**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.

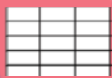
Interreg FCRBE partnership: Bellastock (FR), the Belgian Building Research Institute / BBRI (BE), Brussels Environment (BE), the Scientific and Technical Center of Building / CSTB (FR), Confederation of Construction (BE), Rotor (BE), Salvo (UK) and University of Brighton (UK).

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

Stone has always been used and re-used in construction, in particular to cover exterior façades and interior walls. In his architectural treatise published in 1485 (*De re ædificatoria...*), Alberti already speaks of the use of stone to build what he calls “the skin” or “the bark” of buildings, that is to say the exterior and interior faces of the walls of which, he says, “... one receives the wind and the sun on the outside, while the other protects the interior shade ...”. Although the terminology has changed since the 15th century, we still use stone for the same purpose. A distinction is made today between the stone wall covering slabs and veneers (or tiles). The latter are thinner and smaller in size. Thicker and larger elements fall into the category of facing stones, which are usually laid with other techniques.

This sheet covers the reclamation of natural stone slabs intended for use in wall cladding. It is also possible to reuse the slabs elsewhere, as flooring for example (see the sheet dedicated to natural stone flagstones).

The market for reclaimed wall tiles includes a very wide variety of products. We can separate them according to different criteria:

→ **Original use.** Some batches come from the façades of office buildings and other large public and private facilities (e.g. stations, banks, etc.). The demolition of these buildings generally results in the release of large quantities of similar slabs, often in excellent condition and of good quality. Other slabs are the result of the careful dismantling of window sills, flooring, etc. from various types of buildings, including older structures.

→ **Geological nature.** Many types of rocks are used for the manufacture of wall facing slabs: granite, marble, limestone, sandstone, slate, travertine and many others, all available according to many local variations.



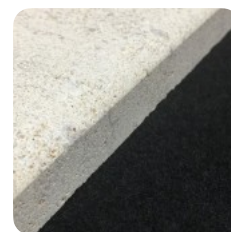
Chamfered edges
© Pierre de Bourgogne



Chipped edges



Sharp edges



Rounded edges

→ **Dimensions.** Usually, reclaimed slabs have widths and lengths between 30 and 150 cm and thicknesses between 1 and 8 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.). Over time, their appearance also varies according to the stresses of use: softening, polishing of the visible face, darkening of the hue, traces of paint or mortar on the underside, growth of organisms (mosses, lichens), etc.

The treatment of the surface of certain types of stones may require the use of putty, fillers or other similar products for plugging natural holes, defects or cracks. These treatments

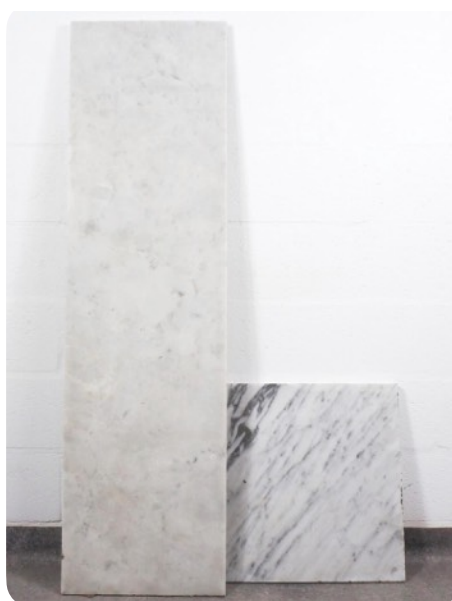
are often not specific to reclaimed stone but also apply to new products.. Sometimes, an anti-graffiti treatment is present (e.g. tiles from the feet of a building).

The edges of the slabs can be straight, rounded, chipped or even chamfered.

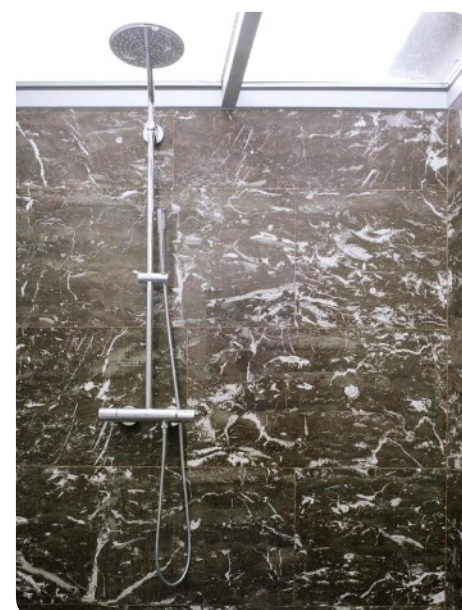
When a re-machining of the reclaimed slabs is envisaged (sawing, squaring, milling, etc.), this will generally modify the appearance of the visible faces.



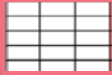
Polished grey granite slab



Carrara marble slab



Shower room made of reclaimed red marble
© Séverin Malaud



→ **Fixation.** The slabs may have been bonded or fastened.

- Bonding is generally reserved for thinner slabs (1 to 2 cm thick, depending on the density of the stone).
- Mechanical fasteners are suitable for thicker slabs (2 to 8 cm). There are several types: metal clips with or without stud, fixed to an intermediate frame or directly into the wall. Non-destructive methods such as the use of a pachometer make it possible to locate the metal anchoring elements without dismantling the slabs.

→ **Geological nature.** Depending on the type of installation, the presence or not of an insulation, the location of the slabs and the height of the building, we may encounter common solid joints (mortar, grout, epoxy, etc.), flexible control joints or horizontal and vertical expansion joints (epoxy, sealant, etc.) or even hollow joints, left empty or decorated with metallic elements.



Stone cladding fixed with metal clips embedded in mortar studs



Searching for metallic anchoring elements of a natural stone facing using a pachometer. © CSTC



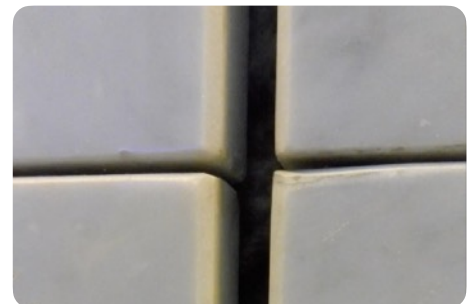
Fastened stone cladding



Full joint



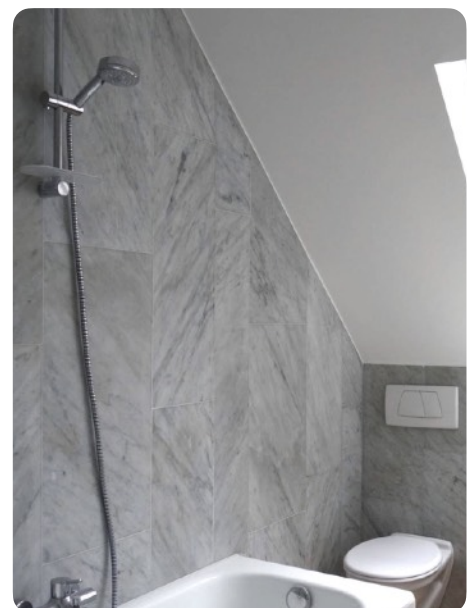
Hollow joint filled with metal elements

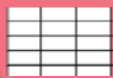


Hollow joint



Shower room made of reclaimed marble © Lionel Billiet



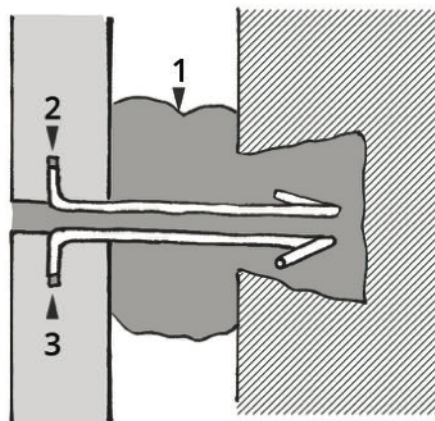
**Material reclamation**

Natural stone wall coverings 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. 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, dimensions fixing type, type of 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. When the joints between the slabs are full, it is sometimes advisable to separate the slabs using tools (diamond saw on a rail, pressurized water, etc.) and handling means suitable for the covering to avoid splintering. Then the slabs can be laid. (Figure 1) If the slabs are fixed using a mechanical anchor, it is advisable to break a first slab to create an access then to break the mortar stud (1) surrounding the metal fasteners (2 & 3) using a chisel.



- (1) Mortar stud
- (2) Load-bearing clip
- (3) Anti-buckling clip

Figure 1. Mortar-embedded fasteners in the edges of the slabs

It is then necessary to remove the fasteners using the chisel or a crowbar or to disconnect them at the joints. 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 tiles to be detached. This usually involves breaking non-free edge lines. It is advisable to proceed with the disassembly from top to bottom. In addition, some slabs can be particularly heavy due to their size and the density of the stone (> 2.5 t/m³). If necessary, it is advisable to equip oneself with specific lifting means. Removal may also involve making arrangements for work at height. Finally, a sand bed can be installed at the foot of the slabs to absorb shocks.

→ *Cleaning and sorting*. The slabs will be sorted by quality, colour, size and degree of cleaning. Elements showing deterioration (split slabs) or significant defects are discarded. The rate of loss strongly depends on the type of rock, the original conditions of use, the type of installation, the thickness of the slabs and the care taken in dismantling. Cleaning with water or by scraping is generally sufficient to remove laying residues, jointing products and other elements which could adhere to it. The metal fasteners are also removed.

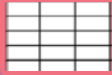
→ *Operations*. While some slabs can be reused as is after a rough cleaning, others may require additional operations such as:

- *Sawing*: the slabs can be sawn to make their dimensions consistent and facilitate their installation.
- *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 even the growth of moss. Their restoration to original condition is not always pos-

sible. 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, etc.

- *Finishes*: it is very rare for reclaimed slabs to undergo a surface treatment in the workshop since in general the desire is to keep their patina. However, to meet the desired requirements (standardize 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.
- *Repair of lug/clamp holes*: the existing holes may have been damaged during use or during the removal of the slabs (chip, crack, widening of the holes, etc.). In this case, the visible holes can be filled with a suitable product and new holes can be drilled in the workshop (respecting the positioning and strength of the new fasteners prescribed by the technical standards relating to the product).



→ *Storage and packaging.* The slabs are generally stored outside, arranged on their edge in wooden crates or packaged horizontally and strapped on pallets. Depending on the fragility of the slabs to be kept, they will be sheltered by avoiding contact with the ground and by providing for 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 (it must be very dry and not contain tannins liable to stain the stones) and 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.

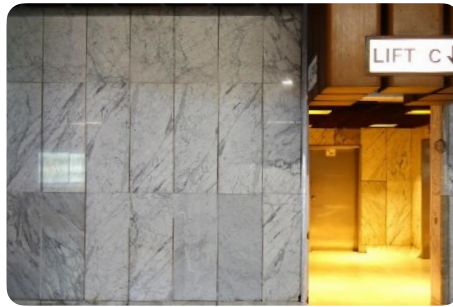
The ready-to-install reclaimed slabs are grouped together in uniform batches. They are generally sold by batch or per m². Most suppliers are able to provide a technical sheet showing their main characteristics (type of rock, nominal dimensions and tolerances, finish, intended applications) and, in certain cases, their origin.

Point of attention!

Thinner façade slabs in metamorphic marble can be subject to granular decohesion which can lead to the bowing of the elements, their cracking and causing a risk of falling. This phenomenon is accentuated for façades subject to rain and sun (south, south west) and for large, very thin slabs. It often leads to cracks at the anchors. A detailed visual inspection will usually reveal this problem. A more in-depth analysis of the microstructure of the stone also makes it possible to observe this phenomenon.



*Bowed slabs. Alvar Aalto's Finlandia Hall, Helsinki
© University Of Helsinki*



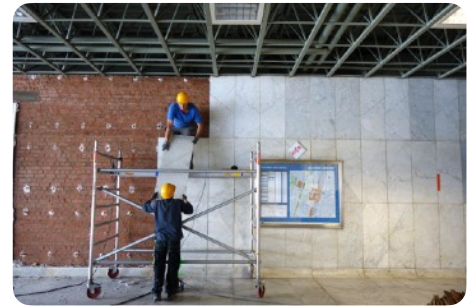
Marble slab wall covering



Fixing by hooks



Cutting fasteners



Removal of marble slabs



Palletizing slabs



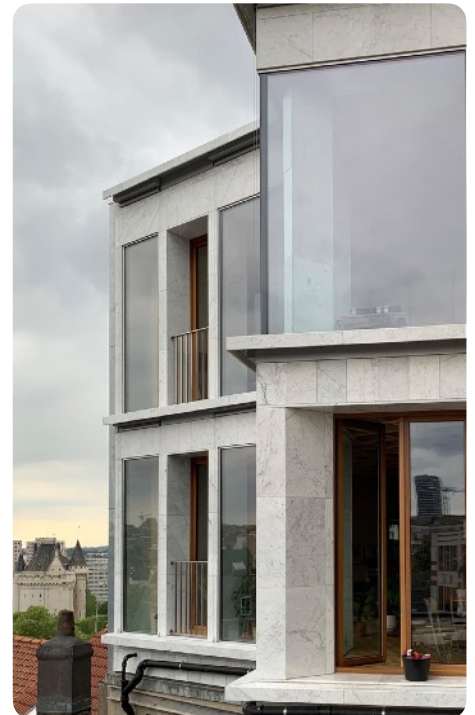
Loading and transporting slabs



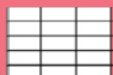
Removal of grout residues from the edge using a lapidary machine



Storage of slabs



*Refitting the slabs on exterior facing, Project Jaspar,
Architect Guillaume Sokal, Brussels (BE).
© Guillaume Sokal*



Applications and installation

The applications presented here relate to stone slabs which were used as wall cladding and which are used for identical purposes. Other uses are of course possible for these elements (for example: splashback, floor covering, etc.) but they are not examined here (see for example the sheet devoted to natural stone flooring slabs). The case of reusing a stone slab from another application as wall cladding is not explicitly broached in this sheet either.

As a rule, the choice of slabs must necessarily take into account the expected stresses (see § "Characteristics and fitness for use").

On the façade, the main stresses are the own weight of the natural stone and the effects of the wind, but other factors must also be taken into account (climate action, thermal shocks, vibrations, impacts, etc.). In all cases, reference should be made to the design standards (Eurocode 1), to national and European standards relating to products (EN 1469: natural stone wall covering slabs), to the rules of art in force and the applicable installation standards.

The installation of a complete batch of reclaimed wall covering slabs in good condition is no different from that of new slabs. Depending on the characteristics of the batch, they lend themselves to the same diversity of installation methods and raise the same points of attention, in particular: format of the elements, properties of the stone, installation method and properties of the installation elements (fasteners or binders), property and condition of the substrate, insulation, waterproofing, common joints and control joints, stone defects at the attachment points (cracks, chips), stone surface condition (greasy stains, oxidation stains, runs, etc.).

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 geological nature (granite, marble, limestone, etc.), 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 covered with the same application. However, mixed slab batches may be suitable for less demanding applications.

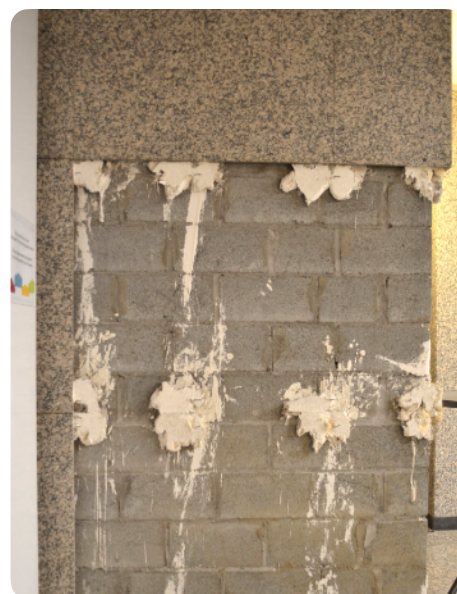
→ *Thickness.* The thickness of the wall slabs affects their mechanical behaviour. It must be chosen taking into account several criteria: nature and texture of the rock, intended use, format, positioning, installation and anchoring process, type and intensity of the stresses (wind, vibrations, shocks, humidity, thermal deformations, creep and shrinkage of the framework, etc.). In most common cases, for soft and semi-hard limestone (density <math><2500\text{ kg/m}^3</math>) mechanically attached, a thickness of 4 cm is generally considered necessary. It can be reduced to 3 cm for denser stones (marble, granite, hard stone, etc.), or even to less than 2 cm in very specific conditions (hard and homogeneous rock, good quality grip, proximity to a rigid stopping point in the event of a fall, etc.). These must then be justified by specific procedures. Conversely, for a bonded installation, the slabs must be between 1 and 2 cm thick, depending on the density of the stone.

→ *Dimensions.* The dimensions of reclaimed slabs generally vary from batch to batch. Depending on the original application, they may also vary within the same batch. It is important to specify the expected dimensions as well as the dimensional tolerance. Good to know: the installation standards set different grip requirements depending on the surface of each slab, the proportion between their length and their width (typically in the order of 1:3 for outdoor use and up to 1:5 indoors) and the height at which they are installed (below 6 m, between 6 and 28 m, etc.). For slabs with atypical dimensions, specific approaches may therefore be necessary.

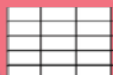
→ *Hue.* By nature, natural stones have a wide variety of colours and appearances. Depending on usage requirements (for example, in the context of heritage renovation), it is possible to specify this characteristic by referring to a general hue or to a specific colour. It's also possible to mix the tiles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

Think reversible!

Certain laying methods complicate or even prevent recovery of slabs. In this sense, as soon as possible and with comparable performance, it is best to use mechanical anchoring (hooks, clips, studs, etc.) for installation. And without joints or with easily cleanable joints!



Removal of interior facing slabs in granite



→ **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 (runs, greasy stains, halos, oxidation) 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"). Where appropriate, certain surface treatments, or even cutting, can make it possible to correct these alterations.

However, the batch must not contain any elements with cracks or major damage that could compromise its solidity (for example cracks, chips or other defect in the stone at the level of the attachment points). The designer/specifier should define the degree of imperfections tolerated with regard to the intended use and the installation conditions.

Watch out for the holes in the old lugs/clips. Sometimes the slabs have worked loose so that the holes have become "craters". Sometimes mortar studs fill in the holes. The holes can be redone on site or in the workshop with suitable tools.

→ **Finishing.** Depending on the requirements (functional and aesthetic) and the type of rock, specify the appearance of the visible face and the edges of the slabs (rough, sawn, bush hammered, shot peened, flamed, polished, softened, etc.). Certain types of finish (rough sawn, scoured, etc.) make it possible to limit the absorption of solar energy from the façade. This phenomenon can be found in the case of dark bonded stone façades which under the effect of the sun can peel off and contribute to the creation of an urban heat island.

→ **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 the margin will be necessary because of the cutting brought about.

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 also 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, for example: a free-length stone-setting.
- a composition strategy for the recovered batches: either by mixing the batches to create a random distribution of shades of colours, or by assigning each batch of material to a particular space.



Above: lug hole intact
Below: lug hole filled with mortar



Lug hole enlarged during removal



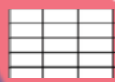
Lug hole enlarged during removal

For more information!

Diagnostic and performance evaluation methodology for the reuse of attached natural stone façade cladding - Fondation Bâtiment (FR)

Énergie, <http://www.batiment-energie.org/doc/70/FBE-ECB-enjeu-A-facade-V5.pdf>





Characteristics and fitness for use

By knowing the family or the type of stone present, it is generally possible to find its general characteristics. 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 slabs which are frequently reclaimed. It is important to point out that each stone has its own characteristics and that two batches of slabs of the same rock can however have different performances.

The harmonised European standard EN 1469 establishes the relevant characteristics (according to the context) in order to determine the fitness for use of natural stone slabs intended for wall covering. 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 slabs (Table 2).

Tip!

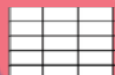
If the performance is to be determined by laboratory tests, a representative sample of the batch in question should be established. The number and dimensions of the samples to be taken depend on the type of test to be carried out. In order for the test results to be usable, the sampling procedure must 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 stone slabs.

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

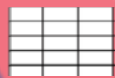
	Bulk density (kg/m³)	Flexural strength (MPa)	Porosity	Wear resistance
Sandstone	2000 - 2700	3 - 14	little porous (0.5 to 25%)	good to very good
Soft limestone (e.g. white stone)	< 2500	2-17	porous (5 to 50%)	good
Compact limestone (e.g. bluestone)	> 2500	2-17	little porous (0.2 to 5%)	good
Granite	2500 - 3000	8 - 25	very little porous (0.2 to 2%)	very good
Marble	2600 - 2900	8 - 22	very little porous (0.2 to 2%)	good

Table 2: Characteristics to be evaluated in order to determine the fitness for use of reclaimed natural stone wall covering slabs

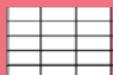
Characteristics	Indoor	Outdoor	Comments
Geological origin and petrographic description	x	x	The reclaimed slabs come from building works that may have been made from batches of multiple origins. If it is possible to visually characterize the type of rock present, it is however more difficult to affirm 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. Thus, slabs in good condition that have been dismantled 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 (exterior façade, interior wall cladding) or the area where the slabs come from.
Bulk density and open pores	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. Their homogeneity depends closely on 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 pattern layout, the type of stone and the functionality of the works (these various aspects are described in standard EN 1469). The requirements in terms of flatness and straightness should also be detailed. For example, if the slab is secured with an adhesive mortar or thin layer of mortar, tighter tolerances may be required. Finally, some reclaimed metamorphic marble slabs may have undergone bending during their previous use. These slabs should be excluded with regard to their intended use.</p> <p>In general, raw reclaimed slabs show irregularities in shape related to the original manufacture and the degree of wear.</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> $P = \frac{R_f \times W \times t^2}{1500 \times L \times F_s}$ <p>where P : breaking load [kN]</p> <p>W, L, t : width, length and thickness [mm]</p> <p>R_f : flexural strength [MPa]</p> <p>F_s : safety factor, generally $F_s = 1.6$</p> <p>For façade clipping applications, the flexural strength of the stone is rarely a problem. Rather, it is the resistance to the anchor studs that is decisive in responding to wind stress depending on the height of the building and the surface of the slabs. As a first estimate, it can be assumed that compact stones of moderate dimensions ($\approx 0.75 \text{ m}^2$) and thickness greater than or equal to 3 cm meet these requirements in most areas.</p>
Resistance to fixings	x	x	<p>The resistance to the fasteners must be demonstrated according to the test standard EN 13364. It must be at least equal to 200 N indoors and 300 N outdoors. Different justifications must be provided: strength of the anchor in the support, strength of the mechanical fastener, strength of the threaded rod, bending strength of the natural stone perpendicular to the façade, strength of the stone at the anchor pin. The first three criteria are generally given by the suppliers in the technical sheets. The resistance at the anchor pin can be determined by means of specific tests described in standard EN 13364.</p>
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>
Water vapour permeability	x	x	<p>The water vapour permeability of a stone represents the amount of water vapour that passes through the material for a given vapour pressure and time. This characteristic should be evaluated if the slab is intended for use in an area subject to vapour control requirements. The coefficient of permeability can be determined by laboratory test or obtained from tabulated values in accordance with EN ISO 12572 and/or EN ISO10456.</p>
Direct overhead sound insulation	x	x	<p>The insulating quality of a wall depends both on the specific characteristics of the wall (rigidity, density) but also on the frequency of the sound emitted. It is characterized by the sound reduction index (measured in the laboratory) or the gross sound insulation (measured in situ). In general, the heavier a material (dense and thick), the more it insulates, in particular, against airborne noise. If required, this characteristic can be determined in the laboratory according to the test method of EN 1936.</p>



Characteristics	Indoor	Outdoor	Comments
Thermal conductivity	x	x	The thermal insulation power depends on the presence and size of the voids present in the material. Thermal conductivity is then defined as the amount of heat that passes through the material per unit of time and area. In general, the lower the density of the slabs, the greater the insulating power. If the slabs are to contribute to the thermal performance of a building, this characteristic can be determined in the laboratory according to the test method of EN 1745.
Reaction to fire	x	x	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 may affect this performance.
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 and 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 historical and 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 shock resistance		x	Resistance to thermal shocks is the stone's ability to withstand rapid changes in temperature (a façade that has a lot of sun and is then exposed to rain, for example). The latter can cause possible damage to the thin façade coverings: cracks generally localized at the level of the breaks (veins, stylolithic joints, etc.), microcracks between the grain of the rock causing intergranular decohesion, the bending of certain elements (e.g. in marble and marble limestone). As for the previous section, many old slabs are likely to have withstood more thermal shock cycles during their first use than what is recommended by the test standard (EN 14066). A visual examination of the slabs helps to remove damaged elements.
Resistance to thermal and humidity cycles		x	For an exterior application, the crystalline marble elements must be able to justify their good resistance to granular decohesion through a test of resistance to thermal cycles and humidity. As for the previous section, many old slabs are likely to have withstood more thermal and humidity cycles during their first use than what is recommended by the test standard (EN 16306). A visual examination of the slabs will rule out invalid slabs.
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 staining product.</p> <p>Internal staining is first and foremost an aesthetic concern for the material and it is therefore appropriate for the project developer 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 pollution, 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. Where appropriate, there are surface treatments to improve this performance by slowing the infiltration of greasy substances into the stone's pores.</p>



Availability

The supply of reclaimed natural stone wall covering slabs is relatively variable. The size of the batches can fluctuate from a few dozen to several hundred square metres. For large orders, it is recommended to check early enough with professional suppliers.

Hazardous substances and precautions

Some exterior stones may have come into contact with dangerous substances (pollution, graffiti, urine, etc.) that they may have absorbed, especially if they are porous stones. In the absence of more precise information on the subject, it is therefore recommended not to use them for applications in contact with food and people.

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 may vary depending on the sources of supply, the types of slabs and the use of sorting and cleaning services.

- Slabs of random sizes in Burgundy limestone (thickness 2 to 4 cm): ~ 15 - 25 €/m²
- Red granite slabs: ~ 20 €/m²
- Paloma marble slabs (3 cm thick) in good condition but different sizes: ~ 50 €/m²
- Belgian blue stone slabs (3 cm thick), good condition, different sizes: ~ 120 €/m²
- Carrara marble slabs (87 × 84 × 5 cm) scratches and small chips possible, traces of angle grinder on the rough sides: ~ 160 €/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 wall covering slabs prevents the production of ~ 1490 to ~ 3180 kg of CO₂ equivalent related to the manufacture of new slabs (production phase only). According to sources, this corresponds to the emissions of a trip of ~ 9000 to ~ 19000 km in a small diesel car.



Reclamation of 5300 m² of red granite slabs from the façades of the Tour Cèdre in La Défense, Paris (FR). © Incomex <http://pierre-reemploi.com/offre/granit-rouge-de-facade-nr01/>