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Slabs of natural stone for external paving - Requirements and test methods

Dalles de pierre naturelle pour le pavage extérieur - Exigences et méthodes d'essai

Platten aus Naturstein für Außenbereiche - Anforderungen und Prüfverfahren

This European Standard was approved by CEN on 6 October 2012.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 1341:2012) has been prepared by Technical Committee CEN/TC 178 “Paving units and kerbs”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by May 2013, and conflicting national standards shall be withdrawn at the latest by August 2014.

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 1341:2001.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

The following changes have been made in this new edition:

a) Where possible the requirements refer to separate test methods prepared by CEN/TC 246, "Natural stones". The change was made to allow those placing the products on the market to use the same test results for a number of products.

b) The values to be declared have been clarified and where applicable the declared values are now ‘lower expected values’.

c) Annex A (Annex B in the 2001 version) has been extended to include safety factors specific to different uses.

According to the CEN/CENELEC Internal Regulations, the national standards organisations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

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1 Scope

This European Standard specifies the performance requirements and the corresponding test methods for all natural stone slabs used for external paving and road finishes.

External paving use includes all pavements typical of road works, such as pedestrian and trafficked areas, outdoor squares and similar to be used in an outdoor condition that are subject to the weathering agents, such as temperature changes, rain, ice, wind, etc.

This European Standard provides also for the evaluation of conformity and for marking of the natural stone slabs.

This European Standard covers also characteristics that are of importance to the trade.

This European standard does not cover natural stone slabs for floors and stairs in buildings. In these cases EN 12058 [1] applies.

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 1936, *Natural stone test methods — Determination of real density and apparent density, and of total and open porosity*

EN 12371, *Natural stone test methods — Determination of frost resistance*

EN 12372, *Natural stone test methods — Determination of flexural strength under concentrated load*

EN 12407, *Natural stone test methods — Petrographic examination*

EN 12440, *Natural stone — Denomination criteria*

EN 13373:2003, *Natural stone test methods — Determination of geometric characteristics on units*

EN 13755, *Natural stone test methods — Determination of water absorption at atmospheric pressure*

EN 14157, *Natural stone test methods — Determination of the abrasion resistance*

EN 14231, *Natural stone test methods — Determination of the slip resistance by means of the pendulum tester*

3 Terms and definitions

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

3.1
external paving slab
unit of natural stone obtained by cutting or splitting used as a paving material, used for external paving and road finishes in which the working width exceeds two times the thickness

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3.2
upper face
surface of a slab intended to be seen when in use

3.3
bed face
surface of a slab intended to be in contact with the bedding material when in use

3.4
side face
surface of a slab perpendicular to upper face and intended to be vertical in use

3.5
work dimension
dimension of a slab, specified for its manufacture, to which the actual dimension is to conform within specified permissible tolerances

3.6
actual dimension
dimension of a slab as measured

3.7
irregular plan form
slab of random plan dimensions

3.8
thickness
distance between the upper face and the bed face of the slab

3.9
overall length
longer side of the rectangle with the smallest length able to enclose the slab

3.10
overall width
shorter side of the rectangle with the smallest area able to enclose the slab

3.11
textured
slab face with a surface finish produced by secondary processing, from a saw or hewn surface

3.12
fine textured
surface finish with a maximum difference of 1,0 mm between peaks and depressions (e.g. polished, honed or sawn with a diamond disc or blade)

3.13
coarse textured
surface finish with more than 1,0 mm difference between peaks and depressions (e.g. dolly pointed, shot blasted or flame textured)

3.14
hewn
slab face or edge with a rough surface finish, e.g. a riven or split face or edge

3.15
tooled
coarse finish resulting from mechanical surface treatment and showing tool marks

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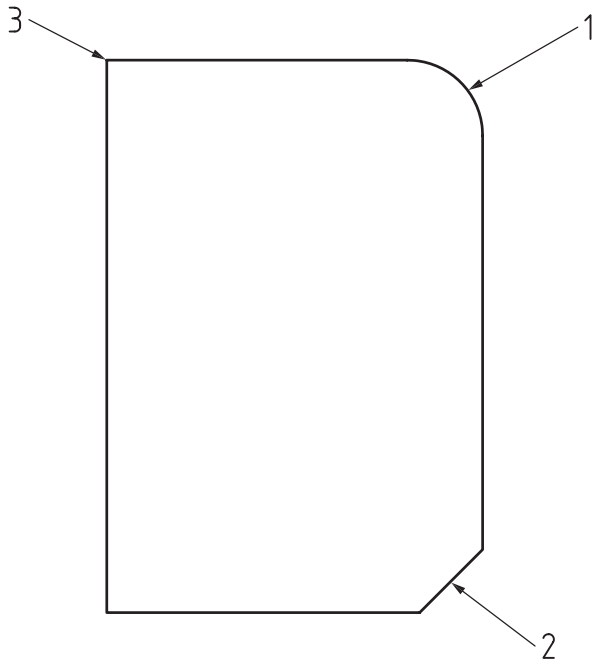
3.16
arris
edge produced by the meeting of two surfaces

Note 1 to entry: Sharp, rounded and chamfered arrises are shown in Figure 1.

3.17
lower expected value
E_L
value which corresponds to the 5 %-quantile of a logarithmic normal distribution for a confidence level of 75 %

3.18
higher expected value
E_H
value corresponds to the 95 %-quantile of a logarithmic normal distribution for a confidence level of 75 %



Key

1 rounded arris

2 chamfered arris

3 sharp arris

Figure 1 — Illustration of types of arris

4 Requirements and test methods for slabs of natural stone

4.1 General

4.1.1 Denomination

The denomination shall always be declared in accordance with EN 12440 (meaning traditional name, petrological family, typical colour and place of origin as precisely as possible for example geo coordinates).

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4.1.2 Alteration of physical properties of the natural stone

If during production the natural stone slabs have been subjected to a treatment that physically alters the properties of the stone (e.g. chemical treatment, patching, or filling or other similar products for natural holes, faults or cracks), then the use of such treatment shall be stated.

In addition, specimens for testing shall be representative of the product and any processes that the stone is subjected to.

4.2 Dimensions

4.2.1 General

The work dimensions of the slabs shall be declared unless they are being supplied in random lengths. Where supplied in random lengths, only the widths and thickness shall be declared.

Dimensions shall be measured in accordance with EN 13373.

4.2.2 Permissible tolerances

4.2.2.1 Plan dimensions (excluding slabs with irregular plan form)

Plan dimensions of a slab shall be measured in accordance with EN 13373:2003, 5.2 and the deviations from the declared dimensions shall conform to the tolerances given in Table 1.

Table 1 — Tolerances on plan dimension

	Tolerances on plan dimension of slabs [a] for:		
	Class 0	**Class 1**	**Class 2**
Marking designation	P0	P1	P2
Sawn edges	No requirement	± 4 mm	± 2 mm
Hewn and tooled edges		± 10 mm	± 10 mm
[a] For natural stone slabs with regular plan form only.			

The two diagonals of a rectangular slab shall be measured in accordance with EN 13373:2003, 5.2, and the maximum difference between them shall not exceed the values given in Table 2.

Table 2 — Tolerances on diagonals

	Tolerances on diagonals of slabs [a] for:		
	Class 0	**Class 1**	**Class 2**
Marking designation	D0	D1	D2
Sawn edges	No requirement	6 mm	3 mm
Hewn and tooled edges		15 mm	10 mm
[a] For natural stone slabs with regular plan form only.			

Tolerances stricter than P2 and D2 may be declared.

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4.2.2.2 Thickness

The thickness of a slab shall be measured in accordance with EN 13373:2003, 5.2, and the deviations from the declared thickness shall conform to tolerances given in Table 3.

Table 3 — Tolerances on thickness

	Tolerances on thickness of slabs for:		
	Class 0	**Class 1**	**Class 2**
Marking designation	T0	T1	T2
≤ 30 mm thick	No requirement [a]	± 3 mm	± 10 %
30 mm < thickness ≤ 80 mm		± 4 mm	± 3 mm
> 80 mm thick		± 7 mm	± 4 mm
[a] Manufacturers are encouraged to declare deviations measured in accordance with EN 13373:2003, 5.2.			

Dimensions between faces may be declared as a range of nominal minimum-maximum thicknesses, e.g. 30 – 60 mm and a tolerance declared on the limits of the range. This is particularly applicable to hewn slabs.

Tolerances stricter than T2 may be declared.

4.2.2.3 Face irregularities

The face irregularities on hewn slabs, measured in accordance with EN 13373:2003, 5.3, shall never be greater than 20 mm above the work thickness and not below the work thickness (i.e. (+20/-0) mm) and the greatest measured value shall be declared.

4.2.2.4 Flatness and straightness

4.2.2.4.1 Arrises

The straightness along the arrises of textured slabs plan dimensions shall be measured in accordance with EN 13373:2003, 5.4, and the deviations from the declared straightness shall conform to tolerances given in Table 4.

Table 4 — Tolerances on straightness along arrises

	Tolerances on straightness along arrises of slabs		
Longest test straight edge	0,5 m	1 m	1,5 m
Fine textured face	± 2 mm	± 3 mm	± 4 mm
Coarse textured face	± 3 mm	± 4 mm	± 6 mm

4.2.2.4.2 Faces

Flatness and bow shall be measured in accordance with EN 13373:2003, 5.4, and the deviations from the declared flatness and bow shall conform to tolerances given in Table 5 unless the surface is riven in which case information on the deviations shall be declared.

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The vertical faces of hewn or tooled slab shall be undercut relative to the top arrise by no more 12 mm for a slab 80 mm thick or less and by no more 15 mm for slab greater than 80 mm thick. The vertical faces shall not be overcut by more than the permitted dimensional tolerance.

Table 5 — Tolerance on flatness for faces

Tolerance on flatness for faces for		
a) Fine textured face		
Gauge length mm	**Max. convex tolerance** mm	**Max. concave tolerance** mm
300	2,0	1,0
500	3,0	2,0
800	4,0	3,0
1 000	5,0	4,0
b) Coarse textured face		
Gauge length mm	**Max. convex tolerance** mm	**Max. concave tolerance** mm
300	3,0	2,0
500	4,0	3,0
800	5,0	4,0
1 000	8,0	6,0

4.2.2.5 Arrises

Arrises described as square or sharp may have a bevel with horizontal or vertical dimensions not exceeding 2 mm at the manufacturer's discretion.

When slabs are supplied with a chamfered or rounded arris, the dimensions shall be declared and the vertical and horizontal dimension shall be within ± 2 mm of the declared dimensions.

4.2.2.6 Angles and special shapes

Each slab angle shall be in accordance with the agreed geometry. Pieces of special or irregular shape shall be checked for compliance with the required shape by use of a specified template, the permissible tolerance at any point shall be in accordance with Table 1.

Deviations stricter than in Table 1 may be declared.

Deviations may not be added to each other, e.g. deviations on thickness and flatness.

4.3 Freeze/thaw resistance

4.3.1 Freeze- thaw under normal conditions

When the slabs are intended to be used in areas subjected to freeze-thaw requirements, the freeze/thaw resistance shall be determined using the test method in EN 12371. The results shall be expressed and declared as the mean flexural strength after 56 cycles of freeze/thaw (technological test).

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The frost damage, which a natural stone may suffer when installed, depends on the climatic conditions of the place of use, the relative position in the works (which determines the degree of saturation) and the predicted service life of the works. This number of cycles is appropriate to a specific project and may help to provide guidance for the interpretation of the test results. The selection of the stones is subjected to climatic zones and/or to codes of practice.

For some specific uses, for example in locations that are subject to temperatures below -12 °C, it may be appropriate to use different test cycles, e.g. freezing in water, freezing to a lower temperature, or testing specimens embedded in non-porous siliceous granules or a different number of cycles, e.g. the identification test as defined in EN 12371.

4.3.2 Freeze-thaw in the presence of de-icing salts

Where required, freeze-thaw resistance with the effect of de-icing salts shall be determined and declared. In the absence of a European test method, freeze-thaw resistance with the effect of de-icing salts shall be determined and declared according to national provisions valid in the place of use of the product.

4.4 Breaking strength — Flexural strength

The flexural strength shall be determined using the test method in EN 12372 and the lower expected value (E_L) shall be declared.

An identification test as defined in EN 12372 is normally carried out. However, where the surface finish of the delivered product is known, the test may be carried out with this finish, in accordance with the technological tests defined in EN 12372.

NOTE 1 Guidance on the appropriate thickness for different classes of use is given in Annex A.

NOTE 2 An example of the calculation used to determine the lower expected value is given in Annex C.

4.5 Abrasion resistance

The abrasion resistance shall be determined using the test method in EN 14157 and the higher expected value (E_H) shall be declared.

4.6 Slip and skid resistance

4.6.1 Slip resistance

The slip resistance shall be declared when the intended use of the slabs is subject to regulatory requirements, or upon request, and, in any case, when the roughness of the surface, measured following EN 13373:2003, 5.3, is less than 1,0 mm.

The slip resistance shall be determined and the results expressed in accordance with the test procedure for wet conditions in EN 14231.

NOTE 1 Coarse textured and hewn slabs are assumed to give satisfactory slip resistance.

NOTE 2 The unpolished slip resistance value (USRV) relates to slabs as manufactured and helps to ensure adequate slip/skid resistance on installation.

NOTE 3 Experience has indicated that a USRV measurement, made using a wide slider/full swing on a pendulum that is greater than 35 in wet conditions, can usually be considered acceptable for surfaces that are horizontal or sloping at less than 6 %.

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4.6.2 Skid resistance

Where required, skid resistance shall be declared.

In the absence of a European test method, skid resistance shall be determined and declared according to national provisions valid in the place of use of the product.

4.6.3 Durability of slip and skid resistance

When required, durability of slip and skid resistance shall be declared.

In the absence of European test methods, durability of slip and skid resistance shall be determined and declared according to national provisions valid in the place of use of the product**.**

4.7 Appearance

4.7.1 General

The colour, veining, texture, etc. of the natural stone shall be identified visually, typically by a reference sample of the same stone suitable for providing a general description of visual appearance.

A reference sample shall be provided by the supplier of the stone according to 4.7.2.

4.7.2 Reference sample, visual inspection and acceptance criteria

A reference sample shall be an adequate number of pieces of natural stone of sufficient size to indicate the general appearance of the finished work. The dimensions of individual pieces shall be at least 0,01 m^2 (typical values are between 0,01 m^2 and 0,25 m^2 in face area but may be greater) and shall indicate the range of appearance regarding the colouring, the vein pattern, the physical structure and the surface finish. In particular the reference sample shall show specific characteristics of the stone, such as typical holes, glass seams, spots, crystalline veins and rusty spots.

The reference sample does not imply strict uniformity between the sample itself and the actual supply; natural variations may always occur.

If the processing of the stone involves the use of patching, fillers or other similar products for natural holes, faults or cracks, then the reference sample shall similarly display the impact of the same on the finished surface.

All the characteristics as shown by the reference sample shall be considered typical of the stone and not as flaws, therefore they shall not become a reason for rejection, unless their concentration becomes excessive and the typical character of the stone is lost.

The name and address of the manufacturer or the supplier of the stone, as well as the denomination of the stone in accordance with 4.1 and/or information on the treatment in accordance with 4.1.2, above, shall be indicated on the reference sample.

Any comparison between production sample and reference sample shall be carried out by placing the reference sample against the production samples and viewing them at a distance of about 2 m under normal daylight conditions and recording any visible differences in the characteristics of the stones.

4.8 Water absorption

Where required the water absorption shall be determined using the test method in EN 13755 and the higher expected value (E_H) shall be declared.

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4.9 Apparent density and open porosity

The apparent density and open porosity shall be determined using the test method in EN 1936 and the mean values declared.

4.10 Petrographic description

A petrographic description shall be provided, including a petrographic name, of the stone type, in accordance with EN 12407.

4.11 Dangerous substances

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 harmonised 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/ .

5 Evaluation of conformity

5.1 General

The conformity of the product (i.e. natural stone slabs) to the requirements of this standard and with the declared performances (e.g. values, classes) for the characteristics relevant for the intended use of the product, shall be demonstrated by:

a) initial type testing,

b) factory production control by the manufacturer, including product assessment.

For the purposes of testing, the products may be grouped into product families, where it is considered that the results for one or more characteristics from any product within the family are representative for the same characteristics for all products within that family.

A product may be in more than one family for different characteristics.

5.2 Initial type testing (ITT) - Type Testing (TT)

Initial type testing and type tests, if any, shall be performed for all characteristics included in this standard for which the performances are to be declared:

— when a new product type is developed (and before it is placed on the market or

— at the beginning of a new or modified method of production where this may affect the declared performances.

The declared performances should be representative of the current production, e.g. the lower expected value in normal production.

Whenever a significant change occurs in the raw material or the production process, which could change any of the declared performance of the product, this shall be considered as a new product and any of such characteristic shall be re-assessed for a new declared performance.

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Reference to the test method standards should be made to allow the selection of a suitable representative sample.

All essential characteristics, given in bold in Table 6, for which the manufacturer declares performances, are subject to Initial Type Testing.

In addition, the need to perform Type Tests applies to all other characteristics included in Table 6, when the manufacturer claims compliance, unless the standard gives provisions (e.g. use of previously existing data, CWFT and conventionally accepted performance) for declaring performances without performing tests.

Initial type testing and type tests of the product shall be carried out on:

— first application of this document or at the beginning of the production with a new type of stone;

— when significant variations occur in the material, determined visually or by significant changes in FPC results.

Tests previously performed in accordance with the provisions of this document (i.e. same type of stone, same characteristic measured with the same test method, same sampling procedure and system of attestation of conformity) may be taken into account for the purpose of ITT.

Table 6 — Characteristics of natural stone slabs for paving for initial type testing and type tests

Requirements subclause	Characteristics (properties)	Test method in accordance with:	Expression of results
4.4	Breaking strength - Flexural strength	EN 12372	Declared value
4.3.1	Durability of flexural strength against freeze/thaw resistance – normal conditions	EN 12371	2 declared values
4.3.2	Durability of flexural strength against freeze/thaw resistance - de-icing salts	See 4.3.2	Declared value(s)
4.6.1	Slipperiness – Slip resistance	EN 14231	Declared value
4.6.2	Skid resistance	See 4.6.2	Declared value
4.2.2.6	Tolerances – Angles and special shapes	See 4.2.2.6	Table 1
4.5	Abrasion resistance	EN 14157	Declared value
4.8	Water absorption	EN 13755	Declared value
4.9	Apparent density and open porosity	EN 1936	Declared values
4.10	Petrographic description	EN 12407	Declared description
4.11	Dangerous substances	See 4.11	Declared value or class, as relevant

Assessment of compliance should be undertaken using the same method (identification or technological).

The declared performances may be supported by a test report supplied with the block or raw slabs provided that test have been performed according to the requirements and test methods of this European Standard.

The results of the selected tests shall be expressed as referred to in Clause 4.

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5.3 Factory production control

5.3.1 A factory production control system (FPC) shall be established and documented. The factory production control system shall consist of procedures for the internal control of production. The results of the tests carried out during FPC shall demonstrate that products placed on the market conform to this document and with the declared performances of the product's characteristics, established under ITT in accordance with Clause 4.

In cases when the processing of the natural stone is likely to change any of these declared performances, relative to the initial stone (e.g. as a consequence of the type of processing or because the physical properties have been modified by impregnation, use of patching, fillers or other similar products for natural holes, faults, cracks and similar), then this shall be considered within FPC as requested by this document.

5.3.2 The factory production control shall consist of regular inspection checks and tests and the utilisation of the results to control incoming materials (i.e. stone), equipment, the production process and the product.

When alternative tests to the reference tests are used for the test procedure, their correlation to the reference test shall be determined and available for inspection.

All test equipment shall be calibrated and the procedure, frequency and acceptance criteria stated.

5.3.3 A sampling plan for the testing of products shall be defined and the results shall be recorded and available for inspection.

NOTE Guidance on sampling is given in Annex B.

5.3.4 The stock control of the products, together with procedures for dealing with non-conforming products, shall be detailed.

5.3.5 Manufacturers' records shall include at least the following:

a) identification of the product tested;

b) information on sampling:

   1) place and date of sampling;

   2) identification of the production lot sampled;

   3) frequencies of sampling;

   4) size and number of samples;

c) test methods applied;

d) test and inspection results;

e) calibration records of apparatus.

5.3.6 Any testing procedure (reference or alternative tests) adopted for the FPC shall include the relevant acceptance criteria. In case of non compliance, a specific action plan shall be defined as part of the FPC. As a rule this plan shall include the repetition of the FPC procedure on an extended quantity of specimens or of products. In cases when the results of these tests do not conform with the declared performances, final assessment of compliance shall be provided adopting the same test method (identification or technological) as used in determination of declared performances and making reference to Table 7.

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Table 7 — Characteristics of natural stone slabs for paving for factory production control

Requirement		Verification during production	Verification on finished product		
Subclause	**Characteristics (properties)**		**Test method in accordance with:**	**Minimum testing frequency** (see 1) and 3) below)	**Acceptance criteria**
4.2.1	Dimensions	Continuous verification in accordance with manufacturer's factory production control (see 2) below)	EN 13373	Each lot	Within the tolerance range [a]
4.2.2.1	Tolerances – Plan dimensions		EN 13373:2003, 5.2		
4.2.2.2	Tolerances – Thickness		EN 13373:2003, 5.2		
4.2.2.3	Tolerances – Face irregularities		EN 13373:2003, 5.3		
4.2.2.4.1	Tolerances – Flatness and straightness – Arrises		EN 13373:2003, 5.4		
4.2.2.4.2	Tolerances – Flatness and straightness – Faces		EN 13373:2003, 5.4		
4.2.2.5	Tolerances – Arrises		See 4.2.2.5		
4.2.2.6	Tolerances – Angles and special shapes		See 4.2.2.6 [c]		
4.4	Flexural strength		EN 12372	Every 2 years [b]	>80 % of the individual results >declared value
4.8	Water absorption		EN 13755		>80 % of the individual results <declared value
4.9	Apparent density and open porosity		EN 1936		No requirement
4.3.1	Freeze/thaw resistance – normal conditions		EN 12371	Every 10 years [b]	Within the tolerance range [a] for 2 declared values
4.3.2	Freeze/thaw resistance – de-icing salts		See 4.3.2		Within the tolerance range [a] for declared value(s)
4.5	Abrasion resistance		EN 14157		>80 % of the individual results <declared value

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Table 7 *(continued)*

Requirement		Verification during production	Verification on finished product		
Subclause	**Characteristics (properties)**		**Test method in accordance with:**	**Minimum testing frequency** (see 1) and 3) below)	**Acceptance criteria**
4.6.1	Slip resistance	Continuous verification in accordance with manufacturer's factory production control (see 2) below)	EN 14231	Every 10 years [b]	≥ declared value
4.6.2	Skid resistance		See 4.6.2		≥ declared value
4.6.3	Durability of slip resistance Durability of skid resistance		See 4.6.3		≥ declared value ≥ declared value
4.10	Petrographic description		EN 12407		Complies with declared description
4.11	Dangerous substances		See 4.11		Individual results complying with declared value or class

1) The testing frequency should be established so that it represents a means to guarantee constancy of the product's performance and a reliable declaration for both the users and the manufacturer.

2) The control testing of each of these characteristics is to be carried out using the most appropriate indirect test/check method(s), which is to be detailed in the manufacturer's quality control plan for the parameter(s), set up under ITT, if any, and related to the performance of such characteristic (e.g. incoming materials, composition).

3) In cases when the processing of the stone is likely to change the characteristics of the finished product relative to the initial material (e.g. as a consequence of the type of processing or because the use of patching, fillers or other similar products for natural holes, faults, cracks and similar), then this has to be considered in determining the frequency of testing.

[a] Usually referred to in the requirements subclause.

[b] These represent the upper limits of the testing frequency (see 1)).

[c] Only where special shapes are being produced.

6 Marking, labelling and packaging

As a minimum of identification, each consignment of natural stone slabs shall carry the following indications:

a) the denomination of the natural stone in accordance with EN 12440 (see 4.1.1);

b) the quantity and dimensions of the slabs.

Additional information is advisable:

c) the mass of the slabs;

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d) dimensions and mass of packaging.

These indications shall be given on labels, packaging or on accompanying documents.

An identification system may be used in order to identify individual slabs; in such a case individual stones shall be clearly marked accordingly. Marking usually consists of alphanumeric codes and symbols (e.g. to define proper orientation at installation).

The slabs shall be clean before packaging.

Packaging shall allow adequate, solid and durable protection for packed slabs, both during transport and during handling and storage. Movement of slabs inside the packaging shall be prevented by securing individual pieces.

Packaging shall be of appropriate mass and size in consideration of transportation and lifting facilities; the top and bottom of the packaging as well as stacking possibility shall be indicated.

Safety against contamination, caused by packaging materials, in wet or dry conditions, shall be ensured. Packaging and tapes which are likely to stain shall not be used. Sensitive polished surfaces of the slabs shall be protected by appropriate means (e.g. plastic foil). Products with caustic properties shall not be used.

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Annex A
(informative)

Guidance on the appropriate thickness for different classes of use

A.1 Introduction

A number of structural calculation methods are available for determining the thickness of paving slabs for specific situations and loadings and these should be used for designing paving and roads in natural stone slabs.

However, if a simple method is required as part of the selection process, then the method described in A.2 can be followed.

A.2 Simplified method for the calculation of slab thickness

The thickness of a slab may be determined by calculation from the minimum required breaking load *P* (in kN) using the formula:

$$t = \sqrt{\frac{1500.P.L.F_S}{W.R_f}}$$

where

t is the thickness of the slab (in mm),

P is the breaking load (in kN), for the expected use of the paving,

NOTE Guidance on expected breaking loads for different uses is given in Table A.2.

L is the length of the slab (in mm),

W is the width of the slab (in mm),

R_f is the lower expected value (E_L) for flexural strength (in MPa) determined in accordance with EN 12372,

F_S is a safety factor, as given in Table A.1.

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Table A.1 — Safety factor (F_s)

Dimension *L* mm	Safety factors, F_s, for slabs on				
	Paving over		Paving over a gap, supported		
	concrete using mortar and joints (bound construction)	sand or aggregate (unbound construction)	on 4 sides	on 2 sides	on 4 corners
≤ 600	1,2	1,8	2,4	2,7	3,0
> 600	1,8	2,4	2,7	3,1	3,5

A.3 Guidance on expected breaking loads

Guidance on expected breaking loads for different uses is given in Table A.2.

Table A.2 — Breaking load

Class	Minimum breaking load kN	Typical use
0	No requirement	Decoration
1	0,75	Slabs bedded in mortar, pedestrian area only
2	3,5	Pedestrian and cycles areas
3	6,0	Occasional car, light vehicle and motorcycle access. Garage entrances
4	9,0	Walking areas, market places occasionally used by delivery vehicles and emergency vehicles
5	14,0	Pedestrian areas often used by heavy lorries
6	25,0	Roads and streets, petrol stations

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Annex B
(informative)

Guidance on sampling

B.1 General

The annex specifies guidelines for methods for obtaining samples of natural stone from quarries, plants and construction works. Sampling from buildings may be necessary if the delivered natural stone slab is already applied in construction works.

The aim of sampling is to obtain a bulk sample that is representative of the average properties of the batch and of its variability.

The methods described are based on manual procedures. The methods described are limited to building and civil engineering purposes.

It is important that samplers are accordingly trained in the application of the methods set out in this European Standard.

In case of dispute or if tests are to be done by more than one organisation, all interested parties should have the opportunity to observe the sampling and should agree upon the number of sampling increments to be taken.

B.2 Principles of sampling

Proper and careful sampling and sample transport is a prerequisite for an analysis that can give reliable results. An adequate number of samples should taken to obtain a good estimation of the natural heterogeneity of the batch.

The sampler should be informed of the aim of the sampling.

B.3 Taking bulk samples

The number and sizes of samples depend on the test methods for which they are taken. The number and shapes of specimens required are given in the relevant test methods.

B.4 Preparing a sampling plan

A sampling plan should be prepared, prior to sampling, taking into account the following:

— type of natural stone (following EN 12440 and EN 12670);

— aim of the sampling, including a list of the properties to be tested;

— identification of sampling points;

— orientation of samples relative to resource or bed, etc.;

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— approximate size of samples;

— number of samples;

— sampling apparatus to be used;

— methods of sampling;

— marking, packaging and dispatch of the samples.

B.5 Sampling apparatus

Any suitable cutting equipment for natural stone may be used for sampling. In addition, drills, which are suitable for taking drill cores, may be used.

B.6 Sampling methods

B.6.1 General

The sampling methods will inevitably involve the samplers working at a quarry, plant or construction works. Regulations for safety and ergonomics should be followed.

B.6.2 Sampling from quarries

B.6.2.1 General

The main objective of sampling from such deposits is to establish, where possible, the average, the range of variations and the differences in the structure and properties of the rock, taking account of the fabric and geological structure and the anticipated mining conditions.

B.6.2.2 Sampling of solid rock

a) Identification of anisotropy and orientation of samples

If the exploratory work reveals a pronounced fabric or geological structure, which is not necessarily visible at the sample scale (e.g. stratification, massive bedding, lamination, cleavage or rift), the sample should be marked accordingly.

b) Sampling for petrographic analysis

For petrographic analysis hand specimens should be taken from all distinct types and varieties, which characterise the rock in terms of mineral composition, fabric and geological structure.

Samples from drilling (cores and pieces) may also be used.

In addition to samples of fresh material, samples should also be taken to illustrate the effects of weathering.

c) Sampling for physical testing

For physical testing, sample blocks and hand specimens should be used as samples, their number and location depending on the results of the petrographic analysis and the test methods required.

The sample blocks should measure approximately 0,40 m × 0,25 m × 0,25 m, or more where a coarse-grained and/or a large-pored rock is to be sampled.

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The sample blocks should be broken as carefully as possible. It is recommended that they are taken from larger natural stones, which have been least affected by blasting. Care has to be taken to ensure that neither the sample blocks nor the hand specimens show any hairline cracks resulting from the removal process.

Samples may also be cut from rough blocks, slabs or dimension stones, the number and size of samples depending on the particular test method.

B.6.3 Sampling from production units and consignments

A representative sample of adequate size and characteristic of the rock in terms of mineral composition, fabric and geological structure, should be taken from the material to be tested (e.g. slabs, dimension stones), taking into account the intended use of the material.

B.6.4 Sampling from construction works

Sampling points should be selected according to the rules for obtaining a representative sample taking into consideration any differences in properties visible to the naked eye. Where necessary, taking a single slab to assess the mechanical properties of slabs, should be sufficient.

The location of the sample in the construction works should be reported.

B.7 Marking, packaging and dispatch of the samples

The samples or containers should be clearly and durably marked. Marking should include:

a) unique code; or

b) identification of the laboratory samples, place of sampling, date of sampling and denomination of the material.

The laboratory samples should be packed and transported in such a way that they are protected from damage.

B.8 Sampling report

B.8.1 The sampler should prepare a sampling report for each laboratory sample or for each group of laboratory samples from a single source. The sampling report should refer to this document and state:

a) sampling report identification (serial number);

b) laboratory sample identification mark(s);

c) date and place of sampling;

d) sampling point or identification of the batch sampled;

e) reference to the sampling plan prepared according to B.4;

f) name of the sampler(s).

B.8.2 Depending on the circumstances, other information might be relevant. Table B.1 shows an example of a comprehensive sampling report.

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Table B.1 — Example of a sampling report

Sampling report identification (serial n°):
Laboratory sample identification mark: no. of package

Description of the natural stone and sampling places

Name of the quarry or production plant or building:
Name of producer:
Origin of batch:
Purpose for which the natural stone is to be used:
Location of sampling point(s):
Identification of the batch:
Size of the batch:
Other comments (e. g. warnings, if appropriate):

Description of the sampling method

Date and time of sampling:
Reference to sampling plan used:
Sampling procedure (drilling, cutting, etc.):
Purpose of the sampling:

Samples

No. and dimensions of samples:
Other comments:
Dispatch of the samples:
Sampler(s) (print name):

Contract details

Contract identification:
Name and address of party requesting the sampling:…….. ……
Name of person(s) present at sampling:…… ……
Signatures:…… …… ……

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Annex C
(informative)

Example of calculation of Lower Expected Value

C.1 Scope

This annex establishes a method for the lower expected value (E_L).

C.2 Symbols and definitions

Measured values $x_1, x_2, .. x_i .., x_n$

Number of measured values n

Mean value $\bar{x} = \frac{1}{n}\sum_i x_i$

Standard deviation $s = \pm\sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$

Coefficient of variation $v = \frac{s}{\bar{x}}$ (for individual values)

Logarithmic mean $\bar{x}_{\ln} = \frac{1}{n}\sum_i \ln x_i$

Logarithmic standard deviation $s_{\ln} = \pm\sqrt{\frac{\sum (\ln x_i - \bar{x}_{\ln})^2}{n-1}}$

Maximum value Max

Minimum value Min

Lower expected value $E = e^{(\bar{x}_{\ln} - (k_s \cdot s_{\ln}))}$ where k_S (quantile factor) is given in Table C.1

Quantile factor k_S; see Table C.1

C.3 Calculation of Lower Expected Value

For the calculation of the lower expected value (E_L) a logarithmic normal distribution is assumed. The lower expected value (E_L) corresponds to the 5 % quantile of a logarithmic normal distribution for a confidence level of 75 %.

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Table C.1 — Quantile factor (k_S) in dependence on the number of measured values (n) in correspondence to the 5 % quantile for a confidence level of 75 %

n	k_s
3	3,15
4	2,68
5	2,46
6	2,34
7	2,25
8	2,19
9	2,14
10	2,10
15	1,99
20	1,93
30	1,87
40	1,83
50	1,81
∞	1,64
Quantile factor (ks) dependent on the number of measured values (n) in correspondence to the 5 % quantile for a confidence level of 75 %.	

The following examples should help to clarify the method:

EXAMPLE 1

Calculation of mean value, standard deviation, maximum value and minimum value of six measured values

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Table C.2 — Calculation of mean and standard deviation

Measurement no	Measured value *x*
1	2 000
2	2 150
3	2 200
4	2 300
5	2 350
6	2 400

Mean value	2 333
Standard deviation	147
Maximum value	2 400
Minimum value	2 000

EXAMPLE 2

Calculation of mean value, standard deviation, coefficient of variation and lower expected value of 10 measured values

Table C.3 — Calculation of lower expected value

Measurement no	Measured value *x*	(ln *x*)
1	2 000	(7,60)
2	2 150	(7,67)
3	2 200	(7,70)
4	2 300	(7,74)
5	2 350	(7,76)
6	2 400	(7,78)
7	2 600	(7,86)
8	2 750	(7,92)
9	2 900	(7,97)
10	3 150	(8,06)
	---------	---------
Mean value	2 480	(7,807)
Standard deviation	363	(0,143)
Variation coefficient	0,15	

From Table C.1 for: n = 10 ks = 2,1 and the Lower expected value 1 819

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Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Directive

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under a Mandate M/119, as amended, given to CEN by the European Commission and the European Trade Association.

The clauses of this European Standard shown in this annex meet the requirements of the Mandate M/119, as amended, given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the construction products covered by this annex for their intended uses indicated therein; reference shall be made to the information accompanying the CE marking.

This annex establishes the conditions for the CE marking of the slabs of natural stone intended for the uses indicated in Table ZA.1 and shows the relevant clauses applicable.

This annex has the same scope as Clause 1 of this standard.

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Table ZA.1 — Scopes and relevant clauses

Construction products: Slabs of natural stone **Intended uses:** Paving units for external uses and road finishes			
Essential characteristics	**Requirement clauses in this standard**	**Levels and/or classes**	**Notes**
RELEASE OF DANGEROUS SUBSTANCES	4.11	-	as relevant
BREAKING STRENGTH, dealt with by:			
- **flexural strength**	4.4	-	tested for acc. to EN 12372 and declared as the lower expected value (E_L) (in MPa)
SLIPPERINESS[a], dealt with by:			
- **slip resistance**	4.6.1	-	tested for acc. to EN 14231 and expressed/declared as the wet and dry USRV result
SKID RESISTANCE[b], dealt with by:			
- **skid resistance**	4.6.2	-	declared according to national provisions valid in the place of use of the product
DURABILITY OF BREAKING STRENGTH, OF SLIPPERINESS AND OF SKID RESISTANCE, against:			
- freeze/thaw resistance - general	4.3.1	-	mean values of flexural strength before & after 56 freeze/thaw cycles (technological test acc. to EN 12371) (in MPa)
- freeze/thaw resistance – de-icing salts	4.3.2		declared according to national provisions valid in the place of use of the product
- **polishing in use**	4.6.3		declared according to national provisions valid in the place of use of the product
[a] For the pedestrian circulation areas only. [b] For the vehicular circulation areas only.			

The requirement on a certain characteristic is not applicable in those Members States (MSs) where there are no regulatory requirements on that characteristic for the intended use of the product. In this case, manufacturers placing their products on the market of these MSs are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option “No performance determined” (NPD) in the information accompanying the CE marking (see ZA.3) may be used.

ZA.2 Procedure for the attestation of conformity of slabs of natural stone

ZA.2.1 System of attestation of conformity

The system of attestation of conformity of natural stone slabs indicated in Table ZA.1, in accordance with the Decision of the Commission 97/808/EC of 1997-11-20 *(see OJEC L331 of 1997-12-03)*, as amended firstly by 1999/453/EC of 1999-06-18 *(see OJEC L178 of 1997- 07-14)*, secondly by 2001/596/EC of 2001-01-08 *(see OJEC L209 of 2001-08-02)* and thirdly by 2006/190/EC of 2006-03-01 *(see OJEC L66 of 2006-03-08)*, as given in Annex III of the Mandate M/119 for "Floorings", as amended, is shown in Table ZA.2 for the indicated intended uses and relevant level(s) or classes.

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Table ZA.2 — System of attestation of conformity

Product(s)	Intended use(s)	Level(s) or classes(s)	Attestation of conformity system
Rigid flooring products Paving units (with flat or tactile surface) including pavers; flags; kerbs; blocks; pavement lights; self finished decking of metal sheet; rigid floor tiles; slate; tiles; mosaics; quarry tiles; terrazzo tiles; expanded metal or grid floor decking; floor gratings.	For external uses and road finishes to cover external pedestrian and vehicular circulation areas	-	4 [a]
[a] System 4: See Directive 89/106/EEC (CPD) Annex III.2(ii), Third possibility.			

The attestation of conformity of the slabs of natural stone in Table ZA.1 shall be according to the evaluation of conformity procedures indicated in Table ZA.3 resulting from application of the clauses of this European Standard indicated therein.

Table ZA.3 — Assignment of evaluation of conformity tasks for slabs of natural stone under AoC system 4

Tasks		Content of the task	Evaluation of conformity clauses to apply
Tasks under the responsibility of the manufacturer	Factory production control (FPC)	Parameters related to characteristics of Table ZA.1, the performance of which are to be declared for the intended use.	5.3
	Initial type testing by the manufacturer	Characteristics of Table ZA.1, the performance of which are to be declared for the intended use.	5.2

ZA.2.2 EC declaration of conformity

When compliance with this annex is achieved, the manufacturer or his agent established in the EEA shall prepare and retain a declaration of conformity (i.e. EC declaration of conformity) which authorises the affixing of the CE marking. This declaration shall include:

— name and address of the manufacturer or their authorised representative established in the EEA, and place of production;

NOTE 1 The manufacturer may also be the person responsible for placing the product onto the EEA market, if he takes responsibility for CE marking.

— description of the product (type, identification, use…), and a copy of the information accompanying in the CE marking;

NOTE 2 Where some of the information required for the Declaration is already given in the CE marking information, it does not need to be repeated.

— provisions to which the product conforms (e.g. Annex ZA of this EN);

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— particular conditions applicable to the use of the product (e.g. provisions for use under certain conditions, etc.);

— name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or of his authorised representative.

The above mentioned declaration shall be presented in the official language or languages of the Member State in which the product is intended to be used.

ZA.3 CE marking and labelling

The manufacturer or his authorised representative established within the EEA is responsible for the affixing of the CE marking. The CE marking symbol shall be in accordance with Directive 93/68/EEC and shall be shown on the label attached/affixed to each slab of natural stone, or, when this is not possible, on the packaging of these slabs or in the commercial documents, accompanying the such packaging (e.g. a delivery note). The information could additionally be communicated by the mean of all other modern communication tools (such as e-mail and website).

The following information shall accompany the CE marking symbol:

a) name or identifying mark of the manufacturer (see Note 1 in ZA.2.2);

NOTE 1 Registered address of the manufacturer may also be added.

b) last two digits of the year in which the marking was affixed;

c) reference to this European Standard and the year of its publication (i.e. EN 1341:2012);

d) description of the product and its intended use:

1) generic name: “natural stone slabs”,

2) traditional name, petrological family, typical colour and place of origin;

3) intended use: “for external pedestrian and/or vehicular circulation areas”;

4) surface treatment of the stone (if any).

e) performance on the essential characteristics listed in Table ZA.1, which are to be declared for the relevant intended use, as classes or values, including "Pass" for pass/fail requirements (where necessary), or as "No performance determined" (i.e. NPD) for characteristic(s), where this is relevant, namely:

1) release of dangerous substances: where relevant (see 4.11),

2) breaking strength, dealt with by: flexural strength;

3) slipperiness, dealt with by: slip resistance;

NOTE 2 For the pedestrian circulation areas only.

4) skid resistance, where required,

NOTE 3 For the vehicular circulation areas only.

5) durability of breaking strength, of slipperiness and of skid resistance, dealt with by:

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i) freeze/thaw resistance, measured as the mean flexural strength (in MPa) after 56 freeze/thaw cycles;

ii) freeze/thaw resistance with de-icing salts;

iii) polished slip or skid resistance declared in accordance with national provision.

The “No performance determined” (NPD) option may be used when and where the characteristic, for a given intended use, is not subject to regulatory requirements in the Member State of destination.

Figure ZA.1 contains an example of CE marking to be given on the packaging of slabs of natural stone.

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CE	*CE-marking symbol given in Directive 93/68/EEC*
AnyCo Ltd. **12**	*Name or identifying mark of the manufacturer* *NOTE Registered address of the manufacturer may also be added.* *Last two digits of the year in which the marking was affixed*
EN 1341:2012 Natural stone slabs Gunnersbury Buff, Sandstone, Brown Chiswick, England for external pedestrian and/or vehicular circulation areas	*Number of European Standard and the year of its publication* *Description of product and its intended use* *Traditional name, petrological family, typical colour and place of origin*
RELEASE OF DANGEROUS SUBSTANCES — NPD	*Performances of the regulated essential characteristics, which are to be declared for the relevant intended use*
BREAKING STRENGTH, as:	
- **flexural strength** (EN 12372), as: (lower expected value) — 12,2 MPa	
SLIPPERINESS, as:	
slip resistance wet (EN 14231): — 45	
SKID RESISTANCE, as:	
- **skid resistance according to MS method xx** — 35	
DURABILITY;	
- **of flexural strength against: freeze/thaw** — (12,2/10,0) MPa **Freeze-thaw with de-icing salts** — (9.4) - **of slip resistance** — 42 - **of skid resistance** — 32	

Figure ZA.1 — Example of CE marking on a packaging of slabs of natural stone

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Bibliography

[1] EN 12058, *Natural stone products — Slabs for floors and stairs — Requirements*

[2] EN 12670, *Natural stone — Terminology*

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