STANDARD FIBRE-CEMENT FLAT SHEETS – PRODUCT SPECIFICATION AND TEST METHODS

NATIONAL FOREWORD

This standard was approved by the Sectoral Committee on Building and Construction Materials and was authorized for adoption and publication as a Sri Lanka Standard by the Council of the Sri Lanka Standards Institution on 2018-08-10.

This Sri Lanka Standard is identical with **ISO 8336:2017(E)** Fibre-cement flat sheets – Product specification and test methods, published by the International Organization for Standardization (ISO).

TERMINOLOGY AND CONVENTIONS

The text of the International Standard has been accepted as suitable for publication, with some deviations as a Sri Lanka Standard. However, certain terminology and conventions are not identical with those used in Sri Lanka Standards. Attention is therefore drawn to the following:

a) Wherever the words "International Standard" appear referring to this standard they should be interpreted as "Sri Lanka Standard".

b) The comma has been used throughout as a decimal marker. In Sri Lanka Standards, it is the current practice to use a full point on the baseline as the decimal marker.

c) Wherever page numbers are quoted, they represent those contained in **ISO 8336:2017(E)**

d) **Normative references given in Clause 2**–The ISO and EN standards pertaining to this standard are SLS ISO and SLS EN standards respectively

e) Deviations made to clause **5.7** of this standard to be in line with the national requirements are included in the National Appendix.

NATIONAL APPENDIX

DEVIATION FROM ISO 8336: 2017

5.7 Fire Properties

Whenever fire resistance regulations come into effect, requirements concerning Fire Properties shall be applicable.

SLS 1593: 2018

INTERNATIONAL STANDARD

ISO 8336

Third edition
2017-06

Fibre-cement flat sheets — Product specification and test methods

Plaques planes en fibres-ciment — Spécification des produits et méthodes d'essai

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see the following URL: www.iso.org/iso/foreword.html.

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

This third edition cancels and replaces the second edition (ISO 8336:2009), which has been technically revised.

Introduction

The purpose of this document is to provide manufacturers and purchasers with uniform requirements for fibre-cement flat sheet products. These requirements are performance-based and have been specified with the objective of ensuring product quality, industry efficiency and the performance of the product in service.

ISO/TC 77 aims to harmonize this document, where possible, with other national fibre-cement standards (CEN, ASTM and JIS) to facilitate and promote uniform performance benchmarks for the global use of fibre-cement products.

INTERNATIONAL STANDARD **ISO 8336:2017(E)**

Fibre-cement flat sheets — Product specification and test methods

1 Scope

This document specifies methods for the inspection and testing of fibre-cement flat sheets and provides the acceptance conditions for their use in one or more of the following applications:

— external wall and ceiling finishes;

— internal wall and ceiling finishes;

— internal and external backing sheets.

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

NOTE 1 This document does not apply to sheets for fire protection purposes.

NOTE 2 This document does not include calculations for installation design requirements, wind uplift or water proofing of the installed sheets.

NOTE 3 This document does not apply to the following products:

— boards of Portland or equivalent cement reinforced with fibrous wood particles;

— fibre-reinforced boards of calcium silicate or cement for thermal insulation or fire protection;

— sheets containing asbestos fibre reinforcement;

— sheets containing steel fibre reinforcement;

— fibre-cement roofing slates.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Products in fibre-reinforced cement — Sampling and inspection*

ISO 12572, *Hygrothermal performance of building materials and products — Determination of water vapour transmission properties — Cup method*

ISO 13787, *Thermal insulation products for building equipment and industrial installations — Determination of declared thermal conductivity*

ANSI A118.1, *Specification for Dry-Set Portland Cement Mortar*

ANSI A118.4, *Specification for Latex-Portland Cement Mortar*

ANSI A136.1, *Organic Adhesives for Installation of Ceramic Tile*

ASTM G21:2015, *Standard Practice for determining Resistance of Synthetic Polymeric Materials to Fungi*

ASTM D1037, *Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials*

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
acceptance test
test to establish whether a batch of sheets conforms to a specification

Note 1 to entry: The test is performed on samples drawn from continuous production or from a consignment (see ISO 390).

Note 2 to entry: Test methods, specifications and limit values are specified in this document. Sampling levels and acceptance criteria are specified in Clause 6.

3.2
type test
test carried out to demonstrate conformity with the requirements of this document 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 1 to entry: The test is performed on the as-delivered product, but is not required for each production batch.

3.3
acceptable quality level
AQL
maximum percent defective (or maximum number of defects per 100 units) which can be considered satisfactory as a long-term average quality level in a sampling plan

Note 1 to entry: 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, or ISO 3951 (all parts).

3.4
apparent density
dry weight/unit volume based upon the volume of the sample determined by water displacement or equivalent

Note 1 to entry: This is an average density of the material as-delivered coated or uncoated.

3.5
as delivered
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
upper face
face normally exposed

3.7
under face
reverse of the *upper face* (3.6)

3.8
textured sheet
sheet that has a relief pattern which is either embossed on or applied to the *upper face* (3.6) as a coating

3.9
reinforcement fibre
discrete randomly dispersed elements or continuous strands of cellulose fibre, synthetic organic, inorganic fibre or glass fibre, used in the manufacture of fibre-cement sheets

3.10
small-sized sheet
sheet for which the method of installation includes horizontal overlap

Note 1 to entry: Their dimensions are generally such that they have an area of <0,4 m^2 and a length/width ratio of ≤3.

3.11
large-sized sheet
sheet that do not correspond to indicators for *small-sized sheets* (3.10)

Note 1 to entry: Large sheets can be declared as "small-sized sheets", provided tolerances for small-sized sheets apply and are specified in the manufacturer's literature.

3.12
planks
category A sheet having an *aspect ratio* (3.13) of >7 normally used as horizontal overlapping wall covering

3.13
aspect ratio
ratio of the sheet length to the sheet width

3.14
modulus of rupture
MOR
maximum load/unit area of cross section at breaking, under flexural loading conditions

Note 1 to entry: The modulus of rupture is referred to as the bending strength or flexural strength in some countries.

3.15
quality control
<factory> part of quality management to ensure the product being manufactured meets stated requirements

Note 1 to entry: This is referred to as factory production control (FPC) in some countries.

3.16
ambient laboratory condition
laboratory condition where the temperature is at (23 ± 10) °C and (50 ± 20) % relative humidity

4 Symbols and abbreviated terms

a	nominal length or width of sheet, in mm
b	a) dimension of the specimen (length or width) measured parallel to the test machine supports, in mm b) one of the coefficients of the regression line (see Annex B)
d	apparent density of the sheet, in g/cm^3
e	thickness of sheet, in mm
F	breaking load, modulus of rupture test, in N
l	length, in mm
L_m	length of moisture movement specimen, in mm
l_s	span between support centres in modulus of rupture test, in mm
m	mass of the specimen after drying, in g
MOR	modulus of rupture, in MPa
MOR_{fi}	modulus of rupture of i^{th} exposed specimen after the type test
MOR_{fci}	modulus of rupture of i^{th} unexposed reference specimen
MOR_i	individual ratio of the modulus of rupture of the i^{th} pair of exposed and unexposed specimens
n	number of paired specimens
R	average ratio of the modulus of rupture of exposed and unexposed specimens
R_L	lower estimate of the mean of the ratios at 95 % confidence level of the modulus of rupture of exposed and unexposed specimens
s	standard deviation of the values in the appropriate calculation
μ	water vapour transmission value
λ	thermal conductivity
V	volume of specimen, in cm^3
w	width, in mm
x_i	individual value of the i^{th} specimen tested dry
x_{std}	minimum value to be used as the specification for the dry test method of test. This value is calculated at the 97,5 % lower confidence level from the value specified for the wet method of test (see Annex B)
x_0	actual result obtained when dry testing (see Annex B)
$\bar{x}$	mean value of x_i for i = 1 to n
y_i	individual value of the i^{th} specimen tested wet

y_{std} minimum value specified in the standard for wet testing (see Annex B)

y_0 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 (see Annex B)

$\bar{y}$ mean value of y_i for i = 1 to n

NT new technology (European term for asbestos-free fibre-cement products)

5 Requirements

5.1 General

Sheets covered by this document are divided into three categories: A, B and C, according to their application. Within these categories, there are five classes based upon the minimum modulus of rupture performance (see 5.6.1). The dimensional sizes are based upon the installation requirements (see 5.5.1 and 5.5.2). They may be supplied coated or uncoated.

Dimensional tolerances are specified for two levels of product quality: Level I and Level II, which are selected according to the installation requirements of the product.

NOTE When selecting a sheet product for a particular building application, consideration is given to the sheet category.

Table 1 provides information concerning the sheet category which should be selected for various typical building applications.

Table 1 — Sheet applications and categories

Application	Category
Façades	A
Lap siding (planks) or cladding	A
Backing for tile façade	A
Sub-flooring (external)	A
Soffits (eaves lining)	B
External backing for render or cladding	B
Rigid underlay for roofs or walls	B
Formwork or shuttering	B
Backing for internal wall or floor tiles	C
Ceiling linings	C
Interior substrate for walls for paint or wallpaper finish	C
Sub-flooring (internal)	C

NOTE Table 1 provides examples of common building applications. Other applications can be agreed upon by the manufacturer and the purchaser.

5.2 Sheet classifications

5.2.1 Category A

Sheets are intended for exterior applications where they may be subjected to the direct action of sun, rain, frost or snow. They may be supplied coated or uncoated.

5.2.2 Category B

Sheets are intended for applications where they may be subjected to heat, moisture and occasional frost, e.g. where they are either protected from or not subjected to severe weathering conditions.

5.2.3 Category C

Sheets are intended for internal applications, such as interior walls, floors, tile underlayment and backer board, where they may be subjected to heat and moisture, but not to frost.

5.3 Composition and manufacture

5.3.1 General

Fibre cement flat sheets shall consist essentially of cement or a calcium silicate formed by the chemical reaction of a siliceous and a calcareous material and shall contain reinforcement fibres (see 3.9). Process aids, fillers, aggregates and pigments which are compatible with fibre-reinforced cement may be added.

5.3.2 Reinforcement fibre

Reinforcement fibre shall be one or a combination of the following materials:

a) cellulose fibre;

b) synthetic organic or inorganic fibre;

c) glass fibre.

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

— discrete elements randomly dispersed;

— continuous strands.

5.3.3 Cement

The cement shall comply with the relevant national standards in the country of manufacture.

5.3.4 Manufacture

These products may be formed either with or without pressure and cured, under either natural or accelerated conditions, to meet the physical requirements specified in this document.

5.4 Appearance and finish

The upper face (3.6) of the sheet can be with or without texture. The sheets can be coloured or left in their natural colour. The sheets can also receive coatings such as sealers, primers, and/or finished top coats. Variations of the surface appearance which do not impair the fitness for purpose of the sheets are permitted.

5.5 Dimensions and tolerances

5.5.1 Nominal length and width

The manufacturer shall specify the nominal lengths and widths of the fibre-cement sheets.

5.5.2 Thickness

The manufacturer shall specify the nominal thicknesses of the sheets. For non-textured sheets, the nominal thickness refers to the average thickness. For textured sheets, the nominal thickness refers to the maximum thickness.

NOTE The nominal thickness of textured sheets cannot be used for the calculation of mechanical performance.

5.5.3 Tolerances on nominal dimensions and shape

5.5.3.1 General

When measured, sheet dimensions and shapes shall be within the tolerance ranges specified in this clause, except where alternative values have been agreed between the purchaser and manufacturer, or where national standards specify alternative values.

5.5.3.2 Tolerances on length and width

Tolerances on nominal length and width dimensions, a, when measured in accordance with the procedure in 7.2, shall be in accordance with the values given in Table 2, for the appropriate level nominated for the product.

Table 2 — Tolerances on nominal length and width dimensions for levels I and II

Nominal dimension (a)[a] mm	Tolerance	
	Level I	Level II
$a \leq 600$	±3 mm	±4 mm
$600 < a \leq 1\,000$	±3 mm	±5 mm
$1\,000 < a \leq 1\,600$	±0,3 % a	±0,5 % a
$1\,600 < a$	±5 mm	±8 mm
[a] Nominal length or width.		

5.5.3.3 Tolerances on thickness

5.5.3.3.1 Non-textured sheets

For sheets without a textured surface, the tolerances on the nominal thickness, e, when measured in accordance with 7.2, shall comply with Table 3. The maximum difference between extreme values of the thickness measurements within one sheet shall not exceed 10 % of the maximum measured value.

Table 3 — Tolerances on nominal thickness for non-textured sheets

Thickness mm	Tolerance
$e \leq 6$	±0,6 mm
$6 < e \leq 20$	±10 % e
$e > 20$	±2 mm

5.5.3.3.2 Textured sheets

For sheets with a textured surface, the tolerances on the nominal thickness, e, when measured in accordance with 7.2, shall comply with Table 4. The maximum difference between extreme values of the eight thickness measurements within one sheet shall not exceed 15 % of the maximum measured value.

Table 4 — Tolerances on nominal thickness for textured sheets

Thickness mm	Tolerance
$e \leq 6$	−0,6 mm + 0,9 mm
$6 < e \leq 20$	−10 % e + 15 % e
$e > 20$	−2 mm + 3 mm

5.5.3.4 Tolerances on shape

5.5.3.4.1 General

When measured for straightness and squareness of edges, sheets shall comply with the requirements given in 5.5.3.4.2 and 5.5.3.4.3, respectively. Edge straightness tolerances are only applicable to large-sized sheets.

5.5.3.4.2 Straightness of edges

When measured in accordance with 7.2, the tolerances on the straightness of edges, defined as a percentage of the length of the edge of the relevant dimension (length or width), shall be in accordance with Table 5 for the appropriate level, I or II.

Table 5 — Tolerances on straightness of edges

Level I	Level II
≤0,1 %	≤0,3 %

5.5.3.4.3 Squareness of edges

The tolerances on the squareness of edges of sheets measured in accordance with 7.2 shall be in accordance with Table 6 for the appropriate level, I or II.

Table 6 — Tolerances on squareness of edges

Level I	Level II
≤0,2 %	≤0,4 %

5.6 Physical requirements and characteristics

5.6.1 General

Compliance with this document requires that the sheets satisfy the prescribed minimum physical or mechanical performance requirements, according to their category and class, as listed in Table 7. These properties are determined on as-delivered sheets. Test results shall identify whether they apply to coated or uncoated sheets.

Table 7 — Minimum physical test requirements

Physical property	Minimum test performance requirement			Test requirements	Test method
	Category A (Saturated condition)	Category B (Saturated condition)	Category C (Ambient condition)		
Density	See 5.6.3	See 5.6.3	See 5.6.3	See 7.3.2	Annex E
Modulus of rupture				See 7.3.1	Annex C
Class 1	4 MPa	4 MPa	4 MPa		
Class 2	7 MPa	7 MPa	7 MPa		
Class 3	13 MPa	13 MPa	10 MPa		
Class 4	18 MPa	18 MPa	16 MPa		
Class 5	24 MPa	24 MPa	22 MPa		

NOTE 1 Values stated in this table are the minimum values at 4 % AQL. Minimum value (4 % AQL) for this property is to be declared by the manufacturer.

NOTE 2 For acceptance testing, use 4 % AQL values.

NOTE 3 For initial type testing, where production variance is not yet known, an estimate of the mean MOR at the 95 % confidence level is calculated to determine the class. See D.6.

5.6.2 Modulus of rupture

When tested as specified in 7.3.1 using the test method given in Annex D, the minimum modulus of rupture (MOR) of the sheets expressed in MPa shall be as specified in Table 7. The MOR shall be the average of the values obtained from testing the samples in both directions.

The MOR of the sheets in the weaker direction shall not be less than 70 % of the value specified in Table 7 (this is not applicable for plank products).

NOTE For textured sheets, the MOR is not used for calculating mechanical performance.

5.6.3 Apparent density

The manufacturer's literature shall specify the minimum apparent density for each category of sheet manufactured. When tested in accordance with 7.3.2, using the test method given in Annex E, the apparent density shall not be less than the specified value.

5.6.4 Moisture movement

The manufacturer's literature shall state the percentage value of lineal sheet moisture movement measured when the sheet is exposed to a relative humidity change from 30 % to 90 %. The stated value shall be determined in accordance with 7.3.3 using the test method given in Annex F. For category C sheets, this shall be ≤0,07 %.

NOTE Some national testing methods and performance requirements for moisture movement will differ from those given in this document.

5.6.5 Water permeability

Category A, B and C sheets, when tested for water permeability in accordance with 7.3.4, using the test method given in Annex G, may exhibit traces of moisture on the underside of the sheet, but in no instance shall there be any formation of water drops.

NOTE Some national testing methods and performance requirements for water permeability will differ from those given in this document.

5.6.6 Water vapour transmission

The manufacturer's literature may state the value for the water vapour transmission, μ. An example of a suitable test method is ISO 12572.

5.6.7 Thermal conductivity

The manufacturer's literature may state the value for the thermal conductivity, λ. An example of a suitable test method is ISO 13787.

5.6.8 Freeze-thaw performance

When tested in accordance with 7.3.5, using the test method given in Annex H, the ratio of the lower estimate mean values of the modulus of ruptures for the exposed and unexposed specimens, determined at the 95 % confidence levels, R_L, shall not be less than 0,8.

NOTE 1 The number of freeze-thaw test cycles required varies according to category of sheet (see Table 9).

NOTE 2 In countries of product use where there are, under normal circumstances, never or only occasionally temperatures below 0 °C, determination of freeze-thaw performance is not necessary.

NOTE 3 This is not a performance requirement for category C sheets.

5.6.9 Heat-rain performance

When tested in accordance with 7.3.6, using the test method given in Annex I, any visible cracks, delamination, warping or bowing or other defects in the sheet shall not be sufficient to affect their in-use performance.

a) Water tightness is assessed according to 5.6.5;

b) Warping and bowing are visually assessed.

NOTE 1 The number of heat test cycles required varies according to the category of the sheet (see Table 9).

NOTE 2 This is not a performance requirement for category C sheets.

5.6.10 Warm water performance

When tested in accordance with 7.3.7, using the test method given in Annex J, the ratio of the lower estimate mean values of the modulus of rupture for the exposed and unexposed specimens, determined at the 95 % confidence levels, R_L, shall not be less than 0,8.

This test applies to all sheet categories.

5.6.11 Soak-dry performance

When tested in accordance with 7.3.8, using the test method given in Annex K, the ratio of the lower estimate mean values of the modulus of rupture for the exposed and unexposed specimens, determined at the 95 % confidence levels, R_L, shall not be less than 0,75.

This test applies to all sheet categories.

NOTE The number of soak-dry test cycles required varies according to category of sheet (see Table 9).

5.6.12 Resistance to mould growth

When resistance to mould growth is to be demonstrated to the purchaser or specifier, the product shall satisfy the minimum performance requirements when tested using a method approved in the country of application. Where no standard or performance requirement has been established, the product,

without decoration, shall be tested in accordance with ASTM G21 and the mould growth shall not exceed the value of 1, as specified by ASTM G21:2015, 9.3.

5.6.13 Resistance to nail head pull-through

When minimum performance requirements for resistance against sheet fastening nail head pull-through is to be demonstrated to the purchaser or specifier, the product shall satisfy the minimum performance requirements when tested using a method approved in the country of application. Where no standard or performance requirement has been established, the 6 mm thick product shall have a minimum saturated nail head pull-through resistance of 400 N when tested in accordance with ASTM D1037 under the conditions given in 7.3.10.

Sheets of thickness greater than 6 mm shall also satisfy this requirement.

5.6.14 Saturated shear bond performance

When the minimum saturated interlaminar sheet shear bond strength is to be demonstrated to the purchaser or specifier, the product shall satisfy the minimum performance requirements when tested using a method approved in the country of application. The saturated condition is as defined in this document. Where no standard or performance requirement has been established, the product shall be tested in accordance with the method given in ANSI A118.1, ANSI A118.4 or ANSI A136.1, using sheets of material bonded together with the specified adhesive. The minimum shear bond strength after 7 d of adhesive curing shall be 345 kPa.

5.6.15 Surface burning characteristics

When specific limitations on surface burning characteristics are required to satisfy national performance requirements, testing shall be conducted using the method approved in the country of application. Where no standard or performance requirement has been established, fibre-cement sheets of 6 mm thickness shall have a reported flame spread index of 0, and a smoke developed index of not more than 5, when tested in accordance with ASTM E84. Sheets of thicknesses greater than 6 mm shall meet this requirement or shall be formed at 6 mm thickness with the same formulation for test purposes.

5.7 Fire properties

For the purpose of conformity with national regulations, products may 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.

5.8 Product performance

The sheet categories defined in this document (see 5.2) cannot be considered to give an indication of the service life of the product. Product service life will be influenced by factors such as the geographical location, location of product on structure, type and method of installation and applied surface coatings. This document only defines minimum physical performance requirements and does not prescribe sheet material formulations. Therefore, presumption that the service life of sheets of similar category, made by various manufacturers will be similar cannot be made. Service life can only be estimated for clearly specified product applications and products in defined climate zones. (Refer to ISO 15686-8 to obtain further information regarding service life prediction.)

6 Evaluation of conformity

6.1 General

The conformity of products with the requirements of this document shall be demonstrated by

— type testing, and/or

— factory production control by the manufacturer.

6.2 Type testing

6.2.1 General

Type tests shall be carried out on as-delivered sheets. If the same composition and production method is used to produce sheets of various nominal sizes and thicknesses, type tests only need to be conducted on the maximum and minimum thicknesses. If the ratio of the maximum to minimum thickness is greater than three, an additional intermediate thickness shall be tested.

All product characteristics listed in Table 8 shall be subjected to initial type testing. The type tests relevant to each category are listed in Table 9.

Testing of mechanical characteristics is normally carried out with the upper face in compression. If a relationship between the upper and under face testing values is required for design purposes, or because a significant difference in values is expected, the load shall be applied to the upper and under face.

Table 8 — Number of samples and compliance criteria

Characteristic	Requirement	Assessment method	Number of samples	Compliance criteria
Dimensional conformity	5.5.3	7.2	Inspection S_3 in accordance with ISO 390	5.5.3
Modulus of rupture	5.6.2	7.3.1	Inspection S_3 in accordance with ISO 390	5.6.1, Table 7 apply 4 % AQL
Density	5.6.3	7.3.2	Inspection by variables; method σ or s	5.6.3
Moisture movement	5.6.4	7.3.3	3 test sheets	5.6.4
Water permeability	5.6.5	7.3.4	3 test sheets	5.6.5
Water vapour transmission	5.6.6	ISO 12572	3 test sheets	5.6.6
Thermal conductivity	5.6.7	ISO 13787	3 test sheets	5.6.7
Freeze-thaw performance	5.6.8	7.3.5	10 samples	5.6.8
Heat-rain performance	5.6.9	7.3.6	minimum of 3,5 m^2	5.6.9
Warm water performance	5.6.10	7.3.7	10 samples	5.6.10
Soak-dry performance	5.6.11	7.3.8	10 samples	5.6.11
Resistance to mould	5.6.12	7.3.9	4 samples	5.6.12
Resistance to nail head pull-through	5.6.13	7.3.10	10 samples	5.6.13
Saturated shear bond performance	5.6.14	7.3.11	Refer to appropriate ANSI document	5.6.14

6.2.2 Initial type testing

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

Additional type testing shall be carried out for the approval of a new product or where a fundamental change in formulation or method of manufacture creates effects which cannot be predicted on the basis of previous experience.

For initial type testing, where production variance is not yet known, an estimate of the average characteristic at the 95 % confidence level shall be calculated to determine the class.

The results of all type tests shall be recorded and held by the manufacturer for at least 5 years.

6.2.3 Further type testing

Whenever a change in the fibre-cement sheet design, the raw material or supplier of components, or the production process occurs, which would significantly change one or more of the sheet characteristics, the type test shall be performed for the appropriate characteristic(s).

Table 9 — Type testing and property evaluation test requirements

Physical property	Minimum test performance requirement			Test condition	Test method
	Category A	Category B	Category C		
Moisture movement	See Notes 1 and 3 5.6.4	See Notes 1 and 3 5.6.4	See Notes 1 and 3 5.6.4	7.3.3	Annex F
Water permeability	Test required 5.6.5 See Note 3	Test required 5.6.5 See Note 3	Test required 5.6.5 See Note 3	7.3.4	Annex G
Water vapour transmission	5.6.6 See Note 4	5.6.6 See Note 4	Not required	ISO 12572, Condition C	ISO 12572, Condition C
Thermal conductivity, λ	5.6.7 See Note 4	5.6.7 See Note 4	5.6.7 See Note 4	ISO 13787	ISO 13787
Freeze-thaw performance	Test required 100 cycles 5.6.8	Test required 25 cycles 5.6.8	Not required	7.3.5	Annex H
Heat-rain performance	Test required 50 cycles 5.6.9	Test required 25 cycles 5.6.9	Not required	7.3.6	Annex I
Warm water performance	Test required 5.6.10	Test required 5.6.10	Test required 5.6.10	56 ± 2 d 7.3.7	Annex J

NOTE 1 Minimum value for this property is declared by the manufacturer.

NOTE 2 The manufacturer states the value measured.

NOTE 3 Some national testing methods and performance requirements for water permeability and moisture movement can differ from those given in this document.

NOTE 4 It is possible for national building codes or standards to require this physical property to be stated by the manufacturer. The value is determined using either the test method specified or a method satisfying the requirements of that national code.

Table 9 *(continued)*

Physical property	Minimum test performance requirement			Test condition	Test method
	Category A	Category B	Category C		
Soak-dry performance	Test required 50 cycles 5.6.11	Test required 25 cycles 5.6.11	Test required 25 cycles 5.6.11	7.3.8	Annex K
Resistance to mould	Not required	Not required	5.6.12 See Note 4	7.3.9 7.3.11	ASTM G21
Resistance to nail head pull-through	Not required	5.6.13 See Note 4	5.6.13 See Note 4	7.3.10	ASTM D1037
Saturated shear bond performance	Not required	See Note 4 345 kPa (7 d shear strength)	See Note 4 345 kPa (7 d shear strength)	ANSI A118.1 or ANSI A118.4 or ANSI A136.1	ANSI A118.1 ANSI A118.4 ANSI A136.1

NOTE 1 Minimum value for this property is declared by the manufacturer.

NOTE 2 The manufacturer states the value measured.

NOTE 3 Some national testing methods and performance requirements for water permeability and moisture movement can differ from those given in this document.

NOTE 4 It is possible for national building codes or standards to require this physical property to be stated by the manufacturer. The value is determined using either the test method specified or a method satisfying the requirements of that national code.

6.3 Quality control system

6.3.1 General

The manufacturer shall establish and maintain a documented quality management system which ensures that the products placed into the market conform to the stated performance characteristics. The quality control (QC) system shall consist of procedures, regular inspections and tests and/or assessments of the incoming materials, components, manufacturing equipment, manufacturing process and the product.

A manufacturer meeting the requirements of a quality management system, such as ISO 9001, is considered to meet the above requirements. The results of inspections, tests or assessments which require action shall be recorded together with the remedial action taken.

6.3.2 Acceptance tests

The specifications of acceptance tests apply to the product as delivered, but some of the tests may be completed at an earlier stage of maturity.

Sampling from continuous production testing of the base sheet prior to coating, and/or in conditions other than those listed in Table 8, is acceptable provided that it is statistically established (see Annex B) that compliance with the requirements in Table 8 is achieved.

Acceptance tests can also be used to confirm that a batch of sheets conforms to this document, for example in conjunction with type tests or for receiving inspection.

The tests include:

— measurement of dimensions such as length, width and thickness (method specified in Annex C);

— measurement of apparent density (method specified in Annex E);

— measurement of mechanical characteristics such as bending strength (method specified in Annex D).

Each limit of specification for the characteristics in Table 10 shall be subject to an AQL of 4 %. The sampling schemes provided in ISO 390, with an AQL of 4 % and with an inspection level of S_3, ensure that for large batches approximately 95 % of the items satisfy the requirements.

6.3.3 Equipment

All weighing, measuring and testing equipment shall be calibrated and regularly inspected according to documented procedures, frequencies and criteria.

6.3.4 Raw materials and components

The specification of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring conformity.

Table 10 — Minimum sampling schemes

ISO 2859-1	
Length and width	Inspection by attributes
Thickness	Double sampling
Straightness of edges	AQL 4 %
Squareness of edges	Level S_1
ISO 3951 (all parts)	
Apparent density	Inspection by variables; method σ or s
Bending strength	AQL 4 %
	Level S_3

6.3.5 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of all the characteristics are maintained.

6.3.6 Non-conforming products

Non-conforming products shall be separated and handled according to documented procedures.

6.4 Inspection of a consignment of finished products

Inspection of a consignment of finished products is not a requirement of this document but if, in special cases, this is demanded by the customer, it may be conducted in accordance with Annex A and ISO 390.

7 Test requirements

7.1 General

This clause specifies the requirements for acceptance and type testing.

7.2 Dimensional and geometrical tests

7.2.1 General

The measurements shall be made on whole sheets as delivered and without conditioning using the apparatus and procedure given in Annex C.

7.2.2 Number of measurements

7.2.2.1 Small-sized sheets

Five randomly selected sheets shall be measured. See 3.10.

7.2.2.2 Large-sized sheets

One sheet shall be measured. See 3.11.

7.3 Physical performance tests

7.3.1 Modulus of rupture

7.3.1.1 General

The MOR tests shall be carried out using the test method and apparatus identified in Annex D with test specimens prepared and conditioned as specified in 7.3.1.3.

7.3.1.2 Number of specimens

For each MOR determination, five specimens are required.

7.3.1.3 Preparation of specimens

7.3.1.3.1 Small-sized sheets

Where the sheets are smaller than 250 mm × 250 mm, the whole sheet is tested; if the sheet has larger dimensions, a specimen satisfying the requirements of 7.3.1.3.3 is cut from each sheet.

7.3.1.3.2 Large-sized sheets

Test specimens are cut from the same part of the sheet. Specimens shall be cut with their dimensions perpendicular and parallel to the manufacturing direction of the sheet. Where rectangular specimen dimensions are used, an equal number of specimens are cut perpendicular and parallel to the manufacturing direction. All specimens shall satisfy the requirements of 7.3.1.3.3

7.3.1.3.3 Shape and dimensions of test specimens

Specimens may be either square or rectangular.

The preferred dimensions of the test specimens are 250 mm × 250 mm.

The specimens shall also satisfy the following requirements:

a) ratio of span, l_s, to the nominal thickness shall be equal to or greater than 15;

b) ratio of span, l_s, to the deflection at rupture shall be equal to or greater than 20;

c) length of specimen shall be equal to or greater than span, l_s, plus 40 mm;

d) width of specimen shall be greater than or equal to five times the nominal thickness of specimen.

NOTE The MOR testing is normally completed using a test machine which has a span, l_s, of 200 mm. It is possible that, when tested using the preferred dimensions, some products do not satisfy the requirements given in a) to d). Where this occurs, the dimensions of the specimen and span are adjusted in order to satisfy those requirements. For plank products in particular, it might not be possible to test the specimen in both directions. Where this is the case, the MOR in a single direction can be used for the purposes of product classification.

7.3.1.3.4 Specimen conditioning

Prior to testing, the specimens shall be conditioned in accordance with Table 11.

Table 11 — Conditioning requirements

Test	Conditioning procedure
Acceptance test (wet) Categories A and B	24 h immersion in water for nominal thickness ≤20 mm 48 h immersion in water for nominal thickness >20mm
Acceptance test (ambient) Category C	From 7 d to 14 d in ambient laboratory conditions
Type test Categories A, B and C	Prior to the bending test: from 7 d to 14 d in ambient laboratory conditions; followed by 24 h immersion in water for sheets with thickness. ≤20 mm or 48 h for thickness >20 mm

7.3.2 Apparent density

7.3.2.1 General

The apparent density shall be determined using the procedure and apparatus details given in Annex E.

7.3.2.2 Number of specimens

One specimen shall be tested.

7.3.2.3 Dimensions of specimen

The specimen shall preferably be a piece of sheet used for the MOR test.

7.3.3 Moisture movement test

7.3.3.1 General

The moisture movement shall be determined at a temperature of (23 ± 2) °C using the test procedure and apparatus details given in Annex F.

7.3.3.2 Number of specimens

Two specimens shall be tested; one specimen shall be cut parallel with the long dimension of the sheet and the other shall be cut at right angles to the long dimension from the same sheet.

7.3.3.3 Dimensions of specimens

The test specimens shall be at least 75 mm wide and 300 mm long.

7.3.3.4 Conditioning of specimens

Condition specimens at (30 ± 2) % relative humidity at a temperature of (23 ± 2) °C until weight loss or gain during a 24 h period is not greater than 0,1 % of specimen weight.

7.3.4 Water permeability

7.3.4.1 General

The water permeability test shall be conducted using the procedure and apparatus given in Annex G, with specimens conforming to the requirements of 7.3.4.

7.3.4.2 Number of specimens

Tests shall be conducted on three specimens.

7.3.4.3 Specimen dimensions

For large sheets, the preferred specimen dimensions shall be 600 mm × 500 mm minimum. When the sheet width is less than 500 mm, then specimen width should be the maximum possible.

For small sheets, the whole sheet shall constitute the specimen.

7.3.4.4 Conditioning

The specimens shall be kept in ambient laboratory conditions for at least 7 d.

7.3.5 Freeze-thaw test

7.3.5.1 General

The freeze-thaw test shall be carried out using the procedure and apparatus given in Annex H. Each freeze-thaw cycle shall be as stated in H.4 d) and the number of test cycles for each sheet category shall be in accordance with H.4 e).

7.3.5.2 Number and configuration of specimens

From each of 10 as-delivered sample sheets, cut a pair of specimens conforming to the requirements for the MOR test (see 7.3.1.3.3). Each pair of specimens shall be cut from the sheet so that they are adjacent and in the machine direction as shown in Figure 1. The specimen pairs should be given identification, which will enable later comparison of test results.

7.3.5.3 Conditioning

Ten specimens, being one specimen from each pair, shall be conditioned as detailed in Table 11; these will be subjected to MOR testing. The remaining 10 specimens should be immersed in water at ambient temperature (>5 °C) for 48 h prior to freeze-thaw testing.

7.3.6 Heat-rain test

7.3.6.1 General

The heat-rain test shall be carried out using the procedure and apparatus given in Annex I. Each heat-rain test cycle shall be as given in I.5 b) and the number of test cycles for each sheet category shall be in accordance with I.5 c).

7.3.6.2 Preparation of specimens

The sheets shall be selected at random and stored in ambient conditions prior to assembly for the test.

7.3.6.3 Number of test specimens

The number of sheets required will depend upon the specific installation being tested or on the size of the sheets. Where possible, maximum-sized sheets should be used.

7.3.7 Warm water test

7.3.7.1 General

The warm water test shall be carried out using the procedure and apparatus given in Annex J.

7.3.7.2 Number and configuration of specimens

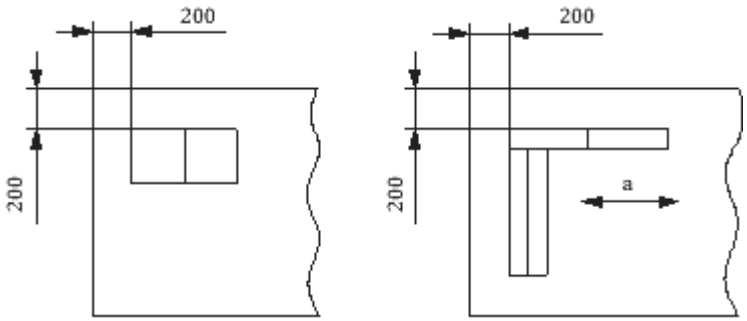
From each of 10 as-delivered sample sheets, cut a pair of specimens conforming to the requirements for the MOR test (see 7.3.1.3.3). Each pair of specimens shall be cut from the sheet so that they are adjacent and in the machine direction as shown in Figure 1. The specimen pairs should be given identification, which will enable later comparison of test results.

7.3.8 Soak-dry test

7.3.8.1 General

The soak-dry test shall be carried out using the procedure and apparatus given in Annex K.

Dimensions in millimetres



Key

a Machine direction.

Figure 1 — Adjacent specimen cutting

7.3.8.2 Number and configuration of specimens

From each of 10 as-delivered sample sheets, cut a pair of specimens conforming to the requirements for the modulus of rupture test (see 7.3.1.3.3). Each pair of specimens shall be cut from the sheet so that they are adjacent and in the machine direction as shown in Figure 1. The specimen pairs should be given identification, which will enable later comparison of test results.

7.3.9 Mould testing

Test specimens shall be prepared and conditioned as specified in the referring standard (see 5.6.12).

7.3.10 Nail head pull-through

7.3.10.1 General

Test specimens shall be prepared and conditioned as specified in the referring standard (see 5.6.13).

7.3.10.2 Nail dimension

Unless otherwise specified, the nail shall have a nominal shank diameter of 3 mm and a nominal head diameter of 10 mm.

7.3.10.3 Test sheet thickness

The test sheet shall have a thickness of at least 6 mm.

7.3.11 Saturated shear bond test

Test specimens shall be prepared and conditioned as specified in ANSI A118.1, ANSI A118.4 or ANSI A136.1, as appropriate (see 5.6.14).

8 Marking

The packaging of sheets shall be marked with at least the following information:

a) manufacturer's identification;

b) reference to this document, i.e. ISO 8336;

c) size and/or name;

d) category;

e) class;

f) level of tolerance;

g) date of manufacture;

h) NT (where required).

A minimum of 50 % of sheets greater than 2,5 m^2 in each delivered unit shall be durably marked with at least items a), d), e) and g) of this clause. For smaller sizes, there shall be on average one marking every 5 m^2.

For sheets intended for decorative purposes, the marking of the sheets may be reduced by agreement between the manufacturer and purchaser.

Annex A
(normative)

Consignment and inspection sampling

A.1 General

This annex provides details of a system for inspecting and sampling a consignment of finished products (see 6.4), which may, by agreement between the manufacturer and the purchaser, be included in a tender or product order.

NOTE Compliance with 6.4 is not a requirement of this document.

A.2 Sampling

A.2.1 When specified, the acceptance sampling shall be made on lot(s) of the consignment in accordance with the test programme of this document, unless there is a special agreement. Table 8 specifies the characteristics to be tested

Details related to the application of the sampling procedure (see Clause 6) shall be established between the manufacturer and purchaser.

A.2.2 After agreement on the sampling procedure, sampling shall be carried out, in the presence of both parties, from lot(s) which is/are to be delivered to the purchaser. If the inspection lot(s) is/are not yet formed, the manufacturer should present to the purchaser the stock(s) from which the inspection lot(s) can be selected and marked. Unless otherwise agreed between the manufacturer and purchaser, the maximum and minimum inspection lots shall be 8 000 and 4 000 fibre-cement flat sheets

A.3 Testing

The tests shall be carried out in the laboratory of the manufacturer or by an independent laboratory selected by mutual agreement between the manufacturer and purchaser. In case of dispute, the tests shall be completed in the presence of both parties.

A.4 Non-destructive tests

When non-destructive tests are carried out and the result of the sampling inspection does not meet the acceptance test requirements of this document, the tests shall be required on each item of the consignment. The units of the consignment which do not meet the requirements when tested individually can be refused and disposed of, unless otherwise agreed between the manufacturer and purchaser.

Annex B
(normative)

Statistical method for determining the corresponding wet values or revised dry specifications for the MOR when making the dry method of test or when tested prior to coating for quality control purposes

B.1 Procedure

Sample at least 20 sheets. Cut them into paired specimens for the bending strength test described in Annex D.

Both specimens of a pair shall be cut from the same sheet and each given the same number.

Test one set of specimens wet and one set of specimens dry for bending in accordance with Annex D.

For the paired results, determine whether there is a correlation between them at a 97,5 % confidence level using the method in B.2.

If there is no significant correlation, then dry testing cannot be used. If the correlation is positive, continue as follows:

a) determine the regression line using the method described in B.3;

b) determine either

- a wet value for each specimen from the obtained dry value, using the method described in B.4, or
- a revised minimum value to be used as the specification for dry testing corresponding to the appropriate minimum value for wet testing as specified in this document using the method described in B.5.

B.2 Determination of the correlation between the results of testing wet and dry specimens

Calculate the coefficient of correlation between wet and dry values, *r*, using Formula (B.1):

$$r = \frac{\sum_{1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{1}^{n}(x_i - \bar{x})^2 \sum_{1}^{n}(y_i - \bar{y})^2}} \quad \text{(B.1)}$$

where

n is the number of paired specimens;

x_i is the individual value of the i^{th} specimen tested dry;

y_i is the individual value of the i^{th} specimen tested wet;

$\bar{x}$ is the mean value of x_i for i = 1 to n;

$\bar{y}$ is the mean value of y_i for i = 1 to n.

Calculate the value of t using Formula (B.2):

$$t = \left| \frac{r}{\sqrt{1 - r^2}} \right| \sqrt{n - 2} \tag{B.2}$$

Compare t to the Student's coefficient, $t_{0,025/n-2}$.

If $t > t_{0,025/n-2}$, then there is a significant relationship between the results of wet and dry testing and the regression line is straight. Dry testing can be carried out for quality control purposes.

When n = 20, then $t_{0,025/n-2}$ = 2,101.

For n > 20, refer to Student's t tables.

B.3 Determination of the regression line

The regression line, y, is given by Formula (B.3):

$$y = a + bx \tag{B.3}$$

Calculate the values of a and b using Formulae (B.4) and (B.5):

$$b = \frac{\sum_{1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sum_{1}^{n} (x_i - \bar{x})^2} \tag{B.4}$$

$$a = \bar{y} - b\bar{x} \tag{B.5}$$

A plot of the regression line is shown in Figure B.1.

B.4 Determination of a value for wet testing from an obtained value for dry testing

The residual standard deviation (also called the standard error of the estimate), s, is calculated using Formula (B.6):

$$s = \sqrt{\frac{\sum_{1}^{n}(y_i - a - bx_i)^2}{n-2}} \tag{B.6}$$

The value for wet testing, y_0, is calculated from Formula (B.6) using the obtained dry value x_0:

$$y_0 = (a + bx_0) - t_{0,025/n-2}\sqrt{\frac{n+1}{n} + \frac{(x_0 - \bar{x})^2}{\sum_{1}^{n}(x_i - \bar{x})^2}} \tag{B.7}$$

where

x_0 is the actual result obtained when dry testing;

y_0 is the value calculated from x_0 which is the estimate at the lower 97,5 % confidence level of the value expected from wet testing.

When n = 20, then $t_{0,025/n-2}$ = 2,101.

For n > 20, refer to Student's t tables.

For routine quality control testing, individual values of y_0 can be calculated each time or, alternatively, by substituting a suitable range of values for x_0 in Formula (B.7), a plot of x_0, y_0 can be made (see Figure B.1) from which future values can be read.

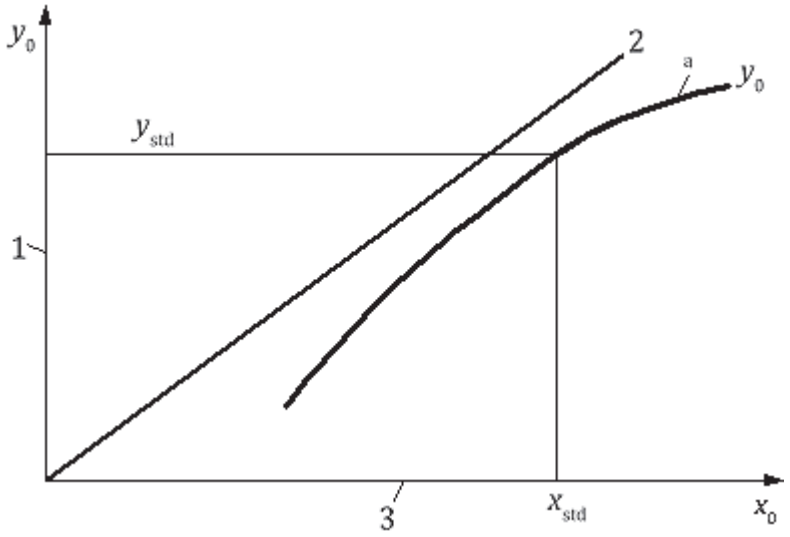
B.5 Determination of the minimum value specified for dry testing, x_{std}, corresponding to the minimum value specified for wet testing in this document, y_{std}

Plot the line for x_0, y_0 by substituting a suitable range of values for x_0 in Formula (B.7).

Read the value for x_{std} corresponding to the value for y_{std} from the graph (see Figure B.1), where

y_{std} is the minimum value specified in the standard for wet testing;

x_{std} is the minimum value to be specified for dry testing calculated from y_{std} at the 97,5 % lower confidence level.



Key

1 wet values
2 regression line
3 dry values
[a] From Formula (B.7).

Figure B.1 — Regression line for wet/dry values with lower confidence level

Annex C
(normative)

Dimensional measurement and geometrical testing procedure

C.1 General

This annex provides the details of the measuring apparatus and measuring procedure which are to be used for the determination of compliance with the requirements of this document.

C.2 Principle

Sample sheets, selected from batches of sheets, are measured to determine their compliance with the length, width and thickness requirements of this document.

C.3 Apparatus

The apparatus shall include the following items.

C.3.1 Inspection surface, smooth, flat, rigid, of standard quality, having dimensions appropriate to the size of the sheets being measured.

Two metal rules shall be fixed at right angles along adjacent edges of the inspection surface. The straightness of each metal rule shall be at least 0,3 mm/m and the right angle shall be accurate to at least 0,1 % (less than 1 mm deviation from normal per metre of length) or 0,001 rad.

Alternatively, a portable square of at least 1 000 mm in each direction shall be used. The same requirements for straightness and angularity apply.

C.3.2 Rules, short, metal and capable of being read to an accuracy of 0,5 mm.

C.3.3 Measuring tape, metal, of sufficient length to measure the length of a sheet to an accuracy of 1 mm.

C.3.4 Dial gauge, reading to at least 0,1 mm, with flat parallel metal jaws between 10 mm and 15 mm in diameter.

C.4 Measuring procedure

C.4.1 Measurement of length and width

C.4.1.1 General

Avoid taking the measurement over a local deformation which could be considered as a visual defect. Smooth any rough areas.

Take each dimensional reading to the nearest 1 mm.

C.4.1.2 Small-sized sheets

Measure each dimension twice on each sheet, i.e. one at about 50 mm from either end.

C.4.1.3 Large-sized sheets

Measure each dimension three times on each sheet, i.e. one in the middle and one at about 50 mm from either end.

C.4.2 Measurement of thickness

C.4.2.1 Non-textured sheets

C.4.2.1.1 For large-sized sheets, make three thickness measurements, with a dial gauge, along one side of the sheet taking each reading to an accuracy of 0,1 mm, as indicated in Figure C.1.

Report the individual results and calculate the arithmetic mean and difference between extreme values.

C.4.2.1.2 For small-sized sheets, make two measurements with a dial gauge on each sheet, approximately 20 mm from the edge in the middle of two adjacent sides.

Report the individual results and calculate the arithmetic mean and difference between extreme values.

Dimensions in millimetres

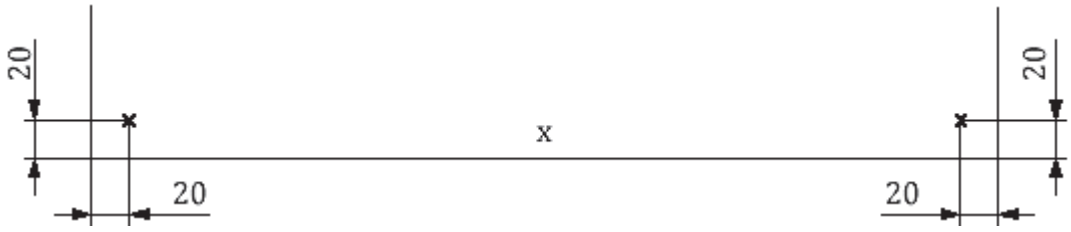


Figure C.1 — Measurement of thickness on large-sized non-textured sheets

C.4.2.2 Textured sheets

C.4.2.2.1 For large-sized sheets, make thickness measurements with a dial gauge at the eight positions shown in Figure C.2, between 20 mm and 50 mm from the edge, taking each reading to an accuracy of 0,1 mm.

Report the individual results and calculate the arithmetic mean and difference between extreme values.

C.4.2.2.2 For small-sized sheets, make thickness measurements with a dial gauge, in the middle of all four sides of the sheet, between 20 mm and 50 mm from the edge, taking each reading to an accuracy of 0,1 mm.

Report the individual results and calculate the arithmetic mean and difference between extreme values.

The thickness measurements obtained by this method for textured sheets shall not be used for the calculation of MOR and density (see C.4.2.3).

NOTE Sheets with thick applied coatings (>0,5 mm) are measured in accordance with C.4.2.1 without the coating.

C.4.2.3 Determination of sheet thickness by volume determination

For textured sheets and sheets with thin applied coatings ≤0,5 mm, determine the specimen thickness, *e*, in mm, required for MOR and density calculation by measuring the volume displacement in water using Formula (C.1):

$$e = \frac{V}{lw} \tag{C.1}$$

where

V is the volume of fluid displacement, in mm^3;

l is the specimen length, in mm;

w is the specimen width, in mm.

Dimensions in millimetres

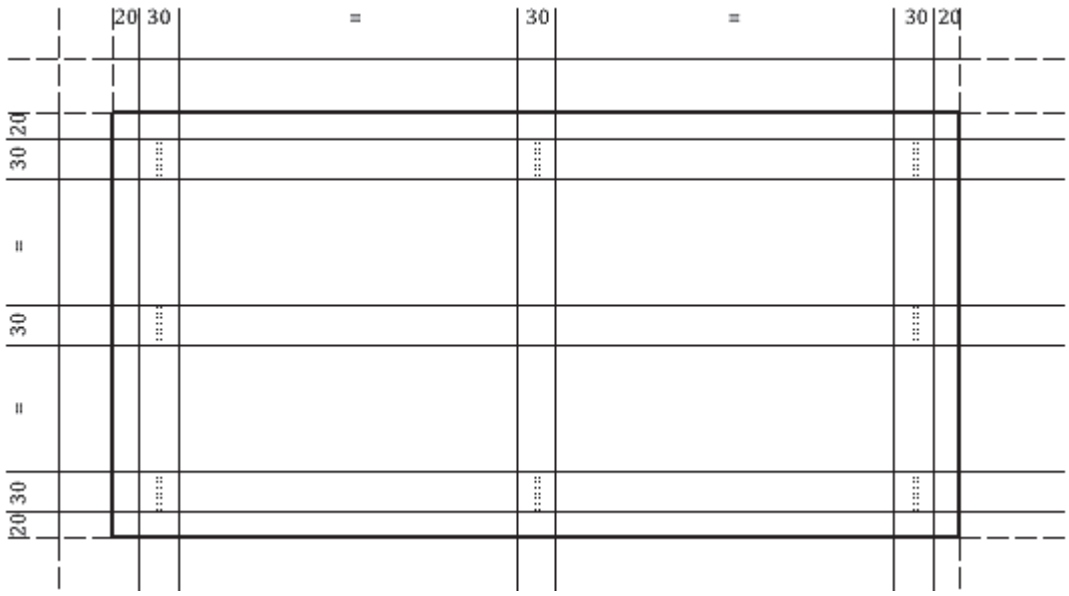


Figure C.2 — Measurement of thickness of large textured sheets

C.4.3 Measurement of edge straightness

For large-sized sheets, measure on all four edges the greatest distance between the edge of the sheet and a string or wire stretched from one corner to the adjacent corner with a steel rule.

Record the measured value.

C.4.4 Measurement of sheet squareness

Place two adjacent corners of the sheet in succession between the arms of the square, keeping one edge against the full length of the large arm and the other in contact with the small arm at least one point.

In this position, measure to the nearest 0,5 mm the greatest distance of the sheet edge from the small arm of the square. Record the measured value.

C.5 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the nominal dimensions of the test sheets;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the measured values from the tests;

g) the date of the test.

Annex D
(normative)

Test method for the determination of fibre-cement sheet modulus of rupture (bending strength)

D.1 General

This annex provides a method for determining the modulus of rupture for fibre-cement sheets.

D.2 Principle

A specimen is cut from a sample sheet and subjected to a flexural bending load until failure occurs. The failure load and specimen thickness are recorded. This test is repeated on the specimen with the bending mode at right angles to the initial test. The average modulus of rupture for the material is calculated from the test results.

D.3 Apparatus

D.3.1 Bending testing machine, which shall apply a load at a constant rate of deflection with an error of accuracy and an error of repeatability of 3 % comprising:

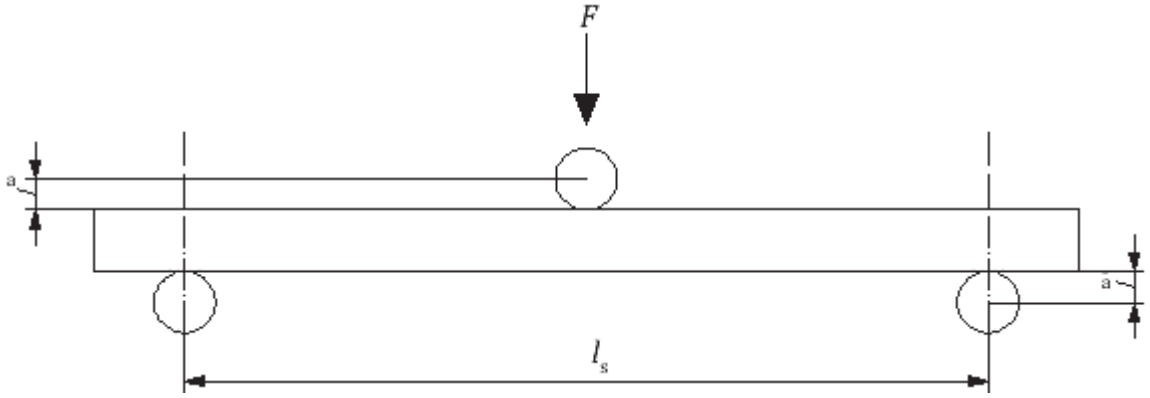
— two parallel horizontal supports, one fixed and the second free to move to permit alignment with the specimen. The upper face of each support shall be rounded and shall have a radius between 3 mm and 25 mm (see Figure D.1).

— a loading bar having the same edge radius as the supports, located parallel to and equidistant from the supports. The loading bar is attached to the loading mechanism through a flexible connection.

The lengths of the supports and loading bar shall be greater than the width of the test specimen.

D.3.2 Micrometer, reading to an accuracy of at least 0,05 mm, with flat parallel metal jaws between 10 mm and 15 mm in diameter.

Dimensions in millimetres



Key

[a] 3 mm to 25 mm.

Figure D.1 — Bending test configuration

D.4 Specimen preparation

Prepare specimens to conform with the dimensional requirements of the referring standard (see 7.3.1) and condition samples prior to testing, as appropriate for the sheet category (see Table 11).

D.5 Test procedure

a) Arrange the supports to be at the appropriate spacing for the specimen.

NOTE This is normally 200 mm between bar centres, but can be altered according to the specimen characteristics (see 7.3.1.3.3).

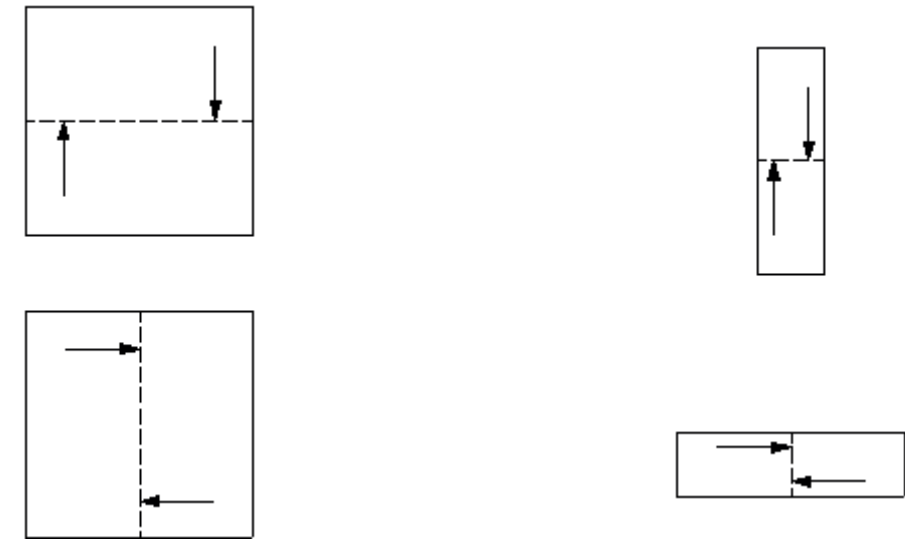
b) Measure the thickness of smooth (non-textured) sheets along the imaginary line of breakage (see Figure D.2) at two points. For textured sheets, the thickness shall be calculated from the volume measured by water displacement. Alternative methods for determination of average thickness of textured product may be used, provided that they can be proven, on average, to yield a thickness measurement within plus or minus 2 % of that determined from the volume measurement by water displacement.

c) Arrange the specimen with the under face against the supports and the loading bar on the upper face equidistant between and parallel with the supports.

d) Load the specimen such that the breakage occurs within 10 s and 30 s. A constant rate of deflection is preferred; if this cannot be achieved, a constant rate of loading is acceptable. Record the load at break.

e) For square specimens, reassemble the broken pieces and submit the specimen to a second bending test with the line of load application at right angles to that of the first test. Record the load at break.

NOTE Where rectangular specimens are being used, the strengths in two directions are obtained by testing each of the appropriate specimens (see Figure D.2).



a) Square specimens **b) Rectangular specimens**

Figure D.2 — Measurement of thickness specimens

D.6 Calculation of modulus of rupture value

The MOR, in MPa, for each breaking load direction is given by Formula (D.1):

$$\text{MOR} = \frac{3Fl_s}{2be^2} \tag{D.1}$$

where

F is the breaking load, in N;

l_s is the span between the centre-lines of the supports, in mm;

b is the width of the test piece, in mm;

e is the thickness, in millimetres.

For non-textured sheets, it is the arithmetic mean of two measurements for each breaking load direction.

For textured sheets, it is the arithmetic mean of four measurements for each breaking load direction.

NOTE Alternative methods for the determination of average thickness of textured product may be used, provided that they can be statistically proven, on average, to yield a thickness measurement within ±2 % of that determined from volume measurement by water displacement.

The MOR of the sheet(s) shall be the arithmetic mean of the five (10) values (two values in each direction).

For initial type tests, to determine product class where production variance is unknown, an estimate of the mean MOR at the 95 % confidence level shall be determined. This shall be done by taking one square sample or two rectangular samples from a minimum of 10 individual sheets, and carrying out the following procedure:

a) for each sheet, calculate MOR_i as the average of MOR along and MOR across for the i^{th} sheet;

b) calculate the mean, R_i, and the standard deviation, s, of the combined average MOR_i values;

c) calculate the mean, R_{cl}, of the MOR_i values at the 95 % confidence level using Formula (D.3):

$$R_{cl} = R_i - 0{,}58s \quad \text{(D.3)}$$

See ISO 2602.

d) determine the product class by comparing the R_{cl} value with the category and minimum class requirement in Table 7 ($R_{cl} \geq$ Table 7 value).

D.7 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the break loads of the specimens;

g) the calculated values of the modulus of rupture;

h) the date of the test.

Annex E
(normative)

Test method for the determination of the apparent density of fibre-cement sheets

E.1 General

This annex provides the test method for the determination of the apparent density (see 3.4) of fibre-cement sheets. This is the average density of the material and its pores.

E.2 Principle

The volume of a saturated specimen is determined by immersion in water. The specimen's oven-dry weight is then measured. The apparent density is determined by calculation from the measured values.

E.3 Apparatus

E.3.1 **Oven**, ventilated, capable of achieving a temperature of (100 ± 5) °C with a full load of specimens.

E.3.2 **Balance**, accurate to within 0,1 % of the specimen mass, equipped to determine both the immersed mass and the non-immersed mass of the specimen.

E.4 Test procedure

a) Immerse specimen in water. Specimens having a thickness ≤20 mm shall be immersed for at least 24 h.

b) Specimens having a thickness >20 mm shall be immersed for at least 48 h.

c) Take the saturated specimen, remove excess water from surfaces and then determine the volume of the water displaced, V, by the saturated specimen when placed into a water bath. Record this value.

d) Remove specimen from the water bath and place it into a ventilated oven which is maintained at a temperature of (100 ± 5) °C until constant mass, m, is reached (i.e. mass gain in any 24 h period does not exceed 0,1 % of specimen weight). Record this value.

E.5 Calculation of apparent density

The apparent density, d, in g/cm^3, is given by Formula (E.1):

$$d = \frac{m}{V} \tag{E.1}$$

where

m is the mass of the specimen after drying;

V is the volume of the specimen, in cm^3.

E.6 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the measured displacement and weight of the specimen;

g) the calculated value of the apparent density;

h) the date of the test.

Annex F
(normative)

Test method for the determination of moisture movement characteristic of fibre-cement sheets

F.1 General

This annex provides the details of the apparatus and test procedure required to determine the moisture movement characteristic of fibre-cement sheets.

F.2 Principle

The lengths of sheet specimens, conditioned in air at the prescribed temperature and relative humidity, are measured when a steady weight condition is achieved. The specimens are then exposed to a higher relative humidity until a second steady weight condition is reached. The change in length which occurs is measured.

F.3 Apparatus

F.3.1 Conditioning chamber, ventilated and capable of maintaining a temperature of (23 ± 2) °C at relative humidities of either (30 ± 2) % or (90 ± 5) % with a full load of specimens.

F.3.2 Balance, accurate to within 0,1 % of the specimen mass.

F.3.3 Measuring device, metal, of sufficient length to measure the length of the specimen to an accuracy of 0,02 mm.

F.4 Specimen preparation

Prepare specimens to conform with the dimensional requirements of the referring standard (see 7.3.3.3) and condition samples prior to testing (see 7.3.3.4).

F.5 Test procedure

a) Remove specimens from the conditioning chamber and measure their lengths and weights. Record the values.

b) Replace specimens in the conditioning chamber, increase humidity to (90 ± 5) %, maintaining temperature at (23 ± 2) °C.

c) When specimens have reached a steady-state condition (i.e. weight gain or loss in any 24 h period does not exceed 0,1 % of specimen mass), reweigh specimens and measure their lengths. Record the values.

F.6 Calculation of results

The linear, L_m, expressed as a percentage, due to a change in the moisture, is calculated from Formula (F.1):

$$\% = \frac{(L_{90} - L_{30}) \times 100}{L_{30}} \quad \text{(F.1)}$$

where

L_{90} is the measured specimen length at 90 % relative humidity;

L_{30} is the measured specimen length at 30 % relative humidity.

F.7 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the measured values from the tests;

g) the calculated value of percentage moisture movement;

h) the date of the test.

Annex G
(normative)

Test method for the determination of water permeability of fibre-cement sheets

G.1 General

This annex provides details of the test procedure and apparatus required to determine that sheets of fibre cement comply with the water permeability requirements of this document (see 5.6.5).

G.2 Principle

A specified depth of water is applied to the upper face of a horizontally positioned sheet specimen for a prescribed period of time. Compliance with the requirement stated in 5.6.5 is determined by visual examination of the test specimen at the end of the prescribed time period.

G.3 Apparatus: Frame sealed on top of the sheet specimen

For small-sized sheets, the frame shall be 50 mm less than the length and width of the sheet. For large-sized sheets, the frame dimensions shall be 600 mm × 500 mm. A narrow frame of the same length shall be used for narrow sheets.

G.4 Test procedure

a) Place and seal the frame to the top face of the sheet and position so that sheet face is horizontal.

b) Fill the frame with water to a height of 20 mm above the sheet face.

c) Place the specimen in ambient laboratory conditions so that the underside of the sheet can be viewed without moving the specimen during the test.

d) After 24 h, examine the under face for the presence of water drops. Report the visual condition of the specimen.

G.5 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the visual condition of the test specimen at the conclusion of the test;

g) the date of the test.

Annex H
(normative)

Test method for the evaluation of freeze-thaw performance of fibre-cement sheets

H.1 General

This annex provides the details of the apparatus and test procedure required to evaluate the freeze-thaw performance of fibre-cement sheets.

H.2 Principle

Paired fibre-cement sheet specimens are taken from sample sheets. One of each specimen pair is subjected to a number of test cycles comprising a period of immersion in warm water followed by freezing. A comparison of the bending strengths of the specimens exposed to freeze-thaw test cycling to the unexposed specimens is made.

H.3 Apparatus

The apparatus shall include the following items.

H.3.1 Freezer unit, having forced-air circulation, with an air temperature control capable of reaching the temperature specified in H.4 d) within 1 h to 2 h with a full load of specimens.

H.3.2 Water bath, with water at a temperature of (20 ± 4) °C. The water in the water bath shall be saturated with soluble salts derived from fibre-cement sheets.

H.3.3 Test equipment, for determining the bending strength (see Annex D).

H.4 Test procedure

a) Divide the sheet specimen pairs (see 7.3.7.2) to form two sets of 10 specimens each.

b) Condition one set of 10 specimens to the appropriate sheet category type test conditioning requirements as specified in Table 11. Following the conditioning period, determine the bending strengths of these specimens according the test method given in Annex D. Record the results.

c) Immerse the second set of 10 specimens in a water bath at ambient temperature (>5 °C) for 48 h.

d) Remove samples from the water bath and commence the freeze-thaw test cycle. A freeze-thaw cycle shall consist of:

   1) cooling in air to (–20 ± 2) °C in not less than 1 h and not more than 2 h; the specimens shall be held at that temperature for 1 h;

   2) thawing in water to reach (20 ± 2) °C within 1 h to 2 h maximum; the specimens shall be maintained in water at (20 ± 2) °C before recommencement of the cycle.

   An interval between cycles of up to 72 h is permissible. During such an interval, specimens should be stored in warm conditions above 20 °C.

An alternative method, in which the saturation of the specimen during cycling is ensured by sealing the saturated specimens in plastic bags, may be used where suitable automatic equipment for the preferred method is not available.

e) Repeat d) for the prescribed number of freeze-thaw cycles appropriate for the category of sheet being tested. The value of the ratio, R_L, of the lower estimate mean values of the modulus of ruptures for the exposed and unexposed specimens shall be determined for category A sheets after 100 freeze-thaw cycles and for category B sheets after 25 freeze-thaw cycles.

f) When e) has been completed, condition immersed specimens to the appropriate sheet category type test conditioning requirements as specified in Table 11, then determine the bending strengths of these specimens according the test method given in Annex D. Record the results.

NOTE During the cooling and heating (freezing and thawing) cycles, position the specimens to allow the circulation of the heat conducting medium (i.e. air or water) around them.

H.5 Calculation of results

For each pair of specimens i (i = 1 to 10), calculate the individual ratio, MOR_i, as given by Formula (H.1):

$$MOR_i = \frac{MOR_{fi}}{MOR_{fci}} \quad \text{(H.1)}$$

where

MOR_{fi} is the modulus of rupture of the i^{th} specimen after freeze-thaw cycling;

MOR_{fci} is the modulus of rupture of the i^{th} reference specimen (from the first batch).

Calculate the average, R, and standard deviation, s, of the individual ratio, MOR_i.

Calculate the lower estimation, R_L, of the mean of the ratios at 95 % confidence level (see ISO 2602) using Formula (H.2):

$$R_L = R - 0{,}58s \quad \text{(H.2)}$$

H.6 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the break load of the specimens;

g) the calculated values of the modulus and the modulus of rupture ratios and the lower estimate of the mean ratios at 95 % confidence level of the modulus of rupture of the freeze-thaw and reference specimens;

h) the date of the test.

Annex I
(normative)

Test method for the evaluation of heat-rain performance of fibre-cement sheets

I.1 General

This annex provides the details of the apparatus and test procedure required to evaluate the heat-rain performance of fibre-cement sheets.

I.2 Principle

Sample sheets are fixed to a framing system to simulate a typical sheet installation system. One side of the test assembly is subjected to a number of test cycles comprising a water spray and radiant heating. A visual assessment of the sheet performance is made.

I.3 Apparatus

I.3.1 Framing system, to which sheets can be fixed in a vertical position.

Spacing of framing members and type of material used shall be specified by the manufacturer (see I.4).

I.3.2 Water spray system, capable of completely wetting the sheet faces, having a water flow rate of approximately 1 l/m^2/min.

I.3.3 Device, capable of heating and uniformly maintaining the surface of the test elements conforming to the following.

a) The heating device shall be controlled via a black body sensor positioned in the central area of the test rig where the maximum temperature is expected.

b) The temperature at the sensor location shall be maintained at (60 ± 3) °C and this temperature shall be reached within 15 min of the commencement of heating.

c) The difference between the black body temperature in the centre of the rig and the edges of the rig shall not exceed 15 °C.

I.3.4 Control system, capable of providing test cycles complying with Table I.1.

I.4 Framing and fixing requirements

I.4.1 Frame requirements

The frame construction shall include at least one joint in the central region and allow for standard size sheet fixing.

The frame shall provide a minimum area of 3,5 m^2 and a maximum area of 12 m^2, shall allow vertical orientation of the sheets and shall allow for the installation of at least two sheets.

I.4.2 Specimen requirements

Where the sheet specimen is greater than 1,8 m^2, two sheets may be used.

Where the sheet specimen is not greater than 1,8 m^2, there shall be sufficient sheets to cover an area of at least 3,5 m^2.

NOTE If the combined area of the specimens is 12 m^2, the sheet length can be reduced to provide a test area of not more than 12 m^2.

I.5 Test procedure

a) Assemble the test rig in accordance with the manufacturer's recommendations.

b) Subject the assembled frame to the water spray and drying cycle given in Table I.1.

Table I.1 — Heat-rain cycle

Cycles	Duration
Water spray	2 h 50 min ± 5 min
Pause	5 min to 10 min
Radiant heat	2 h 50 min ± 5 min
Pause	5 min to 10 min
Total cycle	5 h 55 min ± 15 min

c) Repeat step b) for the prescribed number of cycles appropriate to the category of sheet. Assemblies made with category A sheets shall be tested for 50 heat-rain cycles. Assemblies made with category B sheets shall be tested for 25 heat-rain cycles.

d) Visually inspect the test assembly and record its condition.

I.6 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the visual condition of the test specimen at the conclusion of the test;

g) the date of the test.

Annex J
(normative)

Test method for warm water evaluation of fibre-cement sheets

J.1 General

This annex provides the test procedure and apparatus required to perform the warm water evaluation test for fibre-cement sheets.

J.2 Principle

Paired fibre-cement sheet specimens are taken from sample sheets. One of each specimen pair is subjected to a period of immersion in warm water. A comparison of the strength of the warm water immersed specimens with the un-immersed specimens is made.

J.3 Apparatus

J.3.1 Water bath, capable of being controlled to (60 ± 3) °C.

The water in the water bath shall be saturated with soluble salts derived from the fibre-cement sheets.

J.3.2 Test equipment, for determining the bending strength (see Annex D).

J.4 Test procedure

a) Divide the sheet specimen pairs (see 7.3.7.2) to form two sets of 10 specimens each.

b) Condition one set of 10 specimens to the appropriate sheet category type test conditioning requirements as specified in Table 11. Following the conditioning period, determine the bending strengths of these specimens according to the test method given in Annex D. Record the results.

c) Immerse the second set of 10 specimens in the water bath at a temperature of (60 ± 3) °C for a period of (56 ± 2) d.

d) When step c) has been completed, condition immersed specimens to the appropriate sheet category type test conditioning requirements given in Table 11. Then determine the bending strengths of these specimens in accordance with the test method given in Annex D. Record the results.

J.5 Calculation of results

For each pair of specimens i (i = 1 to 10), calculate the individual ratio MOR_i, as given in Formula (J.1):

$$MOR_i = \frac{MOR_{fi}}{MOR_{fci}} \quad \text{(J.1)}$$

where

MOR_{fi} is the modulus of rupture of the i^{th} specimen after freeze-thaw cycling;

MOR_{fci} is the modulus of rupture of the i^{th} reference specimen (from the first batch).

Calculate the average, R, and standard deviation, s, of the individual ratio, MOR_i.

Calculate the lower estimation, R_L, of the mean of the ratios at 95 % confidence level (see ISO 2602) as given in Formula (J.2):

$$R_L = R - 0{,}58s \quad \text{(J.2)}$$

Record the result.

J.6 Test Report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the break loads of the specimens;

g) the calculated values of the modulus and the modulus of rupture ratios and the lower estimate of the mean ratios at 95 % confidence level of the modulus of rupture of immersed and reference specimens;

h) the date of the test.

Annex K
(normative)

Test method for soak-dry evaluation test of fibre-cement sheets

K.1 General

This annex provides the details of the apparatus and test procedure required to perform the soak-dry evaluation test for fibre-cement sheets.

K.2 Principle

Paired fibre-cement sheet specimens are taken from sample sheets. One of each specimen pair is subjected to a number of test cycles comprising a period of immersion in warm water and drying in an oven. A comparison of the bending strengths of the specimens exposed to soak-dry test cycling to the unexposed specimens is made.

K.3 Apparatus

K.3.1 Oven, ventilated and capable of maintaining a temperature of (60 ± 3) °C at a relative humidity of less than 20 % with a full load of specimens.

K.3.2 Water bath, with water at ambient temperature (>5 °C). The water in the water bath should be saturated with soluble salts derived from the fibre-cement sheets.

K.3.3 Test equipment, for determining the bending strength (see Annex D).

K.4 Test procedure

a) Divide the sheet specimen pairs (see 7.3.7.2) to form two sets of 10 specimens each.

b) Condition one set of 10 specimens to the appropriate sheet category type test conditioning requirements specified in Table 11. Following the conditioning period, determine the bending strengths of these specimens in accordance with the test method given in Annex D. Record the results.

c) Immerse the second set of 10 specimens in the water bath and commence the soak-dry test cycle. A soak-dry test cycle shall consist of:

   1) immersion in water at ambient temperature (>5 °C) for 18 h;

   2) drying in a ventilated oven at (60 ± 3) °C and a relative humidity of less than 20 % for 6 h. The 20 % humidity shall be achieved for at least 3 h prior to the conclusion of the drying period.

   If necessary, an interval of up to 72 h between cycles is allowed. During this interval, specimens shall be stored in immersed conditions.

d) Repeat step c) for the prescribed number of soak-dry cycles appropriate for the category of sheet being tested.

The value of the ratio, R_L, of the lower estimate mean values of the modulus of ruptures for the exposed and unexposed specimens shall be determined for category A sheets after 50 soak-dry cycles and for categories B and C sheets after 25 soak-dry cycles.

e) When step d) has been completed, condition the immersed specimens to the appropriate sheet category type test conditioning requirements specified in Table 11. Determine the bending strengths of these specimens in accordance with the test method given in Annex D. Record the results.

K.5 Calculation of results

For each pair of specimens i (i = 1 to 10), calculate the individual ratio, MOR_i, as given in Formula (K.1):

$$MOR_i = \frac{MOR_{fi}}{MOR_{fci}} \quad \text{(K.1)}$$

where

MOR_{fi} is the modulus of rupture of the i^{th} specimen after freeze-thaw cycling;

MOR_{fci} is the modulus of rupture of the i^{th} reference specimen (from the first batch).

Calculate the average, R, and standard deviation, s, of the individual ratio, MOR_i.

Calculate the lower estimation, R_L, of the mean of the ratios at 95 % confidence level (see ISO 2602) as given in Formula (K.2):

$$R_L = R - 0{,}58s \quad \text{(K.2)}$$

K.6 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 8336;

b) all details necessary for complete identification of the batch of sheets from which the sample sheet was taken;

c) the dimensions of the test specimens;

d) test equipment details;

e) the test temperature and condition of the test piece;

f) the break load of the specimens;

g) the calculated values of the modulus and the modulus of rupture ratios and the lower estimate of the mean ratios at 95 % confidence level of the modulus of rupture of the soak dry and reference specimens;

h) the date of the test.

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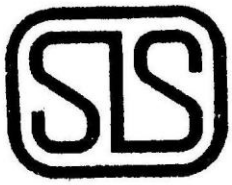

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