Unglazed porcelain tiles

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.

Unglazed porcelain tiles

Material Description

Unglazed porcelain stoneware tiles (hereinafter referred to simply as 'tiles') are suitable for reuse. Their composition based on clays and feldspar and their production involving pressing and firing at 1300 °C ensure their high resistance. They are very hard, scratch-resistant, non-porous and frost-resistant. Produced in abundance in Europe from the beginning of the 20th century until the 1980s, they are frequently found in private and public buildings and community facilities, mainly in the form of interior floor coverings. They are readily found on the reclamation market. The tiles referred to here are dry pressed and unglazed/engobed. They should not be confused with their counterparts in extruded stoneware, terracotta or cement-based, which are often more porous and/or more sensitive to wear.

→ *Formats*: most tiles are square, hexagonal and octagonal (+ cabochons). Their nominal dimensions are generally in the order of 10 × 10 cm, 13 × 13 cm, 15 × 15 cm and 20 × 20 cm. The thickness varies depending on the model, but they are rarely thicker than 2.5 cm. Straight, grooved and high heel skirting boards associated with this material are rarely salvageable and are therefore rarely reused.

→ *Finish*: unglazed/engobed.

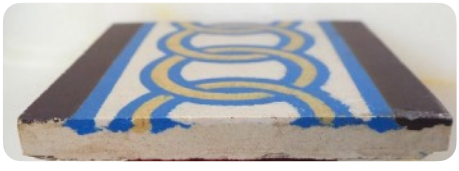
→ *Texture*: upper surface (visible) mostly smooth and uniform, rarely with relief. The edges are smooth and straight. Occasionally, the tiles are ground (slightly bevel) on the upper edge. The underside (not visible) is provided with a slight relief for reasons of adhesion to the substrate.

Rectified tile

→ *Colours*: the colours are varied, solid, two-tone (speckled, flamed) or polychrome (flowery, etc.). The design of the patterns is very clear. Reclaimed tiles are very often 'full body', single or double-layered. In the former case, the colour is uniform throughout the thickness and surface wear has less effect on the aesthetic qualities. It is advisable to involve specialised professionals to ensure the smooth running of these operations

Single-layer tile

Double-layer tile



Double-layer tile

Material reclamation

→ *Dismantling tests*: Dismantling tests make it possible to check the feasibility of removal. Generally, tiles laid on adhesive mortar or accessories such as skirting boards are often difficult to remove properly.

→ *Removal*: careful dismantling should aim to ensure the integrity of the tiles and a certain uniformity of the batches. To minimise the risk of deterioration during dismantling, it is advisable to weaken the tensions within the tiles by first freeing 2 sides (perpendicular) of the tiles to be detached. This usually involves breaking non-free edge lines. The tiles will be sorted by quality, colour, size and degree of cleaning. Particular attention will be paid to batches characterised by a defined pattern and for which certain pieces must be recovered intact (e.g.: patterned carpet with frieze and corner pieces).

→ *Treatment*: tile edges and undersides are cleaned to make installation easier. Most reclaimed tile suppliers clean the batches they resell by mechanical treatment and, less commonly, by physicochemical treatment. Some offer this service separately. Generally, the tiles are not degreased and some stains are to be removed after refitting.

→ *Storage*: Tiles are stored in bulk on pallets, in boxes or reconditioned in bundles. Ideally, the tiles should be stored away from the elements to prevent water condensation which can lead to the development of mould.

→ *Transport and delivery*: the necessary precautions must be taken during transport and delivery in order to minimise breakage (strapped, shrink wrapped pallet etc.). It should be noted that pre-packaged facilitate laying.

Tile dismantling

Reclaimed tiles

Reclaimed tiles in packets

Applications and laying

Reclaimed unglazed porcelain stoneware tiles can be applied both indoors and outdoors. They are generally used as floor coverings for applications subject to moderate stress (private accommodation) or more intense stress (entrance hall, retail space). When they are not too thick, they can also be used for wall application. Very slightly porous, they are suitable for uses involving humidity (sanitary facilities) or staining and aggressive products (kitchens, laboratories).

Think reversible!

The use of a hybrid mortar (lime-cement) and cement-based joints without resin facilitates future dismantling. However, these laying methods have lower adhesion. They are also not recommended for uses involving significant temperature variations or significant moving loads.

The choice of tiles must, however, take into account the expected stresses (see § 'characteristics and fitness for use' below). In all cases, reference should be made to the European and national standards relating to the product (EN 14411) and to the rules of practice in force (or implementation standards).

The reuse of completely cleaned reclaimed tiles is no different from that of new tiles. They lend themselves to the same diversity of installation methods, patterns and fittings. They raise the same points of attention, in particular: properties and condition of the substrate, products and techniques for laying and grouting, drying times and laying times, costs, expansion joints, finishing joints, flatness, separation layer, underlying insulation, underfloor heating, etc.

Tiles showing residual traces of mortar on the underside will be limited to laying in a fresh screed or in mortar on a stabilised sand bed or hardened substrate, in order to make up for differences in thickness. In this case, the use of adhesive mortar should be avoided. Likewise, the possible presence of residual mortar on the edges can affect the nominal size of the joints as well as their colour and composition

To facilitate installation, the designer/specifier will take care to use batches with a certain degree of uniformity in terms of the following characteristics:

→ *Batch composition*: the batch must consist entirely of unglazed porcelain stoneware tiles.

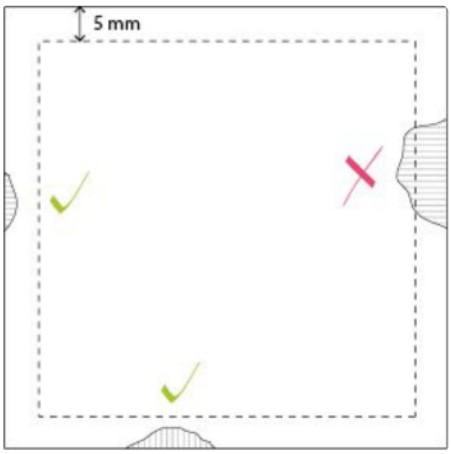
→ *Dimensions*: the dimensions of the tiles must be uniform, including their thickness. The dimensional tolerance is determined by the designer/specifier according to the equipment, the thickness of the joints and the laying technique.

→ *Colour*: slight variations in colour are possible (even for new products). In the case of reclaimed tiles, these variations may be due to the original exposure. It is advisable to mix the tiles when laying. The designer can also opt expressly for a pattern including tiles of very different colours. This is one way to take advantage of a greater variety of reclaimed tiles that can lead to architecturally interesting results.

Most the reclaimed building materials are sold as is. The conditions of sale may however contain specific 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).

→ *Condition*: reclaimed tiles may show signs of deterioration such as signs of surface wear, chipped or cut edges, cracks, etc.

It is up to the designer/specifier to define the degree of imperfection tolerated, with regard to the intended use, by specifying the acceptance or rejection of these defects (for example, breaks and chipping < 25 mm²). This principle can be described in visual form to facilitate the examination of the tiles. Example:

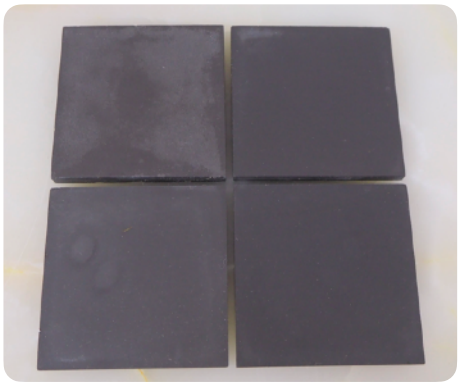


→ *Quantity*: some suppliers can include a 5% surplus when the product is delivered if they are not able to guarantee the absolute uniformity of the characteristics mentioned above. This surplus can also be applied in the case of an on-site salvage scenario.

To facilitate installation, the designer/specifier will take care to use batches with a certain degree

Most professional suppliers are able to ensure that delivered batches meet these requirements

Tile cleaning station



Variations in colour

Chipped corner

Crack

Characteristics and fitness for use

The harmonised European standard EN 14411 establishes the relevant characteristics (depending on the context) in order to determine the fitness for use of ceramic tiles. Although detailed for new materials, these characteristics may prove useful in considering the specific case of reclaimed unglazed porcelain stoneware tiles (internal and external floor applications).

	Floors		Walls		
Characteristics	**Int.**	**Ext.**	**Int.**	**Ext.**	**Comments**
Dimensions (length, width, thickness)	x	x	x	x	This characteristic is closely related to the degree of sorting and cleaning of reclaimed tiles. A visual or detailed examination of the batch is often sufficient to estimate it.
Geometry (straightness of edges, angularity, flatness of the surface)	x	x	x	x	ditto
Surface quality	x	x	x	x	ditto
Water absorption	x	x	x	x	By their nature, unglazed porcelain stoneware tiles generally have a very low water absorption coefficient (<0.5%).
For specific uses					
Modulus of rupture	x	x	x	x	Mainly depending on the thickness of the tile. Relevant performance to be assessed in the event of high static and/or dynamic loads.
Resistance to deep abrasion	x	x			By their nature, these tiles are generally very resistant to wear. The fact that these tiles have a coloured body and are unglazed generally contributes to improve this characteristic. Important performance relevant to evaluate in spaces subject to intensive traffic (station concourse, airports, industrial workshops, etc.).
Linear thermal expansion	x	x	x	x	Low for most ceramic tiles.
Thermal shock resistance	x	x	x	x	For specific applications where tiles are subjected to high temperature gradients.
Freeze/thaw resistance		x		x	The low porosity of porcelain stoneware tiles generally gives them a frost-resistant character.
Slippage	x	x			The usually smooth character of the surface can cause slippage. Smooth tiles will probably not be suitable for outdoor uses that are uncovered and/or regularly flooded (e.g.: Italian shower).Their performance should be particularly evaluated for intensive use and/or sloping ground.
Adhesion to adhesive mortars, dispersion adhesives or reactive adhesives			x	x	Depending on the type of laying recommended for wall application.
Moisture expansion	x	x	x	x	Low for most ceramic tiles.
Slight colour differences	x	x	x	x	For specific applications.
Shock resistance	x	x			To be considered in areas where impact resistance is considered to be of particular importance.
Reaction to fire	x		x	x	In accordance with European Commission Decision 96/603/EC, ceramic tile floor coverings are classified as non-combustible materials and belong to the European reaction to fire class $A1_{FL}$ without prior testing.
Tactility	x	x			Essential characteristic for tactile paving – visually impaired people. Very specific use.
Stain resistance	x	x	x	x	The low porosity of tiles generally gives them good stain resistance.
Resistance to low and high concentrations of acids and base products	x	x	x	x	Ceramic tiles are generally resistant to common chemicals.
Resistance to household products	x	x	x	x	Ceramic tiles are generally resistant to common chemicals.
Thermal conductivity	x				To be assessed if the tiles should contribute to the thermal performance of an element.
VOC emissions	x		x		Volatile Organic Compounds are destroyed at the time of combustion of organic materials possibly present in clay raw materials. Ceramic tiles are therefore considered to be free of VOCs. However, the laying and protection products can potentially emit VOCs.

Unglazed porcelain tiles

Availability

Unglazed porcelain stoneware ceramic tiles are a relatively common product in the reclamation market. However, availability depends a lot on the quantities required. As an example:

Frequent	Batch from 0 to 50 m²
Ocasional	Batch from 50 to 100 m²
Rare	Batch > 100 m²

Design tip

To increase the chances of meeting the offer available on the reclamation market, the designer/specifier can choose to split large surface areas into smaller quantity batches (for example, by providing different patterns in each room).

Dismantling

Dismantling efficiency: ~ 15 m² of tiles in good condition person/day

This rate includes laying, logistics and percentage of breakage. It varies according to the size of the tiles, the degree of adhesion of the mortar, the configuration of the building, etc.

Indicative Prices (excl. tax)

A non-exhaustive sample of the Western European reclaim market (Belgium, France, UK, and the Netherlands) has allowed us to extract some indicative prices:

→ Cost of removal: 15 - 25 €/m²

→ Cleaning service: 25 - 35 €/m²

Supply: depending on size, pattern, general condition, etc. (excluding antiques)

→ Cleaned tiles: 50 - 85 €/m²

→ Uncleaned tiles: 25 - 50 €/m²

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

	kg CO_2 eq./m²	kg CO_2 eq./kg
INIES database (FR) – Generic data	9.29	0.40
ICE database (UK)	17.94	0.78

Indicative values for an average thickness of 10 mm and estimated density of 2300 kg/m³

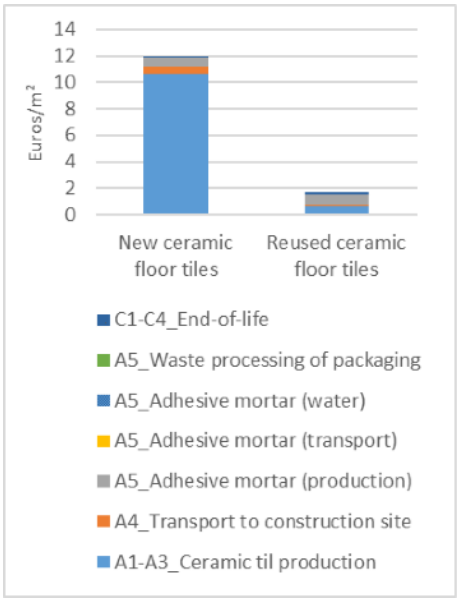
Reusing 100 m² of tiles prevents the production of ~ 1000 to ~ 1800 kg of CO_2 equivalent related to the manufacture of new tiles (production phase only). This corresponds to a journey of ~ 6000 to ~ 11,500 km in a small diesel car.

Hazardous substances and precautions

Asbestos: Some tile adhesives used before 1990 may contain asbestos. Even if the risk is low (< 1 to 10% depending on the application and the countries), adequate measures must be taken in order to make a correct diagnosis. The risk is slightly higher for adhesives used in skirting board applications. The presence of asbestos in expansion joints is also possible.

Did you know?

A life cycle analysis carried out on a process for cleaning reclaimed tiles by a Brussels-based company showed that their environmental impact was 2 to 6 times less than that of a new tile.
Source: Careno project (Be Circular 2016) led by Rotor and the BBRI (Belgian Building Research Institute – Belgium). Details of this study are available on request (info@rotordb.org)



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