BS EN 12326-2:2011

BSI Standards Publication

Slate and stone for discontinuous roofing and external cladding

Part 2: Methods of test for slate and carbonate slate

National foreword

This British Standard is the UK implementation of EN 12326-2:2011. It supersedes BS EN 12326-2:2000 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/542/7, Slate and stone products.

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

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English Version

Slate and stone for discontinuous roofing and external cladding - Part 2: Methods of test for slate and carbonate slate

Ardoises et pierres pour toiture et bardage extérieur pour pose en discontinu - Partie 2: Méthodes d'essais pour ardoises et ardoises carbonatées

Schiefer und Naturstein für überlappende Dachdeckungen und Außenwandbekleidungen - Teil 2: Prüfverfahren für Schiefer und carbonathaltige Schiefer

This European Standard was approved by CEN on 19 May 2011.

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Foreword

This document (EN 12326-2:2011) 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of an identical text or by endorsement, at the latest by December 2011, and conflicting national standards shall be withdrawn at the latest by December 2011.

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

This document supersedes EN 12326-2:2000.

The most important changes in this version of the standard concern:

- Clause 10 "Determination of the modulus of rupture, and characteristic modulus of rupture";

- Clause 12 "Freeze-thaw test";

- Clause 13 "Determination of the apparent calcium carbonate and non carbonate carbon content by catalytis thermal decomposition";

- a new informative Annex B has been added "Petrographic examination of origin and identification of slate".

EN 12326 consists of the following parts:

- *Part 1: Product specification*;

- *Part 2: Methods of test for slate and carbonate slate*.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies test methods for slate and carbonate slate for roofing and wall cladding. It is applicable to natural roofing products as defined in EN 12326-1:2004 used for assembly into discontinuous roofs and external wall cladding.

NOTE Where the term "slate" is used in this document it means slate and carbonate slate unless otherwise indicated.

2 Normative references

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

EN 12326-1:2004, *Slate and stone products for discontinuous roofing and cladding — Part 1: Product specification*

3 Terms, definitions and symbols

3.1 Terms and definitions

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

3.1.1
test piece (of slate)
piece sawn from a slate and prepared for testing as defined by the relevant test procedure

3.1.2
powdered test piece (of slate)
piece or pieces of a slate or slates prepared for testing by grinding to a powder of a defined particle size

3.1.3
sampling
process of selecting a slate or a set of slates for testing

3.1.4
constant mass
mass achieved when two successive weightings taken 24 h apart do not differ by more than 0,001 g (or 0,01 % of the weight of the test piece)

3.1.5
modulus of rupture
maximum stress sustained by a slate test piece when a bending moment is applied

NOTE In this European Standard the geometry of the test is three point bending.

3.2 Symbols

Symbol	Physical quantity	Unit
A_w	water absorption	%
a	rate of application of stress in the bend strength test	(N/mm^2)/s

b	width of a slate or a test piece	mm
C'_a	apparent mass percentage calcium carbonate in slate	%
C_c	carbonate carbon content of slate	%
$\overline{C}_c$	mean carbonate carbon content of a slate	%
C_d	carbon dioxide content of a test piece or standard preparation	%
C_T	total carbon in a slate	%
C_{nc}	non-carbonate carbon in a slate	%
e	thickness of a slate	mm
e_m	mean of three thickness measurements used to determine the rate of application of load in the bend strength test	mm
e_{max}	maximum of four thickness measurements carried out on one slate test piece	mm
$\overline{e}$	mean thickness of a slate test piece or series of test pieces	mm
$\overline{e}_i$	mean of 8 thickness measurements in the modulus of rupture test	mm
E_d	maximum deviation of the thickness of a slate from the mean thickness	%
e_s	thickness of the softened layer in the SO_2 exposure test	mm
e_{1A} to e_{4A}	individual thickness measurements in the SO_2 exposure test	mm
E_1	conductivity reading for total carbon	S/m
E_2	conductivity reading for non-carbonate carbon	S/m
f	gas volume reduction factor of the pump in the determination of non-carbonate carbon content by coulometry	-
f'	gas volume reduction factor of the pump in the blank determination of non-carbonate content by coulometry	-
$f_1 f_2$	means of three dial gauge readings in the flatness test	mm
f_d	deviation from flatness of a slate	mm
F_d	deviation from flatness of a slate as a percentage of its length	%
I	number of pulses recorded in the determination of non-carbonate carbon content by coulometry	-
I'	number of pulses recorded in the blank determination of non-carbonate carbon content by coulometry	-
k	proportionality factor specific to the apparatus in the determination of non-carbonate carbon content by coulometry	-

$\lambda K\alpha$	wavelength of the α radiation used in the x-ray diffraction analysis	nm
l_s	length of a slate	mm
l_t	distance between the bending supports to base	mm
m_o	dry mass of a test piece in the water absorption test	g
m_p	mass of a powdered test piece of slate	mg
m_c	mass of a powdered test piece used for total carbon in the determination of apparent calcium carbonate content by the conductivity of sodium hydroxide	mg
m_{nc}	mass of a powdered test piece for non-carbonate carbon in the determination of apparent calcium carbonate content by the conductivity of sodium hydroxide	mg
m_s	mass of calcium carbonate used in the determination of apparent calcium carbonate content by conductivity of sodium hydroxide	mg
m_w	wet mass of a test piece in the water absorption test	g
m_1	total carbon content in the determination of apparent calcium carbonate content by catalytic thermal decomposition	%
m_2	content of non-carbonate carbon in the determination of apparent calcium carbonate content by catalytic thermal decomposition	%
m_3	content of carbonate carbon in the determination of apparent calcium carbonate content by catalytic thermal decomposition	%
n	number of slates subject to a test	-
P_i	failure load of individual slates in the bending strength test	N
r_d	individual measurements of the deviation of a slate from a rectangle	mm
r_{dmax}	maximum deviation of a slate from a rectangle	mm
R_d	deviation of a test slate from a rectangle as a percentage of its length	%
R R_i	modulus of rupture of test slates	N/mm^2
$\overline{R}$	sample mean modulus of rupture of test slates	N/mm^2
$\overline{R}_l$	sample mean modulus of rupture of test slates measured in the longitudinal orientation	N/mm^2
$\overline{R}_t$	sample mean modulus of rupture of test slates measured in the transverse orientation	N/mm^2
R_c	characteristic modulus of rupture of test slates	N/mm^2
$\overline{R}_1$	sample mean modulus of rupture of the control test pieces in the freeze-thaw test	N/mm^2

$\overline{R}_2$	sample mean modulus of rupture of the frost exposed test pieces in the freeze-thaw test	N/mm^2
s	sample standard deviation of the modulus of rupture	-
s_l	sample standard deviation of the modulus of rupture in the longitudinal orientation	-
s_t	sample standard deviation of the modulus of rupture in the transverse orientation	-
s_1	sample standard deviation of the modulus of rupture of the control test pieces after the freeze-thaw test	-
s_2	standard deviation of the modulus of rupture of the frost exposed test pieces after the freeze-thaw test	-
s_d	deviation of the edge of a slate from a straight edge	mm
S_d	deviation of the edge of a slate from a straight edge as a percentage of its length	%
v_l	rate of application of the load in the bend strength test	N/s
α	deviation of a slate from rectangle	°
θ	angle of incidence of the beam in the X-ray diffraction analysis	°

4 Surveillance sampling procedure

Sampling shall be carried out by selecting slates from each lot separately in a random way so that every slate has an equal chance of being selected. Selected slates shall be marked so as to identify which lot they came from. Table 1 indicates the number of slates required for each test. In the case of disputes test slates need only be taken for those tests which are in doubt.

Table 1 — The number of slates required to carry out each test

Test	Number of slates required from each lot for each test
Length and width	1
Straight edges	1
Rectangularity	1
Individual thickness	1
Curvature	1
Bend strength	20/40*
Water absorption	5
Freeze-thaw	20/40*
Non-carbonate carbon content	3
Carbonate content	3
Sulfur dioxide exposure for less than or equal to 20 % carbonate	12
Sulfur dioxide exposure for more than 20 % carbonate	6 or 12*
Thermal cycle	6

NOTE 1 Because many of the tests do not require whole slates it is possible to carry out a full set of tests with fewer than the total number of slates listed in this table.

NOTE 2 For the tests marked * the number of slates required depends on their size.

NOTE 3 The individual tests indicate the size and number of test pieces or powdered test pieces required.

NOTE 4 Where there is a possibility that the slates being tested may contain localised harmful inclusions such as calcite veins or oxidisable minerals the preparation of the test pieces or powdered test pieces should be modified to ensure sufficient inclusions are contained in the test piece to provide a representative result.

NOTE 5 Sampling should preferably be carried out by the recipient or his representative in the presence of the supplier.

5 Determination of the length and width and the deviation from the specified length and width

5.1 Principle

The dimensions of slates are measured using a steel rule placed on the midline of the length and the width. The percentage deviation from the specified dimension is calculated.

5.2 Apparatus

5.2.1 **A steel rule** capable of reading to 0,5 mm.

5.2.2 **Two steel bars** longer and thicker than the slates under test.

Each bar shall have one edge which shall not deviate from a straight edge by more than ± 0,1 mm.

5.3 Preparation of test pieces

Whole slates are used and do not need any preparation unless any corners are oversized within 50 mm of the corner. In this case remove the over size corner(s) at an angle of approximately 45° from a point 50 mm from the corner, using a suitable cutting tool.

5.4 Procedure

Place the slate with the chamfered edge facing down. Align the straight edges of the two steel bars along the long edges of the slate. Using a steel rule find the midpoints of the length of the slate on each side to the nearest 1,0 mm at each end and mark the positions on the slate. Place the steel rule across the distance between the bars at the marked points. Read off and record the width to the nearest 1,0 mm.

Repeat for the length.

5.5 Expression of the results

Calculate the difference of the length from the specified length as a percentage.

Calculate the difference of the width from the specified width as a percentage.

5.6 Test report

Report the length and width in millimetres and the deviation in percentage from the specified length and width.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

6 Determination of the amount by which the edges deviate from a straight edge

6.1 Principle

The deviation of the long edges of slates from a straight edge is measured using a steel rule. For slates 500 mm long or longer the deviation is calculated as a percentage of the length.

6.2 Apparatus

6.2.1 A steel rule capable of reading to 0,5 mm.

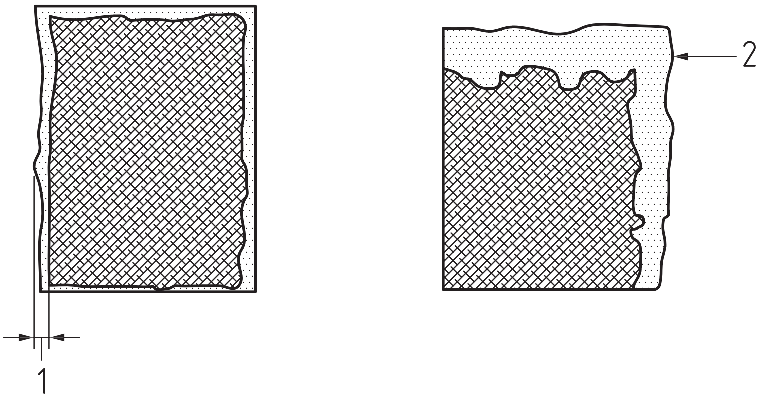
6.2.2 A steel bar longer and thicker than the slates under test with one edge which shall not deviate from a straight edge by more than ± 0,1 mm.

6.3 Preparation of test pieces

Whole slates are used and do not need any preparation unless any corners are oversized within 50 mm of the corner. In this case the over size corner(s) shall be removed at an angle of approximately 45° from a point 50 mm from the corner, using a suitable cutting tool.

6.4 Procedure

Place the slate with the chamfered edge facing down and position the straight edge of the steel bar alongside one edge of the slate. Using the steel rule measure the maximum deviation (S_{d1}) of the edge of the slate from the steel bar to the nearest 0,5 mm. Ignore small deviations and flaking resulting from the dressing of the edges (Figure 1). Repeat and record the deviation for the other edge (S_{d2}).



Key

1 deviation from a straight edge

2 acceptable minor deviations and flaking

Figure 1 — Illustration of acceptable small variations and flaking resulting from the dressing of the edges of slates. The chamfer is shown facing upwards.

Measure the length of the slate (l_s) by the method given in Clause 5.

6.5 Expression of the results

For slates of 500 mm or longer and for each edge calculate the percentage deviation from a straight edge (S_d) using the equation:

$$S_d = \frac{s_{dx} \times 100}{l_s}$$

where

S_{dx} is the deviation for each edge, s_{d1} and s_{d2} in millimetres;

l_s is the length of the slate in millimetres.

6.6 Test report

For slates less than 500 mm long report for each edge the deviation in mm from a straight edge.

For slates 500 mm long or longer report for each edge the deviation in mm from a straight edge and the percentage deviation.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

7 Determination of the rectangularity of slates

7.1 Principle

The deviation from a right angle of the angles enclosing any two sides is measured using a goniometer or an engineering set square. The deviation is calculated as a percentage of the length.

7.2 Apparatus

7.2.1 A try square with blades longer and thicker than the slates under test calibrated to an accuracy of 0,1°.

7.2.2 Alternatively, a goniometer (calibrated adjustable square) with blades longer and thicker than the slates under test capable of being read to 0,1°.

7.3 Preparation of test pieces

Whole slates are used and do not need any preparation unless any corners are oversized within 50 mm of the corner. In this case remove the over size corner(s) at an angle of approximately 45° from a point 50 mm from the corner using a suitable cutting tool.

7.4 Procedure

Place the slate in the set square with one end tightly against the blade so that the long edge of the slate touches the opposite blade. Using the steel rule measure the maximum deviation (r_{d1}) of the long edge from the opposing blade of the set square to the nearest 0,5 mm.

Repeat for all four corners to obtain the values (r_{d2}), (r_{d3}) and (r_{d4}).

Alternatively, if a goniometer is used read the deviation in degrees to the nearest 0,1°.

Measure the length of the slate (l_{s}) by the method given in Clause 5.

7.5 Expression of the results

For each edge, calculate the percentage deviation (R_{d}) from a rectangle using the equation:

$$R_{\mathrm{d}} = \frac{r_{\mathrm{dmax}} \times 100}{l_{\mathrm{s}}}$$

where

r_{dmax} is the maximum value of (r_{d1}) to (r_{d4}) in millimetres;

l_{s} is the slate length in millimetres.

Alternatively, if a goniometer has been used calculate the percentage deviation using the equation:

$$R_{\mathrm{d}} = \tan \alpha \times 100$$

where

α is the maximum angle measured in 7.4.

7.6 Test report

Report the maximum percent deviation.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

8 Determination of the thickness of individual slates

8.1 Principle

The thickness of individual slates is measured at four points using a micrometer, or similar equipment. The thickness is expressed as the mean of the four readings.

8.2 Apparatus

Dial gauge, micrometer or similar equipment capable of measuring thickness to 0,05 mm with a contact area of 5 mm to 10 mm diameter.

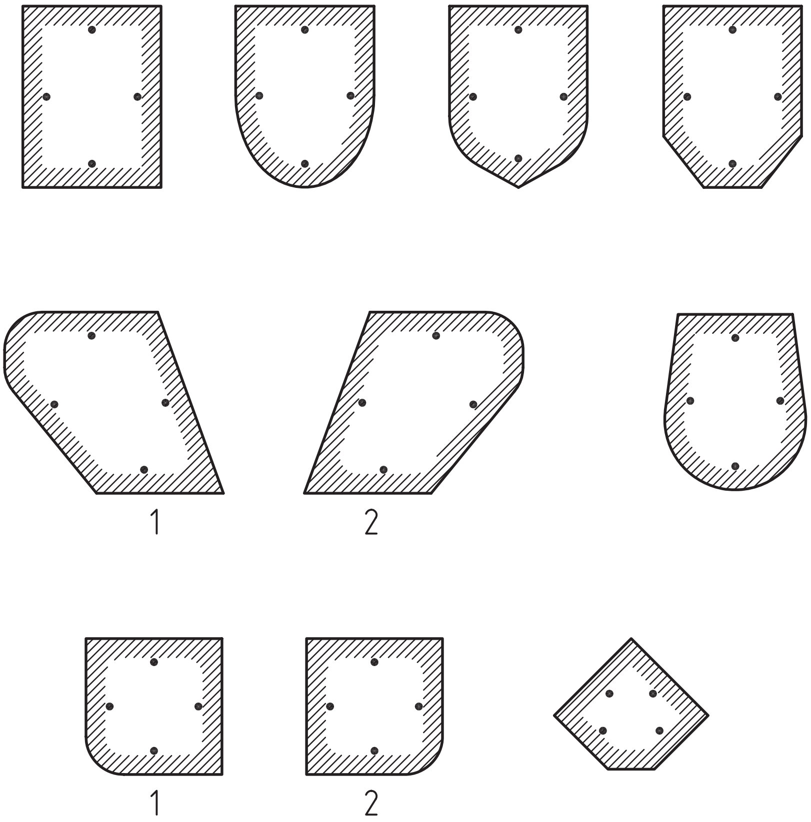
8.3 Preparation of test pieces

Whole slates are used. They do not require any preparation.

8.4 Procedure

Measure the thickness of the slate to 0,1 mm at four points avoiding all dressed edges and any localised thick or thin areas.

NOTE Figure 2 indicates the approximate points of measurement for various slate shapes.



Key

▨ perimeter zone of the slate (width 25 mm) excluded from thickness measurements.

● point of measurement recommended (25 mm to 30 mm from edge)

1 Right

2 Left

Figure 2 — Approximate positions for measurements of individual thickness

8.5 Expression of results

Calculate the mean of the four measurements and, using the largest individual value, the maximum deviation from the mean thickness (E_d) as a percentage to two significant figures using the equation:

$$E_\mathrm{d} = \left(\frac{e_\mathrm{max} - \bar{e}}{\bar{e}} \right) \times 100$$

where

e_max is the maximum individual thickness measurement in millimetres;

$\bar{e}$ is the mean thickness in millimetres.

8.6 Test report

Report the mean value of the individual thicknesses to 0,1 mm and the maximum percent deviation from the mean.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

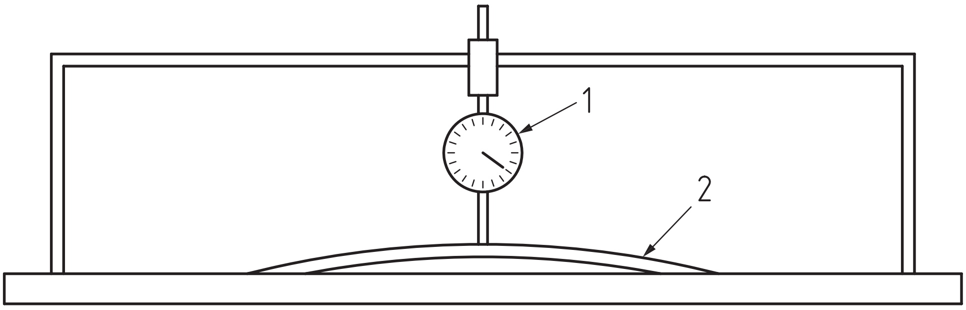
9 Determination of the deviation from flatness

9.1 Principle

The deviation from flatness of individual slates is determined by measuring the difference in millimetres in the deflection of a dial gauge when placed in turn in contact with the concave and convex faces of a slate.

9.2 Apparatus

9.2.1 Apparatus comprising a dial gauge or similar device capable of reading deflections of 0,1 mm and with a contact area of 5 mm to 10 mm diameter arranged above a surface plate as large as the slates to be tested. The dial gauge shall be capable of being moved to various positions above the slate. A typical apparatus is shown in Figure 3. Other similar apparatus may be used.



Key

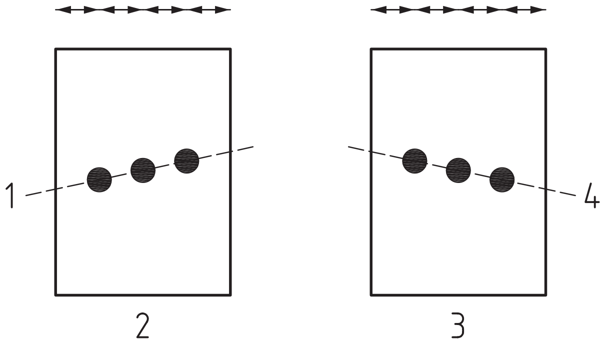
1 dial gauge

2 test slate in position with maximum curvature under gauge

Convex side upwards

Figure 3 — Typical apparatus for measuring the deviation from flatness

9.2.2 The apparatus described in 5.2.



Key

1 line of high points

2 convex face

3 concave face

4 line of low points

Figure 4 — Approximate measurement positions in the determination of deviation from flatness

9.3 Preparation of test pieces

Individual slates are used but they do not need any preparation.

9.4 Procedure

Lay the slate convex face uppermost on the surface plate of the test apparatus and move the dial gauge over the highest point on the slate. Record the height of the slate surface in millimetres at three positions equally spaced along the high point of the curvature (Figure 4). Turn the slate over without disturbing the position of the dial gauge and repeat the measurements at the same three positions.

Measure the length of the slate (l_s) to the nearest 1 mm using the method described in Clause 5.

9.5 Expression of results

Calculate the mean of the first three readings (f_1) and the mean of the second three readings (f_2).

Calculate the deviation from flatness (f_d) using the equation:

$$f_d = f_2 - f_1$$

Calculate the percentage deviation from flatness (F_d) using the equation:

$$F_d = \frac{f_d \times 100}{l_s}$$

where

f_d is the deviation from flatness in millimetres;

l_s is the slate length in millimetres.

9.6 Test report

Report the percentage deviation from flatness to the nearest 0,1 %.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

10 Determination of the modulus of rupture, and characteristic modulus of rupture

10.1 Principle

Tests are carried out on prepared test pieces to measure the failure load in bending. From the results the modulus of rupture and the characteristic modulus of rupture are calculated.

10.2 Apparatus

10.2.1 A three point bending test machine, capable of applying a constant rate of loading. The support bars and load bar shall have a diameter of 20 mm and the load bar and any two of the load and support bars shall be free to align themselves to the test piece. The load bar shall be parallel to the support bars. The support bars shall be (180 ± 1,0) mm apart and the load bar shall be central over the span.

NOTE Where an apparatus capable of applying a constant rate of loading is not available a constant rate of deflection is acceptable.

10.2.2 Oven, ventilated and capable of maintaining a temperature of (110 ± 5) °C.

10.2.3 Water cooled diamond saw.

10.2.4 Metal rule or similar equipment, capable of measurements to 1 mm.

10.2.5 Micrometer or similar equipment, capable of measuring thickness to 0,05 mm with a contact area of 5 mm to 10 mm diameter.

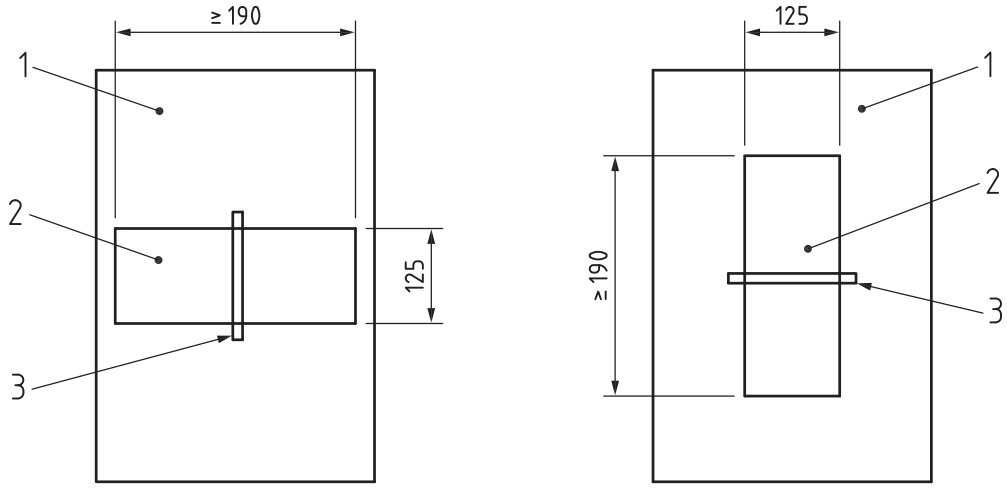
10.3 Preparation of test pieces

Determine the number of test pieces required by reference to Clause 4 but using not less than 20 for each orientation (Figure 5).

Using a water cooled diamond saw cut from each slate one test piece parallel (longitudinal) to the long edge and measuring (125 ± 1,0) mm by the length of the slate (minimum 190 mm), and one test piece perpendicular (transverse) to the long edge and measuring (125 ± 1,0) mm by the width of the slate (minimum 190 mm). Make the saw cuts so that they avoid the dressed edges of the slates and trim off the ends with the saw. If the slates are too small to cut test pieces for each orientation from one slate, two slates shall be used.

Dry the test pieces in the oven at (110 ± 5) °C for (17 ± 2) h and then allow them to cool to ambient temperature.

Dimensions in millimetres



Key

1 slate

2 test piece

3 orientation of the load bar in the test

4 perpendicular or transverse orientation

5 parallel or longitudinal orientation

NOTE The description of the test pieces as transverse or longitudinal is the opposite of that used in some standards for roofing slates.

Figure 5 — Orientations of test pieces in the bend strength test

10.4 Procedure

Using the micrometer or similar apparatus measure the thickness of each test piece in three equally spaced positions across the width. For each test piece calculate the mean (e_m) of the three values. Using a metal ruler measure the width (b) of each test piece to the nearest 1 mm by the method given in Clause 5.

Calculate the loading rate in N/s for each test piece using the equation:

$$v_l = a\frac{2be_m^2}{3l_t}$$

where

a is the rate of application of stress and is equal to (1,00 ± 0,25) (N/mm^2)/s;

v_l is the rate of loading to be used in the test in N/s;

b is the width of the test piece in millimetres;

e_m is the mean thickness of the test pieces in millimetres;

l_t is 180 mm.

Place the test piece in the three point bending test machine centrally under the load bar and check that the distance between the support bars is (180 ± 1,0) mm. Apply the load at the calculated rate v_l.

NOTE If it is not possible to apply a constant rate of loading, it is acceptable to apply a constant rate of deflection so that failure occurs in 20 s to 30 s.

Record the failure load in bending in Newtons to the nearest 1 N. Using a micrometer or similar equipment measure the thickness of the slate (*e*) to 0,1 mm at four evenly spaced points on each side of the break at a distance of 25 mm to 30 mm from the rupture line (8 measurements). Repeat for each of the test pieces.

10.5 Expression of the results

For each orientation calculate:

a) the modulus of rupture (R_i) in N/mm^2 for each test piece using the equation:

$$R_i = \frac{3 \times P_i \times l_t}{2 \times b \times \overline{e}_i^{\,2}}$$

where

P_i is the failure load, in Newtons;

l_t is 180 mm;

b is the test piece width, in millimetres;

$\overline{e_i}$ is the mean of the 8 thickness measurements in mm, taken after testing, at a distance of 25 mm of the rupture line

(4 measurements in each side of the rupture line equally spread).

b) the mean modulus of rupture ($\overline{R}$) in N/mm^2, for the total number of slates tested;

c) calculate the characteristic modulus of rupture (RC), in N/mm^2, for the total number of slates tested (20) using the equation (for one-sided confidence interval of 95 %):

$$R_c = \overline{R} - 1{,}729s$$

where

$$s = \sqrt{\frac{\Sigma\left(R_i - \overline{R}\right)^2}{(20-1)}}$$ the estimate of the standard deviation of the modulus of rupture of 20 slates:

$\overline{R}$ is the mean value of R for the slates tested;

R_i is the individual value of R for each slate tested;

20 is the number of slates tested.

10.6 Test report

The test report shall contain the following information:

a) the loading rate, in Newtons per second for constant rate of loading, (or deflection rate employed, in millimetres per second), stating the mode of loading;

b) the mean thickness of the test pieces, determined after testing, in millimetres;

c) the mean modulus of rupture in each orientation, in N/mm^2, and the standard deviation;

d) the characteristic modulus of rupture in each orientation, in N/mm^2;

e) the orientation of the maximum modulus of rupture.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

11 Water absorption test

11.1 Principle

Dried test pieces are immersed in water at ambient temperature for 48 h and the absorption determined from the difference of the wet and dry mass.

11.2 Reagents

Distilled water, demineralized water or deionized water.

Polishing pastes, 6 µm to 15 µm and 25 µm to 50 µm.

11.3 Apparatus

11.3.1 Oven, ventilated and capable of maintaining a temperature of (110 ± 5) °C.

11.3.2 Water cooled diamond saw.

11.3.3 Balance, capable of weighing to 0,002 g.

11.3.4 Water bath, containing water as specified in 11.2.1 and capable of being maintained at (23 ± 5) °C.

11.3.5 Absorbent cloth.

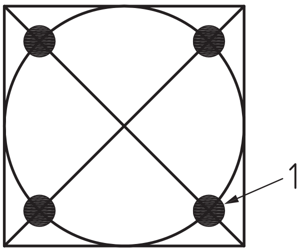
11.4 Preparation of test pieces

From each of five separate slates cut a test piece (100 ± 5,0) mm × (100 ± 5,0) mm by the thickness of the slate using a water cooled diamond saw. Examine the edges of the test piece by naked eye or normal corrected vision to ensure that the edges are free from cracks or splinters. If such defects can be seen either prepare further test pieces or remove the defects by grinding to a smooth finish with a paste of water and fine abrasive between 6 µm and 15 µm. Wash with water and a stiff brush to ensure all the paste is removed..The surfaces of the test pieces shall be free of flakes or loose material.

11.5 Procedure

Measure the thickness of each test piece to 0,1 mm at each of four points as indicated in Figure 6 using the apparatus described in 8.2.2.

Dry the test pieces in an oven at (110 ± 5) °C to constant mass (3.1.4). Allow the test pieces to cool to room temperature overnight in a desiccator and then weigh them to an accuracy of 0,002 g (m_0) or 0,01 % of the weight of the test piece. Immerse the test pieces completely in water (11.2.1) at (23 ± 5) °C for 48 h. Remove them from the water and immediately remove the excess water with a damp absorbent cloth. Weigh each test piece to an accuracy of 0,002 g (m_w) or 0,01 % of the weight of the test piece.



Key

1 indicates the positions of thickness measurements

Figure 6 — Approximate position for the measurement of the thickness of water absorption test pieces

11.6 Expression of the results

Calculate the mean of the 20 thickness measurements.

Calculate the mass percentage water absorption (A_w) to two decimal places using the equation:

$$A_\mathrm{w} = \frac{(m_\mathrm{w} - m_\mathrm{o}) \times 100}{m_\mathrm{o}}$$

where

m_o is the mass of the dry test piece, in grams;

m_w is the mass of the wet test piece, in grams.

Calculate the mean of the five measured absorptions.

If the result for any individual test piece differs from the mean by more than 0,1 % water absorption repeat the test with new test pieces.

NOTE Because the absorption of water is mainly from the edges, test pieces of different thickness can give different absorption values. For strict comparisons between different slates, a thickness of 10 mm should be used for the test pieces.

11.7 Test report

Report the mean thickness of the test pieces to the nearest 0,1 mm, the water absorption of each test piece and the mean of the water absorption as a mass percentage to two decimal places.

If the test was repeated report the second set of results.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

12 Freeze-thaw test

12.1 Principle

The difference in characteristic modulus of rupture of untreated test pieces and similar test pieces subjected to 50 freeze-thaw cycles is determined.

12.2 Reagent

Distilled water, demineralized water or deionized water.

12.3 Apparatus

12.3.1 Water bath, containing water as specified in 12.2 and capable of being maintained at (23 ± 5) °C.

12.3.2 Freezing cabinet, capable of cooling the air temperature to (- 20 ± 2) °C within 2 h of being fully loaded with test pieces.

12.3.3 Bend strength apparatus as described in 10.2.1.

12.3.4 Oven, ventilated and capable of maintaining a temperature of (110 ± 5) °C.

12.3.5 Water cooled diamond saw.

12.3.6 Metal rule.

12.3.7 Micrometer, or similar equipment capable of measuring thickness to 0,05 mm with a contact area of 5 mm to 10 mm diameter.

12.4 Preparation of test pieces

Prepare two sets of 20 pairs (80 in total) of test pieces (125 ± 1,0) mm wide, as specified in 10.3. For slates of sufficient width cut pairs of test pieces from single slates (Figure 7). For narrower slates cut single test pieces from twice the number of slates.

12.5 Procedure

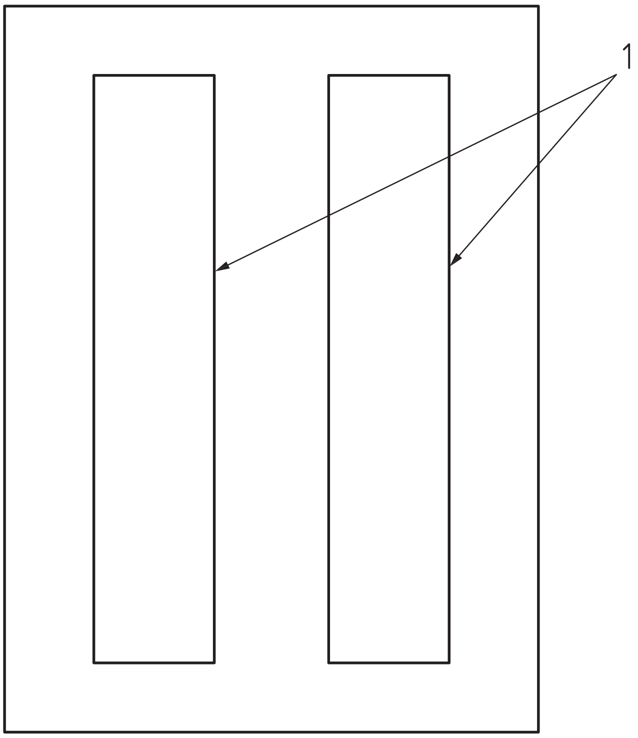
Divide the paired test pieces into two lots, the test lot and the control lot. Test the control lot as described in 10.4. Immerse the test lot in the water bath at (23 ± 5) °C for 48 h.

When soaking is complete place the test pieces in the freezing cabinet (see 12.3.2) until the temperature has been held at (- 20 ± 2) °C for at least 3 h. Then replace the test pieces in the water bath for at least 1 h. This constitutes 1 cycle. During each phase of the cycle separate the test pieces from each other by at least 3 mm.

Repeat the freeze-thaw cycle 49 times to give a total of 50 cycles.

If the procedure has to be interrupted store the test pieces in the water bath at (23 ± 5) °C.

When the 50 cycles are complete dry the test pieces in the oven at (110 ± 5) °C for (17 ± 2) h and then allow them to cool to ambient temperature. Carry out the bend strength test as described in 10.4.



Key

1 test pieces

Figure 7 — Orientation of the test pieces in the freeze-thaw test

12.6 Expression of results and test report

Calculate and report the mean modulus of rupture for each orientation before and after the freeze-thaw test (four values).

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

13 Determination of the apparent calcium carbonate and non carbonate carbon content by catalytic thermal decomposition

NOTE Other methods are acceptable provided that their correlation with the standardized test results are reported and proven accurate and satisfactory. It is the responsibility of the manufacturer to prove this correlation.

13.1 Principle

The total carbon content is determined by thermal decomposition in the presence of a tungsten/tin accelerator using an infra-red detector to measure the amount of carbon dioxide evolved. The total carbon content is indicated directly by the apparatus.

To ensure complete conversion of carbon monoxide to carbon dioxide the gas is passed over a platinum catalyst at a temperature of (1 350 ± 25) °C.

The non-carbonate carbon is separately determined and deducted from the total carbon. The mass percentage apparent calcium carbonate is calculated assuming all the carbonate is present as the calcium salt.

13.2 Reagents

13.2.1 Tungsten/tin accelerator.

13.2.2 Iron chips.

13.2.3 Platinum catalyst.

13.3 Apparatus

13.3.1 Carbon combustion analyser, comprising a furnace capable of achieving a temperature of (1 350 ± 25) °C, balance, infra-red detector, gas flow system and micro-processor control unit.

NOTE The required temperature can be achieved by use of a RF (radio frequency) furnace of 2,0 kW to 2,5 kW at a frequency of 18 MHz.

13.3.2 Grinding mill, capable of producing a powder passing a 100 µm sieve.

13.3.3 Sieve, 100 µm mesh size.

13.3.4 Balance, capable of measuring to 0,000 1 g.

13.4 Preparation of powdered test pieces

Grind sufficient material to obtain an homogenised sample from each of three slates to produce six powdered test pieces each weighing (0,01 ± 0,001) g passing a 100 µm sieve. Different quantities may be used according to the characteristics of the equipment.

13.5 Procedure

13.5.1 Determination of the total carbon content C_T

Add (1,0 ± 0,1) g of tungsten/tin accelerator and (0,70 ± 0,1) g of iron chips to each of the powdered test pieces and mix thoroughly. Different quantities may be used according to the characteristics of the equipment.

Follow the manufacturer's instructions for the preparation of the apparatus and insert one powdered test piece. Ensure the platinum catalyst is at a temperature of (1 350 ± 25) °C. Initiate combustion and record the total carbon as a mass percentage (C_T), as indicated by the infra-red detector. Repeat for the other two powdered test pieces.

Calculate the mean of the three results for total carbon content to two decimal places.

13.5.2 Determination of the non carbonate carbon content C_{nc}

Remove the carbonate carbon by adding an excess of hydrochloric acid separately to each of the three powdered test pieces in turn and allow to stand for 15 h. Wash thoroughly with distilled water and then dry for not less than 10 h at (140 ± 5) °C.

Add (1,0 ± 0,1) g of tungsten/tin accelerator and (0,70 ± 0,1) g of iron chips to each of the dried powdered test pieces and mix thoroughly. Different quantities may be used according to the characteristics of the equipment.

Follow the manufacturer's instructions for the preparation of the apparatus and insert one powdered test piece. Ensure the platinum catalyst is at a temperature of (1 350 ± 25) °C. Initiate combustion and record the mass percentage of non-carbonate carbon (C_{nc}) as indicated by the infra-red detector. Repeat for the other two powdered test pieces.

Calculate the mean of the three results for non-carbonate carbon to two decimal places.

If the apparatus does not indicate carbon directly, calculate the mass percentage non-carbonate carbon using the equation:

$$C_{\mathrm{nc}} = \frac{C_{\mathrm{d}} \times 12}{44}$$

where

C_{nc} is the mass percentage non-carbonate carbon content;

C_{d} is the mass percentage carbon dioxide content indicated by the analyser.

13.6 Expression of results

Calculate the mean of the three values for non-carbonate carbon (C_{nc}) to one decimal place.

Calculate the mean of the three values for total carbon (C_{T}) to one decimal place.

Calculate the mass percentage of carbonate carbon (C_{c}) to one decimal place using the equation:

$C_{\mathrm{c}} = C_{\mathrm{T}} - C_{\mathrm{nc}}$

Assume all of the carbonate carbon content is derived from calcium carbonate and calculate the apparent mass percentage calcium carbonate to one decimal place using the equation:

$$C'_{\mathrm{a}} = \frac{C_{\mathrm{c}} \times 100{,}1}{12}$$

where

C'_{a} is the apparent mass percentage calcium carbonate;

C_{c} is the mass percentage carbonate carbon.

13.7 Test report

Report the mean apparent calcium carbonate content as a mass percentage to one decimal place.

Report the non carbonate carbon content.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

14 Sulfur dioxide exposure tests

14.1 Sulfur dioxide exposure test for slates with a carbonate content less than or equal to 20 % (mass percentage)

14.1.1 Principle

Pairs of test pieces sawn from roofing slates, one dry and one soaked in water, are exposed to sulfur dioxide atmospheres at each of two concentrations for up to 21 days. Depending on the physical changes observed during or on completion of the exposure, a code as specified in EN 12326-1:2004 is assigned to the slates.

14.1.2 Reagents

14.1.2.1 Sulfurous acid solution, containing 5 % to 6 % by mass of sulfur dioxide in water.

14.1.2.2 Prepare two solutions as follows for each 60 l volume of the container:

a) solution A. Dilute (0,6 ± 0,01) l of the 5 % to 6 % sulfurous acid with (0,18 ± 0,01) l of distilled, demineralized or de-ionised water;

b) solution B. Dilute (0,18 ± 0,01) l of the 5 % to 6 % sulfurous acid with (0,6 ± 0,01) l of distilled, demineralized or de-ionised water.

14.1.2.3 Polishing paste, 6 µm to 15 µm.

14.1.2.4 Distilled, demineralized or deionized water.

14.1.3 Apparatus

14.1.3.1 Two gas tight acid resistant containers, with an inner volume of at least 60 l.

NOTE 1 For convenience of observations during exposure glass containers are preferable.

NOTE 2 The apparatus should be placed in a room maintained at (23 ± 2) °C.

14.1.3.2 Water cooled diamond saw.

14.1.3.3 Two frames, non-corroding and capable of supporting six test pieces separated and in a vertical position approximately 100 mm above the acid during exposure to the sulfurous acid solutions.

14.1.3.4 Oven, ventilated and capable of maintaining a temperature of (110 ± 5) °C.

14.1.4 Preparation of test pieces

Using a water cooled diamond saw cut six pairs of test pieces measuring (150 ± 5,0) mm × (100 ± 5,0) mm, one pair from each of six slates. The pieces shall not contain any dressed edges.

Inspect the sawn edges by naked eye or normal corrected vision to ensure the edges are free from cracks or splinters. If such defects can be seen either prepare further test pieces or remove the defects by grinding to a smooth finish with a paste of water and fine abrasive between 6 µm and 15 µm. Wash with water and a stiff brush to ensure all the paste is removed.

14.1.5 Procedure

Confirm that the apparent carbonate content of the slates is less than 20 % using one of the methods specified in Clause 14.

Take one of each of the pairs of test pieces and dry them for 24 h in an oven at (110 ± 5) °C. Completely immerse the other six test pieces in water (14.1.2.4) at (23 ± 5) °C for 24 h.

Introduce the whole of solution A into one of the containers and place not more than six of the test pieces, three dry and three soaked in a frame, approximately 100 mm above the acid solution. Close and seal the container and maintain at (23 ± 5) °C for 21 days or until the test criteria listed below can be observed without opening the container.

Repeat for the other six test pieces using solution B.

Alternatively the exposure to solution B may be completed before the exposure to solution A. If the test pieces exhibit the characteristics listed below when this test is complete, it is not necessary to carry out the test in solution A.

After 21 days, or sooner if the test criteria have been observed, remove the test pieces and allow them to dry in air at (23 ± 5) °C for 24 h. Inspect the edges and surfaces of the test pieces by naked eye or normal corrected vision for colour changes, swelling or softening, splitting or cracking of the edges, or surface flaking. Determine the appropriate code depending on the inspection (EN 12326-1:2004).

14.1.6 Test report

Report any splitting or cracking of the edges and swelling, softening or surface flaking of any one or more test piece, the solution (A or B) used and the appropriate code. Also report any colour changes as information but do not use them to determine the code.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

14.2 Sulfur dioxide exposure test for slates with a calcium carbonate content more than 20 % (mass percentage)

14.2.1 Principle

The softening of a slate resulting from exposure to an atmosphere of moist sulfur dioxide is determined by scraping the surface under a standard load before and after exposure and measuring the increased depth of the scratches.

14.2.2 Reagents

14.2.2.1 Sulfur dioxide gas.

14.2.2.2 Distilled water, demineralized water or deionized water.

14.2.2.3 Polishing paste, 6 µm to 15 µm.

14.2.3 Apparatus

14.2.3.1 Hermetically sealed acid resistant vessel, capacity 300 l, including a means of regulating the water temperature at (40 ± 3) °C, a means of introducing a measured volume of sulfur dioxide into the vessel above the water surface, a vent to safely release excess pressure and an inclined upper surface which prevents drops of moisture falling onto the test pieces.

NOTE 1 For convenience of observation a glass vessel is preferable.

NOTE 2 For vessels with a different volume, corrections should be made to the quantities of reagents used so that the ratio of the concentration of sulfur dioxide vapour to the surface area of the test pieces is the same as that specified.

NOTE 3 The apparatus should be maintained at (23 ± 5) °C and if opened it should be exposed to an atmosphere of (50 ± 5) % relative humidity.

NOTE 4 An apparatus suitable for this test is described in EN ISO 6988.

14.2.3.2 Non-metallic frame, acid resistant, capable of supporting the test pieces inside the vessel 20 mm apart and approximately 200 mm above the surface of the water and 100 mm from the sides of the vessel. The frame shall not significantly shield the test pieces from exposure to the acid atmosphere.

14.2.3.3 Scraping device 1, for scraping the surface of the test piece, comprising essentially the arrangement shown in Figure 8. A tungsten alloy square-edged blade 20 mm wide by 5 mm thick arranged perpendicular to the test piece and capable of applying a constant force of 12 N to 15 N as it is drawn linearly across the test piece for a distance of 40 mm and withdrawn from contact as it is returned to the original position.

or

14.2.3.4 Scraping device 2, as shown in Figure 9 comprising a blade (see Figure 10) held in a fixed position applying a force of 9,8 N through a horizontal curved scraping area of 180° and, to support the test piece, a motorised turntable. A tool with a scraping edge ground to 25 mm radius, mounted on a beam at 22° shear angle to the slate surface. The beam shall be capable of adjustment by means of weights to apply a predetermined load to the scraping tool when it is in contact with the slate.

14.2.3.5 Template, suitable to mark the positions for thickness measurements when using scraping device 1 as shown in Figure 11.

14.2.3.6 Micrometer, or similar equipment, capable of measuring thickness to 0,01 mm with a spherical contact point with a maximum diameter of 10 mm.

14.2.3.7 Grinding and polishing machine.

14.2.4 Preparation of test pieces

Cut 12 test pieces (100 ± 5,0) mm × (50 ± 5,0) mm using a water cooled diamond saw, two from each of six separate slates, avoiding the dressed edges. Examine the edges of the test pieces by naked eye or normal corrected vision to ensure that the edges are free from cracks or splinters. If such defects can be seen either prepare further test pieces or remove the defects by grinding to a smooth finish with a paste of water and fine abrasive between 6 µm and 15 µm.

Grind the upper and lower faces of the test pieces to a smooth surface and polish with a paste of water and fine abrasive between 6 µm and 15 µm. Wash with water and a stiff brush to ensure all of the abrasive paste is removed.

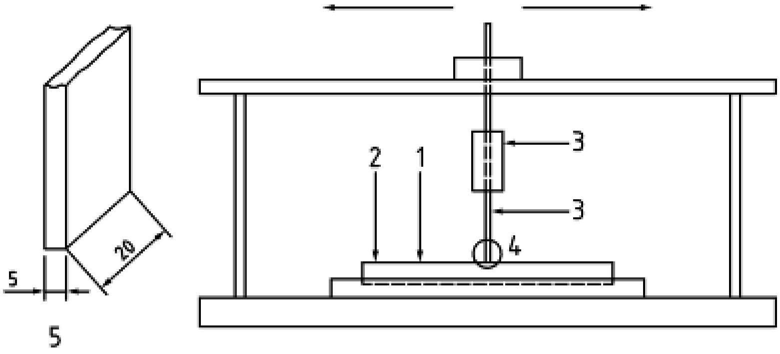
14.2.5 Procedure

Confirm that the apparent carbonate content is 20 % or more using one of the test methods specified in Clause 14.

To define the scraping area mark each test piece by gently drawing the blade across the surface. For device 1 use the template to locate the measurement positions. If scraping device 2 is used mark the measuring positions on the test piece as shown in Figure 12. Measure the thickness (e_1) in millimetres to ± 0,01 mm at each of the four points on the first test piece and then place it in the scraping apparatus. Carry out one scraping and repeat the four thickness measurements (Figure 13) (e_2).

Repeat for each test piece.

Dimensions in millimetres

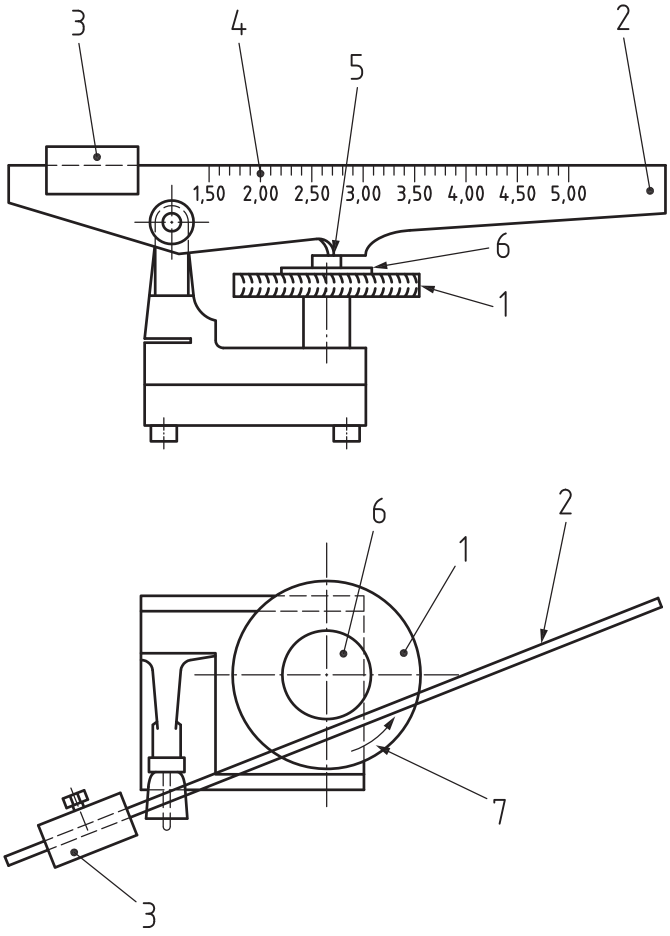


Key

1	test piece
2	test piece carrier
3	load of 12 N to 15 N
4	blade in lowered position
5	detail of square edged blade

Figure 8 — Scraping device 1 for the sulfur dioxide exposure test for slates with an apparent calcium carbonate content of more than 20 %

Dimensions in millimetres



Key

1	rotary sample carrier
2	lever arm for scraping tool
3	sliding counterweight
4	lever arm graduation
5	scraping tool (see Figure 10)
6	tightening nut
7	direction of rotation

Figure 9 — Scraping device 2 for the sulfur dioxide exposure test for slates with an apparent calcium carbonate content of more than 20 %

Dimensions in millimetres

Angles in degrees

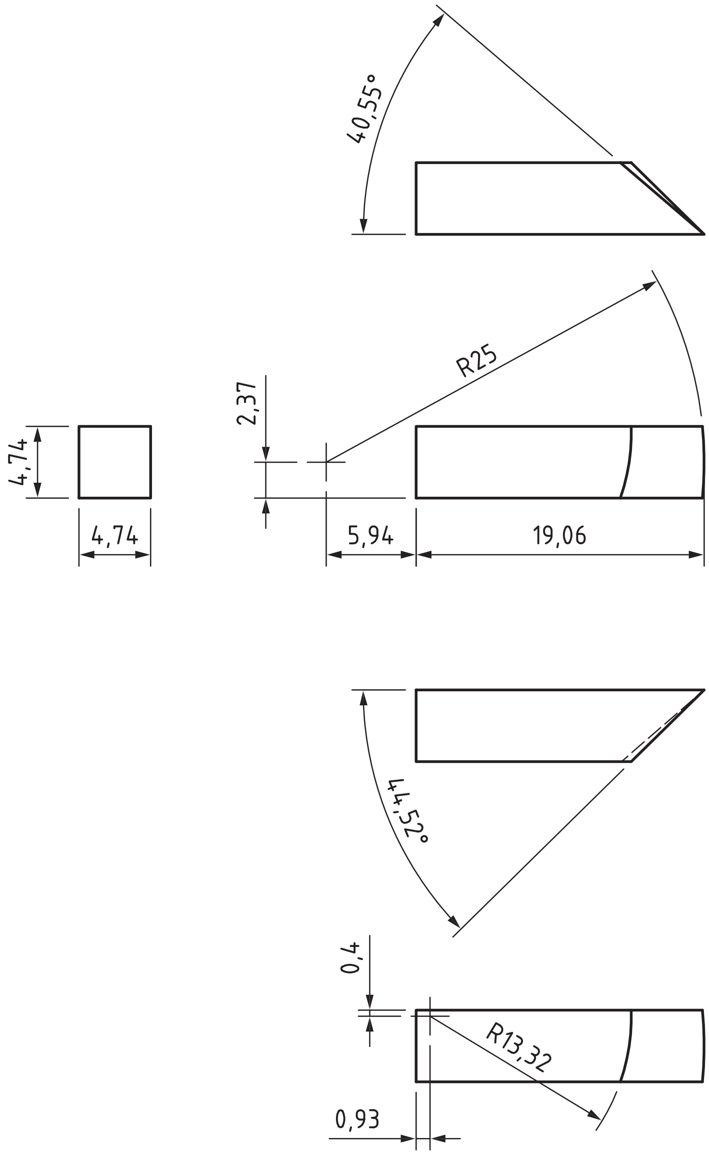
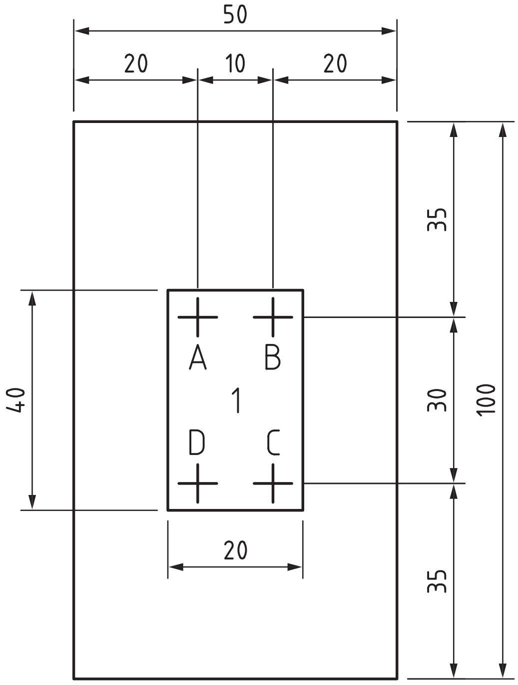


Figure 10 — Blade for use in scraping device 2 in the sulfur dioxide exposure test for slates with an apparent calcium carbonate content of more than 20 %

Dimensions in millimetres



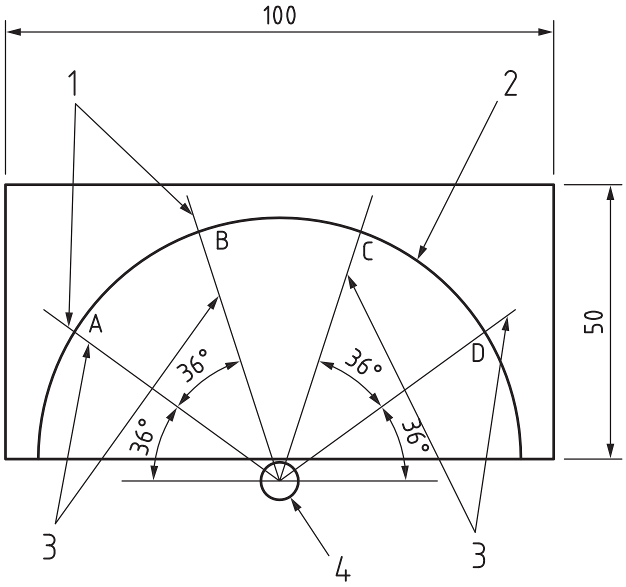
Key

1 scraped area

A to D positions for measurements

Figure 11 — Positions of thickness measurements for a linear scrape through 40 mm in the sulfur dioxide exposure test for slates with an apparent calcium carbonate content of 20 % or more

Dimensions in millimetres



Key

1 pencilled lines
2 arc drawn with pencil compass (path of shearing tools)
3 points where dial readings are taken
4 centre pivot of turntable
A to D points where measurements are taken

Figure 12 — Positions of thickness measurements for a curved scrape through 180° in the sulfur dioxide exposure test for slates with an apparent calcium carbonate content of more than 20 %

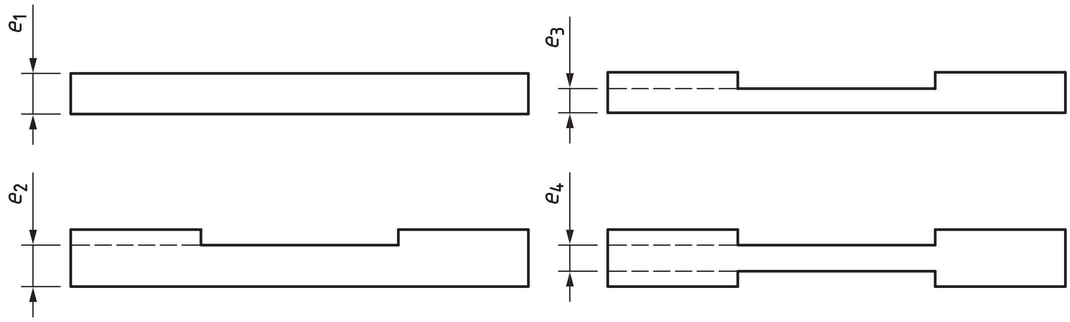


Figure 13 — Thickness measurements in the sulfur dioxide exposure test for slates with an apparent calcium carbonate content of more than 20 %

Assemble the test pieces on the support frame and place in the exposure vessel. Introduce 2 l of water (14.2.2.2), equivalent to 0,67 % of the vessel's volume, and seal the vessel against vapour leaks.

Carry out the following steps which comprise one cycle:

a) raise the temperature of the water to (40 ± 3) °C and allow to stand for 30 min. Introduce 2 l of sulfur dioxide gas, equivalent to 0,67 % of the vessel’s volume and maintain the temperature until 8 h has expired;

b) switch off the water heater and thoroughly ventilate the vessel by opening it to the environment defined in 14.2.4 for 16 h;

c) remove the water.

Repeat steps a) to c) for a further 24 cycles.

If the procedure is interrupted the apparatus and the test pieces shall be maintained in the ventilated condition for the duration of the interruption.

When the 25 cycles are complete wash the test pieces and allow them to dry for (24 ± 2) h. Repeat the thickness measurements (e_3) in the four positions of each test piece on the other face to that originally measured.

Replace each test piece in turn in the scraping apparatus with the other face to that originally scraped towards the blade and scrape the face until constant thickness is achieved. This will normally take only a few passes of the blade. Measure the thicknesses (e_4) in the four positions for each test piece.

14.2.6 Expression of results

For each test piece calculate the thickness of the softened layer (e_s) for each of the measuring positions A to D using the equation:

Thickness of the softened layer $e_s = (e_3 - e_4) - (e_1 - e_2)$

where

e_1 to e_4 are individual thickness measurements in millimetres.

Repeat for each position of each test piece and calculate the mean value for all the tests to 0,10 mm.

14.2.7 Test report

Report the following information:

a) the mean value of the thickness of the softened layer and the range, in millimetres;

b) the type of scraping apparatus used.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

15 Thermal cycle test

15.1 Principle

Test pieces sawn from slates are subjected to cycles of drying at (110 ± 5) °C and immersion in water at (23 ± 5) °C. On completion of 20 cycles the test pieces are inspected for physical changes indicative of the presence of harmful mineral components. A code, as specified in EN 12326-1:2004 is assigned to the slates.

15.2 Reagents

15.2.1 Polishing paste, 6 µm to 15 µm.

15.2.2 Distilled water, de-mineralised water or de-ionised water.

15.3 Apparatus

15.3.1 Oven, ventilated and capable of maintaining a temperature of (110 ± 5) °C.

15.3.2 Water bath, containing water (15.2.2) and capable of being maintained at (23 ± 5) °C.

15.3.3 Water cooled diamond saw.

15.3.4 Non-corroding frame, capable of supporting the test pieces separated and in a vertical position throughout the test. The frame shall not significantly shield the test pieces during immersion and drying.

15.3.5 Magnifying lens of 2 dioptres power.

15.4 Preparation of test pieces

Test pieces shall be (200 ± 5,0) mm × (300 ± 5,0) mm but may be smaller if the original slates are smaller than this size.

From each of six separate slates cut a test piece the thickness of the slate using a water cooled diamond saw. Examine the edges of the test piece with a magnifying lens of 2 dioptres to ensure that the edges are free from cracks or splinters. If such defects can be seen either prepare further test pieces or remove the defects by grinding to a smooth finish with a paste of water and fine abrasive of 6 µm to 15 µm.

15.5 Procedure

Place the test pieces in the frame and immerse all the test pieces in water (15.2.2) at (23 ± 5) °C for 6 h and then dry them in a well ventilated oven at (110 ± 5) °C for 17 h. Following drying allow the test pieces to cool before inspecting them.

One hour after removal from the oven replace the test pieces in the water. This constitutes one cycle. Repeat for 20 cycles. The orientation of the test pieces shall not alter throughout the 20 cycles.

If the test is to be interrupted it shall be during the heating stage and the test pieces shall remain in the oven until the test recommences.

After each cycle inspect the test pieces with the naked eye or normal corrected vision for signs of oxidation, staining or changes in the colour of any metallic minerals.

After every fifth cycle inspect the test pieces with a magnifying lens of 2 dioptres power for swelling, splitting flaking or exfoliation. Determine the appropriate code, depending upon the observations (EN 12326-1:2004).

Colour changes in this test result from the oxidation (rusting) of metallic minerals and are brown coloured. Other colour changes should be ignored. Oxidative colour changes can be limited to the surface of the metallic minerals and be non-progressive, or they can be progressive leading to staining of the surface of the slate beyond the mineral and may cause disruption of the mineral and/or slate. Report colour changes as:

a) a patina affecting the surface of the metallic mineral;

b) staining of the surface of the slate beyond the metallic mineral but not affecting the structure of the slate;

c) staining associated with structural alterations of the slate.

15.6 Test report

Report all signs of oxidation, staining, changes of colour of metallic inclusions, swelling, splitting, flaking or exfoliation and the appropriate code.

The test report shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.

16 Petrographic examination

16.1 Introduction

A petrographic identification of slates is important not only for the purposes of petrographic description but also in order to highlight features influencing its chemical, physical and mechanical behaviour. It is therefore necessary to characterise the slates not only from the point of view of their mineralogical components and of their fabric and structure but also in terms of any features.

It is not always necessary to carry out all the tests in this clause. Annex B gives guidance on the selection of tests.

To ensure that the petrographic identification is objective, the characterisation of the material should, as far as possible, be quantitative.

16.2 Principle

Slates are examined using petrologic techniques and inspections including use of thin sections and polished sections (or thin polished sections) and X-ray diffraction.

16.3 Apparatus

16.3.1 Petrographic microscope, suitable for use with transmitted and reflected light with a magnification of up to x800.

16.3.2 Petrographic apparatus, for preparing thin and polished sections.

16.3.3 X-ray diffraction apparatus, with the following specification:

- beam cobalt anticathode with an iron filter (Co $\lambda K\alpha$), or
- iron anticathode with a manganese filter (Fe $\lambda K\alpha$), or
- copper anticathode with a nickel filter (Cu $\lambda K\alpha$).

NOTE Other apparatus may be used provided it is capable of giving comparable results.

16.3.4 Grinding mill, capable of producing a powder of less than 100 µm grain size.

16.3.5 Desiccator.

16.4 Reagents

16.4.1 Alumina polishing paste:

a) 5 µm to 12 µm for petrographic thin sections;

b) 5 µm to 12 µm for petrographic polished sections;

c) 18 µm to 30 µm for X-ray diffraction specimens.

16.4.2 Diamond polishing paste, 6 µm, 3 µm and 1 µm for petrographic polished sections.

16.4.3 Silica gel, or similar desiccant.

16.5 Preparation of test pieces

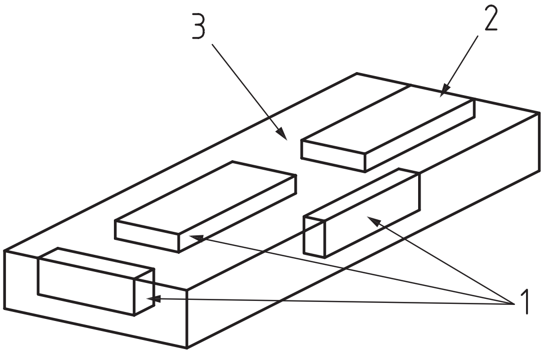
16.5.1 Thin sections

Prepare two thin sections perpendicular to the cleavage and 25 µm thick and one thin section parallel to the schistosity (Figure 14). Polish the faces with alumina polishing paste finishing with the 5 µm to 12 µm grade.

NOTE If required thin sections are impregnated before preparation using for example fluorescent epoxy resins. Impregnation of thin sections can be an extremely useful technique for the identification of cracks or features and distinguishing between features natural to the slate and those introduced by thin section preparation.

16.5.2 Polished sections

Prepare two polished sections perpendicular to the cleavage (Figure 14). Polish the faces with alumina polishing paste 5 µm to 12 µm grades and 6 µm, 3 µm and 1 µm diamond pastes.



Key
1 orientation of the thin and polished sections
2 orientation of the X-ray diffraction specimen
3 cleavage plain

Figure 14 — Orientation of thin and polished sections for petrographic analysis

16.5.3 X-ray diffraction specimens

16.5.3.1 Polished specimens

Cut a block of slate to a size suitable for mounting in the X-ray equipment using a water cooled diamond saw. Polish the cleavage face using the 18 µm to 30 µm alumina paste.

NOTE Further information can be obtained using other orientations.

16.5.3.2 Powder specimens

Grind sufficient slate to less than 100 µm grain size to produce the quantity of powder specified by the manufacturer of the X ray apparatus. Dry the powder in a desiccator to constant weight. Do not sieve the powder.

16.6 Procedure

16.6.1 Macroscopic examination

Determine the following by the petrographic examination of whole slates:

a) the sedimentary stratification differentiating between slate with induced cleavage, where cleavage and bedding form a definite angle with each other, and mass or plate slate where cleavage and bedding are parallel;

b) open and healed cracks;

c) joints, faults and/or kinkbands;

d) calcite or other carbonates in veins or in layers;

e) carbonaceous material;

f) presence of pyrite, pyrrhotite, marcasite or other metallic minerals;

g) where carbonates are present, whether they are surrounded by mica.

To the extent the observations listed in 16.6.1 a) to g) are not recognisable at the slate slab, they may also be identified microscopically or in outcrop field respectively.

16.6.2 Microscopical examination

16.6.2.1 Thin sections

Report the mineralogy of the section with estimated percentage composition as follows:

a) if the slate contains carbonates or ores, report whether these are finely distributed in the matrix, are concentrated in individual large formations or whether they are concentrated in small cracks, veins or in irregular ramified pockets;

b) report the presence of healed joints or faults, traces of earlier stratification and traces of schistosity;

c) report the distribution of the fabric and structure of the mica layers as follows:

   1) the structural type of the mica fabric;

   2) the number of the mica layers per millimetre in accordance with Figure 15;

   3i) the average thickness of 10 of the mica layers;

   4) for a given number of mica layers, the value obtained by multiplying the number of mica layers per millimetre by their average thickness and multiplying the product by 10.

NOTE 1 Figure A.1 is based on sections examined at a magnification of x500, and provides guidance on interpretation of mica fabric for a) and b).

NOTE 2 In view of the outstanding significance of micaceous minerals to the quality of roof slates, special attention should be paid to their distribution and grouping.

16.6.2.2 Polished sections

Report the presence of, for example, pyrite, pyrrhotite, marcasite and mineral phases of the system TiO_2 - FeO - Fe_2O_3 (titanomagnetite, ilmenite) and other opaque minerals.

16.6.2.3 X-ray diffraction

16.6.2.3.1 Principle

X-ray diffraction examinations are carried out on powdered specimens for mineral identification and semi-quantitative analysis, and on polished specimens for mineral identification and orientation.

The resulting traces are examined for the position and height of the peaks and compared with traces obtained by the same method for slates from the stated source to confirm their origin.

16.6.2.3.2 Procedure

Mount the polished specimen in the X-ray equipment and expose to the beam to produce traces in the range $2\theta = 5°$ to 65°, Depending on the radiation a maximum range from 2° to 65° can be useful. In the range from 2° to 5° the alteration of the slates (mica and chlorite into clay minerals) can be detected. Examine the traces and report the peak heights. Record the anticathode and filter used.

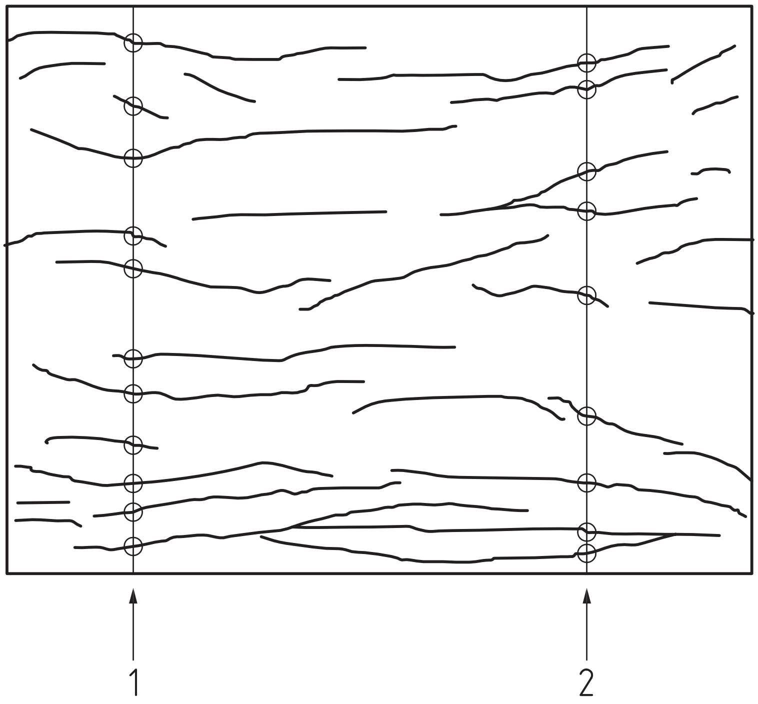
Place the specified quantity of slate powder loosely in the sample holder so that the mineral grains are not orientated. Repeat the X-ray analysis using the procedure and settings described above. Examine the traces and report the peak heights and the relative quantities of minerals present as major, minor or trace. Record the anticathode and filter used.

16.7 Expression of results

Produce a report based on the examinations carried out describing the characteristics of the structure, fabric, and major, minor and trace mineralogy and including the details and settings of the X-ray diffraction apparatus.

16.8 Test report

The test report shall comprise a report (16.7) and shall also include the identification of the product, reference to this method and the identifier of this European Standard, i.e. EN 12326-2:2011.



Measurement 1: 11 mica layers

Measurement 2: 9 mica layers

Figure 15 — Examples of measurements of the number of mica layers

Annex A
(informative)

Petrographic interpretation

A.1 Connection between the micas (Figure A.1 (a) and (b))

Every phyllosilicate can be either:

a) perfectly connected to others (Figure A.1 (a));

b) separated (Figure A.1 (b)).

A.2 Bedding and cleavage, angle of intersection (Figures A.1 (c) to (q))

A.2.1 If bedding and cleavage are exactly parallel the splitting plane will follow bedding and cleavage.

Phyllosilicate spacing can be:

a) very irregular (Figure A.1 (c));

b) irregular (Figure A.1 (d));

c) regular (Figure A.1 (e)).

NOTE A very regular fabric such as Figure A.1 (e) with even spacing of the micas can look the same as Figure A.1 (f) to (q).

A.2.2 If bedding and cleavage intersect at an angle splitting will follow the cleavage plane.

Phyllosilicates parallel to the cleavage can be:

a) continuous (Figure A.1 (f), (g), (j), (k), (n) and (o));

b) discontinuous (Figure A.1(h), (l), (p));

c) isolated (Figure A.1 (i), (m) and (p)).

The phyllosilicate layers can be:

d) separated from each other (Figure A.1 (f) to (i)): or

e) oblique to the cleavage and imperfectly tied together (Figure A.1 (j) to (m));

f) oblique to the cleavage and tied together (Figure A.1 (n) to (q)).

If the phyllosilicates are continuous and tied together they will form a net (Figure A.1 (j), (k), (n) and (o)).

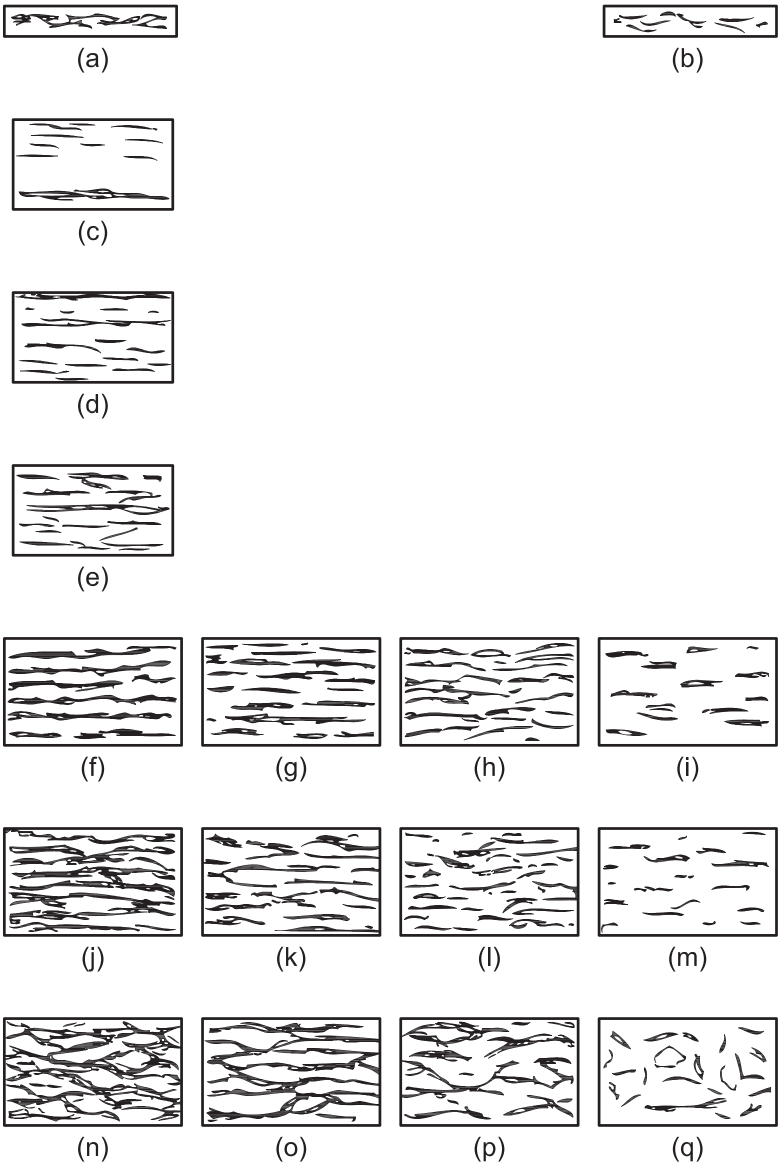

(a) (b)
(c)
(d)
(e)
(f) (g) (h) (i)
(j) (k) (l) (m)
(n) (o) (p) (q)

Figure A.1 — Illustration of the fabric and structure of mica layers at a magnification of x500 for use with microscopic thin sections

Annex B
(informative)

Petrographic examination of origin and identification of slate

B.1 Identification of slate

B.1.1 The results of the identification are the accurate definition from EN 12326-1:2004, 3.1, 3.2 and 3.3 and the correct petrographic name like e.g. "shales", “argillaceous schist", "slate”, “sedimentary (stone) slate”, "parallel slate" or "carbonate slate" or "marnes".

B.1.2 From B.1.1 decide whether the product falls within the scope of the EN 12326-1:2004.

B.1.3 It is not always necessary to carry out all tests indicated: Table B.1 gives instructions for use:

Table B.1 — Applicability of tests for identification

Identification					
Clause	Test method	Initial type testing	Further type testing		
			a	b	c
				a = inconclusive:	a + b = inconclusive:
16.6.1	Macroscopic examination	**x**	**x**		
16.6.2.1	Microscopical examination: Thin sections	**x**		**x**	
16.6.2.2	Microscopical examination: Polished sections	**x**			**x**
16.6.2.3	X-ray diffraction: Powdered specimens	**x**			**x**
16.6.2.3	X-ray diffraction: Polished specimens				

B.2 Origin

B.2.1 The result of the Petrographic examination is the verification that every slate in a consignment is supplied from the declared source quarry, mine or vein of slate and is of the declared slate type as defined in EN 12326-1:2004, 3.2 or 3.3.

B.2.2 It is not always necessary to carry out all tests indicated: Table B 2 gives instructions for use:

Table B.2 — Applicability of tests for origin

origin					
Clause	Test method	Initial type testing	Further type testing		
			a	b	c
				a = inconclusive:	a + b =inconclusive:
16.6.1	Macroscopic examination	**x**	**x**		
16.6.2.1	Microscopical examination: Thin sections	**x**		**x**	
16.6.2.2	Microscopical examination: Polished sections	**x**			**x**
16.6.2.3	X-ray diffraction: Powdered specimens				
16.6.2.3	X-ray diffraction: Polished specimens	**x**		**x**	

B.3 Report

The report of the further type testing should include the results of all test methods, if necessary including the results of the initial type testing.

Bibliography

[1] EN ISO 6988, *Metallic and other non organic coatings — Sulfur dioxide test with general condensation of moisture (ISO 6988:1985)*

[2] ISO 3534-1, *Statistics — Vocabulary and symbols — Part 1: General statistical terms and terms used in probability*

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