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ISO 9384

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Fibre-cement siding shingles

Bardeaux en fibres-ciment

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Contents

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Foreword

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

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

International Standard ISO 9384 was prepared by Technical Committee ISO/TC 77, *Products in fibre reinforced cement*.

Annex A forms an integral part of this International Standard. Annex B is for information only.

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Fibre-cement siding shingles

1 Scope

This International Standard specifies the characteristics and establishes methods of control and test as well as acceptance conditions for fibre-cement siding shingles, which are not covered by ISO 880.

It applies to shingles of dimensions not exceeding 600 mm × 600 mm.[1)]

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 390:1977, *Asbestos-cement products — Sampling and inspection.*

ISO 880:1981, *Asbestos-cement siding shingles.*

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

3 Composition

Siding shingles are flat elements for external cladding, formed by overlapping or juxtaposition of these elements.

Fibre-cement shingles consist essentially of an inorganic hydraulic binder[2)] or a calcium silicate formed by a chemical reaction of a siliceous and a calcareous material, reinforced by organic fibres and/or inorganic synthetic fibres.

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

4 General appearance and finish

The exposed face of the shingles may be smooth or textured. The shingles may be coloured or left in their natural colour. The shingles may also receive coloured or clear coatings that are compatible with the base material.

The shingles may be supplied holed for fixing.

5 Characteristics

5.1 Geometrical characteristics

5.1.1 Thickness

The method of measuring thickness is specified in 6.1.3.

The nominal thickness shall be specified by the manufacturer.

5.1.2 Tolerances on nominal dimensions

a) on length and width: ± 3 mm

b) on thickness:

— smooth shingles: $^{+25}_{-10}$ %

— shingles with textured face: ± 25 %

1) National standards may include shingles with dimensions exceeding 600 mm. In this case, all tests with the exception of the heat-rain test should be carried out on elements cut from such shingles. The heat-rain test should always be conducted on full-size shingles and the dimensions of the test rig should be adapted accordingly.

2) National standards may specify the binder to be used.

5.1.3 Straightness of sides (if applicable)

The straightness of sides shall be ± 2 mm on the absolute value on both length and width.

5.2 Mechanical characteristics[3)]

When tested as specified in 6.1.4, the shingles shall have a minimum modulus of rupture, R_f, at least equal to the values in table 1. This shall be the average of the values obtained from testing the test specimen in both directions.

Table 1

Category	Minimum modulus of rupture, R_f MPa
I	8
II	15

National standards may adopt only one category depending on local conditions and/or regulations.

5.3 Physical characteristics[3)]

5.3.1 Apparent density

The manufacturer shall specify the minimum apparent density of the shingles.

When tested as specified in 6.1.5, the shingles shall have an apparent density equal to or greater than this value.

5.3.2 Frost resistance test

If local climatic conditions justify it or if national standards specify this test, the shingles shall comply with the following requirements.

When tested as specified in 6.2.2, any visible cracks, delamination or other defects in the shingles shall not be of a degree such as to affect their performance in use.

5.3.3 Heat-rain

When tested as specified in 6.2.3, any visible cracks, delamination or other defects in the shingles shall not be of a degree such as to affect their performance in use.

5.3.4 Warm water

When tested as specified in 6.2.4,

a) any visible cracks, delamination or other defects in the shingles shall not be of a degree such as to affect their performance in use;

b) the finished product shall exhibit a ratio $\bar{r}$, as defined in 6.2.4.5, greater than or equal to 0,75.

6 Tests

6.1 Acceptance tests

6.1.1 General

The objective of an acceptance test is to establish whether a batch of products conforms to a specification. The tests are performed on samples drawn either from continuous production or from a consignment.

NOTE 1 Test methods and specification limit values are defined in this standard. Sampling levels and acceptance criteria are defined in ISO 390.

Acceptance tests as described in 6.1.2 to 6.1.5 shall be performed on shingles as delivered.

Sampling and acceptance shall be conducted in accordance with ISO 390 which specifies an AQL of 4 %.[4)]

When a continuous series of lots is considered, the acceptable quality level (AQL), for the purposes of sampling inspection, is the limit of a satisfactory process average.[5)]

6.1.2 Measurement of length and width (obligatory)

The length and width shall be measured by suitable metal rulers capable of being read to 0,5 mm.

For each dimension, take two measurements.

Take each reading to the nearest 0,5 mm.

Verify that each value is within the tolerance given in 5.1.2.

6.1.3 Measurement of thickness (obligatory)

The thickness shall be measured by means of a micrometer reading to 0,05 mm, having flat circular metal jaws of 10 mm diameter.

3) Mechanical and physical properties are normally determined on product as-delivered. The results are to be identified as applying to coated or uncoated material. Failure of the coating does not constitute failure of the product.

4) For the number of samples, see ISO 390.

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

The arithmetic mean of four measurements taken at one point on each side of the shingles shall be within the tolerances fixed in 5.1.2.

6.1.4 **Bending test** (obligatory)

The test shall be carried out on full size shingles or cut specimens. Before testing, they shall be immersed in water at ambient temperature (at least 5 °C) for 24 h (except for shingles of category 1 where the time of immersion shall be reduced to 2 h) and tested immediately after removal from the water.

6.1.4.1 Apparatus

6.1.4.1.1 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) comprising (see figure 1):

a) **Two rigid parallel supports** set in the same horizontal plane and longer than the sample width. The upper face of each support shall be rounded with a radius between 3 mm and 25 mm. The distance between the supports shall be 200 mm provided the sample is large enough. For smaller samples the distance between the supports can be reduced but shall not be less than 18 times the nominal thickness. The sample dimensions shall always exceed the distance between the supports by more than 20 mm.

b) **Loading bar** having the same radius as the support and located parallel and equidistant from them. It shall be attached to the driving mechanism by means of a flexible joint (see figure 1).

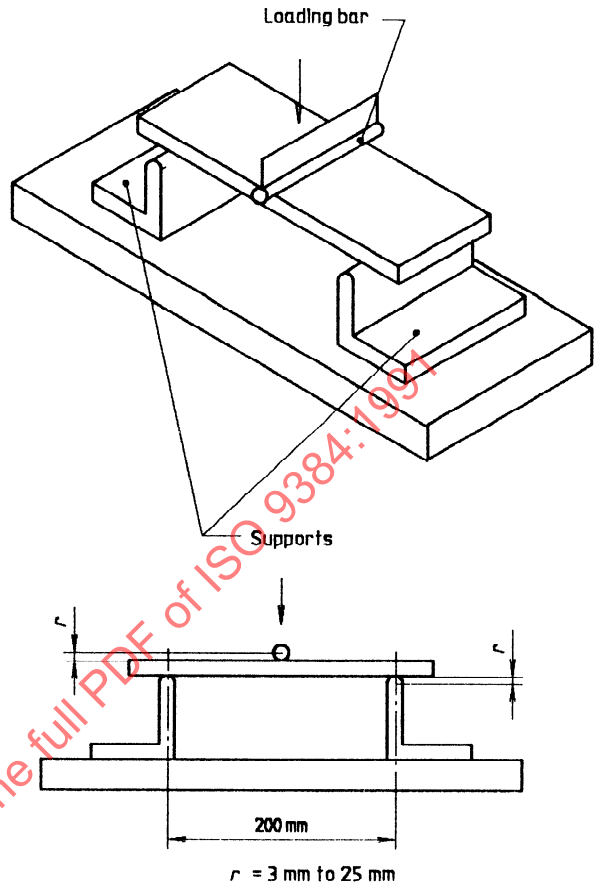

Figure 1

6.1.4.1.2 Micrometer, reading to 0,05 mm with flat metal jaws not less than 10 mm in diameter.

6.1.4.2 Procedure

Arrange the shingle with the weatherface in compression and load the test piece along its centreline by means of the loading bar.

The speed of loading shall be regular and such that breakage occurs at between 5 s and 30 s.

For smooth-faced shingles, measure the thickness at two points along the section of breakage as indicated in figure 2.

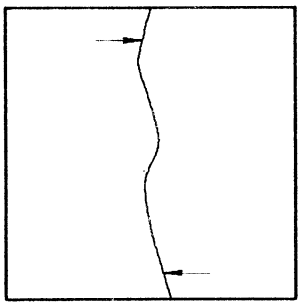

Figure 2

Reassemble the broken pieces.

Submit the reassembled shingle to another bending test with the line of load application at right angles to that of the first test.

For smooth-faced shingles, measure the thickness of the shingle at two points along the new section of breakage as indicated in figure 3.

For shingles with a textured face, see footnote 6).

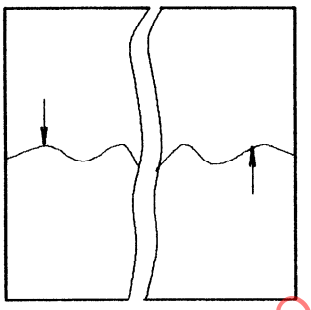

Figure 3

6.1.4.3 Expression of results

The modulus of rupture, R_f, in megapascals, is given by the formula

$$R_f = \frac{M}{W}$$

where

M is the bending moment, in newton metres, given by the formula

$$M = \frac{Pl}{4}$$

in which

P is the breaking load, in newtons;

l is the distance between the centres of the support, in millimetres;

W is the modulus of section, in cubic millimetres, given by the formula

$$W = \frac{be^2}{6}$$

where

e is the average value of the thickness of the shingle for smooth shingles (arithmetic mean of four measurements) measured along the breaking sections, in millimetres (see 6.1.4.2), and the nominal thickness for relief shingles[6],

b is the dimension of the shingle (length or width), measured parallel to the supports, in millimetres.

The bending moment of rupture, R_f, is the arithmetic average of the values obtained in each of the two directions on the same shingle.

The result of the test is considered to be satisfactory if it conforms with the requirements of 5.2.

6.1.5 Apparent density (obligatory)

6.1.5.1 Procedure

The test piece should preferably be a piece of the shingle used for the bending test.

6) The thickness of face-textured shingles, e, should be determined by measuring their volume using the hydrostatic method:

$$e = \frac{V}{S}$$

where

V is the volume, in cubic millimetres;

S is the area, in square millimetres, of the sample.

Other thickness measurement methods which can be correlated with this hydrostatic method are acceptable.

Determine the mass by drying out the test piece in an oven maintained at 100 °C to 105 °C until the difference between two consecutive weighings made at an interval of not less than 2 h is less than 0,2 % of the last value.

Determine the volume by immersion in water or some other method having an equivalent accuracy. In the case of immersion in water, the test piece shall be saturated in water beforehand.

6.1.5.2 Expression of results

The apparent density, ϱ, in grams per cubic centimetre, is given by the formula

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

where

m is the mass, in grams, of the test piece after drying;

V is the apparent volume, in cubic centimetres, of the test piece.

The result of the test piece is considered to be satisfactory if it conforms to the requirements of 5.3.1.

6.2 Type-tests

6.2.1 General

A type-test is concerned with the approval of a new product and/or a fundamental change in formulation and/or method of manufacture. The test is performed on the as-delivered product. The test is required to demonstrate conformity of a generic product to a specification but is not required for each production batch.

6.2.2 Freeze-thaw (optional)

6.2.2.1 Preparation of specimens

Sample five shingles as delivered by the producer.

6.2.2.2 Apparatus

6.2.2.2.1 Freezer unit having forced air circulation capable of cooling the air to a temperature of − 20 °C ± 2 °C within 1 h to 2 h with a full load of specimens.

6.2.2.2.2 Water-bath filled with water and maintained at 20 °C ± 2 °C.

6.2.2.3 Procedure

Immerse the specimens in water at ambient temperature (≥ 5 °C) until the difference between two consecutive weighings taken at 24 h intervals is less than 0,5 %. Then subject the specimens to 50 freeze-thaw cycles consisting of:

— cooling in air down to − 20 °C ± 2 °C within 1 h to 2 h and holding at this temperature for 1 h, and

— thawing in water to 20 °C ± 2 °C within 1 h to 2 h and holding in this condition for 1 h. If essential, specimens can be held in this condition for 72 h.

Each freeze-thaw cycle shall take between 4 h and 6 h in total.

After the 50 cycles have been completed, the result of the test is considered as satisfactory if the shingles satisfy the requirements of 5.3.2.

6.2.3 Heat-rain (obligatory)

6.2.3.1 Apparatus

The apparatus consists of any suitable construction with a vertical frame into which the shingles shall be mounted and alternately heated uniformly by radiant heat and sprayed with water.

The total area of the shingles to be tested shall be approximately square, from 1 m² to 3 m² depending on the shingle size and shall contain not less than 11 full size shingles.

The heating device shall be calibrated in order to maintain a uniform blackbody[7] surface temperature equal to 70 °C ± 5 °C during the heating period. It should provide an approximately uniform power output during this period.

6.2.3.2 Procedure

The test shall be carried out on full size shingles as delivered. The test specimens shall be submitted to a preliminary conditioning as follows:

— immersion for 24 h in water at ambient temperature (≥ 5 °C), and

— storage for 7 days in a laboratory atmosphere with separation to allow air circulation.

7) For the definition of a blackbody, see ASTM E 638-78, clause 4.4. For this test an aluminium plate of 1 mm thickness painted with matt black paint will be used as a blackbody.

The measurement device is a thermocouple or a similar device fixed on the surface of the aluminium plate.

The shingles shall be fixed according to national codes or, in their absence, manufacturer's recommendations.

The shingles shall be submitted to 25 test cycles of heat-rain, with each part of the cycle having the following duration:

— rain: 2 h 55 min

— pause: 5 min

— heat: 2 h 55 min

— pause: 5 min

6.2.3.3 Expression of results

The results of the test are considered as satisfactory if the shingles satisfy the requirements in 5.3.3.

6.2.4 Warm water (optional)

6.2.4.1 General

This test investigates the possible degradation of the products by keeping them in warm water for a protracted period. This test is a comparative one and is only significant for products as-delivered.

6.2.4.2 Preparation of specimens

Sample ten shingles as delivered by the producer. Cut ten sets of paired specimens to suit the bending test in 6.1.4.

Each specimen pair shall be cut from the one shingle and given the same number for later comparison of results.

6.2.4.3 Apparatus

6.2.4.3.1 Water bath, capable of temperature control to 60 °C ± 2 °C.

6.2.4.3.2 Bending strength test equipment, as described in 6.1.4.1.1.

6.2.4.4 Procedure

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

Submit the first lot of ten specimens to the bending test according to 6.1.4 and at the same time immerse the ten specimens of the second lot in water saturated with a product of the same composition and maintained at 60 °C ± 2 °C for 56 days ± 2 days. The pieces of product used shall be broken down to a size and be of sufficient quality to ensure that saturation is complete.

At the end of this period, place the specimens in a laboratory atmosphere for 7 days.

Examine the specimens with the naked eye in order to detect possible cracks, delamination or other defects, and record any observations. Carry out the bending test as specified in 6.1.4 after preliminary conditioning.

6.2.4.5 Expression of results

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

$$r_i = \frac{R_{fi}}{R_{fci}}$$

where

R_{fi} is the modulus of rupture of the i^{th} pair of samples after warm water immersion;

R_{fci} is the modulus of rupture of the i^{th} pair of reference samples (from the first lot).

Calculate the average, $\bar{r}$, and standard deviation, s, of the individual ratios, r_i (see ISO 2602). Calculate the 95 % lower confidence limit, L_i of the average ratio, as follows:

$$L_i = \bar{r} - 0{,}58s$$

7 Marking

Marking of the product or its packaging shall ensure that the category can be identified. The method of marking shall be stated in the manufacturer's catalogue.

8 Conformity with standards

8.1 Conformity with requirements

For the acceptance tests, 95 % of the delivered products shall fulfill the requirements of 5.1 to 5.3. The sampling schemes provided in ISO 390 with an AQL of 4 % and an inspection level S_3 ensure that for large batches approximately 95 % of the items fulfill these requirements. Other methods may be used provided they give the same level of quality.

For each type-test, in the absence of a fundamental change to the formulation and/or method of manufacture, results from one test shall be taken as conformity to the specification.

8.2 Evidence of conformity of consignment of finished products

When tenders and/or orders do not specify receiving inspection, the lots delivered are presumed to be in conformity with the standard.

Inspection of a consignment of finished products should take place only where there is no third party certification.

It is conducted in accordance with ISO 390, which gives an AQL of 4 % with an inspection level S_3, and according to annex A.

Annex A
(normative)

Receiving inspection[8] for products which are not subject to third party certification

A.1 When tenders and/or orders specify it, the receiving inspection is carried out in lot(s) of the consignment according to the test programme of this product standard, unless there is a special agreement. Therefore, the test programme necessarily covers the acceptance tests.

Details related to the application of the sampling clauses shall be established in agreement between the manufacturer and the purchaser.

A.2 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. Failing such an agreement, the maximum and minimum inspection lots shall be 20 000 and 3 000 shingles respectively for all dimensions.

A.3 The tests shall normally be carried out by an independent laboratory selected by mutual agreement between the manufacturer and the purchaser. The laboratory of the manufacturer can be used. In case of dispute, the tests shall be carried out in the presence of both parties.

A.4 When non-destructive tests are carried out and the result of the sampling inspection do not meet the acceptance requirements of the product standard, the tests can 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 between the manufacturer and purchaser.

8) See ISO 390.