BS EN 12467:2012+A2:2018

BSI Standards Publication

# Fibre-cement flat sheets - Product specification and test methods

# National foreword

This British Standard is the UK implementation of EN 12467:2012+A2:2018. It supersedes BS EN 12467:2012+A1:2016, which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CEN text carry the number of the CEN amendment. For example, text altered by CEN amendment A1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee B/542/4, Fibre reinforced cement sheeting for roofing.

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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**Compliance with a British Standard cannot confer immunity from legal obligations.**

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# EN 12467:2012+A2

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English Version

# Fibre-cement flat sheets - Product specification and test methods

Plaques planes en fibres-ciment - Spécifications du produit et méthodes d'essai

Faserzement-Tafeln - Produktspezifikation und Prüfverfahren

This European Standard was approved by CEN on 24 November 2015 and includes Amendment 2 approved by CEN on 9 November 2017.

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## European foreword

This document (EN 12467:2012+A2:2018) has been prepared by Technical Committee CEN/TC 128 "Roof covering products for discontinuous laying and products for wall cladding", the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2018, and conflicting national standards shall be withdrawn at the latest by January 2020.

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

This document includes Amendment 1, approved by CEN on 24 November 2015 and Amendment 2, approved by CEN on 9 November 2017.

This document supersedes [A2] EN 12467:2012+A1:2016 [/A2].

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1] [/A1] and [A2] [/A2].

[A1] In comparison with EN 12467:2004, the following sections in EN 12467:2012 had been changed or added: [/A1] 3.9, 3.10, 4, 5.1.1, 5.4.3, 5.4.4, Table 7, Table 8, 7.3.2, 7.3.2.4.2, 7.3.3.3, 7.3.3.4, 7.3.7, 7.5.2.2 and Annex C.

Annex ZB concerning the EC Directive 76/769/EEC [A1] had been deleted [/A1].

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

For relationship with [A2] EU Regulation No 305/2011 [/A1], see informative Annex ZA, which is an integral part of this document.

A distinction [A1] had been made [/A1] between product appraisal (type tests) and factory production control requirements (acceptance tests).

The performance of a building part constructed with these sheets depends not only on the properties of the product as required by this document, but also on the design, construction and installation of the component as a whole in relation to the environment and conditions of use.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# 1 Scope

This European Standard specifies the technical requirements and establishes methods of inspection and test as well as acceptance conditions for fibre-cement flat sheets, siding shingles and planks (referred to as sheets later in this document) for one or more of the following uses:

— internal wall and ceiling finishes;

— external wall and ceiling finishes.

Products covered by this European Standard can be used for other purposes provided they comply with the relevant application standard, e.g. rigid underlays.

This European Standard covers sheets reinforced with fibres of different types as specified in 5.1.1.

This European Standard does not cover sheets for fire protection purposes.

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

# 2 Normative references

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

EN 197-1, *Cement — Part 1: Composition, specifications and conformity criteria for common cements*

EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire tests*

EN 13823, *Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item*

EN ISO 1716, *Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value) (ISO 1716)*

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

ISO 2602, *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*

# 3 Terms and definitions

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

**3.1**
**acceptance test**
test to establish whether a batch of sheets conforms to a specification and which is performed on samples drawn either from continuous production or from a consignment

Note 1 to entry: Test methods, specifications and limit values are specified in this document. Sampling levels and acceptance criteria are specified in 6.3.2.

**3.2**
**initial 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 ⟩A2⟨ manufacturing process ⟩A2⟨, 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)**
quality level which in a sampling plan corresponds to a specified, relatively high probability of acceptance

Note 1 to entry: It is the maximum percent defective (or maximum number of defects per 100 units) that for purposes of sampling inspection can be considered satisfactory as a process average.

Note 2 to entry: A sampling scheme with an AQL of 4 % means that batches containing up to 4 % defective items have a high probability of acceptance.

**3.4**
**apparent density**
density based on the external dimensions of the sample to calculate the volume

Note 1 to entry: This is an average density of material and pores.

**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 upper face

**3.8**
**textured sheets**
sheets which have a relief pattern embossed or applied as a coating on their upper face before delivery

**3.9**
**NT**
type of fibre-cement flat sheets which cover products made using a non-asbestos technology

**3.10**
**ambient laboratory conditions**
ambient laboratory conditions which are a temperature of (23 ± 5) °C and a relative humidity of (50 ± 20) %

## 4 Symbols and abbreviations

| | |
|---|---|
| $a$ | nominal length or width of the sheet |
| $b$ | 1. dimension of the specimen (length or width) measured parallel to the test machine supports, in millimetres<br>2. one of the coefficients of the regression line (see Annex B) |
| $d$ | apparent density of the sheet in grams per cubic centimetre |
| $e$ | thickness of the sheet, in millimetres |
| $F$ | breaking load, in newtons |
| $l$ | length, in millimetres |
| $l_S$ | span between the centres of the test machine supports in the bending strength test, in millimetres |
| $m$ | mass of the specimen after drying, in grams |
| $n$ | number of paired specimens |
| $MOE$ | modulus of elasticity, in Gigapascals or megapascals |
| $MOR$ | modulus of rupture, in megapascals |
| $MOR_{fi}$ | modulus of rupture of the $i^{th}$ exposed specimen after the type test |
| $MOR_{fci}$ | modulus of rupture of the $i^{th}$ unexposed reference specimen |
| $MR_i$ | individual ratio of the modulus of rupture of the $i^{th}$ pair of exposed and unexposed 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 |
| $\mu$ | water vapour resistance value |
| $V$ | volume of the specimen, in cubic centimetres |

$w$ width, in millimetres

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

$x_{std}$ minimum value to be used as the specification for the dry method of test. This value is calculated at the 97,5 % lower confidence level from the value specified for the wet method of test in this document (see B.5)

$y_{std}$ minimum value specified in the standard for wet testing (see B.5)

$x_o$ actual result obtained when dry testing (see B.4)

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

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

$y_o$ 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 (see B.4)

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

# 5 Requirements

## 5.1 General

### 5.1.1 Composition

Sheets shall consist essentially of cement or a calcium silicate formed by a chemical reaction of a siliceous and a calcareous material, reinforced by fibres. The cement shall comply with EN 197-1 or with technical specifications relevant in the country of use. A2 The cement shall comply with EN 197-1 or an agreed technical specification relevant in the country of use provided the cement compound composition is in accordance with EN 197-1. A2

This European Standard covers fibre-reinforced cement flat sheets of type NT. The reinforcing fibres shall be one or more of the following forms:

— discrete elements randomly dispersed;

— continuous strands or tapes;

— nets or webs.

Process aids, fillers, aggregates and pigments may be added.

### 5.1.2 Appearance and finish

The exposed face of the sheets can be with or without texture. The sheets can be coloured or left in their natural colour. The sheets can also receive adherent coloured or uncoloured coatings on their surface. Variations of the surface appearance which do not impair the fitness for purpose of the sheets are permitted.

The sheets may be supplied with holes for fixing and/or cut to size.

## 5.2 Classification

### 5.2.1 General

Sheets covered by this document are divided into:

— four categories in accordance with their weather resistance (see 5.2.2 to 5.2.5);

— five classes in accordance with their bending strength (see 5.4.3);

— two groups of sizes in accordance with their method of installation (see 5.2.6);

— two levels in accordance with their dimensional tolerances (see 5.3.4).

Type tests for each category are specified in Table 7.

### 5.2.2 Category A

Sheets which are intended for applications where they may be subjected to heat, high moisture and severe frost.

### 5.2.3 Category B

Sheets which 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.

### 5.2.4 Category C

Sheets which are intended for internal applications, where they may be subjected to heat and moisture, but not to frost.

### 5.2.5 Category D

Sheets for rigid underlayer applications.

### 5.2.6 Groups of sizes

#### 5.2.6.1 Small size sheets

Sheets for which the method of installation includes horizontal overlap. Their dimensions are generally such that their area is < 0,4 $m^2$ and have a length/width relation ≤ 3.

#### 5.2.6.2 Large size sheets

Sheets which do not correspond to indicators for small size sheets. Large sheets may be declared as "small size sheets" provided tolerances for small size sheets apply and are specified in the manufacturer's literature.

## 5.3 Dimensions and tolerances

### 5.3.1 General

There are two levels of tolerances for length, width, straightness and squareness of edges. Sheets shall comply with the requirements of the same level for the four sets of tolerances.

### 5.3.2 Nominal length and width

The manufacturer shall specify the nominal length and width of the sheets.

NOTE Sheets are normally available in nominal lengths up to 3 000 mm and nominal width up to 1 250 mm. Greater nominal lengths and widths can be supplied.

### 5.3.3 Thickness

The manufacturer shall specify the nominal thickness 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 1 The nominal thickness of textured sheets cannot be used for the calculation of mechanical performance.

Sheets are normally available in thickness from 3 mm to 30 mm.

NOTE 2 Thicker sheets can be supplied.

### 5.3.4 Tolerances on nominal dimensions[1)]

#### 5.3.4.1 Tolerances on length and width

Tolerances on length and width shall be in accordance with Table 1, for the appropriate level.

**Table 1 — Tolerances on nominal dimensions in accordance with value and level**

| Nominal dimension $a$[a] | Level I | Level II |
|---|---|---|
| $a \leq 600$ mm | ± 3 mm | ± 4 mm |
| 600 mm < $a \leq 1\,000$ mm | ± 3 mm | ± 5 mm |
| 1 000 mm < $a \leq 1\,600$ mm | ± 0,3% $a$ | ± 0,5% $a$ |
| 1 600 mm < $a$ | ± 5 mm | ± 8 mm |
| [a] $a$ is the nominal width or length. | | |

These tolerances are not applicable to oversize sheets.

The method of measurement is given in 7.2.3.1.

#### 5.3.4.2 Tolerances on thickness

For non-textured sheets, tolerances shall be in accordance with Table 2.

**Table 2 — Tolerances on thickness for non-textured sheets**

| | |
|---|---|
| $e \leq 6$ mm | ± 0,6 mm |
| 6 mm < $e \leq 20$ mm | ± 10 % $e$ |
| $e > 20$ mm | ± 2 mm |

For sheets without texture, the maximum difference between extreme values of the thickness measurements within one sheet shall not exceed 10 % of the maximum measured value.

For textured sheets, tolerances shall be in accordance with Table 3.

1) For certain applications, tighter tolerances could be demanded.

**Table 3 — Tolerances on thickness for textured sheets**

| | |
|---|---|
| $e \leq 6$ mm | - 0,6 mm + 0,9 mm |
| 6 mm < $e \leq 20$ mm | - 10 % $e$ + 15 % $e$ |
| $e > 20$ mm | - 2 mm + 3 mm |

For textured sheets, the maximum difference between extreme values of the eight thickness measurements within one sheet shall not exceed 15 % of the maximum measured value.

The method of measurement is given in 7.2.3.2.

### 5.3.5 Tolerances on shape[2)]

#### 5.3.5.1 Straightness of edges

Tolerances are applicable only to large size sheets.

The tolerances on the straightness of edges are defined as a percentage of the length of the edge of the relevant dimensions (length or width), and shall be in accordance with Table 4 for the appropriate level.

**Table 4 — Tolerances on straightness of edges**

| Level I | Level II |
|---|---|
| 0,1 % | 0,3 % |

The method of measurement is given in 7.2.3.3. These tolerances are not applicable for oversize sheets.

#### 5.3.5.2 Squareness of edges

The tolerances on squareness of sheets shall be in accordance with Table 5 for the appropriate level.

**Table 5 — Tolerances on squareness of edges**

| Level I | Level II |
|---|---|
| 2 mm/m | 4 mm/m |

The method of measurement is given in 7.2.3.4.

These tolerances are not applicable for oversize sheets.

## 5.4 Physical requirements and characteristics

### 5.4.1 General

Mechanical and material properties are normally determined on sheets as delivered. The results shall be identified as applying to coated or uncoated material.

NOTE See Annex B for statistic interpretation.

2) For certain applications, tighter tolerances are demanded and should be agreed on between the manufacturer and the purchaser.

### 5.4.2 Apparent density

The manufacturer shall specify in his literature the minimum apparent density for each category and each class of sheet. When tested in accordance with the method specified in 7.3.1, the density shall be not less than this value.

### 5.4.3 Moisture movement

The manufacturer's literature shall state the percentage value of linear 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 7.3.7 using the test method given in Annex C.

### 5.4.4 Mechanical characteristics – Bending strength (*MOR*) – Modulus of elasticity (*MOE*)

When tested as specified in 7.3.2, the minimum modulus of rupture of the sheets, expressed in megapascals, shall be as specified in Table 6. The *MOR* shall be the average of the values obtained from testing the samples in both directions.

NOTE For non-homogeneous e.g. coated sheets, Table 6 refers to the apparent *MOR.*

Category A and B sheet strengths are specified in the wet condition (see Table 10).

Category C and D sheet strengths are specified in the ambient condition (see Table 10).

The manufacturer shall specify the characteristic value for mechanical strength. Characteristic values of bending strength are based on statistical data on results of tests in ambient conditions. The statistical interpretation of test results is based on the procedure prescribed in EN 1990:2002, *Eurocode — Basis of structural design*, Table D.1, $V_{x,\,unknown}$).

If a correlation has been established (see Annex B) between the *MOR* from production control and the *MOR* from products as delivered, the k-value of $V_{x,known}$ can be used. The minimum modulus of rupture of the sheets in the weaker direction shall be not less than 70 % of the specified value in Table 6 for the average of the two directions. This requirement does not apply to textured sheets.

The modulus of elasticity of the sheets, expressed in Giga- or Megapascals, shall be specified on test results of tests in ambient conditions. The *MOE* shall be the average of the values obtained from testing the sampling in both directions with indication of the standard deviation.

It is up to the manufacturer to determine the *MOE* for information purposes, i.e. with type testing.

**Table 6 — Minimum modulus of rupture (*MOR*)**

| min. *MOR* in the wet condition MPa | | min. *MOR* in the ambient laboratory conditions MPa | |
|---|---|---|---|
| *Classes* | Category A & B | *Classes* | Category C & D |
| 1 | 4 | 1 | 4 |
| 2 | 7 | 2 | 7 |
| 3 | 13 | 3 | 10 |
| 4 | 18 | 4 | 16 |
| 5 | 24 | 5 | 22 |
| Where manufacturers state minimum product *MOR* this should be at the 4 % acceptable quality level (AQL). NOTE For textured sheets, the *MOR* cannot be used for calculating mechanical performance. | | | |

#### 5.4.5 Water impermeability for Categories A, B and D

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

#### 5.4.6 Water vapour permeability for Category D

For flat sheets used as rigid underlays, the water vapour resistance value $\mu$ shall be determined according to 7.3.4 and shall be specified in the manufacturer's literature.

The $\mu$ value obtained from the test shall not be higher than the value specified by the manufacturer.

### 5.5 Durability requirements

#### 5.5.1 General

Mechanical and material properties are normally determined for sheets as delivered. The results shall be identified as applying to coated or uncoated material. The performance of the coating in the following tests shall not be considered in the assessment of the product.

#### 5.5.2 Freeze-thaw for Categories A, B and D

When tested in accordance with 7.4.1, after 100 freeze-thaw cycles for Category A and 25 cycles for Category B and D, the ratio $R_L$ as defined in 7.4.1.4 shall be not less than 0,75.

#### 5.5.3 Heat-rain for Categories A and B

When tested in accordance with 7.4.2, after 50 heat-rain cycles for Category A and 25 cycles for Category B, any visible cracks, delamination, warping and bowing or other defects in the sheets shall not be of such a degree as to affect their performance in use.

a) Water tightness is tested according to 5.4.4.

b) Warping and bowing are visually assessed.

#### 5.5.4 Warm water for Categories A, B, C and D

When tested in accordance with 7.3.5, after 56 days at 60 °C, the ratio $R_L$ as defined in 7.3.5.4 shall be not less than 0,75.

#### 5.5.5 Soak-dry for Categories A, B , C and D

When tested in accordance with 7.3.6, after 50 soak-dry cycles for Category A and 25 cycles for Categories B, C and D the ratio $R_L$ as defined in 7.3.6.4 shall be not less than 0,75.

### 5.6 Fire and safety

#### 5.6.1 Reaction to fire

When subject to regulatory requirements, the reaction to fire of the sheets shall be declared in accordance with 7.5.

### 5.6.2 Release of dangerous substances

〉A1〈 National regulations on dangerous substances may require verification and declaration on release, and sometimes content, when construction products covered by this standard are placed on those markets.

In the absence of European harmonized test methods, verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction web site on EUROPA accessed through:

http://ec.europa.eu/enterprise/construction/cpd-ds/. 〈A1〉

## 5.7 Product information

The manufacturer shall include the following in his literature:

a) designation of the sheet:

   1) type of product: NT (see 5.1.1);

   2) name of the sheet;

   3) category;

   4) class;

   5) level of tolerances.

b) nominal values for:

   1) thickness;

   2) length and width.

c) minimum apparent density;

d) instructions relevant to the handling and installation.

# 6 〉A1〈 Assessment and verification of constancy of performance — AVCP

## 6.1 General

The compliance of fibre-cement flat sheets with the requirements of this standard and with the performances declared by the manufacturer in the DoP shall be demonstrated by:

— determination of the product type;

— factory production control by the manufacturer, including product assessment.

The manufacturer shall always retain the overall control and shall have the necessary means to take responsibility for the conformity of the product with its declared performance(s).

## 6.2 Type testing

### 6.2.1 General

Type tests shall be carried out on products as delivered. If several formats or sizes of the same category and class are being produced from the same composition and by the same [A2] manufacturing process [A2], type tests only need to be carried out on maximum and minimum thickness. If the ratio of the maximum to minimum thickness is greater than three then an additional intermediate thickness shall be tested.

All characteristics listed in Table 8 shall be subject to product type determination, except reaction to fire Class A1 without testing. The type tests relevant for each category are listed in Table 7.

[A2] Testing of mechanical characteristics is normally carried out 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. [A2]

Product type determination shall be performed to demonstrate conformity to this standard. Tests previously performed in accordance with the provisions of this standard (same product, same characteristic(s), test method, sampling procedure, same attestation of conformity, etc.) may be taken into account. In addition, product type determination shall be performed for the approval of a new product, or a fundamental change in formulation or [A2] manufacturing process [A2], the effects of which cannot be predicted on the basis of previous experience.

Whenever a change occurs in the fibre-cement flat sheets design, the raw material or supplier of components or the [A2] manufacturing process [A2], which would change significantly one or more of the characteristics, the type test shall be performed for the appropriate characteristic(s).

**Table 7 — Type tests relevant to each category of sheet**

| | Category | | | |
|---|---|---|---|---|
| | **A** | **B** | **C** | **D** |
| Water impermeability | yes | yes | n.a. [a] | yes |
| Warm water | yes | yes | yes | yes |
| Soak-dry | 50 cycles | 25 cycles | 25 cycles | 25 cycles |
| Freeze-thaw | 100 cycles | 25 cycles | n.a. [a] | 25 cycles |
| Heat-rain | 50 cycles | 25 cycles | n.a. [a] | n.a. [a] |
| Water vapour permeability | n.a. [a] | n.a. [a] | n.a [a] | yes |
| Reaction to fire | yes | yes | yes | yes |
| Release of dangerous substances | yes | yes | yes | yes |

[a] Not applicable.

**Table 8 — Number of samples and compliance criteria**

| Characteristic | Requirement | Assessment method | Number of samples | Compliance criteria |
|---|---|---|---|---|
| Mechanical resistance | 5.4.4 | 7.3.2 | at least 10 samples | 5.4.4 Table 6 apply 4 % AQL |
| Density | 5.4.2 | 7.3.1 | Inspection by variable; method $\sigma$ or $s$ | 5.4.2 |
| Reaction to fire | 5.6.1 | 7.5.2 | 7.5.2 | 7.5 |
| Water impermeability | 5.4.5 | 7.3.3 | 3 test sheets | 5.4.5 |
| Water vapour permeability | 5.4.6 | 7.3.4 | 3 test sheets | 5.4.6 |
| Dimensional variations | 5.3 | 7.2 | at least 10 samples | 5.3.4 and 5.3.5 |
| Release of dangerous substances | 5.6.2 | 5.6.2 | | 5.6.2 |
| Warm water | 5.5.4 | 7.3.5 | 10 samples | 5.5.4 and 7.3.5.4 |
| Soak-dry | 5.5.5 | 7.3.6 | 10 samples | 5.5.5 and 7.3.6.4 |
| Freeze-thaw | 5.5.2 | 7.4.1 | 10 samples | 5.5.2 and 7.4.1.4 |
| Heat rain | 5.5.3 | 7.4.2 | 7.4.2.4 | 5.5.3 and 7.4.2.5 |

### 6.2.2 Test samples, testing and compliance criteria

The number of samples of fibre-cement flat sheets to be tested / assessed shall be in accordance with Table 8 of this standard.

### 6.2.3 Test reports

The results of the determination of the product type shall be documented in the test reports. All test reports shall be retained by the manufacturer for at least 10 years after the last date of production of the fibre-cement flat sheets to which they relate.

## 6.3 Factory production control (FPC)

### 6.3.1 General

The manufacturer shall establish, document and maintain a FPC system to ensure that the products placed on the market comply with the declared performance of the essential characteristics.

The FPC system shall consist of procedures, regular inspections and tests and/or assessments and the use of the results to control raw and other incoming materials or components, equipment, the A2 manufacturing process A2 and the product.

All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures.

This factory production control system documentation shall ensure a common understanding of the evaluation of the constancy of performance and enable the achievement of the required product performances and the effective operation of the production control system to be checked. Factory

production control therefore brings together operational techniques and all measures allowing maintenance and control of the compliance of the product with the declared performances of the essential characteristics.

### 6.3.2 Requirements

#### 6.3.2.1 General

The manufacturer is responsible for organizing the effective implementation of the FPC system in line with the content of this product standard. Tasks and responsibilities in the production control organization shall be documented and this documentation shall be kept up-to-date.

The responsibility, authority and the relationship between personnel that manages, performs or verifies work affecting product constancy, shall be defined. This applies in particular to personnel that need to initiate actions preventing product non-constancies from occurring, actions in case of non-constancies and to identify and register product constancy problems.

Personnel performing work affecting the constancy of performance of the product shall be competent on the basis of appropriate education, training, skills and experience for which records shall be maintained.

In each factory the manufacturer may delegate the action to a person having the necessary authority to:

— identify procedures to demonstrate constancy of performance of the product at appropriate stages;

— identify and record any instance of non-constancy;

— identify procedures to correct instances of non-constancy.

The manufacturer shall draw up and keep up-to-date documents defining the factory production control. The manufacturer's documentation and procedures should be appropriate to the product and manufacturing process. The FPC system should achieve an appropriate level of confidence in the constancy of performance of the product. This involves:

a) the preparation of documented procedures and instructions relating to factory production control operations, in accordance with the requirements of the technical specification to which reference is made;

b) the effective implementation of these procedures and instructions;

c) the recording of these operations and their results;

d) the use of these results to correct any deviations, repair the effects of such deviations, treat any resulting instances of non-conformity and, if necessary, revise the FPC to rectify the cause of non-constancy of performance.

NOTE Manufacturers having an FPC system, which complies with EN ISO 9001 and which addresses the provisions of the present European Standard are considered as satisfying the FPC requirements of the Regulation (EU) No 305/2011.

#### 6.3.2.2 Equipment

##### 6.3.2.2.1 Testing

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

#### 6.3.2.2.2 Manufacturing

All equipment used in the manufacturing process shall be regularly inspected and maintained to ensure use, wear or failure does not cause inconsistency in the manufacturing process. Inspections and maintenance shall be carried out and recorded in accordance with the manufacturer's written procedures and the records retained for the period defined in the manufacturer's FPC procedures.

#### 6.3.2.3 Raw materials and components

The specifications of all incoming raw materials and components shall be documented, as shall the inspection scheme for ensuring their compliance. In case supplied kit components are used, the constancy of performance system of the component shall be that given in the appropriate harmonized technical specification for that component.

#### 6.3.2.4 Traceability and marking

Fibre-cement flat sheets shall be identifiable and traceable with regard to their production origin. The manufacturer shall have written procedures ensuring that processes related to affixing traceability codes and/or markings are inspected regularly.

#### 6.3.2.5 Controls during manufacturing process

The manufacturer shall plan and carry out production under controlled conditions.

#### 6.3.2.6 Product testing and evaluation

The manufacturer shall establish procedures to ensure that the stated values of the characteristics he declares are maintained. The characteristics, and the means of control, for fibre-cement flat sheets are detailed in Table 9.

**Table 9 — Minimum sampling schemes**

| | |
|---|---|
| Length and width<br>Thickness<br>Straightness of edges<br>Squareness of edges | ISO 2859-1<br>Inspection by attribute<br>Double sampling<br>AQL 4 %<br>Level $S_1$ |
| Apparent density<br>Bending strength | ISO 3951-1<br>Inspection by variable; method $\sigma$ or $s$<br>AQL 4 %<br>Level $S_3$ |

The specification of acceptance tests apply to the product as delivered, but may be carried out at an earlier stage of maturity.

Sampling from continuous production testing

— on the base sheet prior to coating,

— in conditions other than in Table 10,

is acceptable provided that it has been statistically established (see Annex B) that compliance with the requirements given in Table 6 is ensured.

Acceptance tests can also be used to confirm that a batch of flat sheets conforms with the standard, e.g. in conjunction with type tests or for receiving inspection.

The tests include the:

— measurement of dimensions – length, width and thickness – (methods specified in 7.2);

— measurement of apparent density ( method specified in 7.3.1);

— measurement of mechanical characteristics–bending strength and bending modulus– (method specified in 7.3.2).

Each limit of specification, for the characteristics in Table 7, shall be subject to an AQL of 4 %. The sampling schemes provided in ISO 2859-1 and ISO 3951-1, with an AQL of 4 % and inspection levels S1 and $S_3$ respectively, ensure that for large batches approximately 95 % of the items fulfill the requirements.

**6.3.2.7 Non-complying products**

The manufacturer shall have written procedures which specify how non-complying products shall be dealt with. Any such events shall be recorded as they occur and these records shall be kept for the period defined in the manufacturer's written procedures.

Where the product fails to satisfy the acceptance criteria, the provisions for non-complying products shall apply, the necessary corrective action(s) shall immediately be taken and the products or batches not complying shall be isolated and properly identified.

Once the fault has been corrected, the test or verification in question shall be repeated.

The results of controls and tests shall be properly recorded. The product description, date of manufacture, test method adopted, test results and acceptance criteria shall be entered in the records under the signature of the person responsible for the control/test.

With regard to any control result not meeting the requirements of this European Standard, the corrective measures taken to rectify the situation (e.g. a further test carried out, modification of manufacturing process, disposal, recycle or correction of product) shall be indicated in the records.

**6.3.2.8 Corrective action**

The manufacturer shall have documented procedures that instigate action to eliminate the cause of non-conformities in order to prevent recurrence.

**6.3.2.9 Handling, storage and packaging**

The manufacturer shall have procedures providing methods of product handling and shall provide suitable storage areas preventing damage or deterioration.

**6.3.3 Product specific requirements**

The FPC system shall address this European Standard and ensure that the products placed on the market comply with the declaration of performance.

The FPC system shall include a product specific FPC, which identifies procedures to demonstrate compliance of the product at appropriate stages, i.e.:

a) the controls and tests to be carried out prior to and/or during manufacture according to a frequency laid down in the FPC test plan,

and/or

b) the verifications and tests to be carried out on finished products according to a frequency laid down in the FPC test plan

The manufacturer shall establish and maintain records that provide evidence that the production has been sampled and tested. These records shall show clearly whether the production has satisfied the defined acceptance criteria and shall be available for at least three years.

### 6.3.4 Initial inspection of factory and of FPC

Initial inspection of factory and of FPC shall be carried out when the [A2] manufacturing process [A2] has been finalised and in operation. The factory and FPC documentation shall be assessed to verify that the requirements of 6.3.2 and 6.3.3 are fulfilled.

During the inspection it shall be verified:

a) that all resources necessary for the achievement of the product characteristics included in this European Standard are in place and correctly implemented,

and

b) that the FPC-procedures in accordance with the FPC documentation are followed in practice,

and

c) that the product complies with the product type samples, for which compliance of the product performance to the DoP has been verified.

All locations where final assembly or at least final testing of the relevant product is performed, shall be assessed to verify that the above conditions a) to c) are in place and implemented. If the FPC system covers more than one product, production line or [A2] manufacturing process [A2], and it is verified that the general requirements are fulfilled when assessing one product, production line or [A2] manufacturing process [A2], then the assessment of the general requirements does not need to be repeated when assessing the FPC for another product, production line or [A2] manufacturing process [A2].

All assessments and their results shall be documented in the initial inspection report.

### 6.3.5 Continuous surveillance of FPC

Surveillance of the FPC shall be undertaken once per year. The surveillance of the FPC shall include a review of the FPC test plan(s) and [A2] manufacturing process(s) [A2] for each product to determine if any changes have been made since the last assessment or surveillance. [A2] The significance of any changes shall be assessed. [A2]

Checks shall be made to ensure that the test plans are still correctly implemented and that the production equipment is still correctly maintained and calibrated at appropriate time intervals.

The records of tests and measurements made during the [A2] manufacturing process [A2] and to finished products shall be reviewed to ensure that the values obtained still correspond with those values for the samples submitted to the determination of the product type and that the correct actions have been taken for non-compliant products.

### 6.3.6 Procedure for modifications

If modifications are made to the product, [A2] manufacturing process [A2] or FPC system that could affect any of the product characteristics declared according to this standard, then all the characteristics for which the manufacturer declares performance, which may be affected by the modification, shall be subject to the determination of the product type, as described in 6.2.1.

Where relevant, a re-assessment of the factory and of the FPC system shall be performed for those aspects, which may be affected by the modification.

All assessments and their results shall be documented in a report.

### 6.4 Inspection of a consignment of finished products

Inspection of a consignment of finished products is not a requirement of this standard but if, in special cases, it is demanded, it may be carried out in accordance with Annex A, ISO 2859-1 and ISO 3951-1. 〈A1▌

## 7 Test methods

### 7.1 General

This part of the document details both acceptance and initial type testing.

### 7.2 Dimensional and geometrical tests

#### 7.2.1 Preparation of specimen

##### 7.2.1.1 General

The test shall be performed on whole sheets as delivered and without conditioning.

##### 7.2.1.2 Small size sheets

Five randomly sampled sheets are tested.

##### 7.2.1.3 Large size sheets

One sheet is tested.

#### 7.2.2 Apparatus

**7.2.2.1** **Smooth, flat, rigid inspection surface**, of standard quality and of dimensions appropriate to the dimensions of the sheets.

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 may be used. The same requirements for straightness and angularity apply.

**7.2.2.2** **Suitable short metal rulers**, capable of being read to 0,5 mm.

**7.2.2.3** **Suitable metal tape,** capable of measuring the length of the sheet to an accuracy of 1 mm.

**7.2.2.4** **Micrometer,** reading at least to 0,1 mm, with flat parallel metal jaws between 10 mm and 15 mm in diameter.

#### 7.2.3 Procedure

##### 7.2.3.1 Measurement of length and width

##### 7.2.3.1.1 General

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

Take each reading to the nearest 1 mm.

#### 7.2.3.1.2 Small size sheets

For each dimension carry out two measurements on each sheet i.e. one at about 50 mm from either end.

#### 7.2.3.1.3 Large size sheets

For each dimension, carry out three measurements i.e. one in the middle and one at about 50 mm from either end.

### 7.2.3.2 Measurement of thickness

#### 7.2.3.2.1 Non-textured sheets

a) Carry out three measurements with a dial gauge, taking each reading to an accuracy of 0,1 mm.

   Report the individual results. Calculate the arithmetic mean and difference between extreme values. Assess the results against the tolerances given in 5.3.4.2.

   1) Small size sheets:

      Carry out two measurements on each sheet, approximately 20 mm from the edge in the middle of two adjacent sides of the sheet.

   2) Large size sheets:

      Carry out three measurements across the width at one end of the sheet as indicated in Figure 1.

Dimensions in millimetres

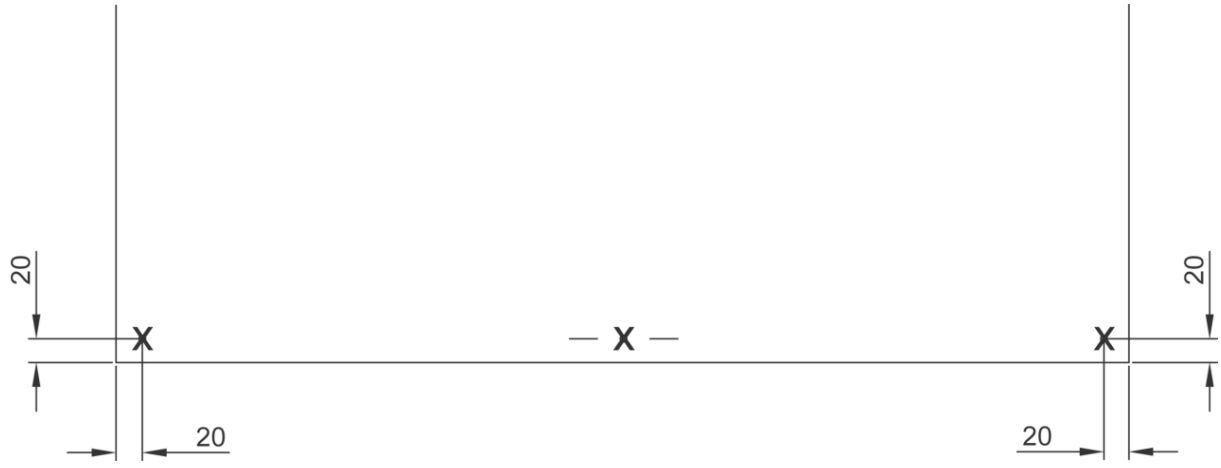



**Figure 1 — Measurement of thickness of large size non-textured sheets**

#### 7.2.3.2.2 Textured sheets

a) Carry out the measurements with a dial gauge, taking each reading to an accuracy of 0,1 mm.

   Report the individual results. Calculate the arithmetic mean of the measurements and the difference between extreme values.

   Assess the results against the tolerances given in 5.3.4.2.

The thickness obtained by this method shall not be used for calculation of *MOR* and density.

1) Small size sheets:

   Measure the maximum thickness in the middle of all four sides of each sheet between 20 mm and 50 mm from the edge.

2) Large size sheets:

   Measure the maximum thickness of each test sheet at the eight positions as shown in Figure 2 between 20 mm and 50 mm from the edge.

b) For calculation of *MOR* and density:

1) For embossed sheets and sheets with thin applied coating ≤ 0,5 mm, determine the thickness of specimens from volume measurement by water displacement using the formula:

$$e = \frac{1\,000 \times V}{I \times w}$$

where

*e* is the specimen thickness in millimetres;

*V* is the volume of fluid displacement in cubic centimetres;

*l* is the length in millimetres;

*w* is the width in millimetres.

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

2) For sheets with thick applied coating (> 0,5 mm), thickness is measured without the coating in accordance with 7.2.3.2.1.

Dimensions in millimetres

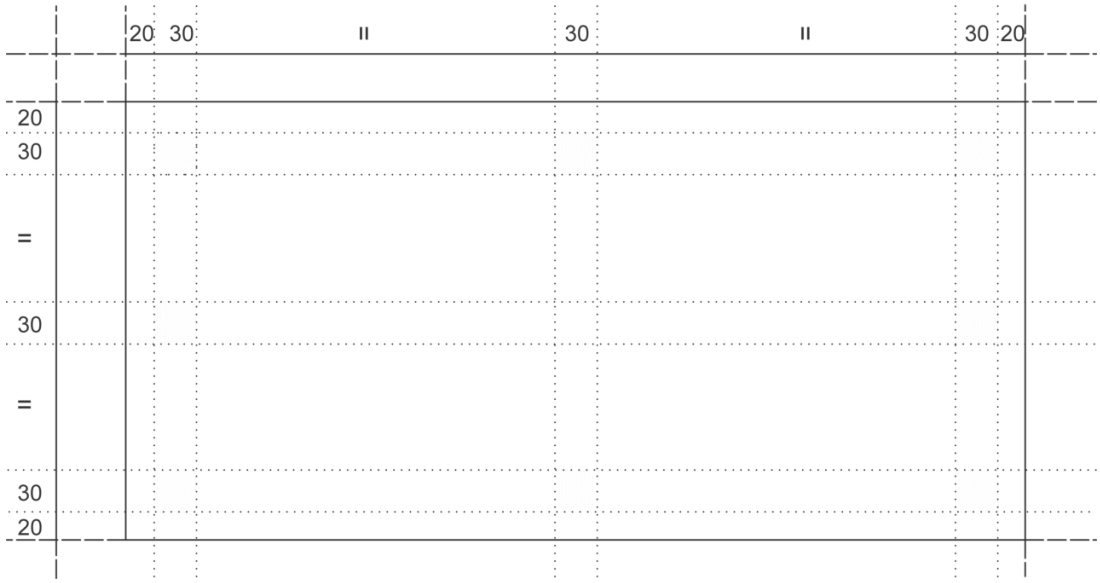



**Figure 2 — Measurement of thickness of large textured sheets**

### 7.2.3.3 Measurement of straightness of edges

For large size sheets, measure on all four edges the greatest distance between the edge of the sheet and a string or wire stretched from one corner of the panel to the adjacent corner with a steel rule capable of reading to an accuracy of 0,5 mm.

### 7.2.3.4 Measurement of out squareness of sheet

Place two adjacent corners of the sheets in succession between the arms of the square keeping one side against the full length of the large arm and the other side in contact with the small arm at least at 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. Report each result.

### 7.2.4 Expression and interpretation of results

| | |
|---|---|
| Length and width: | Each value shall comply with the tolerances specified in 5.3.4. |
| Thickness: | The average of the measurements shall be not less than the minimum specified by the manufacturer and shall comply with the tolerances specified in 5.3.4.2. |
| Straightness of edges: | Each result shall be not more than the tolerances given in 5.3.5.1, appropriate for the intended level. |
| Squareness of edges: | Each result shall be not more that the tolerances given in 5.3.5.2, appropriate for the intended level. |

## 7.3 Tests for physical performance and characteristics

### 7.3.1 Apparent density

#### 7.3.1.1 Preparation of specimen

The specimen shall preferably be a piece of a fibre-cement sheet used for the bending strength test.

#### 7.3.1.2 Apparatus

**7.3.1.2.1 Ventilated oven,** capable of achieving a temperature of 100 °C to 105 °C with a full load of specimens.

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

#### 7.3.1.3 Procedure

Determine the volume $V$ of the specimen by immersion in water or another method having an equivalent accuracy. In the case of immersion in water, the specimen shall be saturated in water beforehand.

Determine the mass $m$ of the specimen after drying it in a ventilated oven maintained at 100 °C to 105 °C for 24 h.

#### 7.3.1.4 Expression and interpretation of results

The apparent density is given by the formula:

$$d = \frac{m}{V}$$

where

$d$ is the apparent density in grams per cubic centimetres;

$m$ is the mass of the specimen after drying in grams;

$V$ is the volume of the specimen in cubic centimetres.

The result shall comply with the specification of 5.4.2.

### 7.3.2 Mechanical characteristics - Bending strength – Modulus of elasticity (Bending modulus)

#### 7.3.2.1 Preparation of specimens

##### 7.3.2.1.1 Shapes, dimensions of specimens and test span

The dimensions of specimens and test span shall be such that:

a) ratio span/nominal thickness is greater than or equal to 15;

b) ratio span/deflection at rupture is greater than or equal to 20;

c) length of specimens is greater than or equal to span plus 40 mm;

d) width of specimens is greater than or equal to five times the nominal thickness of specimens.

Specimens may be either square or rectangular.

The preferred dimensions of specimens are 250 mm x 250 mm.

The preferred span is 200 mm.

Where the preferred dimensions and span do not meet conditions a) to d), the dimensions and span shall be adjusted to meet those conditions.

The dimensions of specimens and test span may be changed from the preferred values provided the conditions a) to d) are fulfilled.

#### 7.3.2.1.2 Cutting

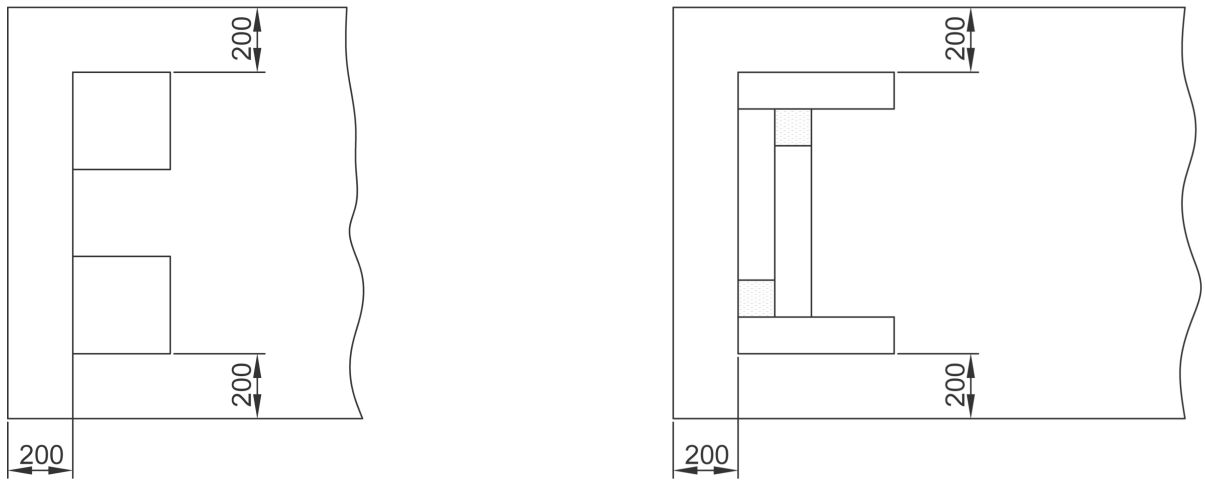
##### 7.3.2.1.2.1 Small size sheets

Five randomly sampled sheets are taken. For sheets smaller than 250 mm x 250 mm, whole sheets are tested; for larger sheets, one square test specimen of 250 mm x 250 mm is cut from each sheet.

##### 7.3.2.1.2.2 Large size sheets

The test specimens are cut from the same part of the sheet. One possible layout is shown in Figure 3 (the distance of 200 mm is indicative). Other cutting layouts may be used provided that an equal number of specimens are cut perpendicular and parallel to the manufacturing direction.

Dimensions in millimetres




Square specimens

Rectangular specimens

**Figure 3 — Cutting of specimens from large size sheets**

#### 7.3.2.1.3 Conditioning

Specimens shall be conditioned in accordance with Table 10.

**Table 10 — Conditioning**

| Test | Conditioning procedure |
|---|---|
| Acceptance test (wet)<br>Categories A & B | 24 h immersion in water for thickness ≤ 20 mm<br>48 h immersion in water for thickness > 20 mm |
| Acceptance test (ambient)<br>Categories C & D | Between 7 and 14 d in ambient laboratory conditions |
| Type test<br>Categories A, B & C | Prior to the bending test:<br>between 7 and 14 d in ambient laboratory conditions<br>followed by 24 h immersion in water for sheets with thickness <= 20 mm<br>or 48 h for thickness > 20 mm<br>The specimens shall be tested immediately upon removal from the water. |
| Type test<br>Category D | Between 7 and 14 d in ambient laboratory conditions |

### 7.3.2.2 Apparatus

**7.3.2.2.1 Bending test machine,** with a constant rate of deflection when applying the load (where this facility is not available a constant rate of loading is acceptable) and with an error of accuracy and an error of repeatability less than or equal to 3 % comprising:

**7.3.2.2.1.1 Two parallel horizontal supports,** one fixed and the second free to move in order to align with the specimen.

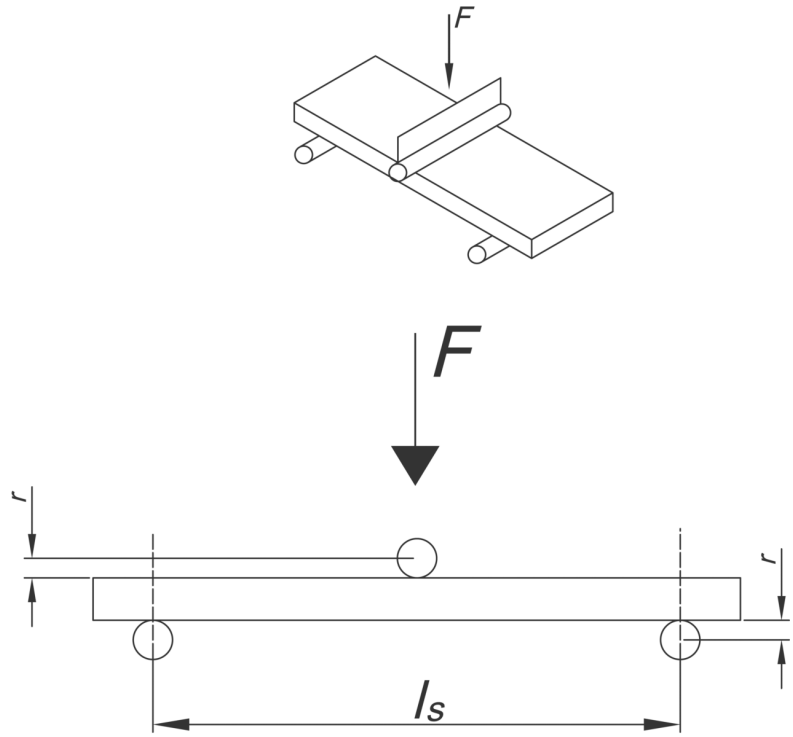
The upper face of each support shall be rounded with a radius between 3 mm and 25 mm. The distance $l_S$ between the supports shall be in accordance with 7.3.2.1.1 (see Figure 4).

**7.3.2.2.1.2 Loading bar,** having the same radius as the supports and located parallel and equidistant from them.

The loading bar shall be attached to the loading mechanism by means of a flexible joint.

The length of the supports and loading bar shall be at least equal to the width of the specimen.

**7.3.2.2.2 Micrometer,** reading to at least 0,1 mm with flat parallel metal jaws between 10 mm and 15 mm in diameter.




**Key**

*r* 3 mm to 25 mm

*F* breaking load

$l_s$ span between the centres of the test machine supports

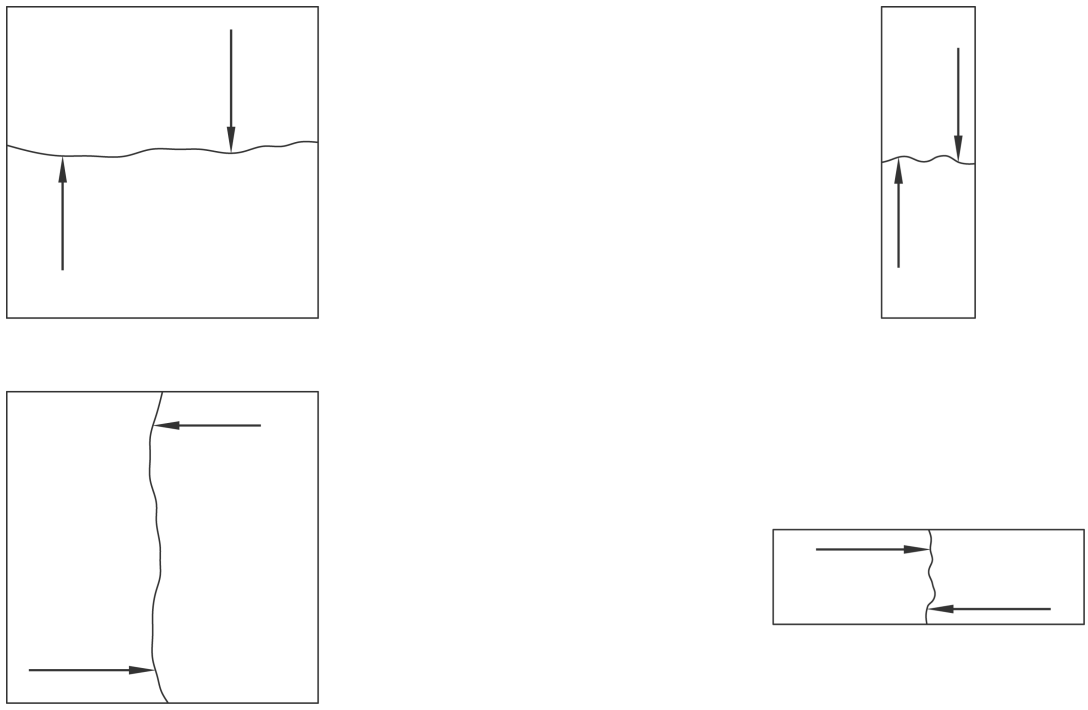
**Figure 4 — Bending test machine**

### 7.3.2.3 Procedure

Arrange the test piece with the under face against the supports and load the test piece by means of the central loading bar.

Load the specimen such that breakage occurs within 10 s and 30 s. A constant rate of deflection is preferred. Where this facility is not available, a constant rate of loading is acceptable.

For non-textured specimens, measure the thickness at two points, either before breaking along the loading line or after breaking along the broken edge as shown in Figure 5.



Square specimens

Rectangular specimens

**Figure 5 — Measurement of thickness of specimens**

For square specimens, re-assemble the broken pieces.

Submit the re-assembled specimens to a second bending test with the line of load application at right angles to that of the first test. Measure the thickness of the test piece at two points for smooth sheets along the new section of breakage as indicated in Figure 5.

Where rectangular specimens are used, the strengths in the two directions are obtained by testing each of the appropriate specimens (see Figure 5).

#### 7.3.2.4 Expression and interpretation of results

##### 7.3.2.4.1 Modulus of rupture *MOR*

The modulus of rupture *MOR*, in megapascals, for each breaking load direction is given by the formula:

$$MOR = \frac{3F\,l_s}{2be^2}$$

where

$F$ is the breaking load, in newtons;

$l_S$ is the span between the axes of supports, in millimetres;

$b$ is the width of the test piece, in millimetres;

$e$ is the thickness, in millimetres:

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

For face-textured sheets, it is calculated from the volume measured by water displacement.

The modulus of rupture of the sheet(s) shall be the arithmetic mean of minimum ten values (five in each direction). Assess the results against the specifications of 5.4.3.

The manufacturer shall specify the characteristic values for mechanical strength. Characteristic values of bending strength are based on statistical data on results of tests in ambient conditions on as delivered products.

#### 7.3.2.4.2 Modulus of elasticity *MOE*

Calculate the modulus of elasticity *MOE*, in Giga- or Megapascal, for each sample specimen and each breaking load direction by the following formula:

$$E = (F_2 - F_1) \times l_s^3 / 4be^3 \times (f_2 - f_1)$$

where

| | |
|---|---|
| $E$ | is the modulus of elasticity, in GPa or MPa; |
| $F_2$ *and* $F_1$ | are loads, taken from two points within the linear section of the plot, below the limit of proportionality; |
| $l_S$ | is the span between the axes of supports, in millimetres; |
| $b$ | is the width of the test piece, in millimetres; |
| $e$ | is the thickness, in millimetres; |
| $f_2$ *and* $f_1$ | are deflections corresponding to the loads selected, in millimetres. |

The modulus of elasticity of the sheet(*s*) shall be the arithmetic mean of minimum ten values (five in each direction).

### 7.3.3 Water impermeability

#### 7.3.3.1 Preparation of specimens

Three specimens shall be cut, i.e. one from each of three sheets. For large size sheets, those used to provide specimens for other type-tests may be used or other sheets may be taken.

Specimen dimensions shall be according to the actual size for small size sheets. For large size sheets, the dimensions shall be 600 mm x 500 mm minimum except for narrow sheets where the dimensions shall be 600 mm x the maximum possible width.

#### 7.3.3.2 Apparatus

**7.3.3.2.1 Suitable frame,** which shall be sealed on top of the specimen.

The frame dimensions for small size sheets shall be 50 mm less than the length and width of the sheets. For large size sheets, the frame dimension shall be 550 mm x 450 mm minimum. A narrow frame of the same length shall be used for narrow sheets.

#### 7.3.3.3 Specimen conditioning

The specimens shall be kept in ambient laboratory conditions for at least seven days.

#### 7.3.3.4 Procedure

Place and seal the frame on top of the face of the specimen and fill with water to a height of 20 mm above the face of the sheet. Place the specimens in ambient laboratory conditions so that the under face can be viewed without moving the specimen during the test. The duration of the test shall be 24 h.

#### 7.3.3.5 Expression and interpretation of results

Examine the under face after 24 h and verify that it conforms to the specification of 5.4.5.

### 7.3.4 Water vapour permeability

The determination of the water vapour resistance value $\mu$ shall be carried out according to EN ISO 12572, Condition C. Compare the results with the specifications of 5.4.5.

### 7.3.5 Warm water

#### 7.3.5.1 Preparation of specimens

Sample ten sheets as delivered by the producer. Cut ten sets of paired specimens to suit the bending strength test specified in 7.3.2.

Each specimen pair shall be cut adjacent in the machine direction in accordance with Figure 6 from one sheet and given the same number for later comparison of results.

Dimensions in millimetres

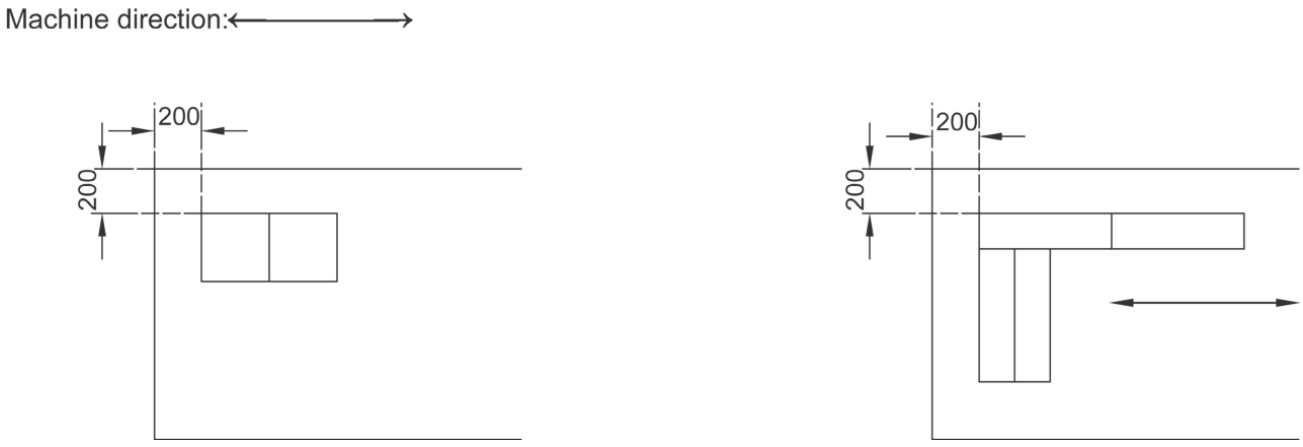



**Figure 6 — Adjacent cutting**

#### 7.3.5.2 Apparatus

**7.3.5.2.1** **Water bath**, capable of temperature control to (60 ± 2) °C.

**7.3.5.2.2** **Testing equipment for determination of bending strength**, as described in 7.3.2.2.

#### 7.3.5.3 Procedure

Divide the paired specimens to form two sets of ten specimens each.

Submit the first lot of ten specimens to the bending strength test in accordance with 7.3.2.3 after conditioning in accordance with Table 10.

Immerse the ten specimens of the second lot in water at (60 ± 2) °C saturated with product of the same composition, for (56 ± 2) d.

At the end of this period, condition the specimen in accordance with Table 10, then carry out the bending strength test in accordance with 7.3.2.

#### 7.3.5.4 Expression and interpretation of results

For each pair of specimens i (i = 1 to 10), calculate the individual ratio, $MR_i$, as follows:

$$MR_i = \frac{MOR_{fi}}{MOR_{fci}}$$

where

$MOR_{fi}$ is the modulus of rupture of the $i^{th}$ specimen after the warm water test;

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

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

Calculate the lower estimation, $R_L$, of the mean of the ratios at 95 % confidence level (ISO 2602) as follows:

$R_L = R - 0{,}58 \times s$

Compare the results with the specifications of 5.5.4.

### 7.3.6 Soak-dry

#### 7.3.6.1 Preparation of specimens

Sample ten sheets as delivered by the producer. Cut ten sets of paired specimens to suit the bending test in 7.3.2.

Each specimen pair shall be cut adjacent in the machine direction in accordance with Figure 6 from one sheet and given the same number for later comparison of results.

#### 7.3.6.2 Apparatus

**7.3.6.2.1 Ventilated oven**, capable of achieving a temperature of (60 ± 5) °C and a relative humidity less or equal to 20 % with a full load of specimens.

**7.3.6.2.2 Bath filled with water**, at ambient temperature of more than 5 °C.

**7.3.6.2.3 Testing equipment for determination of bending strength test**, as defined in 7.3.2.2.

#### 7.3.6.3 Procedure

Divide the paired specimens to form two lots of ten specimens each. After conditioning in accordance with Table 10, submit the first lot of ten specimens to the bending test as described in 7.3.2.

At the same time, submit the second lot to the relevant number of soak-dry cycles as specified in Table 7 consisting of:

— immersion in water at ambient temperature (more than 5 °C) for 18 h;

— drying in a ventilated oven of (60 ± 5) °C and 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 6 h drying.

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

After the required number of cycles, place the specimens in a ambient laboratory conditions for seven days.

At the end of this period, condition the specimens in accordance with Table 10 and carry out the bending strength test as specified in 7.3.2.

#### 7.3.6.4 Expression and interpretation of results

For each pair of specimens i (i = 1 to 10), calculate the individual ratio, $MR_i$, as follows:

$$MR_i = \frac{MOR_{fi}}{MOR_{fci}}$$

where

$MOR_{fi}$ is the modulus of rupture of the $i^{th}$ specimen after the soak-dry cycling;

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

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

Calculate the lower estimation, $R_L$, of the mean of the ratios at 95 % confidence level (ISO 2602) as follows:

$R_L = R - 0{,}58 \times s$

Compare the result with the specification of 5.5.5.

### 7.3.7 Moisture movement test

#### 7.3.7.1 General

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

#### 7.3.7.2 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.

#### 7.3.7.3 Dimensions of specimens

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

#### 7.3.7.4 Conditioning of specimens

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

## 7.4 Tests for climatic performance

### 7.4.1 Freeze-thaw

#### 7.4.1.1 Preparation of specimens

Sample ten sheets as delivered by the producer. Cut ten sets of paired specimens to suit the bending test (see 7.3.2).

Each specimen pair shall be cut adjacent in the machine direction in accordance with Figure 6 from one sheet and given the same number for later comparison of results.

#### 7.4.1.2 Apparatus

**7.4.1.2.1 Freezer unit,** having forced air circulation, with air temperature control and capable of reaching the temperature specified in 7.4.1.3 within 1 h to 2 h with a full load of specimens.

**7.4.1.2.2 Water bath**, filled with water and maintained at (20 ± 4) °C.

**7.4.1.2.3 Bending test machine**, as described in 7.3.2.2.

#### 7.4.1.3 Procedure

Divide the paired specimens to form two lots of ten specimens each.

Submit the first lot of specimens to the bending strength test as described in 7.3.2 including the conditioning procedure (see Table 10).

At the same time, immerse the second lot of specimens in water at ambient temperature (> 5 °C) for 48 h.

Then subject the second lot of specimens to the relevant number of freeze-thaw cycles as specified in Table 7:

— cool (freeze) in the freezer which shall reach a temperature of (-20 ± 4) °C within 1 h to 2 h and hold at this temperature for a further 1 h;

— heat (thaw) in the water bath which shall reach a temperature of (20 ± 4) °C within 1 h to 2 h and hold at this temperature for a further 1 h.

During both the cooling and heating (freezing and thawing) cycles, position the specimens to enable free circulation of the conducting medium (air in the freezer or water in the bath) around them.

The temperature indicated refers to the temperature of the media, i.e. air or water.

Each freeze/thaw cycle shall take between 4 h and 6 h but an interval of 72 h maximum may be taken between cycles during which the specimens shall be stored in water at 20 °C.

Control of the freeze/thaw cycles can be automatic or manual. Continuous automatic cycling is preferable. For manual control, record the completion of each cycle.

After the required number of cycles, carry out the bending strength test as specified in 7.3.2 including the conditioning procedure (see Table 10).

#### 7.4.1.4 Expression and interpretation of results

For each pair of specimens, i (i = 1 to 10), calculate the individual ratio, $MR_i$, as follows:

$$MR_i = \frac{MOR_{fi}}{MOR_{fci}}$$

where

$MOR_{fi}$ is the modulus of rupture of the specimen from the $i^{th}$ pair after freeze-thaw cycling (the second lot);

$MOR_{fci}$ is the modulus of rupture of the specimen from the $i^{th}$ pair tested for reference (the first lot).

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

Calculate the lower estimation, $R_L$, of the mean of the ratios at 95% confidence level (ISO 2602) as follows:

$$R_L = R - 0{,}58 \times s$$

Compare the result with the specification of 5.5.2.

### 7.4.2 Heat-rain

#### 7.4.2.1 General

This test method provides a practical moisture movement test designed to determine the installed performance of flat sheets under cyclic changes in moisture content.

#### 7.4.2.2 Preparation of specimens

Sheets used for the test shall be selected at random. The number of sheets required will depend upon the specified installation recommendations or on the size of sheets being tested (where appropriate, maximum size sheets), see 7.4.2.4.

#### 7.4.2.3 Apparatus

**7.4.2.3.1 Framing system,** to which the sheets under test may be fixed in a vertical position, with the supporting members of a specified material and spacing.

**7.4.2.3.2 Water spray system,** with an output of approximately 1 l/m²/min, which provides a complete wetting on the face.

**7.4.2.3.3 Heating device,** capable of maintaining the specified uniform temperature on the surface of the tested elements.

The heating device shall have a power output regulated by means of a black body temperature sensor located at the central area of the test rig where the maximum temperature is expected, i.e. at the closest distance underneath a heating unit.

The temperature at this location shall be regulated at (60 ± 5) °C and shall be reached after 15 min of heating.

At any time, the difference between black body temperature in the centre and black body temperatures near the corners of the test rig (also measured underneath heating units) shall not exceed 15 °C.

**7.4.2.3.4 Control system**, allowing the test conditions to alternate as prescribed in the test procedure.

#### 7.4.2.4 Procedure

One installation system, which is regarded as the most severe test for the sheets, shall be selected.

Assemble the test frame in accordance with the manufacturer's recommendations. The frame construction shall include at least one joint in its central region. The perimeter of the frame shall allow standard size sheet fixing.

The actual frame dimensions shall provide a minimum area of 3,5 m² and a maximum area of 12 m² and:

a) allow the specimens to be installed with vertical orientation; and

b) allow the installation of at least two specimens as follows:

1) area per sheet greater than 1,8 $m^2$ - two sheets;

2) area per sheet not greater than 1,8 $m^2$ - sufficient sheets to cover an area of at least 3,5 $m^2$.

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

Fix the specimens to the test frame in accordance with the manufacturer's recommendations as decisive for the sheets and the following:

— edge fixing distance: minimum specified;

— spacing between fixings: maximum specified;

— include all waterproofing and other attachments: normally specified;

— include joints in both directions.

Subject the assembled frame to the test cycle in accordance with Table 11:

**Table 11 — Heat-rain cycle**

| Cycles | Duration |
|---|---|
| Water spray | 2 h 50 min ± 5 min |
| Pause | 10 min ± 1 min |
| Radiant heat | 2 h 50 min ± 5 min |
| Pause | 10 min ± 1 min |
| Total cycle | 6 h ± 12 min |
| Repeat all steps | |

#### 7.4.2.5 Expression and interpretation of results

The result of the visual assessment shall conform to the specification of 5.5.3.

## 7.5 Test for reaction to fire performance

### 7.5.1 Sheets satisfying the requirements for the fire reaction Class A1 without the need for testing

Sheets containing 1 % or less organic substances by mass or volume, whichever is the more onerous, are considered to satisfy the requirements for performance Class A1 of the characteristics reaction to fire, in accordance with the provisions of EC Decision 96/603/EC, as amended, without the need for testing.

### 7.5.2 Other sheets

#### 7.5.2.1 General

Sheets not covered by 7.5.1 shall be tested and classified in accordance with EN 13501-1. The sheets to be tested shall, where the test method requires, be installed, in addition to the general provisions given in the test method, in a manner representative of their intended use in accordance with the manufacturer's specifications.

#### 7.5.2.2 Mounting and fixing provisions for EN 13823

##### 7.5.2.2.1 End use applications

The end uses covered by the standardized mounting and fixing are fibre cement flat sheets used as external and internal wall and ceiling finishes. In these end uses, flat sheets are fixed to a wooden or metal substructure with mechanical devices. The side of the flat sheets directed away from the fire is in contact with a ventilated cavity which is closed by either a rigid substructure or a structural wall or ceiling construction. The cavity may or may not be partially filled with thermal insulation. The mounting and fixing provision is based on testing in accordance with EN 13823.

##### 7.5.2.2.2 Test specimen

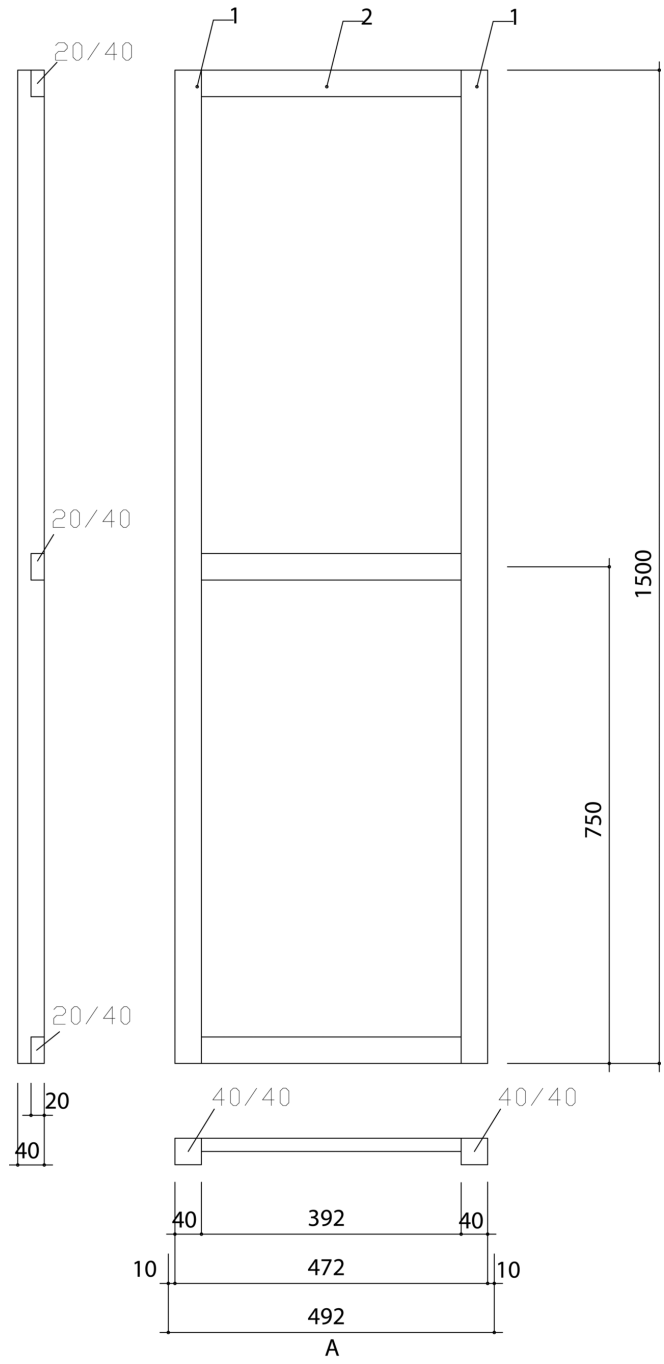
Products used for the construction of the test assembly are fibre cement flat sheets with standard dimensions of length, width and thickness. They are cut to size to accommodate the dimensions of the test assembly. They include all facings and/or coatings that are normally applied to the product as it is placed on the market.

##### 7.5.2.2.3 Test assembly

###### 7.5.2.2.3.1 Dimensions

The test assembly is a corner set up made of two timber frame supporting constructions each with a height of 1,5 m to which the fibre cement flat sheets are fixed. One frame forms a long wing (1,0 m) the other frame forms a short wing (0,5 m). Further information is given in Figures 7, 8, 9, 10 and 11.

Dimensions in millimetres; tolerances: 2 %, unless otherwise specified in text

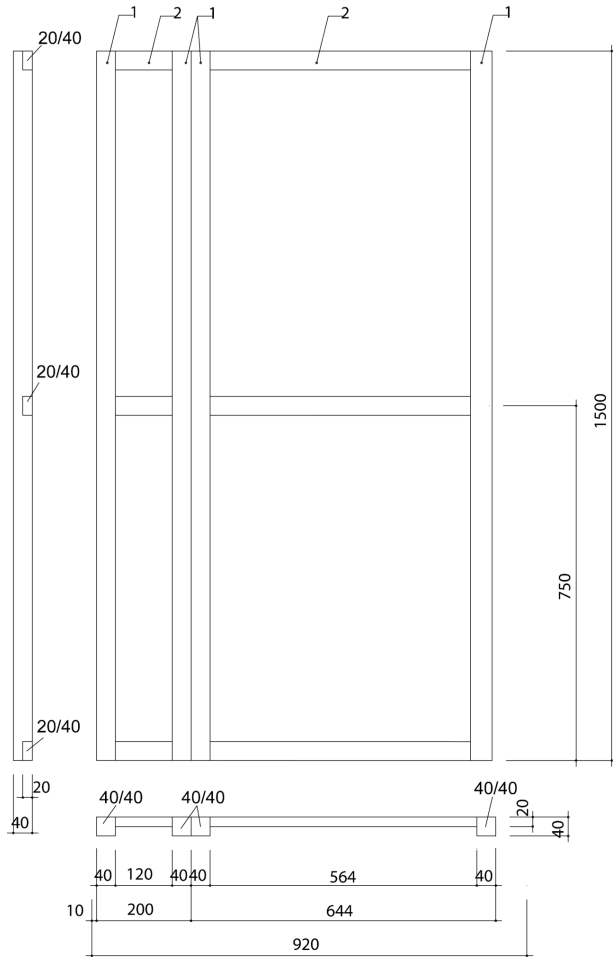



**Key**

1 vertical frame member
2 horizontal frame member
A width of the short wing

**Figure 7 — Wood based frame for fibre cement sheets — short wing**

Dimensions in millimetres; tolerances: 2 %, unless otherwise specified in text



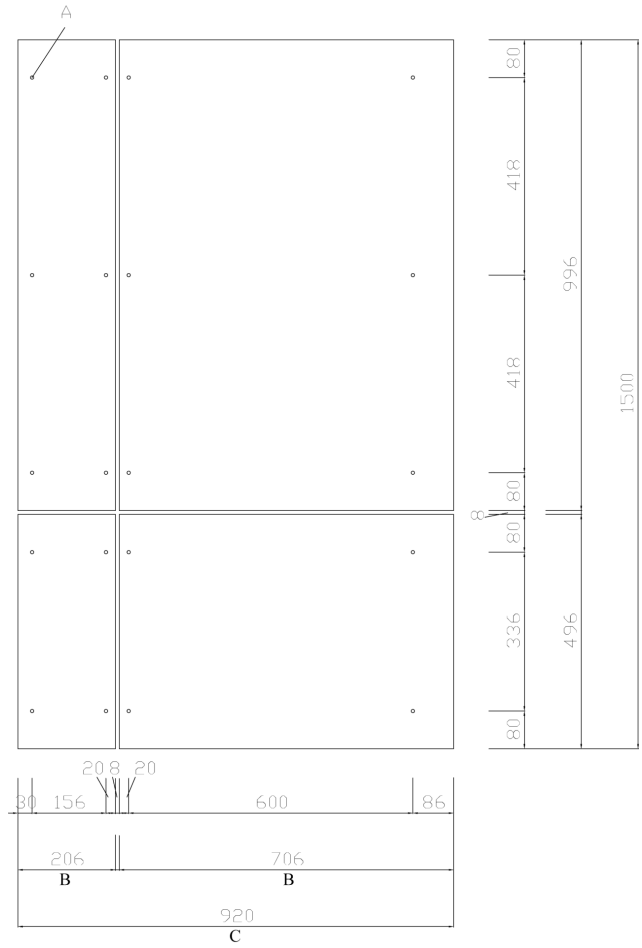

**Key**

1 vertical frame member

2 horizontal frame member

**Figure 8 — Wood based frame for fibre cement sheets — long wing**

Dimensions in millimetres; tolerances: 2 %, unless otherwise specified in text




**Key**

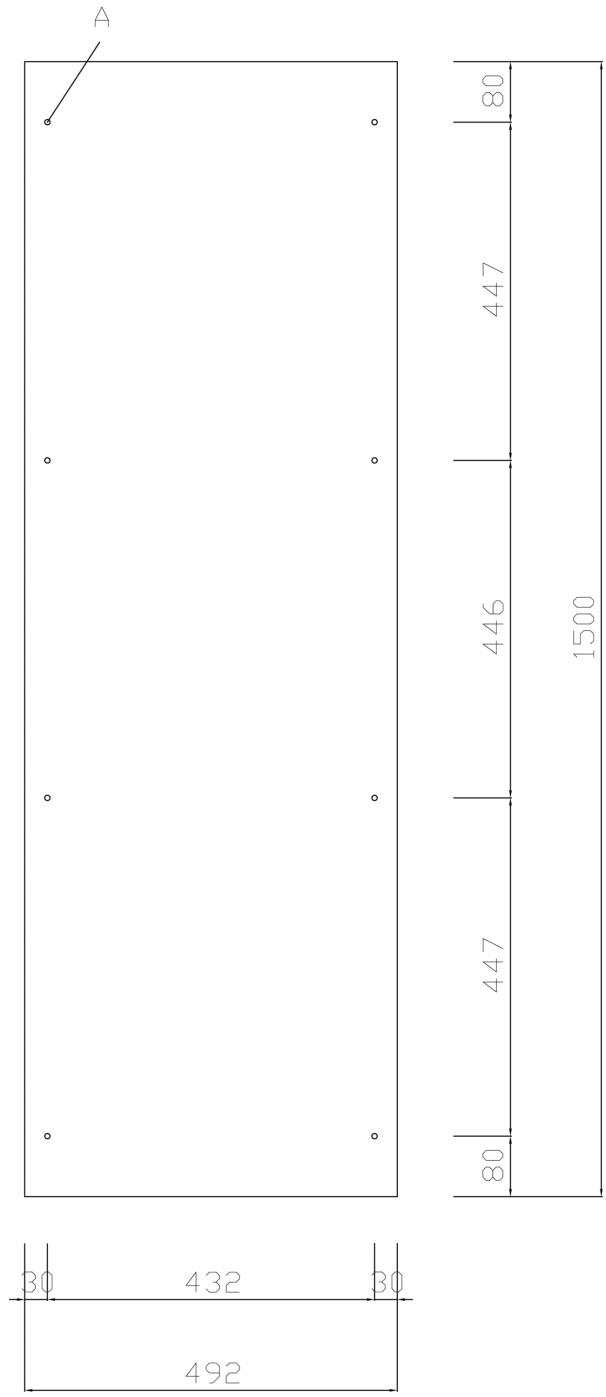
A screw

B width of the sheet

C width of the long wing

**Figure 9 — Mounting instructions for fibre cement sheets and the fixing — long wing**

Dimensions in millimetres; tolerances: 2 %, unless otherwise specified in text

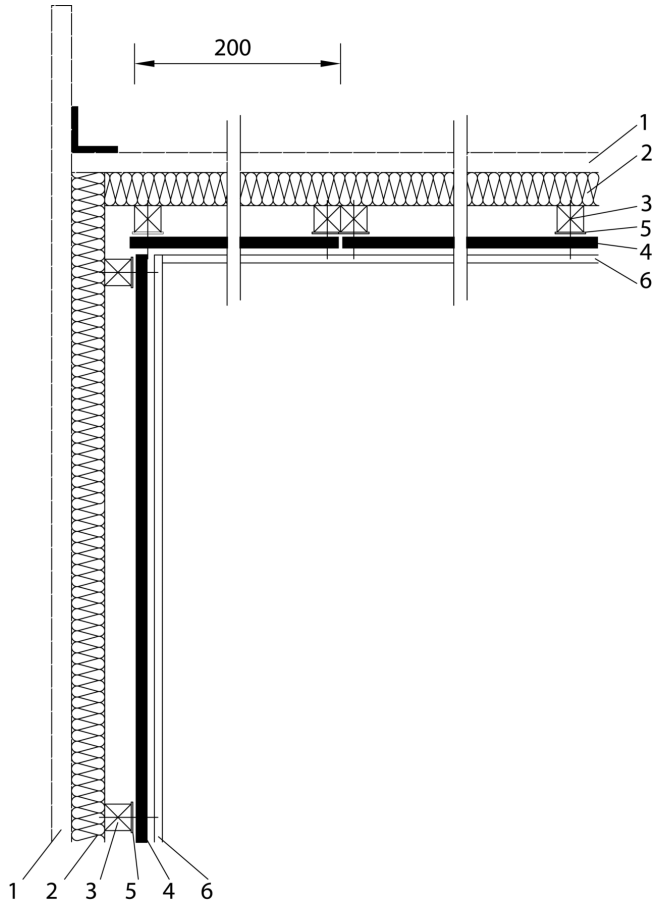



**Key**

A screw

**Figure 10 — Mounting instructions for fibre cement sheets and the fixing — short wing**

Dimensions in millimetres; tolerances: 2 %, unless otherwise specified in text




**Key**

1 backing board
2 insulation (50 mm) – mineral wool
3 vertical member (timber)
4 sheet
5 joint band
6 U-channel

**Figure 11 — Corner set-up**

### 7.5.2.2.3.2 Supporting construction and thermal insulation

Both long and short wing frames are made out of wood, (40 ± 1) mm × (40 ± 1) mm for vertical members; (20 ± 1) mm × (40 ± 1) mm for horizontal members. They are nailed or screwed together. The construction gives a ventilation gap of (40 ± 1) mm between fibre cement sheet and thermal insulation. The frames with the fibre cement flat sheets fixed to it shall be free standing.

The space between test rig backing board and backside of the supporting frame shall be filled with mineral wool insulation with a nominal thickness of 50 mm, a nominal density of (70 ± 20) kg/m$^3$ and a class A2-s1,d0 according to EN 13501-1. The thermal insulation is imprisoned between the wooden frames and the test rig backing board.

#### 7.5.2.2.3.3 Joints and fixings

On the large wing, there is a horizontal joint at (500 ± 10) mm above the bottom and a vertical joint at (200 ± 10) mm from the corner edge. These joints shall be constructed as in practice. Their opening width shall be (8 ± 1) mm or in accordance with the maximum width allowed in the product's end use.

The fibre cement flat sheets are fixed with screws as used in practice.

#### 7.5.2.2.3.4 Product orientation

For all end use applications, the testing is performed in vertical position. Products with identical surface finishes on both sides have to be tested at one side only. Products with different surface finishes or coatings on different sides shall be tested on both sides or with the side representative for the worst performance directed to the fire. The worst performance is normally obtained with the side having the finish with the highest organic content per $m^2$ surface or with the side with the darkest colour. The side with the highest organic content shall be derived from the composition of the different finishing layers or by determining their gross calorific value according to EN ISO 1716, taking account of the respective applied dry weights of the finishing layers.

In case both sides are tested, the classification of the side with the worst performance can be used for the classification of the product, or the classification of each of the sides can be declared separately. In case only one side is tested, the classification of that side can be used for the classification of the product.

#### 7.5.2.2.3.5 Product direction

The product shall be mounted so that the sides of the sheets are vertical.

### 7.5.2.2.4 Number of tests

Three valid tests are required for classification. The products used for the construction of the three test assemblies are taken from standard production lots. The normal manufacturing tolerances apply.

NOTE This is for example the case for the overall thickness and thickness of finishes or coating layers.

### 7.5.2.2.5 Field of application for the obtained classification

The classification is obtained based on the results of testing of three assemblies of the same product subject to the normal manufacturing tolerances. The classification therefore applies to fibre cement flat sheets of the same mix formulation[3)] for the base sheet, same thickness, the same density and with the same facing or coating thickness as used for the test and within a field determined by the normal manufacturing tolerances.

The classification also applies to fibre cement flat sheets:

— of the same type, but with different dimensions of length and width;

— with a thickness equal to or greater than that used for the test;

— with a different surface texture (smooth or embossed);

— with a density, determined in accordance with 5.4.2, within a range of ± 0,15 $g/cm^3$ of the density used in the test;

— with a joint opening width equal to or smaller than those used for the test;

---

3) Mix formulation is the type formula and does not include differences such as raw material variations.

— fixed with all other types of mechanical devices such as metal (excluding aluminium) nails or rivets;

— fixed at different (wider or closer) horizontal or vertical fixing centres;

— fixed to metallic profiles;

— without thermal insulation in the cavity or with other types of class A2-s1,d0 according to EN 13501-1 insulation materials as long as a ventilated air gap of at least (40 ± 1) mm directly behind the sheets is present;

— without finishes or with different finishes or coatings (e.g. different colours) as long as the test was performed considering the worst case as explained in 7.5.2.2.3.4 and 7.5.2.2.4.

In cases where EDPM jointing strip has been used, the result is also valid for other jointing material for a similar or higher fire classification.

## 8 Marking, labelling and packaging

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

a) manufacturers identification;

b) number of this European Standard (EN 12467);

c) size and/or name;

d) category;

e) class;

f) level of tolerances;

g) date of manufacture;

h) “NT” (see 5.1.1);

i) trade name.

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), g) and h) from the above list. 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 manufacturer and purchaser.

Where ZA.3 covers the same requirements as this clause, the requirements of this clause should be met.

# Annex A
(normative)

# Consignment inspection sampling

When tenders or orders specify it, the acceptance sampling shall be carried out in lot(s) of the consignment in accordance with the test programme of this product standard, unless there is a special agreement. Therefore, the test programme necessarily covers the characteristics as specified in Table 8.

Details related to the application of the sampling clause shall be established.

After agreement on the sampling procedure, sampling shall be carried out, in the presence of both parties, from lot(s) which are to be delivered to the purchaser. If the inspection lot(s) 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, the maximum and minimum inspection lots shall be 8 000 and 4 000 fibre-cement flat sheets.

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

When non-destructive tests are carried out and the result of the sampling inspection does not meet the acceptance tests 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 one by one can be refused and disposed of, unless otherwise agreed.

# Annex B
(normative)

# Statistical method for determining the corresponding wet values or revised dry specifications for the *MOR* when carrying out 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 7.3.2.

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 strength in accordance with 7.3.2.

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

If there is no significant correlation, 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 of the following:

   1) a wet value for each specimen from the obtained dry value, using the method described in B.4;

   2) 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 from the following formula:

$$r = \frac{\sum_{1}^{n}\left(x_{\mathrm{i}} - \bar{x}\right)\left(y_{\mathrm{i}} - \bar{y}\right)}{\left\{\sum_{1}^{n}\left(x_{\mathrm{i}} - \bar{x}\right)^{2}\sum_{1}^{n}\left(y_{\mathrm{i}} - \bar{y}\right)^{2}\right\}^{1/2}} \qquad \text{(B.1)}$$

where

$n$ is the number of paired specimens;

$x_{\mathrm{i}}$ is the individual value of the $\mathrm{i}^{\mathrm{th}}$ specimen tested dry;

$y_{\mathrm{i}}$ is the individual value of the $\mathrm{i}^{\mathrm{th}}$ specimen tested wet;

$\bar{x}$ is the mean of the values of $x_{\mathrm{i}}$ for i = 1 to $n$;

$\bar{y}$ is the mean of the values of $y_{\mathrm{i}}$ for i = 1 to $n$.

Calculate the value of $t$ from the following formula:

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

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

If $t > t_{0,025/n\text{-}2}$ 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 $t_{0,025/n\text{-}2} = 2{,}101$;

— for $n > 20$ refer to Student's $t$ tables.

## B.3 Determination of the regression line

The formula of the regression line is:

$$y = a + bx$$

Calculate the values of $a$ and $b$ from the following formulae:

$$b = \frac{\sum_{1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sum_{1}^{n} (x_i - \bar{x})^2} \tag{B.3}$$

$$a = \bar{y} - b\bar{x} \tag{B.4}$$

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

Calculate the residual standard deviation (also called the standard error of the estimate) from the following formula:

$$s = \sqrt{\frac{\sum_{1}^{n} (y_i - a - bx_i)^2}{n-2}} \tag{B.5}$$

Calculate the value for wet testing from the following formula using the obtained dry value $x_O$:

$$y_O = (a + bx_O) - s\,t_{0,025/n\text{-}2}\sqrt{\frac{n+1}{n} + \frac{\left(x_0 - \bar{x}\right)^2}{\sum_1^n \left(x_1 - \bar{x}\right)^2}} \qquad \text{(B.6)}$$

where

$x_O$ is the actual result obtained when dry testing;

$y_O$ is the value calculated from $x_O$ which is the estimate at the lower 97,5% confidence level of the value expected from wet testing:

when $n = 20$ then $t_{0,025/n\text{-}2} = 2{,}101$;

for $n > 20$ refer to Student's $t$ tables.

For routine quality control testing, individual values of $y_O$ can be calculated each time or alternatively by substituting a suitable range of values for $x_O$ in Formula (B.6) a plot of $x_O$, $y_O$ 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 $y_{std}$

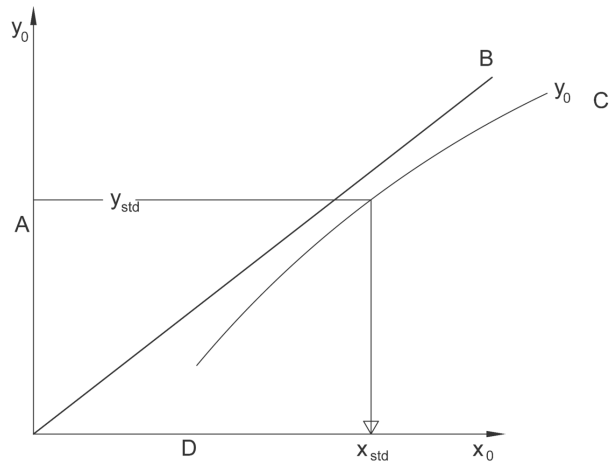
Plot the line for $y_O$, $x_O$ by substituting a suitable range of values for $x_O$ in Formula (B.6).

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**

A wet values
B regression line
C (from Formula (B.6))
D dry values

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

# Annex C
(normative)

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

## C.1 General

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

## C.2 Principle

The lengths of sheet specimens, conditioned in air at a 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.

## C.3 Apparatus

The apparatus shall include the following items:

**C.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.

The humidity in the conditioning chamber shall be recorded.

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

**C.3.3 Measuring device,** made of metal of sufficient length to measure the length of a the specimen to an accuracy of 0,02 mm.

## C.4 Specimen preparation

Prepare specimens to conform with the dimensional requirements of the referring standard (see 7.3.7.3) and condition samples prior to testing (see 7.3.7.4).

## C.5 Test procedure

a) Remove specimens from the conditioning chamber and immediately measure their lengths and weights and record these values.

b) Replace the specimens in conditioning chamber and increase the 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 weight) reweigh specimens and immediately measure specimen lengths. Record these values.

## C.6 Calculation of results

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

$$L_{\mathrm{m}} = \frac{(L_{90} - L_{30})x100}{L_{30}} \qquad (\%) \qquad (C.1)$$

where

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

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

## C.7 Test report

The test report shall include the following information:

a) reference to this European Standard;

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

c) dimensions of the test specimens;

d) test equipment details;

e) test temperature and condition of the test piece;

f) measured values from the tests;

g) calculated value of percentage moisture movement;

h) date of the test.

# Annex ZA
(informative)

## A2 Relationship of this European Standard with Regulation [EU] No. 305/2011

(When applying this standard as a harmonized standard under Regulation [EU] No. 305/2011, manufacturers and Member States are obliged by this regulation to use this Annex)

## ZA.1 Scope and relevant characteristics

This European Standard has been prepared under standardization request M/121 "Internal and external wall and ceiling finishes" given to CEN and CENELEC by the European Commission (EC) and the European Free Trade Association (EFTA).

When this European Standard is cited in the Official Journal of the European Union (OJEU), under Regulation (EU) No 305/2011, it shall be possible to use it as a basis for the establishment of the Declaration of Performance (DoP) and the CE marking, from the date of the beginning of the co-existence period as specified in the OJEU.

Regulation (EU) No 305/2011, as amended, contains provisions for the DoP and the CE marking.

**Table ZA.1.1 — Relevant clauses for fibre-cement flat sheets for internal wall and ceiling finishes**

| **Product:** Fibre cement flat sheets<br>**Intended use:** Internal wall and ceiling finishes | | | |
|---|---|---|---|
| **Essential Characteristics** | **Clauses of this European Standard related to essential characteristics** | **Classes and/or threshold levels** | **Notes** |
| Mechanical resistance[a] | 5.4.4 | - | Minimum *MOR* Classes 1 to 5 |
| Reaction to fire | 5.6.1 | A1 to F | Declared class |
| Release of dangerous substances | 5.6.2 | - | See 5.6.2 |
| Durability against warm water | 5.5.4 | - | $R_L \geq 0,75$ |
| Durability against soak / dry | 5.5.5 | - | $R_L \geq 0,75$ |
| [a] Characteristic which does not apply to wall finishes. | | | |

**Table ZA.1.2 — Relevant clauses for fibre-cement flat sheets for external wall and ceiling finishes**

| **Product:** Fibre cement flat sheets<br>**Intended use:** External wall and ceiling finishes | | | |
|---|---|---|---|
| **Essential Characteristics** | **Clauses of this European Standard related to essential characteristics** | **Classes and/or threshold levels** | **Notes** |
| Mechanical resistance | 5.4.4 | - | Minimum *MOR* Classes 1 to 5 |
| Reaction to fire | 5.6.1 | A1 to F | Declared class |
| Release of dangerous substance | 5.6.2 | - | See 5.6.2 |
| Water impermeability | 5.4.5 | - | No water drops |
| Durability against warm water | 5.5.4 | - | $R_L \geq 0,75$ |
| Durability against soak / dry | 5.5.5 | - | $R_L \geq 0,75$ |
| Durability against freeze-thaw | 5.5.2 | - | $R_L \geq 0,75$ |
| Durability against heat-rain | 5.5.3 | - | Comply – see 5.5.3 |

## ZA.2 System of Assessment and Verification of Constancy of Performance [AVCP]

The AVCP systems of fibre-cement flat sheets, indicated in Tables ZA.1.1 and ZA.1.2, can be found in the EC legal acts adopted by the EC: 98/437/EC of 1998-06-30 (OJEU L194 of 1998-07-10), as corrected (OJEU L278 of 1998-10-15) and amended by 2001/596/EC of 2001-01-08 (OJEU L209 of 2001-08-02).

Micro-enterprises are allowed to treat products under AVCP system 3 covered by this standard in accordance with AVCP system 4, applying this simplified procedure with its conditions, as foreseen in Article 37 of Regulation [EU] No.305/2011.

## ZA.3 Assignment of AVCP tasks

The AVCP systems of fibre-cement flat sheets as provided in Tables ZA.1.1 to ZA.1.2 are defined in Tables ZA.3.1 to ZA.3.3, resulting from application of the clauses of this or other European Standards indicated therein. The content of the tasks assigned to the notified body shall be limited to those essential characteristics, if any, as provided for in Annex III of the relevant standardisation request and to those that the manufacturer intends to declare.

Taking into account the AVCP systems defined for the products and intended uses the following tasks are to be undertaken by the manufacturer and the notified body respectively for the assessment and verification of the constancy of performance of the product.

**Table ZA.3.1 — Assignment of AVCP tasks for fibre cement flat sheets (for reaction to fire classes A1*, A2*, B* and C*) under system 1**

| Tasks | | Content of the task | AVCP clauses to apply |
|---|---|---|---|
| Tasks for the manufacturer | Factory production control (FPC) | Parameters related to essential characteristics of Table ZA.1.1 and/or Table ZA.1.2 relevant for the intended use which are declared | 6.3 |
| | Further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan | Essential characteristics of Table ZA.1.1 and/or Table ZA.1.2 relevant for the intended use which are declared | 6.3 |
| Tasks for the notified product certification body | An assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values or descriptive documentation of the product | Reaction to fire | 6.2 |
| | Initial inspection of manufacturing plant and of FPC | Parameters related to essential characteristics of Table ZA.1.1 and/or Table ZA.1.2, relevant for the intended use which are declared, namely Reaction to fire. Documentation of the FPC. | 6.3 and 6.3.4 |
| | Continuing surveillance, assessment and evaluation of FPC | Parameters related to essential characteristics of Table ZA.1.1 and/or Table ZA.1.2, relevant for the intended use which are declared, namely reaction to fire. Documentation of FPC | 6.3 and 6.3.5 |
| * Products/materials for which a clearly identifiable stage in the production process results in an improvement of the reaction to fire classification (e.g. an addition of fire retardants or a limiting of organic material). | | | |

**Table ZA.3.2 — Assignment of AVCP tasks for fibre cement flat sheets under system 3 subject to reaction to fire (for classes A1**, A2**, B**, C**, D and E) and subject to regulations on dangerous substances**

| Tasks | | Content of the task | AVCP clauses to apply |
|---|---|---|---|
| Tasks for the manufacturer | Factory production control (FPC) | Parameters related to essential characteristics of Table ZA.1.1 and/or Table ZA.1.2 relevant for the intended use which are declared | 6.3 |
| Tasks for a notified laboratory | The notified laboratory shall assess the performance on the basis of testing (based on sampling carried out by the manufacturer), calculation, tabulated values or descriptive documentation of the construction product. | Reaction to fire<br>Release of dangerous substances | 6.2 |
| ** Products/materials for which there is no clearly identifiable stage in the production process that results in an improvement of the reaction to fire classification. | | | |

**Table ZA.3.3 — Assignment of AVCP tasks for fibre cement flat sheets under system 4 subject to reaction to fire (for classes (A1 to E)***, F ) and for other uses (not mentioned in Tables ZA.3.1 and ZA.3.2)**

| Tasks | | Content of the task | AVCP clauses to apply |
|---|---|---|---|
| Tasks for the manufacturer | An assessment of the performance of the construction product on the basis of testing, calculation, tabulated values or descriptive documentation of that product | Essential characteristics of Table ZA.1.1 and/or Table ZA.1.2 relevant for the intended use which are declared except release of dangerous substances. | 6.2 |
| | Factory production control (FPC) | Parameters related to essential characteristics of Table ZA.1.1 and/or Table ZA.1.2 relevant for the intended use except release of dangerous substances. | 6.3 |
| *** Products/materials that do not require to be tested for reaction to fire (e.g. Products/materials of Class A1 according to Commission Decision 96/603/EC, as amended). | | | |

A2

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[2] EN 14964, *Rigid underlays for discontinuous roofing — Definitions and characteristics*

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