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Natural stones — Guidance for use of natural stones

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National foreword

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Natural stones - Guidance for use of natural stones

Pierres naturelles - Guide d'emploi des pierres naturelles

Naturstein - Leitfaden für die Anwendung von Natursteinen

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European foreword

This document (CEN/TR 17024:2017) has been prepared by Technical Committee CEN/TC 246 “Natural stones”, the secretariat of which is held by UNI.

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Introduction

Product standards for natural stone are issued by the European committee for standardization and deal with stone masonry, tiles and slabs for cladding, flooring and stairs.

Producers in countries outside the European Union might not be familiar with these product standards. Therefore, the scope of this document is to inform and assist the user in order to provide recommendations for the proper use of natural stone and the requirements of the product standards regulating their being placed on the market within the countries comprising the European Union.

1 Scope

This Technical Report applies to natural stone products intended for masonry elements, wall coverings (including tiles), internal floor and stair finishes (including tiles) and exterior floor and stair finishes (including paving), as well as massive stone elements.

It provides guidance for the application and use of natural stone products in accordance with European product standards.

This Technical Report does not deal with coatings or staining problems, and does not take into account treatments that could modify the performance characteristics of the materials.

This Technical Report does not apply to agglomerated stones and aggregates.

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 771-6, *Specification for masonry units — Part 6: Natural stone masonry units*

EN 772-1, *Test methods for masonry units — Part 1: Determination of compressive strength*

EN 772-11, *Methods of test for masonry units - Part 11: Determination of water absorption of aggregate concrete, autoclaved aerated concrete, manufactured stone and natural stone masonry units due to capillary action and the initial rate of water absorption of clay masonry units*

EN 1341, *Slabs of natural stone for external paving - Requirements and test methods*

EN 1342, *Setts of natural stone for external paving - Requirements and test methods*

EN 1343, *Kerbs of natural stone for external paving - Requirements and test methods*

EN 1467, *Natural stone - Rough blocks - Requirements*

EN 1468, *Natural stone - Rough slabs - Requirements*

EN 1469, *Natural stone products - Slabs for cladding - Requirements*

EN 1925, *Natural stone test methods - Determination of water absorption coefficient by capillarity*

EN 1926, *Natural stone test methods - Determination of uniaxial compressive strength*

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

EN 12057, *Natural stone products - Modular tiles - Requirements*

EN 12058, *Natural stone products - Slabs for floors and stairs - Requirements*

EN 12059, *Natural stone — Finished products, dimensional stone work Requirements*

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 12670, *Natural stone - Terminology*

EN 13364, *Natural stone test methods - Determination of the breaking load at dowel hole*

EN 13373, *Natural stone test methods - Determination of geometric characteristics on units*

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

EN 14066, *Natural stone test methods - Determination of resistance to ageing by thermal shock*

EN 14146, *Natural stone test methods - Determination of the dynamic modulus of elasticity (by measuring the fundamental resonance frequency)*

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

EN 14158, *Natural stone test methods - Determination of rupture energy*

EN 14579, *Natural stone test methods - Determination of sound speed propagation*

EN 14581, *Natural stone test methods - Determination of linear thermal expansion coefficient*

EN 16140, *Natural stone test methods - Determination of sensitivity to changes in appearance produced by thermal cycles*

EN 16306, *Natural stone test methods - Determination of resistance of marble to thermal and moisture cycles*

CEN/TS 16165, *Determination of slip resistance of pedestrian surfaces - Methods of evaluation*

3 Terms and definitions

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

3.1
order
all products to be delivered on the basis of the contract

3.2
order item
one of a set of products corresponding to one single order

3.3
contractual sample
reference sample which forms part of the contract

3.4
delivery
part or all of the order arriving at the same time and at the same place, and giving rise to a delivery order

Note 1 to entry: In addition to the requirements of CE marking, the documents accompanying the delivery shall state the following:

— reference of the order;

— name and address of the supplier;

— nature and type of the delivered order items;

— date of collection and place of delivery;

— total weight of the load;

— quantity of delivered order items;

— weight of materials packaged in bulk (per packaging unit).

3.5
delivery acceptance
series of operations to verify compliance of the delivery with the contract specification (quantity, tolerance specifications, appearance, mechanical properties, contractual samples, etc.)

3.6
packaging unit
term that designates for instance a pallet, a crate, a bag, a box

Note 1 to entry: Each packaging unit shall carry a marking or label allowing the identification of the batch to which it derives.

3.7
batch
set of packaging units containing one order item in one delivery

Note 1 to entry: A batch necessarily corresponds to a single characterization sheet.

Note 2 to entry: A delivery may include one or several batches.

4 General specifications

4.1 General principles

To assess whether a stone type is suitable for a particular application, a specific testing program is described as mentioned in Table 1. Table 1 contains a detailed overview of the most useful tests, in particular:

— characterization tests (or identification tests): they are used to determine the intrinsic material properties, independent of its transformation into a finished product and the environment in which it will be used;

— tests relating to performance in use: these tests evaluate the performance of the finished product after manufacturing. Therefore, these tests should as nearly as possible reproduce the physical

forces and effects of weathering and contamination that act upon the element in service (taking into account dimensions and surface conditions);

— durability tests: these tests are used to analyse the behaviour of the stone over time and thus make it possible to evaluate the stability of the intrinsic material properties and of the initial performance data after a period of time.

Additionally it is relevant to consider the performance of the same stone type in existing examples of its use under similar climatic conditions.

Table 1 — Examples of stones used in structural applications and related tests

	Product standard	**Structural application**	**Test of performance in use**	**Test standard**
Masonry	EN 771–6	Element in elevation, with no possibility of splash back Splash course Window sill Handrail String course Cornice Pinnacles Gargoyle Massive slab for balcony Plinth	Capillarity	EN 772–11
			Frost resistance	EN 12371
			Compressive strength	EN 772–1
Wall cladding	EN 1469	**Internal cladding**		
		Mechanically fastened cladding	Resistance to breaking at dowel hole	EN 13364
			Flexural strength	EN 12372 (EN 13161)
		External cladding		
		Mechanically fastened cladding Elevation String course Balcony sill Window sill Plinth Horizontal covering	Frost resistance	EN 12371
			Resistance to breaking at dowel hole	EN 13364
			Flexural strength	EN 12372 (EN 13161)
			Resistance of marble to thermal and moisture cycles	EN 16306
			Thermal shock resistance	EN 14066

Wall cladding	EN 1469 EN 12057 EN 12059	**Internal cladding**		
		Glued cladding	Apparent density Open porosity	EN 1936
		External cladding		
		Glued cladding and tiling Elevation String course Balcony sill Window sill Plinth Horizontal covering	Apparent density Open porosity	EN 1936
			Frost resistance	EN 12371
			Thermal shock resistance	EN 14066
Floor covering	EN 12058 EN 12057	Interior floors and stairs	Abrasion resistance	EN 14157
			Flexural strength	EN 12372 (EN 13161)
		Exterior floors and stairs	Abrasion resistance	EN 14157
			Slip resistance	CEN/TS 16165
			Flexural strength	EN 12372 (EN 13161)
			Frost resistance	EN 12371
External Paving	EN 1341	Slabs	Abrasion resistance	EN 14157
			Flexural strength	EN 12372 (EN 13161)
			Slip and skip resistance	EN 14231
			Frost resistance	EN 12371
	EN 1342	Setts	Abrasion resistance	EN 14157
			Compressive strength	EN 1926
			Slip and skid resistance	EN 14231
			Frost resistance	EN 12371
	EN 1343	Kerbs	Abrasion resistance	EN 14157
—			Flexural strength	EN 12372
—			Frost resistance	EN 12371

4.2 Characterization tests

4.2.1 Origin of the stone

The part of the characterization record/sheet reserved to the origin of the stone shall mention, according to EN 12440:

— the name and the address of the supplier of the stone product;

— the commercial name of the stone;

— the petrographic nature of the stone according to the standards EN 12407 and EN 12670;

— the place of origin (as precise as possible, e.g. country, city, GPS data);

— the macroscopic description of the appearance (colour, texture, etc.).

4.2.2 Petrographic analysis

Petrographic characterization (see EN 12407) allows the determination of the mineralogical composition of the natural stone. Based on this information, the correct geological name of the stone can be deduced. According to EN 12440, the name of the stone should state the place of origin, the (geological) type and the colour of the stone. In this context, correct petrographic identification of the stone is important and should prevent the use of misleading names. Besides these geological features, a petrographic analysis can also provide useful information concerning the sensitivity of stone in specific conditions (micro cracking, formation of expansive minerals, oxidation of metallic minerals, etc.).

4.2.3 Visual characteristics: reference sample

Stone is a natural material; its colour, veining and texture can vary. Therefore, the general visual characteristics should be defined by means of a reference sample.

A reference sample shall comprise 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 and 0,25 m^2 in plan area but may be more), 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 holes for travertine, worm holes for marble, 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 visual 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 reference sample should come with a characterization record/sheet (see 4.2.1).

The following information should be given on each specimen comprising the sample:

— name of the supplier;

— commercial name of the stone;

— signatures of the contracting parties;

— date of signing.

4.2.4 Apparent density

The apparent density (see EN 1936) is a property commonly measured for natural stone. It reflects the degree of compactness of the material and allows an assessment of the mass of a given volume. It is expressed in kg/m^3. This characteristic may be used to calculate the approximate weight of a stone unit for manual handling, for thermal and sound insulation purposes and for assumed load. For typical values, see Table 2.

Table 2 — Example of apparent densities

	Apparent density kg/m^3 (EN 1936)
Compact Limestone	> 2 500
Other Limestone	< 2 500
Sandstone	1 900 to 2 700
Slate – Shale – Schist	2 600 to 3 000
Marble	2 600 to 2 900
Gneiss	2 400 to 2 700
Granite	2 400 to 3 000
Basalt	2 550 to 3 000

4.2.5 Open porosity

The open porosity of a stone (see EN 1936) is determined by the ratio of the voids (pores) in the stone, which are interconnected and thus accessible to water. Usually, it is expressed in percentage of volume and it represents the volume of open pores in proportion to the total volume of the stone. For typical values, see Table 3.

Table 3 — Example of open porosities

	Open porosity vol.% (EN 1936)
Compact Limestone	0,3 to 2
Other Limestone	2 to 48
Sandstone	0,4 to 25
Slate – Shale – Schist	0,1 to 6
Marble	0,1 to 2
Gneiss	0,1 to 2
Granite	0,1 to 2
Basalt	0,1 to 6

Open porosity should not be confused with water absorption, which is expressed as percentage of mass. If the water absorption is determined by impregnation under full vacuum (as the open porosity), the open porosity and the water absorption can be compared using a multiplication coefficient: namely the apparent compactness of the material (i.e. its apparent density divided by 1 000). Open porosity is calculated using Formula (1).

$$p = \frac{(A_b \times \rho_b)}{1000} \quad (1)$$

where

p is the open porosity, expressed in percentage of volume;

A_b is the water absorption, expressed in percentage of mass;

ρ_b is the apparent density, expressed in kg/m^3.

For example, a natural stone with a water absorption of 20 % (percentage of mass) and an apparent density of 2 000 kg/m^3 can be characterized by an open porosity of 40 % (percentage of volume).

4.2.6 Water absorption

4.2.6.1 General

Water absorption reflects the ability of the stone to retain water in its pores due to capillary forces. This property should be taken into consideration for building applications where the natural stone could come in contact with water.

For some stone types used in external applications, water absorption can be a useful indicator for susceptibility to frost damage. Internal applications, such as wall and floor coverings of bathrooms, kitchen worktops and tile floorings may also come into contact with water. For these applications, it should be taken into account that high water absorption can lead to:

a) a change in visual appearance in humid conditions;

b) a greater susceptibility to staining;

c) absorption of dirt in the surface texture.

Besides being determined by impregnation under full vacuum, water absorption can be determined by the following two methods: water absorption by capillarity or by immersion at atmospheric pressure. For typical values, see Table 4.

Table 4 — Example of water absorptions

	Water absorption % (percentage of mass) (EN 13755)
Compact Limestone	0,1 to 0,8
Other Limestone	0,8 to 21
Sandstone	2 to 11
Slate – Shale – Schist	< 0,1 to 2
Marble	< 0,1 to 0,7
Gneiss	< 0,1 to 0,8
Granite	< 0,1 to 0,8
Basalt	< 0,1 to 2,5

4.2.6.2 Water absorption by capillarity

This characteristic (see EN 1925 and EN 772-11) reflects the quantity of water that can be absorbed by the stone per time and surface area, if only one plane of the element is in contact with water. It is expressed in $g/(m^2\ s^{0,5})$. It is especially important for elements and structures in contact with the ground e.g. plinths, bases and paving.

4.2.6.3 Water absorption by immersion at atmospheric pressure

This characteristic (see EN 13755) reflects the quantity of water that is absorbed by the stone, in relation to the stone mass in dry condition, when the element is completely immersed in water at atmospheric pressure. It is expressed as a percentage of mass. It is an important indicator for the characteristics described in 4.2.6.1 a) to c).

4.2.7 Determination of uniaxial compressive strength

EN 1926 and EN 772-1 specify methods to determine the uniaxial compressive strength of natural stones that are incorporated in a structural application. Taking into account the appropriate safety factors, this property should be considered for structural applications where stone is used as a load bearing element.

Compressive strength is also often used as a characteristic for the identification of a stone or for comparison with reference values, as an indicator for weathering after ageing (e.g. frost resistance test according to EN 12371).

4.2.8 Determination of flexural strength

EN 12372 or EN 13161 specify methods to determine the flexural strength of natural stones that are incorporated in a structural application. Taking into account the appropriate safety factors, this property should be considered for structural applications where stone is exposed to flexural forces (e.g. ventilated cladding, flooring and paving).

The flexural strength is also often used as a characteristic for the identification of a stone or for comparison with reference values, as indicator for the weathering after ageing (e.g. frost resistance test according to EN 12371).

4.2.9 Modulus of elasticity

The modulus of elasticity of a material may be expressed as the static modulus of elasticity according to EN 14580 or the dynamic modulus of elasticity according to EN 14146.

The static modulus of elasticity characterizes the state of deformation generated in a material in response to an applied load.

The dynamic modulus of elasticity characterizes the response of the material to applied vibration. It is often calculated from the results of a resonance frequency test and sound speed propagation test (see EN 14579). The main advantage of this method is its non-destructive character. In the field of natural stone, the dynamic modulus of elasticity is usually employed as an indicator for possible weathering of the material by comparison of reference values.

4.2.10 Sound speed propagation

The sound speed propagation (see EN 14579) through a stone is defined by the compactness of the material, but also by its water content, its mineralogy, possible fissures, the presence of certain salts, etc..

It is a precise technique which nevertheless depends upon a large number of influencing parameters. It therefore only provides useful information (e.g. about the weathering of the stone) if all these parameters are known and controlled.

4.2.11 Thermal expansion coefficient

Like all common materials, natural stone is subjected to dimensional deformation under the influence of temperature change. Such deformations are characterized by the coefficient of thermal expansion (see EN 14581) and are expressed in millimetre per millimetre per degree Celsius (mm/mm/°C), see Table 5.

Table 5 — Example of thermal expansion coefficients

	Thermal expansion coefficient mm/mm/ °C (EN 14581)		
Compact Limestone	3×10^{-6}	to	6×10^{-6}
Other Limestone	3×10^{-6}	to	7×10^{-6}
Sandstone	2×10^{-6}	to	7×10^{-6}
Slate - Shale - Schist	3×10^{-6}	to	10.10^{-06}
Marble	3×10^{-6}	to	6×10^{-6}
Gneiss	5×10^{-6}	to	8×10^{-6}
Granite	5×10^{-6}	to	9×10^{-6}
Basalt	9×10^{-6}	to	10×10^{-6}

Dimensional deformation should be considered when natural stone units might be exposed to large temperature fluctuations (e.g. cladding, external exterior paving, frameworks of fire places, underfloor heating etc.) and where expansion is constrained. In such cases, their dimensions should be defined having consideration for location, type and size of expansion joints provided.

4.3 Tests relating to performance in use

4.3.1 Resistance to breaking load at dowel hole

EN 13364 specifies a test method to determine the breaking load at the dowel hole in natural stones used for cladding or lining in buildings, fixed by mechanical anchor systems. The dowel holes shall be drilled using non-percussive equipment.

This test defines the breaking load, as that load, which when applied to a pin within a dowel hole, perpendicularly to the slab surface, that leads to a break (failure) of the stone. This breaking load is not only dependent upon the nature of the stone, but also on the slab thickness, the position of the dowel hole (distance from the edge of the hole to the face where the fracture occurs) in the slab and the orientation of any bedding plane within the stone. Using this breaking load, the dimensions of the stone slabs and their anchor system can be calculated, also the number and positions of the anchors per slab.

4.3.2 Rupture energy

The rupture energy test (EN 14158) is carried out in some European countries to determine the extent to which a stone element can withstand impact before breaking. The impact resistance is determined by a 1 kg steel ball falling from a measured height onto a horizontal slab laid upon sand.

This characteristic is relevant for applications where the impact of a hard body is typical of the possible loads in service. It mostly concerns floor coverings. Table 6 shows an example of advice given to designers in Belgium.

Table 6 — Example: The Belgium minimum fall heights before rupture

Class of use[a]	**Minimum fall height before rupture** cm
Private house	30
moderate collective use	45
intensive collective use	60
[a] See Table 5 for class definitions.	

4.3.3 Sensitivity to staining

4.3.3.1 General

Here, it should be distinguished between intrinsic staining, which is due to the reaction of certain constituents of the stone with the environment or associated construction products, and external (or accidental) staining, which is caused by unexpected contact with materials that can create stains on the surface of the stone.

If a national requirement exists for this characteristic, this test should be carried out only on the basis of special requirements.

4.3.3.2 Determination of sensitivity to accidental staining

As a consequence of their acid or alkaline nature, or simply because of their viscosity (greasy nature), numerous products – in various degrees and depending of the stone type - are potential staining agents. The staining can result either from a chemical attack of the product upon certain constituents of the stone (e.g. acid products on a limestone), or the penetration of a liquid through the pores of the surface

(e.g. oil-bearing products). The test is carried out according to EN 16301. This test can be helpful in selecting a stone according to its application. It can also be helpful in deciding whether a protection system might be suitable.

4.3.3.3 Determination of sensitivity to changes in appearance produced by thermal cycling

It is important to emphasize that staining is a problem which is related to the aesthetic quality of the material. Consequently, the result of the test is difficult to convert into objective criteria to define whether or not it is acceptable. The test is carried out according to EN 16140. This test can be helpful in selecting a stone according to its place of use.

4.3.4 Slip resistance

The slip resistance of floors, stairs and paving is a primary requirement for their safe use. Slipping is one of the main causes of work accidents. Requirements for slip resistance are subject to national regulations and differ from country to country.

Slipperiness is influenced by the following factors:

— surface characteristics of the material (e.g. roughness, porosity);

— contamination of the surface (e.g. water or other liquids, dust, leaves);

— material and profile of the soles and heels of the footwear;

— surface changes in use (e.g. wear, polishing);

— maintenance (e.g. coating, cleaning);

— frequency and nature of joints;

— dimension of stone elements.

The following method can be carried out both in a laboratory and *in situ*.

Recommendations

CEN/TS 16165 describes four different methods to measure the slip resistance.

The pendulum test given in CEN/TS 16165, Annex C should only be performed on natural stone elements with a surface roughness (measured in accordance with the standard EN 13373), less than 1 mm. Table 7 shows an example of advices in The United Kingdom

Table 7 — Example: The United Kingdom Slip Resistance Group classification

SRT value (according to EN 14231)	**Risk of slip**
< 25	High
25 ≤ SRT < 35	Moderate
35 ≤ SRT ≤ 65	Low
> 65	Minimal

4.4 Durability tests

4.4.1 Frost resistance

Frost resistance is undoubtedly the most important durability characteristic for external applications. A stone type with low frost resistance used outside will be subjected to rapid degradation and damaged elements might often have to be replaced.

The assessment of this characteristic in a laboratory is very complex for the following reasons.

— The term “natural stone” includes a large number of stone types of various natures and with very variable properties. Depending on the stone type, the porosity can for example range from values of nearly zero to values of about 50 % (percentage of volume). Also the compressive strength can vary strongly from a few MPa to more than 300 MPa.

— Natural stone is one of the few construction materials used for a wide variety of exterior applications: paving, plinths, masonry etc. and can therefore be exposed to different levels of frost action. Consequently, to take into account this enormous variability, a frost resistance test contains one or more variable parameters (degree of water impregnation, number of cycles, etc.).

— The frost resistance of a natural stone in practical use depends on the climatic conditions, the position and orientation of the elements (horizontal or vertical) and different water saturation. Because of differing climatic conditions in European countries, different national specifications exist for frost resistance according to application.

European standard EN 12371 proposes two types of test methods.

— Technological test: the samples undergo a certain number of freeze–thaw cycles (normally 56). Following the required number of freeze–thaw cycles, the loss of mechanical strength is examined (by compression or flexure, depending on the intended application).

— Identification test: before commencement of the test, the number of freeze–thaw cycles is determined depending on the type of application. If no specific application is given, the test is carried out (with a maximum of cycles up to 168) until a failure occurs. One assumes that failure has occurred when at least two samples are damaged, by applying one of the following criteria:

  — the score of the visual inspection attains code 3; this is not valid for stones with large holes or cavities, such as travertine or some shell-limestones

  — the reduction in dynamic modulus of elasticity reaches 30 %.

  For both tests, preparative water impregnation of the samples is achieved by progressive immersion over 48 h. The number of samples and their dimensions depends upon the type of test:

  — technological test: the samples should conform to the prescriptions of the mechanical strength test standards;

  — Identification test: seven samples of 50 mm × 50 mm × 300 mm should be tested.

Recommendations

Concerning the European method, the following Table 8 refers only to the identification test.

Table 8 — Example for specifications for the frost resistance according to its application for Belgium

Exterior use	Number of cycles (according to EN 12371a)
Paving elements – flooring	140
Elements in contact with the floor	140
Non-vertical elements in elevation or elements that stick out the façade	84
Massive masonry elements	70
Thin cladding elements on ventilated façades	14
[a] The stone shall resist the indicated number of cycles. As the current experience with the European method (identification test) is still limited, one should consider the number of cycles mentioned here as indicative and take into account the fact that this might change in the future.	

4.4.2 Determination of abrasion resistance

This characteristic should only be tested for flooring and paving. It is intended to assess the behaviour of the stone in response to mechanical abrasion, due to friction in use. Requirements for abrasion resistance depend on the practical use (place of installation, type and density of traffic, frequency of pedestrians). Safety regulations and therefore requirements are generally subjected to national regulations.

A stone having relatively low resistance to abrasion can suffer rapid degradation of the surface in heavily trafficked areas: loss of texture, changes in colour, reduction in thickness, etc..

Depending on the intensity of pedestrian traffic, the following categories (indicated in Table 9 and Table 10) are representing typical requirements.

Table 9 — Example for typical classification of flooring for resistance to abrasion using the Capon method according to EN 14157, Method A

Use	Examples	Recommendations: maximum abrasion mm	
		Belgium	France
Private house	All the rooms of private residences NOTE In this category are floor areas in frequent use, directly accessible from outside.	42	42
Moderate collective use	Entrance halls of apartment blocks with less than 30 apartments Shared areas of office buildings with less than 50 employees, medium-sized business premises	35	32

Use	Examples	Recommendations: maximum abrasion mm	
		Belgium	**France**
Intensive collective use	Busy halls in railway stations, airports, shopping-arcades, etc. Entrance halls of apartment blocks of more than 30 apartments Shared areas of office buildings with more than 50 employees Supermarkets, wholesales premises, etc.	24	22

Table 10 — Example for typical classification of flooring for resistance to abrasion using the Böhme method according to EN 14157, Method B in Germany

Use	Examples	maximum abrasion $mm^3/50\ cm^2$
Private house	All the rooms of private residences NOTE In this category are floor areas in frequent use, directly accessible from outside.	40 000
Moderate collective use	Entrance halls of apartment blocks with less than 30 apartments Shared areas of office buildings with less than 50 employees, medium-sized business premises	25 000
Intensive collective use	Busy halls in railway stations, airports, shopping-arcades, etc. Entrance halls of apartment blocks of more than 30 apartments Shared areas of office buildings with more than 50 employees Supermarkets, wholesales premises, etc.	15 000

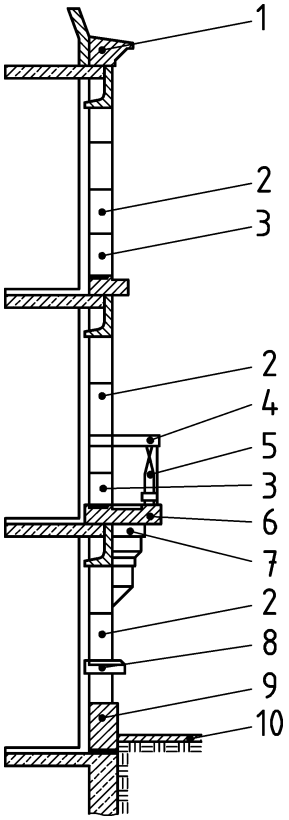
4.5 Dimensional tolerances - Corresponding standards

Depending on the intended uses, dimensional tolerances are given by product standards EN 1341, EN 1342, EN 1343, EN 771-6, EN 1467, EN 1468, EN 1469, EN 12057, EN 12058, and EN 12059.

4.6 Suitability for the intended use

The suitability of the stones for use depends upon their purpose within the structure.

Figure 1 to Figure 3 show examples for the use of natural stone.

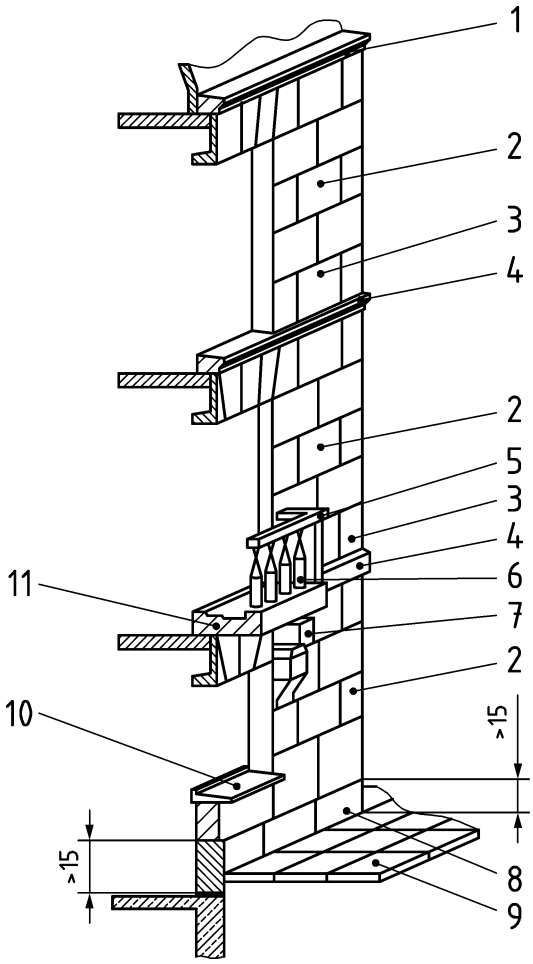


Key

1	Cornice	6	Massive balcony slab
2	Elevation	7	Corbel
3	Spatter course	8	Window sill
4	Handrail	9	Plinth
5	Baluster	10	Paving

Figure 1 — Massive natural stone façade (cross-section view)

All dimensions in centimetre

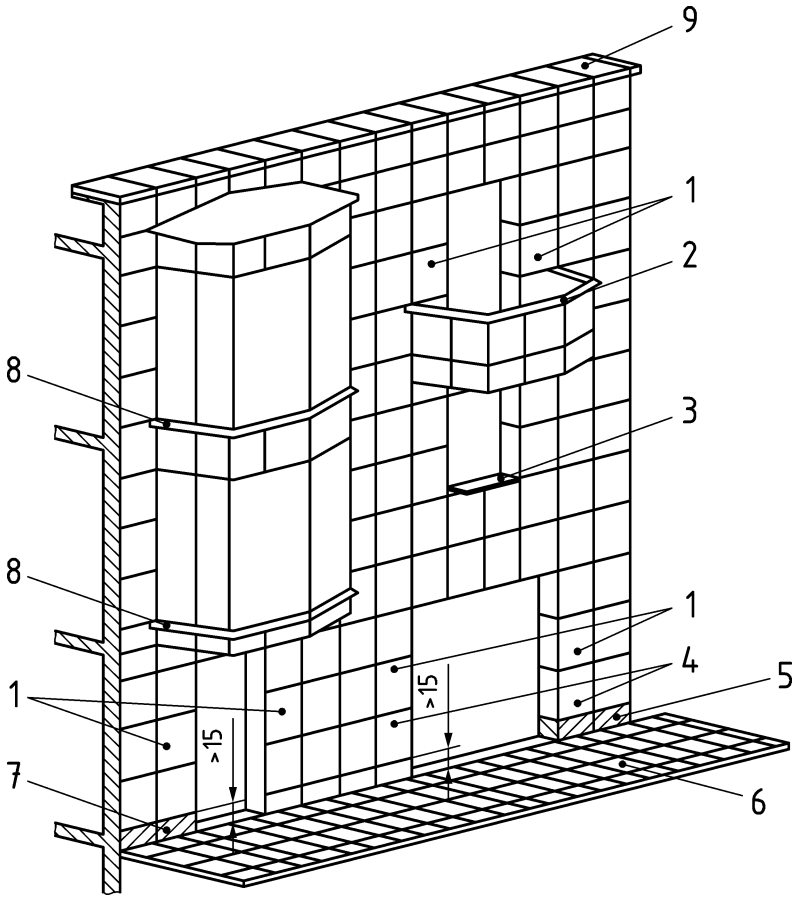


Key

1	Cornice	6	Baluster
2	Elevation	7	Corbel
3	Spatter course	8	Plinth
4	String course	9	Paving
5	Handrail	10	Window sill

Figure 2 — Façade in massive natural stone (perspective view from outside)

All dimensions in centimetre



Key

1	Elevation	6	Paving
2	Balcony cornice	7	Void
3	Window sill	8	Ledge
4	Plinth	9	Parapet coping
5	Void < 15 cm		

NOTE The construction details (projection, dripstone, join) are not shown on the scheme.

Figure 3 — Façade in massive natural stone (front view)

5 Delivery acceptance

5.1 Conditions of delivery acceptance

5.1.1 General

Except in the case of specific contractual arrangements, the acceptance conditions are as follows.

5.1.2 Objective of the delivery acceptance process

Delivery acceptance concerns:

— state of the packing, when needed;

— labelling;

— materials' visual appearance;

— quantity;

— materials' nature;

— geometric characteristics.

5.1.3 Location

Unless otherwise agreed, the delivery acceptance process is done:

— at the delivery location when the transportation is at the supplier's cost;

— at the supplier's office when the transportation is at the customer's cost.

5.1.4 Date

The supplier informs the customer of the availability of the merchandise. The date of delivery acceptance is then mutually agreed on within a specified period (e.g. maximum of 12 working days).

Beyond this period, the order is deemed to "conform".

5.1.5 Staff and equipment for delivery acceptance

All the means for checking the geometric characteristics and the handling, as well as the staff necessary for the acceptance process, is provided by the customer. Opening of the packaging is the responsibility of the customer and should be carried out in the presence of the supplier or their representative.

5.2 Proceedings of delivery acceptance process

5.2.1 General

The delivery acceptance process is carried out by the customer or their representative and if required or agreed in the presence of the supplier or their representative.

5.2.2 Evaluation of the delivered quantity

The delivered quantities can be evaluated by means of weighing, measuring or counting. The relation between the evaluation method and the marketing unity (kg, m^3, m^2, m, and unit) shall be defined in the contract.

5.2.3 Sampling

A random sampling from a total number of packaging units T is carried out.

The number of samples depends on the number of items in the package and knowledge about the variability in the properties of interest For example the number of sampling units SU can be:

— $SU = 1$ when $1 < T \leq 5$

— $SU = 2$ when $5 < T \leq 10$

— $SU = 3$ when $10 < T \leq 30$

If the batch is over 30 packaging units, it is split up into multiples of 30 plus a complementary set (for example: 66 packaging units correspond to 3 sets: 2 sets of 30 plus one set of 6).

For a given product, the number N of items of each of the selected SU packaging units are taken into account to carry out a drawing of K items:

Example for this number K equals:

— $K = N$: all the items if $N \leq 4$

— $K = 3$, if $4 < N \leq 20$

— $K = 5$, if $20 < N \leq 100$

— $K = 7$, if $100 < N \leq 300$

— $K = 10$, if $300 < N \leq 600$

— $K = 15$, if $N > 600$

5.2.4 Testing of the material's nature

A visual comparison is carried out between the contractual sample and a sample taken from the order item in accordance with 5.2.

In case of doubt, the testing of the origin or the nature of the supplied stone may be carried out by means of a comparison of the petrographic analysis of the contractual sample according to standard EN 12407 and the petrographic analysis of the order item.

If this analysis confirms that the supplied stone's nature conforms to that of the contractual sample, the testing expenses are to be paid by the claimant. The delivery of the tested batch is declared to "conform".

If this analysis shows that the provided stone's nature is not in agreement with that of the contractual sample, the testing expenses are chargeable to the supplier. The delivery of the tested batch is declared to "not conform".

5.2.5 Testing of geometric characteristics

The testing of the product's geometric characteristics is carried out according to EN 13373 depending on its purpose in order to respond to the prescriptions given in EN 1341, EN 1342, EN 1343, EN 771-6, EN 1469, EN 1468, EN 12058, EN 12059, EN 1467 and EN 12057.

Among others, the testing of geometric characteristics concerns:

— dimensional tolerances;

— flatness;

— squareness;

— straightness of the edges;

— conformity of the profiles (round-offs, chamfers, undercuts, etc.);

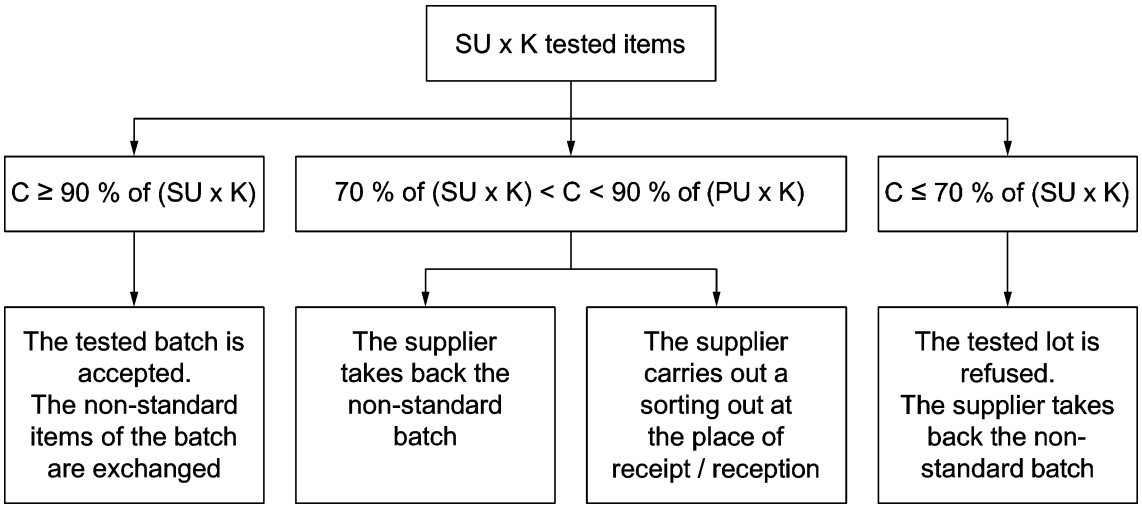
— radius of curves;

— location and diameters of the holes.

5.2.6 Testing of declared performance characteristics

If any of the declared performance characteristics of the supplied stone are in doubt, additional tests may be carried out. If the test results conform to the declaration of performance of the supplied stone the delivery of the tested batch is declared to "conform". If the test results do not conform to the declaration of performance of the supplied stone the delivery of the tested batch is declared to "not conform".

6 Dealing with visual and dimensional non conformities



Key

SU number of sampled packaging units

K number of sampled items

C number of standard items

Figure 4 — Flow chart for dealing with visual and dimensional non-conformities

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