

**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](http://opalis.eu), [nweurope.eu/fcrbe](http://nweurope.eu/fcrbe), [futureuse.co.uk](http://futureuse.co.uk)).

Non-exhaustive directories of dealers in reclaimed building materials are available on [www.opalis.eu](http://www.opalis.eu) and [www.salvoweb.com](http://www.salvoweb.com).

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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**

Unglazed terracotta tiles are obtained by firing clays (or loams) and sands previously mixed and degassed; shaped by extrusion (extruded tiles), moulded or pre-formed; dried and finally fired at a temperature of 900 to 1050 °C for 12 to 48 hours. It is a ceramic material manufactured by hand or industrially, the properties of which depend essentially on the mixture's composition, the firing temperature and the technical skill used in the manufacture.

Unglazed terracotta tiles are characterised by *high strength*, relatively good resistance to wear and puncture, as well as good thermal inertia (accumulation and conduction of heat), ideal for heated floors.

In the raw state, the most common reclaimed terracotta tiles are generally *porous*, which translates into high water absorption, low frost resistance, high sensitivity to stains and poor mechanical performance for the large size and thin models. They are generally intended for indoor use and most often require a protective finish and regular maintenance. Outdoor use is possible in some cases.

Nevertheless, the modernisation of production techniques has allowed the emergence of terracotta tiles for outdoor use offering sufficient resistance to frost. However, these tiles are not easily found on the reclamation market.

The tiles referred to in this sheet are unglazed/engobed and should be distinguished from slabs (larger dimensions and thickness) and terracotta pavers (box shaped format), which can also be used for exterior applications.

Produced in abundance in Europe, and particularly in the south, since the 19th century, they are readily found on the reclamation market. We often find certain models under the name 'tomettes' or 'terracotta'. They should not be confused with their counterparts in extruded stoneware and porcelain stoneware.



Example of 'parefeuilles'



In the South of France, there are rectangular tiles called '*parefeuilles*' or '*covered boxes*', sold as interior floor tiles. Originally, the reclaimed '*parefeuilles*' were installed in under-roof insulation. They are porous tiles and quite sensitive to stains. Ask the dealer for advice.



**Design Tip!**

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



## Unglazed terracotta tiles

→ **Formats:** There is a wide variety of formats, usually associated with their region of origin. Most tiles are square, hexagonal, octagonal or rectangular in shape. Their nominal dimensions are generally in the order of 10 × 10 cm, 12 × 12 cm, 14 × 14 cm, 16 × 16 cm, 30 × 30 cm. The thickness is variable according to the models and generally between 12 and 25 mm. There are also parts such as skirting boards, stair profiles, edges, etc.

→ **Finish:** the rough finish of manufactured terracotta tiles is generally characterised by a rather matte, rough or smooth surface, relatively irregular and with slightly rounded edges. Several levels of mechanical finishes are also found on the market, for example: split edges, extra-smooth,

structured surface, brushed, sandblasted, glazed (not covered in this sheet), etc. The tiles which have been used indoors have generally undergone a water/oil repellent protective treatment and have a matte, satin or gloss appearance.

→ **Texture:** the tiles often have a very uneven appearance and the pores are easily visible. Some so-called 'rustic' tiles have been produced from unpurified and coarsely ground clays, bringing out grains, stones and encrustation on the surface. More or less large cavities may appear on the surface. The underside (not visible) is generally provided with a slight relief to improve adhesion to the substrate. The abbreviation or manufacturer's name often appears on the underside.

→ **Colours:** the nuances of colours are influenced by the clay used and the content of iron oxides. Mixtures are frequent and are mainly due to the firing method (wood fire) and the position of the tiles in the kiln. For handmade tiles, a dark colour will mean a higher temperature rise and improved robustness. Traditional colours are pink, red, and coppery-orange while more contemporary colours may lean towards white, grey, ochre, and brown.





**Material reclamation**

Unglazed terracotta tiles are found in interior or exterior applications in a wide range of buildings, but mainly in rural residential and/or heritage contexts. If the tiles do not find a new use directly on site, they can be sent to professional reclaimed channels.

→ *Dismantling tests*: dismantling tests make it possible to verify removal feasibility and profitability. Type of laying (insertion sealed with a lime, lime/cement or cement mortar or bonded with a tile adhesive), joint and tile characteristics (thickness, composition) strongly affect the removability of the material.

→ *Reclamation*: careful dismantling should aim to ensure the tile integrity 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. They will preferably be stored on their edge in order to limit the risk of breakage.

→ *Treatment*: the main treatments offered by the suppliers of reclaimed terracotta tiles are the surface cleaning and the mechanical cleaning of the remains of mortar on the underside and on the edges. This manual step is generally carried out using suitable tools (pneumatic chisel, circular saw, grinder, etc.) and requires systematic downstream sorting. Tiles that are friable or showing significant chips and knocks are downgraded.

→ *Storage*: the batches of tiles are stored in bulk on pallets or repackaged in bundles, taking the necessary precautions to limit the risk of breakage (packaging on their edge, separation of layers, etc.). Old (porous) and interior tiles will be stored away from frost and bad weather. Owing to their porosity, poorly stored tiles can develop algae and mould, which can leave irreversible stains on the surface.

→ *Transport and delivery*: the necessary precautions must be taken during transport and delivery in order to minimise breakage (strapped, shrink wrapped pallet, etc.). On site, tiles for indoor use must be stored away from frost and bad weather. It is advisable to involve specialised professionals to ensure the smooth running of these operations.

It is advisable to involve specialised professionals to ensure the smooth running of these operations.



Tile front



Tile backside



Tile front



Tile backside



Mechanical cleaning



Storage



Storage



Storage



**Applications and laying**

Reclaimed terracotta tiles are mainly used as indoor flooring for applications subject to moderate stress (private homes, hallways, etc.). They do not lend themselves well to wall applications. Porous in nature, most used terracotta tiles are not recommended for outdoor use, unless their suitability for this use can be demonstrated. They are not suitable for uses subject to intense wear (concourse, commercial area, passage of wheeled vehicles, etc.), or uses involving excess humidity (sanitary facilities) or staining and aggressive products (community kitchens, restaurants, laboratories).

As a general rule, the choice of tiles must take into account the expected stresses (see § 'characteristics and fitness for use'). 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 terracotta tiles is no different from that of new tiles. They lend themselves to the same diversity of laying 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 and waterproofing, underlying insulation, under-floor heating, application of a pore filler, specific maintenance, etc. For exterior tiles, attention should be paid to the slope, drainage, risk of swelling, etc.

Tiles of irregular thickness or showing residual traces of mortar on the underside will be limited to an embedded laying (traditional laying with mortar) 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.

Terracotta is a porous material requiring, during use, an adequate water/oil-repellent treatment to be renewed periodically (for example: waxes, resins, oil-based saturators, linseed oil and turpentine, etc.). Reclaimed tiles are likely to be completely or partially covered by the old impregnation layer. Depending on the aesthetic state of the patina, it is possible to remove this layer through

*Think reversible!*

*The use of a hybrid mortar (lime-cement) and resin-free joints facilitate future dismantling. However, this laying method is not suitable for all situations and involves consequences in terms of adhesion performance, laying costs, delays, etc. Think about it when choosing the laying technique, it will increase the possibility of future reuse.*

stripping (chemical, airbrushing, etc.) before proceeding with the new protective treatment. In all cases, terracotta tiles require regular and specific maintenance.

To facilitate laying, 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 terracotta tiles.

→ **Dimensions:** the dimensions of the tiles must be uniform, including the thickness. Variations in thickness of 1 to 2 mm are however possible for hand-crafted tiles from the same batch. In the case of tiles whose edges have not been cleaned of the remains of mortar, it is important to take this into account. The dimensional tolerance will be determined by the specifier according to the equipment, the thickness of the joints and the laying technique.



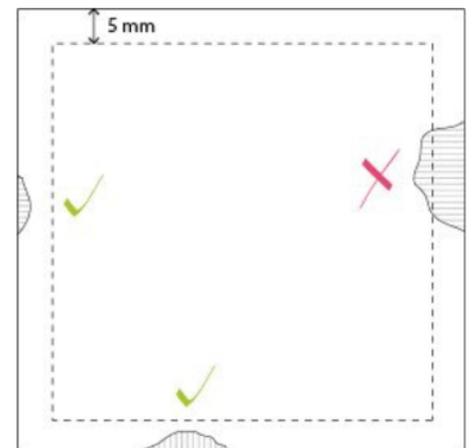
Example of imperfection

→ **Colour:** variations in colour are possible (even for new products). In the case of reclaimed terracotta tiles, these variations may be due to the production method, the original exposure, previously applied treatments, etc. It is advisable to mix the tiles when laying.



Variations in colour

→ **Condition:** reclaimed tiles may have alterations such as traces of surface wear, chipped or cut edges, stains, traces of mould, swelling, etc. It is up to the designer/specifier to define the degree of imperfection tolerated, according to the defined use, by specifying the maximum dimensions of the defects (for example, breaks and chipping <25 mm<sup>2</sup>). This principle can be described in visual form to facilitate the examination of the tiles. Example:



→ **Quantity:** some suppliers may 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.Â

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

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).



**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 terracotta tiles (internal and external floor applications).

| Characteristics  | Int. | Ext. | Comments  |
|--|------|------|---|
| <b>Dimensions (length, width)</b>  | 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. The irregularity of the tiles will influence the thickness of the joints during laying.  |
| <b>Thickness</b>   | x    | x    | A variation of $\pm 10\%$ is tolerated for most new terracotta tiles. These variations, as well as the significant thickness of certain types of tiles, must be considered when laying, particularly in the event of renovation (for example: repercussions on the height of the floor).  |
| <b>Geometry (straightness of edges, angularity, flatness of the surface)</b> | x    | x    | A visual or detailed examination of the batch is often sufficient to estimate these characteristics. Bowed tiles should be avoided in outdoor use in order to limit water stagnation.   |
| <b>Surface quality</b>   | 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. Particular attention will be paid to the presence of stains or mould given their potentially irreversible nature.  |
| <b>Water absorption</b>  | x    | x    | Terracotta tiles vary in porosity and are susceptible to absorbing liquids. This characteristic concerns 1) the lower face, by which a rise in humidity promotes the appearance of swelling at the level of the visible surface, 2) the edges, for which it is not recommended to use a coloured jointing product, 3) the upper face for which it is advisable to apply a water/oil-repellent coating product for interior use. |
| <b>Breaking strength/breaking load</b>                                       | x    | x    | Mainly dependent upon the thickness and porosity of the tile. Older reclaimed terracotta tiles are usually very thick ( $\geq 20$ mm) to meet this requirement. Contemporary production techniques have made it possible to bring thinner tiles to the market. The in-depth evaluation of this performance is relevant in case of high static and/or dynamic loads.   |
| <b>Abrasion resistance (wear)</b>  | x    | x    | Terracotta tiles have low to medium wear resistance. This characteristic excludes their use for heavy-duty applications (for example: schools, supermarkets, passages of wheeled vehicles, etc.)  |
| <b>Shock resistance</b>  | x    | x    | To be considered in areas where impact resistance is considered to be of particular importance.   |
| <b>Slippage</b>  | x    | x    | The generally rough nature of terracotta tiles improves their slip performance. This characteristic deserves to be evaluated for more intensive use, in exterior application and/or for inclined floors. It will be assessed with regard to the degree of wear, dirt, floor maintenance and surface treatment.  |
| <b>Reaction to fire</b>  | x    |      | In accordance with European Commission Decision 96/603/EC, ceramic tile floor coverings, without finishing coat, are classified as non-combustible materials and belong to the European reaction to fire class A1 <sub>FL</sub> without prior testing.  |
| <b>Freeze/thaw resistance</b>  |      | x    | This performance determines the restriction for outdoor use. The porous nature of most used terracotta tiles limits their use to interior use. However, some tiles can meet this performance. For example, it is possible to ensure this by selecting only batches dismantled from outdoor use.   |
| <b>Stain resistance</b>  | x    | x    | Due to the porous nature, terracotta tiles are inherently very sensitive to stains. It is therefore advisable to provide for the application of a water/oil-repellent protective layer (pore-filler) during laying as well as a periodic renewal of the treatment.  |
| <b>Resistance to low and high concentrations of acids and base products</b>  | x    | x    | Terracotta tiles are generally resistant to common chemicals. A jointing product corresponding to this requirement should be provided.  |
| <b>Linear thermal expansion</b>  | x    | x    | Low for most ceramic tiles, which is suitable for underfloor heating systems.   |
| <b>Thermal conductivity</b>  | x    |      | To be assessed if the tiles should contribute to the thermal performance of an element.   |
| <b>VOC emissions</b>   | x    |      | Volatile Organic Compounds are destroyed at the time of combustion of organic materials possibly present in clay raw materials. The original terracotta tiles are therefore considered to be free of VOCs. However, reclaimed tiles may have been "polluted" by substances during their use phase (e.g. laying products, finishing products, etc.).   |

In case of specific and demanding applications, parameters related to characteristics such as wear resistance, frost resistance, slip, modulus of rupture, etc., will have to be measured and quantified using tests carried out by approved laboratories.



**Availability**

Reclaimed unglazed terracotta tiles are a relatively common product in the reclamation market. However, availability depends on the quantities required. As an example:

|            |                                     |
|------------|-------------------------------------|
| Frequent   | Batch from 1 to 50 m <sup>2</sup>   |
| Occasional | Batch from 50 to 100 m <sup>2</sup> |
| Rare       | Batch > 100 m <sup>2</sup>          |

**Find specialised businesses**



[salvoweb.com](http://salvoweb.com)

[opalis.eu](http://opalis.eu)

**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 €/m<sup>2</sup>

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

→ Cleaned reclaimed terracotta tiles: 50-90 €/m<sup>2</sup>

→ New terracotta tiles: 25-90 €/m<sup>2</sup>

→ Protective treatment and finishing: 8-16 €/m<sup>2</sup>

**Hazardous substances and precautions**

During the first half of the 20th century, terracotta tiles were often covered with a red paint (called 'Prussian Red') which could contain lead and emit toxic gases in the presence of acid. The necessary precautionary measures must be taken before re-using or renovating floors with red paint residues.

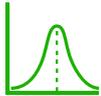


'Prussian Red' paint: warning!

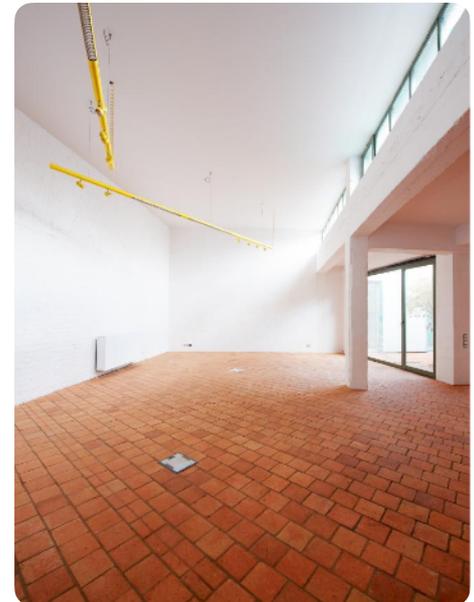
**Embodied carbon (Cradle to gate – production A1-A3)**

|                                    | kg CO <sub>2</sub> eq./m <sup>2</sup> | kg CO <sub>2</sub> eq./k |
|------------------------------------|---------------------------------------|--------------------------|
| INIES database (FR) – Generic data | 27.2                                  | 1                        |
| CTMNC – Collective declaration     | 21.6                                  | 0.8                      |

*Indicative values for an average thickness of 10 mm and estimated density of 2300 kg/m<sup>3</sup>*



Reusing 100 m<sup>2</sup> of tiles prevents the production of ~ 1000 to ~ 1800 kg of CO<sub>2</sub> 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.



Reused tiles in 'Old Marbrerie Albert' (BE) © François de Ribaucourt