

**Disclaimer**

This sheet is intended for designers, specifiers and other members of construction project teams wishing to reuse this building material or product. It is part of a collection of sheets aimed at bringing together the available information to date that is likely to facilitate the reuse of building materials and products.

This sheet has been produced by Rotor vzw/asbl within the framework of the Interreg FCRBE project - Facilitating the Circulation of Reclaimed Building Elements, supported by the entire project partnership. Sources of information include the experience of reclamation dealers and involved project partners, lessons learned from exemplary projects, available technical documentation, etc.

The sheets have been produced between 2019 and 2021. As the reclamation sector is evolving, some information, notably regarding pricing and availability, may change over the time. When the text refers to European standards, it is up to the project team to refer, if necessary, to their national implementations and local specificities.

It is important to note that the information presented here is not exhaustive or intended to replace the expertise of professionals. Specific questions are always project related and should be treated as such.

The complete collection of sheets (including the introductory sheet) is freely available from different reference websites (a.o. opalis.eu, nweurope.eu/fcrbe, futureuse.co.uk).

Non-exhaustive directories of dealers in reclaimed building materials are available on www.opalis.eu and www.salvoweb.com.

Interreg FCRBE partnership: Bellastock (FR), the Belgian Building Research Institute / BBRI (BE), Brussels Environment (BE), the Scientific and Technical Center of Building / CSTB (FR), Confederation of Construction (BE), Rotor (BE), Salvo (UK) and University of Brighton (UK).

The information contained in this document does not necessarily reflect the position of all the FCRBE project partners nor that of the funding authorities.

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Material description

By definition, flooring slabs of natural stone are modular flooring elements used both indoors and outdoors. Thinner than cobbles and larger than tiles, flooring slabs come in a wide variety of types. For a long time, they were cut manually with a spike, chisel and mallet, using traditional techniques. These old slabs can be recognised by their greater thicknesses and their more irregular contours. They were gradually excluded by increasingly regular standardised elements resulting from mechanical sawing.

Like other natural stone materials, the reuse of flooring slabs is a relatively common practice. There are many companies specializing in the recovery and resale of this material. The supply of reclaimed flooring slabs is stable although batch sizes can vary greatly from one batch to another (from a few dozen to several hundred square meters).

This sheet mainly focuses on the use of natural stone slabs for interior and exterior flooring.

The reclamation market has a wide variety of flooring slabs models. These often reflect historical and regional specificities. Several criteria make it possible to distinguish them:

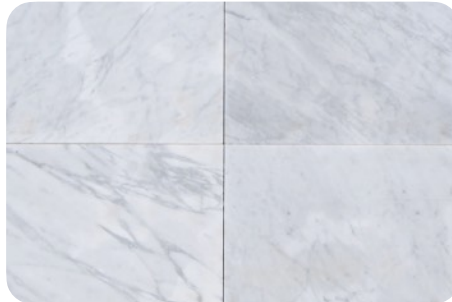
→ **Formats:**

- Square or rectangular slabs with dimensions up to 1 metre per side.
- Church slabs in limestone. These are old slabs of variable sizes, square or rectangular. Their upper face is smooth, their underside is very irregular and their thickness is significant (~ 15 cm).
- Burgundy stone slabs. These are large, thick slabs from old buildings that are very common on the market in France. The typical installation consists in pairing rectangles of various formats.
- "Broken" slabs. These are fragments of broken slabs which are generally assembled in opus incertum.

→ **Geological nature.** Many types of rocks were used in the manufacture of slabs. Among the most common on the reclamation market, we find granite, marble, sandstone, slate, blue stone and white limestone, in all their local variations. There are also slabs made from porphyry, basalt, gneiss, travertine and other rocks.



Ancient Burgundy slabs © authentic.fr



White marble (Carrara)

Terminology!

Depending on the geographical context, or the geometrical characteristics of the elements, or even the nature of the stone, the slabs can also be called "Flags" or "Flagstones".



Black marble



Sandstone © London Reclaimed Brick Merchants Ltd



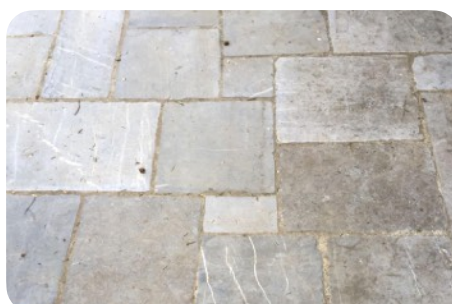
Granite



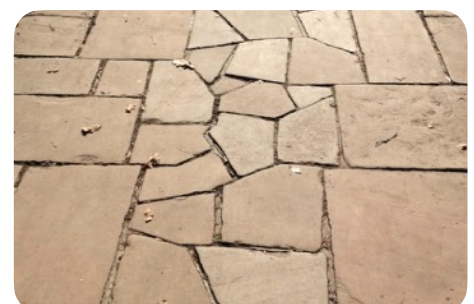
Belgian blue stone



Slate © Stox Reclamation



Old blue stone church slabs (BE)
© Sophie Boone



Mix of square York sandstone slabs and "broken" slabs laid in Opus Incertum, Holland Park, London (UK) © Thornton Kay/Salvo



Natural stone flooring slab

→ **Dimensions.** Usually, reclaimed slabs have widths and lengths between 30 and 100 cm and thicknesses between 2 and 15 cm. However, it is not uncommon to find elements with more specific dimensions.

→ **Appearance.** The diversity of rocks is reflected in a wide range of colours, including within the same family: grey, beige, ochre, brown, pink, bronze, etc. A specific vocabulary is used to designate the stone inlays: veins, grains, strata, flames, stains, etc.

In addition to the original appearance of the rock, the slabs can bear the marks of their cutting method (cleavage, sawing) and of their original finish (flaming, sanding, shot blasting, bush hammering, polishing, etc.). Usually the underside of the slabs has a much coarser texture. Over time, their appearance also varies according to the stresses of use: softening, polishing of the visible face, darkening of the hue, rounding edges, traces of paint, mortar or bitumen on the underside, growth of organisms (algae, mosses, lichens, etc.), etc.

→ **Installation type.** Different types of installation are to be found:

- laying slabs on a flexible base (sand, earth, etc.);
- laying slabs on platforms;
- laying of embedded slabs: plaster, lime mortar, bastard mortar or cement mortar;
- laying of bonded slabs: adhesive mortar.

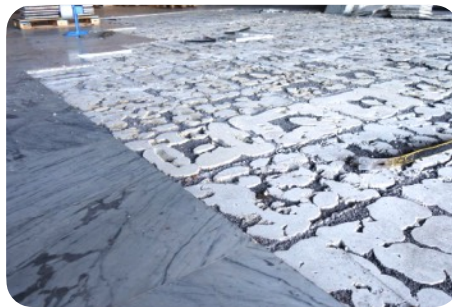
→ **Original grouting.** The mortar grout fills the space between the stones with a binder. The choice of grouts and their thickness is determined according to the type of installation, the location of the slabs, the nature of the stone and the regularity of the slab's edges. The slabs can also be laid without mortar which facilitates their recovery. We speak of a dry joint or a live joint if the slabs are laid edge to edge. There are also flexible joints (sand, gravel, topsoil, etc.).



Slabs on sand © Perrine Henault, [Atelier NOUS](#)



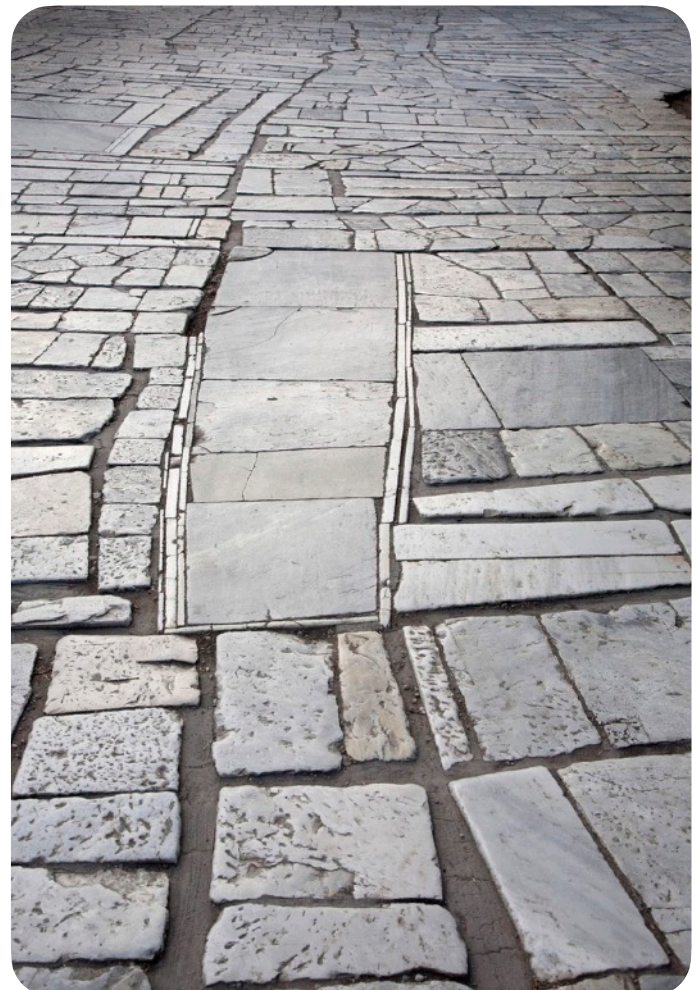
Slabs on platform
© [agencementpierres.com](#)



Sealed slabs



Bonded slabs © [stonenaturelle.fr](#)



Reused paving slabs on the way to the Acropolis in Athens (GR), 1930. Píkionis
© Mayte Piera



Natural stone flooring slab

Material reclamation

Natural stone slabs are a good candidate for reuse, either on-site or through the professional channels of material resellers. They can also ensure the supply of batches of slabs ready for installation.

They are able to ensure the smooth running of the following operations:

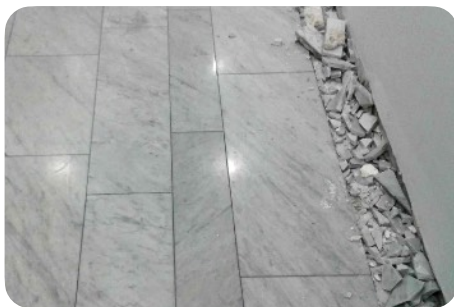
→ *Disassembly test* (or expert opinion). A disassembly test makes it possible to ensure the feasibility and profitability of a removal. It may possibly be supplemented by cleaning tests of the remains of mortar and grout). An “expert eye” generally makes it possible to estimate the interest of a batch based on plans, photos, historical documents or by an on-site visit. The focal points for slabs will be among others:

- the general condition of the batch and the laying method: condition of the stone, formats, thicknesses and dimensions, nature of the laying bed, characteristics of the joints, etc.
- commercial interest, depending on model, quantity, salvage and resale potential, specific regional particularities, etc.
- logistics arrangements: especially in terms of deadline, working time, handling, transport, etc.

→ *Removal*. Careful dismantling should aim to ensure the integrity of the slabs and a certain uniformity of the batches. It is particularly easy if the slabs are laid on a platform or, to a lesser extent, if the adhesion between the laying bed and the slab is weak. This is particularly the case for laying in a lime mortar bed or on stabilised sand. However, this operation will be more complicated if the slabs are bonded or embedded with cement mortar (which will also complicate cleaning). To minimise the risk of deterioration during dismantling, it is advisable to weaken the tensions within the slabs by first freeing 2 sides (perpendicular) of the slabs. This usually involves breaking non-free edge lines. The type of joint also influences the ease of recovery and cleaning of the slabs. For example, epoxy grout often causes damage during disassembly. To optimise the recovery rate, it may be useful to first open the joints using appropriate tools (e.g. diamond rail saw, pressurised water, etc.) and use handling equipment suitable for the cladding to prevent splintering.

→ *Sorting and cleaning*. Slabs of the same covering can show different degrees of wear depending on their location, which is why it is useful to sort them during dismantling, for example according to their quality, their colour, their dimensions or even their degree of soiling. Slabs that are split or have significant defects are downgraded. Cleaning with water, by scraping or by mechanical abrasion (e.g. stone cutter), is generally sufficient to remove the residues of the bedding layer, grouting products and other elements liable to adhere to the stone.

→ *Storage and packaging*. The slabs are generally stored outside, arranged on their edges in wooden crates or packaged horizontally and strapped on pallets. Depending on the fragility of the slabs to be kept, they are sheltered to avoid contact with the ground and thus providing possible protection against frost. Ideally, they are separated by wedging elements in order to limit the risk of damage. The wedge/separation wood must not be treated, be very dry and not contain tannins which could stain the stones. Metal straps should be avoided as there is a risk of staining the stone (rust). The packaging must take into account the large mass of the elements. Appropriate means of transport and lifting are also required.



“Breaking” a first line



Sawing joints



Removing the slabs



Unstacking slabs



Sorting slabs



Transport and loading of slabs



Natural stone flooring slab



Storage on the edge in wooden crates



Pallet storage



Storage on a strapped pallet, face to face
© De Opkamer

→ **Operations.** While some slabs can be reused as is after a rough cleaning, others may require additional operations:

- **Sawing:** to obtain flat faces or to make the dimensions uniform. The thickest slabs (> 10 cm), such as Burgundy slabs, can be sawn along their thickness. The upper part, which has the original patina, is sold for a high price while the remainder is usually sold for much less.
- **Thorough cleaning:** the visible face of some more porous stones may be stained or have changed colour during use due to atmospheric pollution, the passage of users or the growth of moss. Their restoration to original condition is not always possible. It depends on the depth of encrustation, which varies according to the type of pollution and the type of stone. It is advisable to contact a professional to know the compatible products and the appropriate treatment methods. Several techniques are possible: water polishing (different pressures and temperatures), use of chemicals (oxalic acid, polishing chemicals, polishers), mechanical cleaning (sanding, polishing, sandblasting, projection of fine particles, micro-sanding, etc.) or even, in very specific cases, use of laser, latex or poultices. The choice of a suitable cleaning technique will depend essentially on the following aspects: nature and hardness of the stone, fineness of its grain and other surface aspects, presence of alterations, type and degree of soiling, desired result.
- **Finishing:** it is very rare that reclaimed slabs undergo a surface treatment in the workshop. In general, the desire is rather to preserve their patina. However, to meet the desired requirements (standardise the appearance of the stone, give it a rough appearance, etc.) several finishing techniques are possible depending on the nature of the stone and the expected performance:

bush hammering, sanding, flaming, shot blasting, pitting, etc. A specific vocabulary determines the type of finish depending on the type of rock concerned.

These various operations can be carried out by specialised resellers within their facilities. They can also be considered on site, provided that the site logistics allow it.

Ready-to-install slabs are clearly identified and labelled in uniform batches. They are sold by the square meter or by the ton. Most suppliers are able to provide information on their main characteristics: type of rock, nominal dimensions and tolerances, finish, intended applications and, in certain cases, their origin.



Removal of mortar residues from the edge using a lapidary machine



Cutting stone elements



Removal of mortar residues with a pneumatic chisel
© De Opkamer



Bush hammering of slabs



Thickness sawing of the slabs, thicker and irregular bottom part



Thickness sawing of the slabs, smooth and even top part



Natural stone flooring slab

Applications and laying

Reclaimed slabs are mainly used as modular elements for covering indoor or outdoor floors. They are generally reserved for applications subject to moderate stresses: indoor floors, terraces, pedestrian zones, squares, alleys, cycle paths or squares subject to light vehicular traffic (least loaded traffic category). Their resistance to mechanical loads depends overall on their format: the more compact their dimensions (close to a paving stone), the better they resist bending. In this sheet, we consider the reuse of flooring stones for identical uses. However, it is possible to reuse these elements elsewhere (see for example the sheet devoted to natural stone wall cladding slabs).

The choice of a type of slab depends of course on the intended uses (interior, exterior, traffic intensity, etc.). Conversely, the reclamation possibilities of a given batch depend on its intrinsic characteristics. If necessary, specific operations (cutting, finishes, etc.) make it possible to adapt the characteristics of the slabs to meet new use requirements (for example in terms of roughness, ease of maintenance, surface rendering, etc.). The installation type and quality also play an important role in meeting use requirements.

The points of attention related to the installation of reclaimed slabs do not fundamentally differ from those related to new slabs. In all cases, reference should be made to the European and national standards relating to the product (in particular the European standard for natural stone slabs for exterior paving EN 1341 and the standard for natural stone slabs for flooring and stairs EN

12058) and to the rules of practice in force (or implementation standards). It should be noted that some local reference guides on the installation of slabs already include the case of reclaimed slabs (for example: the Qualiroute standard developed in the Walloon Region, Belgium).

The following characteristics can be described and specified when drafting the technical requirements related to the delivery of a batch of reclaimed slabs:

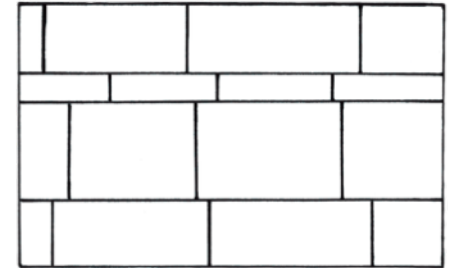
→ **Batch composition.** The batch of reclaimed slabs consists of elements of the same format (square, rectangular, irregular, etc.), of the same geological nature or even of the same original use (interior use, area subject to frost, etc.). It is advisable to define one batch as a surface to be paved and of the same application. However, mixed slab batches may be suitable for less demanding applications.

→ **Format.** Depending on the installation, the slabs must have a greater or lesser dimensional stability (same dimensions and same thickness). While some particular formats (for example, cabochon tiles) require adapted paving layouts, other stone-setting is particularly suited to more irregular elements. For example :

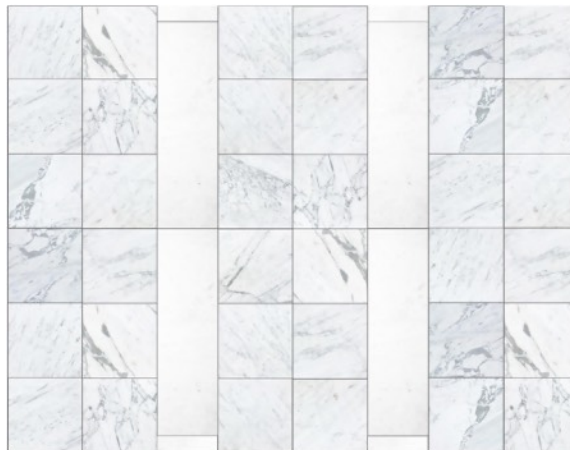
→ **Hue.** By nature, natural stones have a wide variety of colours and appearances. Depending on usage requirements (for example, in the context of heritage renovation), it is possible to specify this characteristic by referring to a general hue or to a specific colour. During the installation, it is advisable to mix the stones of the different pallets in order to obtain a uniform flooring.



Opus incertum: format allowing to work with any fragments of broken slabs.



Free length and variable width: format allowing to work with elements having a constant width and variable lengths (on a same row).



Proposal for a floor layout that combines slabs and marble panelling © Rotor

Think reversible!

Certain laying methods complicate or even prevent future recovery of stone flooring slabs. This is particularly the case with rigid installations where the slabs are bonded (mineral binders, synthetic fillers and resins) or sealed with cement mortars. In this sense, as soon as possible and with comparable performance, it is preferable to favour a flexible installation (flexible base, sand bed and sand joints, stabilised sand or from a bituminous emulsion) or an embedded installation using lime mortars or bastard mortars..



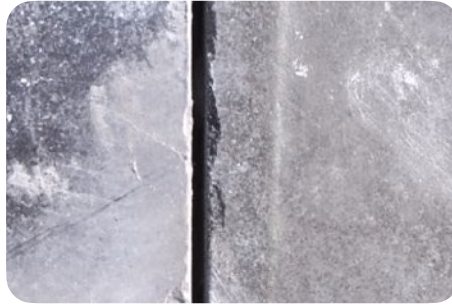
Natural stone flooring slab

→ **Condition.** In addition to traces of mortar, paint and bitumen residues, reclaimed slabs may show minor alterations such as signs of surface wear, chips, light cracks, craters, light flaking, stains, leftover moss, etc. These deteriorations can influence the technical and aesthetic performance of the slabs, as well as their re-installation, but do not constitute a major obstacle to reclamation - except for very specific uses (see § "Characteristics and fitness for use").

The batch must not, however, contain any elements showing cracks or major damage compromising its solidity (e.g. stylolithic joints leading to the surface of limestone, deep cracks, etc.). The specifier should define the degree of imperfections tolerated with regard to the intended use and the installation conditions. He may particularly describe the degree of tolerance of the following elements:



Moss and algae residue



Splintering



Chipping



Scratching



Bedding layer residue



Deep cracks and splinters



Superficial cracking



Stylolithic joint

→ **Finish.** Depending on the requirements (functional and aesthetic) and the type of rock, specify the appearance of the visible face (rough, sawn, bush hammered, shot-peened, flamed, polished, softened, etc.), ask that it be identical for the whole batch and specify what fraction of the surface of the slab it concerns.

→ **Quantity.** Some suppliers may include surplus when the product is delivered if they are not able to guarantee the absolute uniformity of the characteristics mentioned above. This surplus can also be applied in the case of an on-site salvage scenario. It is generally advisable to provide a reserve stock of slabs in order to carry out subsequent repairs. Depending on the layout chosen, a greater or lesser percentage of margin will be necessary because of the cutting brought about (generally between 5 and 10%).

Most professional suppliers are able to ensure that delivered batches meet these requirements. A control test procedure based on a contractual sample and sampling upon receipt can be set up.

Most of the reclaimed building materials are sold as is. The conditions of sale may however contain special guarantees specific to the material. Some suppliers are able to indicate the origin of the material and/or provide documentation on the product purchased (for more information, see the *Introductory sheet*).

Design tip!

In general, the integration of reclaimed stones in the project is greatly facilitated if we plan:

- a layout that tolerates slabs of various sizes.
- a composition strategy for the batches recovered: either by mixing the batches to create a random distribution of colour shades, or by assigning each batch of material to a particular space.
- a method of installation which allows working with slabs of various thicknesses. Indeed, it often happens that the batches of reclaimed stones are not graded.



Characteristics and fitness for use

By knowing the family or the type of stone present, it is generally possible to find its general characteristics (depending on the context). These indications are invaluable for studying the compatibility of the reclaimed stone for the intended use.

See for example: www.febenat.be ; www.stonenaturelle.fr ; www.pierreetisol.com ; www.cstc.be ; etc.

As an indication, the following table (Table 1) shows some of the known performances of some types of rock constituting stone flooring slabs which are frequently reclaimed. It is important to point out that each stone has its own characteristics and that two batches of flooring slabs of the same rock can however have quite different performances.

The harmonised European standard EN 1341 establishes the relevant characteristics for determining the fitness for use of natural stone slabs intended for exterior paving, and the standard EN 12058 defines the relevant characteristics of natural stone products as flooring and staircase slabs. Although detailed for new materials from the extractive and natural stone processing industry, these characteristics may prove useful in considering the specific case of reclaimed indoor/outdoor flooring slabs (Table 2).

Tip!

If the performance is to be determined in the laboratory, a representative sample of the batch in question should be established. The number and dimensions of the samples to be taken depend on the type of test to be carried out. In order for the test results to be usable, the sampling procedure must be rigorous. A professional can assist you in this work to choose the samples and the tests to be carried out. For example, he will ensure that the properties of different samples subjected to identical stresses are assessed in order to obtain a representative mean value. The test procedures will be defined with regard to the previous and subsequent uses of the slabs.

Table 1: Technical characteristics of the most common stones used in flooring slabs

	Bulk density (kg/m³)	Flexural strength(MPa)	Porosity	Wear resistance
Sandstone	1900 - 2700	3 - 14	little porous (0.5 to 25%)	++(+)
Soft limestone (e.g. white stone)	< 2500	2-17	porous (5 to 50%)	++
Compact limestone (e.g. bluestone)	> 2500	2-17	little porous (0.2 to 5%)	++
Granite	2400 - 3000	8 - 25	very little porous (0.2 to 2%)	+++
Marble	2600 - 2900	8 - 22	very little porous (0.2 to 2%)	++

Table 2: Characteristics to be assessed to determine the fitness for use of reclaimed natural stone slabs for indoor/outdoor flooring

Characteristics	Indoor	Outdoor	Comments
Geological origin and petrographic description	x	x	The reclaimed slabs come from building works that may have been made from batches of multiple origins. If it is possible to visually characterise the type of rock present, it is however more difficult to affirm with certainty that their geological origin is identical, unless there are records that allow it to be attested (for example: a certificate of origin, archival documents, etc.). This is all the more true for the batches made up of slabs of various origins.
Geographical origin	x	x	As with the geological provenance, information on the original geographic provenance of a batch of reclaimed slabs is difficult to certify with any certainty. On the other hand, we can deduce certain characteristics if we know where the slabs were removed. Intact and dismantled slabs in an area subject to strong freeze/thaw cycles are likely to show good frost resistance. Thus, in the absence of information on the original quarry, it may be useful to have information on the original use or the area where the slabs come from.
Bulk density and open porosity	x	x	<p>These characteristics are specific to each stone. The density [kg/m³] gives an indication of the degree of compactness of the stone. In general, the more compact a rock, the less porous it is.</p> <p>The open porosity of a stone [% by volume] corresponds to the proportion of pores connected to each other and accessible to water. This characteristic influences in particular the degree of resistance to stains and soiling. It does not directly affect its freezing (it is rather its capacity to return the absorbed water that matters at this level).</p> <p>This information can be estimated based on technical documentation relating to natural stones (see Table 1). If necessary, these characteristics can be measured more precisely by an identity test as defined by the test EN 1936.</p>



Characteristics	Indoor	Outdoor	Comments																
Geometric characteristics	x	x	<p>These characteristics can be found out by taking simple measurements. They are closely linked to the degree of sorting and cleaning of the reclaimed slabs as well as to the transformation operations undertaken on the material. In the case of slabs intended to be re-machined or re-cut, it is advisable to define with the supplier the dimensional tolerances applicable to each of the dimensions (width, thickness, length, etc.) the required stone-setting, the type of stone and the functionality of the works (these various aspects are described in standard EN 1341). The requirements in terms of flatness and straightness should also be detailed.</p> <p>In general, raw reclaimed slabs show irregularities in shape related to the original manufacture and the degree of wear.</p>																
Tactility (for visually impaired people)	x	x	<p>Tactility describes the surface relief of the slabs. If required, this feature can be achieved through mechanical finishes based on CEN/TS 15209.</p>																
Flexural strength	x	x	<p>The flexural strength R_f [MPa] is a mechanical characteristic which provides information on the capacity to resist bending forces in use. It varies according to the type of stone and is generally determined by means of bending tests (as per standard EN 12372).</p> <p>The flexural strength makes it possible to determine the admissible breaking load [kN] of the slabs, according to their dimensions, and to the following formula:</p> $P = \frac{R_f \times W \times t^2}{1500 \times L \times F_s} \quad \text{où} \quad P : \text{breaking load [kN]}$ <p style="margin-left: 40px;">W, L, t : width, length and thickness [mm] R_f : flexural strength [MPa] F_s : safety factor, generally $F_s = 1.6$</p> <p>The thickness here is therefore a determining variable: since it is squared, a small variation can cause a big difference.</p> <p>In the case of roadside slabs, the applicable requirements can be summarised in the following table:</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th>Recommended use</th> <th>Breaking load (kN)</th> </tr> </thead> <tbody> <tr> <td>decoration</td> <td>no requirement</td> </tr> <tr> <td>pedestrian use only</td> <td>> 0.75</td> </tr> <tr> <td>pedestrian and cycling areas</td> <td>> 3.5</td> </tr> <tr> <td>occasional access for light vehicles, garage entrances</td> <td>> 6</td> </tr> <tr> <td>pedestrian traffic area, market places, occasional circulation of delivery/rescue vehicles</td> <td>> 9</td> </tr> <tr> <td>pedestrian traffic area frequently used by heavy trucks</td> <td>> 14</td> </tr> <tr> <td>roads and streets</td> <td>> 25</td> </tr> </tbody> </table> <p>However, in the case of reclaimed slabs, it can be assumed that elements that have been subjected to high loads during their life will continue to meet similar or lower requirements. A detailed examination of the initial conditions of use therefore allows the flexural strength of reclaimed slabs to be assessed without any specific test measures.</p>	Recommended use	Breaking load (kN)	decoration	no requirement	pedestrian use only	> 0.75	pedestrian and cycling areas	> 3.5	occasional access for light vehicles, garage entrances	> 6	pedestrian traffic area, market places, occasional circulation of delivery/rescue vehicles	> 9	pedestrian traffic area frequently used by heavy trucks	> 14	roads and streets	> 25
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Adhesion resistance (if bonding)	x	x	<p>The adhesion strength and durability values depend on several important factors: the type of mortar/bonding, the surfaces to be bonded, the climatic conditions, etc.</p>																
Direct overhead sound insulation	x		<p>In general, the heavier a material (dense and thick), the better it insulates, especially against airborne noise. However, it is rare that one chooses a stone for reasons related to acoustics. If required, however, this characteristic can be determined in the laboratory according to the test method of EN 1936.</p>																

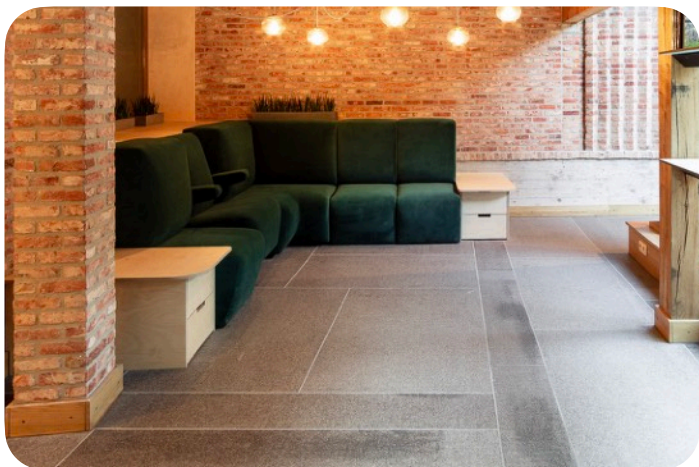


Characteristics	Indoor	Outdoor	Comments
Thermal conductivity	x		Thermal conductivity is defined as the amount of heat that passes through the material per unit of time and area. It depends on the voids present in the material. Generally speaking, the denser the stone, the better its thermal conductivity. If required (underfloor heating), this characteristic can be determined in the laboratory (according to the test method of EN 1745).
Slippage	x	x	<p>This feature influences the comfort and safety of users. It mainly depends on the roughness and texture of the surface. It can be assessed visually. The coarser it is, the more non-slip it is. This characteristic changes over time under the influence of the surface wear, the presence of dirt, the maintenance conditions, the slope, the density of the joints and the climatic context (rainfall). The in-depth evaluation of the slip resistance (managed by the EN 14231 test standard) may be relevant when the structure is intended for pedestrian and vehicles traffic. This standard further stipulates that embossed or cleaved squared slabs, with a surface roughness greater than 1 mm, meet the slip requirements without prior test measurements.</p> <p>In the case of reclaimed slabs, a specific finishing treatment adapted to the type of stone can be considered. Certain finishing treatments (flame treatment, for example) may be applied during use in order to meet the requirements in force.</p>
Resistance to freezing/thawing (and de-icing salts)		x	For an exterior application, the natural stone elements must be able to withstand freezing/thawing without their appearance or their mechanical characteristics being affected. The source and condition of a batch of reclaimed slabs can provide a useful guide to determining their resistance to freezing/thawing. Many old slabs are in fact likely to have withstood, during their first use, more freeze/thaw cycles than what is recommended by the test standard which allows this performance to be assessed (EN 12371). It is therefore important to find out about the geographical origin of the batch to ensure the original climatic conditions (for example, a batch coming from a continental climate in northern Europe will probably be suitable for an application in the Mediterranean climate of the South of France). Generally, less resistant slabs that have suffered frost damage will probably have been discarded during the sorting and cleaning steps.
Thermal deformation	x	x	Natural stone is subject to dimensional variations under the effect of temperature. This deformation is expressed in [mm/mK] by the coefficient of thermal expansion. In the case of slabs subjected to large temperature variations (exterior paving, paving in contact with underfloor heating, etc.), it may be relevant to determine its extent (EN 14581: 2005) in order to size the movement joints (width and spacing). In some marble and, to a lesser extent, some granites, the anisotropic thermal expansion of the stone can cause granular decohesion resulting in significant deformation of the slabs.
Resistance to impact	x	x	The resistance of a slab to the impact of a hard body depends on the characteristics of the stone but also on its installation system and its substrate. The test described in standard EN 14158: 2004 consists in dropping a steel ball on the slab installed in its real conditions of use. For reclaimed slabs, it is also possible to rely on the condition of the slabs still installed. If many slabs in the same room are broken, it can be assumed that even intact slabs are likely to break in turn. These slabs should not be extracted without keeping all the information on the condition of the batch.
Wear resistance	x	x	This durability characteristic depends on the type of stone, the intensity and type of traffic, the presence of abrasive particles and the maintenance conditions. If there is a test standard which allows this characteristic to be evaluated with precision (EN 14157 - Capon test), it can also be used for reclaimed slabs, by relying on the way in which they have withstood the demands of their first use. In general, granites and basalts are suitable for intense stress and are more resistant to wear than sandstones and limestones.



Natural stone flooring slab

Characteristics	Indoor	Outdoor	Comments
Susceptibility to staining	x	x	<p>To assess this characteristic, we differentiate between internal staining caused by the reaction of certain constituents of the stone (metallic minerals or organic materials present in the stone), from accidental staining caused by contact with a potentially staining product for stone.</p> <p>Internal staining is above all a concern for the aesthetics of the material and it is therefore appropriate for the specifier to define the acceptable characteristics with regard to the intended use.</p> <p>The sensitivity to staining is also directly related to the porosity value of the stone. The higher the porosity, the more easily the stone absorbs liquids (and therefore pollution) and the more sensitive it is to staining. A porosity of less than 4% is generally satisfactory in order to limit the risks of soiling. It is also possible to visually identify the degree of soiling of the reclaimed slabs by observing the visible face of the unprocessed (sawn) elements. Specific surface treatments can also be recommended to improve this performance.</p>
Reaction to fire	x		<p>In accordance with Commission Decision 96/603/EC, natural stones are considered to belong to class A1 of reaction to fire (see EN 12 058 for exceptions). However, be careful with the use of filler sealants, which can affect this performance.</p>



Reuse of Italian flamed granite slabs. Zonnige Kempen, Westerlo, (BE). © Rotor



Reuse of granite and Hainaut stone slabs of various sizes and shapes, recovered from the City of Paris warehouse. Square de la biodiversité, Paris (FR)
© Perrine Henault, Atelier NOUS



Natural stone flooring slab

Availability

The professional market for reclaimed slabs is fairly developed. However, the size of the batches varies greatly from one offer to another, from a few dozen to several hundred square meters. It is recommended to check with professionals early enough in the event of a large order (several hundred square meters).

Indicative prices (Excl. tax):

A non-exhaustive sampling of the reclamation market in North West Europe (Belgium, France, Great Britain and the Netherlands) made it possible to extract some indicative prices. These vary depending on the format, the size and type of stone, as well as the degree of sorting and cleaning requested.

- Sandstone slab = 50-150 €/m²
- Blue stone slab = 100-150 €/m²
- Slate slab = 50-200 €/m²
- White limestone slab = 120 - 300 €/m²
- Fragments of broken slab = 10-30 €/m²

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Embodied carbon (Cradle to gate - production A1-A3)

	kg CO ₂ eq./m ²	kg CO ₂ eq./kg
OEKOBAUDAT (DE) database - Thinkstep individual data - Granite slabs *	31,8	0,6
OEKOBAUDAT (DE) database - Thinkstep individual data - Marble slabs *	16,3	0,3
OEKOBAUDAT (DE) database - Thinkstep individual data - Limestone slabs *	14,9	0,3

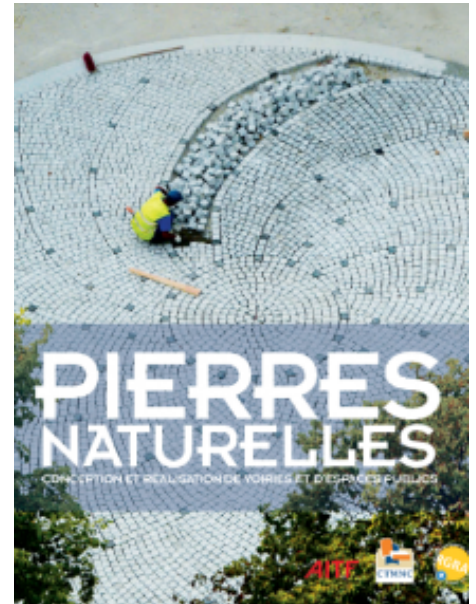
* Indicative value for a façade cladding of 1 m², 2 cm thick and with a basis weight of 52 kg/m².



According to the sources and types of stone, reusing 100 m² of reclaimed natural stone flooring slabs prevents the production of ~ 1490 to ~ 3180 kg of CO₂ equivalent related to the manufacture of new slabs (production phase only). This corresponds to the amount of emissions caused by a small diesel car travelling a distance of ~ 9000 to ~ 19000 km.



Reuse of polished Belgian blue stone slabs. Vignette House, Auderghem (BE). Archi: Karbon' architecture & Urbanism © Giulia Frigerio



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