Concrete rubble
(resulting from the transformation of concrete construction elements)

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 Bellastock 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.

Iconography

Figure 1 : BENOIT J, SAUREL G, BILLET M, BOUGRAIN F, LAURENCEAU S, ADEME, BELLASTOCK, CSTB, *REPAR#2 Reuse as a bridge between architecture and industry, March* 2018, p108.

Material description

This sheet describes a process consisting in reusing certain types of concrete rubble from the demolition of buildings as rubble for the construction of retaining walls, fences, gabions and other landscape applications - works traditionally made of natural stone.

A priori, all the concrete elements present in a building are likely to provide an adequate resource for producing rubble. The best candidates are concrete rubble resulting from the demolition and prior to the crushing phase and containing no (or very little) reinforcement (in order to limit the risk of injury during handling).

The rubble from walls and slabs produces blocks characterized by two flat faces. They thus have regular and flat laying surfaces. Although columns and beams originally also have flat faces, their demolition generally results in more irregular blocks, the size of which corresponds to the volume between reinforcements (depending on their size and the position of the bars).

Reusing this rubble as blocks differs in several ways from crushing concrete to produce recycled aggregates (which, to this day, remains the most common treatment method for concrete scrap). Indeed, the direct reclamation of blocks does not involve crushing the rubble, which therefore retains relatively large dimensions (where crushing tends to reduce them to a much finer grain size).

Concrete rubble deposit from the demolition of a tower at Clos Saint Lazare in Stains (FR).

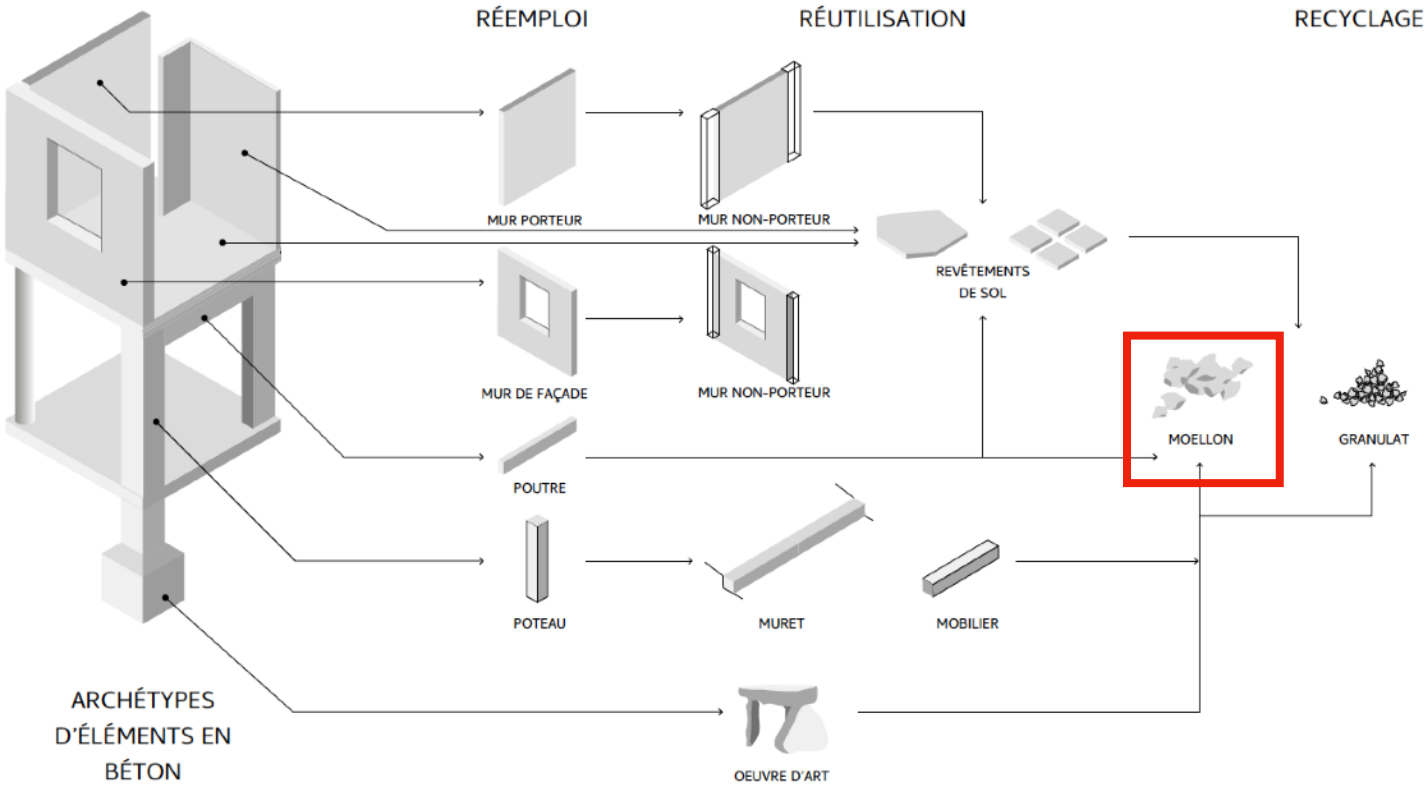

Figure 1: schematic diagram presenting possible reclaim solutions from a typical deposit.

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Material reclamation

The recovery of concrete rubble on a demolition site takes place between the demolition of the building and the crushing of the rubble. It is based on a succession of stages:

→ *Diagnosis and preliminary studies.* The prior identification of the construction elements makes it possible to anticipate the possible shapes of the rubble blocks. The assistance and advice of concrete specialists as well as documentation available on the building to be demolished can also provide useful information.

These preliminary studies must also make it possible to assess the feasibility and the advisability of recovering the rubble according to the volume of concrete to be demolished, the site configuration, the quantity of reclaimed materials to be extracted and other contingencies linked to the project. Given the still experimental nature of this type of approach, it is wise to rely on the advice of demolition companies. If necessary, transformation tests can be carried out during the demolition site phase to adapt the proposed technical solution.

→ *Collection*. The collection of rubble can be done in two ways:

- Sorting during the demolition phase, then transformation at the end of the site to obtain the desired rubble.
- Sorting of rubble after or during demolition.

In both cases, the use of suitable screening increases the yield.

→ *Transformation*. The transformation of concrete blocks is generally quite light. It mainly consists of adapting their shape during installation. It can also include actions to control and remove residual reinforcement. For reasons of economy, it is advisable to rule out the elements whose transformation turns out to be too complex. For this, it is recommended, if the organization of the project allows it, to involve the operator responsible for laying the blocks.

→ *Storage*. The storage conditions must be defined with regard to the overall organization of the site, the intended use of the materials and the volume to be stored.

For on-site use with site demolition in progress, we will prefer storage in an isolated merlon, as close as possible to the structure's location. The installation of cells makes it possible to increase the density of the stock and to limit its footprint on the ground.

→ *Transport and delivery*. Concrete fragments can be transported by dumper or dump truck and deposited in elongated piles (merlon) on the new site to facilitate access to materials.

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

Applications and installation

Reclaimed concrete blocks are mainly used in landscaped masonry such as walls and garden walls. It is advisable to rely on the technical references relating to the installation of the type of work to be carried out (for example, in France, the Professional Rules: *Installation of landscaped walls, soil retaining structures and stairs No.: CC4-R0*).

The landscaped walls and low walls are made with blocks stacked one on top of the other. These can be irregular or have one or more flat faces. Concrete blocks must be laid flat. Their length should not exceed a quarter or a fifth of their height.

As with natural stone walls, the laying of concrete blocks can be dry or sealed.

The shape of the reclaimed concrete blocks and their dimensional regularity can influence the bonding choice. Conversely, the expected regularity at the level of the joint can influence the choice of the shape of the blocks.

In any case, it should be ensured that the stone elements are correct on all sides. Concrete blocks should be laid alternately in several rows, so that each vertical joint rests on one block. There should not be more than three joints at a time that intersect one by one on the front and back sides. It is also necessary to avoid that a sharp joint does not cross more than two beds. It should also be ensured that there is at least one kicker block for two facing blocks or that the kicker and facing blocks alternate. The largest blocks should be placed in the corners.

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

→ *Batch composition*. The rubble must have uniform characteristics. This may involve the implementation of a principle of traceability to ensure that all the rubble comes from the same origin.

→ *Dimensions.* The geometry of the elements can be specified in order to facilitate handling (ensure that each block weighs less than 25 kg, for example). Depending on the chosen installation, it may be requested that the blocks have two flat faces. Other requirements may be indicated here if the project provides for a particular treatment of infill, corner or even crown stones.

→ *Condition.* Concrete rubble may have minor alterations such as traces of superficial wear, stains, traces of mould, efflorescence, etc. On the other hand, they cannot have any defect indicating a heterogeneity of the structure, nor visible cracking, chipping, deformation, or tearing.

Characteristics and fitness for use

The requirements relating to the physical and mechanical characteristics are directly linked to the mechanical strength of concrete blocks over time .

Regarding the mechanical properties of modular concrete elements, the normative requirements come from DTU 20.1 *Building work - masonry works of small elements - Partitions and walls* (French standard).

Characteristics	Comments
Dimensions (length, width), regularity of shape	For the infill rubble: → Concrete rubble must be handled manually (weight < 25 kg) → No reinforcement must protrude from the edges of the rubble → The faces must be perpendicular for the layout plan → The faces must be flat. For corner and crown blocks: → No reinforcement should protrude from the edges of the stone → Blocks with straight edges to ensure a keying on the periphery of the wall
Block thickness	Tolerated variations: → the thickness of the kicking blocks must be equal to approximately one and a half times the height of the bed, and at least equal to 30 cm. → the thickness of the blocks used for cladding must be approximately equal to the height of the bed. → joint thickness ≥ 10 cm for a structure made up of block beds.
Surface quality	Concrete blocks showing defects characteristic of a non-uniform structure or showing visible cracks, chipping, deformation or tearing must be rejected.
Impermeability/Water absorption	Porosity according to EN 1936. Determining resistance to water absorption is not required for the first marking designation defined by standards EN 1338 and EN 1339.
Steel	Concrete rubble should not have visible iron.

However, in the event of specific and demanding applications, parameters related to characteristics such as mechanical resistance, frost resistance or impermeability can be measured and quantified using tests carried out by accredited laboratories.

Embodied carbon (Cradle to gate - production A1-A3)	kg CO_2 eq./m²	kg CO_2 eq./kg
INIES database (FR) - Individual Declaration - ALBAMIEL - Natural stone walls 15 to 45 cm thick (v.1.1) *	11,4	0,02
INIES database (FR) - Collective declaration - Association Pierres du Sud - Wall in « Pierre du Midi » (v.1.2) ***	12,2	0,02
INIES database (FR) - Collective declaration - CERIB - Concrete block (laying with thick joints) (v.1.8) ***	30,6	0,14

** Natural stone wall from 15 to 45 cm. Transport: 1623km.*

*** Load-bearing wall in solid stone 40 cm thick. Transport: 100km.*

**** Hollow concrete block B40, 20 x 50 x (20 à 25 ht) laid with thick joints (or masonry installation) Distance travelled by the product: 57km*

NB: the production steps (A1-A3) of the mortar have been added, when these were not taken into account in the sheet.

According to these sources, the construction of 100 m² of landscaped masonry in reclaimed concrete rubble prevents the production of ~ 300 kg of CO_2 equivalent related to building a wall from new concrete blocks. This corresponds to the emissions caused by a small diesel city car during a trip of ~ 18 350 km.

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Availability

Reclaimed concrete blocks are not a commercial construction product. However, since this material is obtained from the recovery of concrete rubble (which constitutes the main fraction of demolition waste), its potential availability is high. Virtually every demolition operation is likely to produce some. In this regard, it is not impossible that this product complements the ranges of concrete aggregates resulting from the crushing of demolition waste.

Inspiration!

As part of the « Clos factory project » in the Clos-Saint-Lazare district in Stains (Seine-Saint-Denis, France), two types of installation were tested: dry installation and sealed installation.

For the first version, the concrete rubble wall was installed without sealing mortar, then coffered on 3 of its sides. The company then produced a self-compacting concrete to seal the stones on the invisible part, as well as giving it a coating. This gives a protruding stone effect with a hollow joint.

For the second version, a peripheral formwork was made, and once it was filled with loose rubble, a self-compacting concrete was poured. The faces were then staked until the rubble was visible.

Hazardous substances and precautions

During documentary investigation, certain usage restrictions may be issued, in particular in the following cases:

→ Concrete that has been subjected to chemical attack by soils and natural groundwater (corresponding to the three exposure classes XA1, XA2 and XA3 of standard NF EN 206)

→ Possible presence of plaster residues in the concrete, a priori incompatible with reclaim as a floor covering. In fact, the presence of water during the use of the pavers will very probably lead to the formation of swelling mineral species such as ettringite, which will eventually lead to significant degradation of the pavement or the slab.

→ Possible presence of asbestos on the surface of the concrete wall (fireproof insulation on the façade, joint, interior coating glue, etc.). Prior asbestos removal from the building can make it possible to clean the concrete elements of asbestos residues, a concrete element installed in contact with asbestos should not automatically be disqualified for reclaim at the diagnostic stage.

Landscape masonry in concrete rubble resulting from the demolition of a housing building built between 1966 and 1970. The Clos factory is a demonstration site of the potential for reusing concrete elements resulting from demolition. It was fitted out and built from materials resulting from the demolition of buildings as part of the Clos-Saint-Lazare urban renewal project.