



**REUSE IN PRACTICE:
FROM DECONSTRUCTION
TO IMPLEMENTATION**



**GUIDES FOR
ROOFERS**

This guide is intended for contractors active in interior finishing work. It is part of a series of guides introducing the practices of reclamation and reuse of materials. These guides aim to answer the main questions raised by contractors when they reclaim and reuse materials on their worksites.

The guides are available on the website of the Interreg NWE FCRBE project <https://vb.nweurope.eu/fcrbe>. The complete collection covers the following professions: general contractors, wood workers, interior finishing, roofers, demolishers, and companies specialized in infrastructures.

To enable only one guide to be consulted per trade, part of the text is common to all the guides. The parts specific to each guide are indicated by dots or boxes.

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1.

Introduction:
What is reuse
and why is it important
for contractors?

A new context...

The construction sector is experiencing change. It is having to adjust to new challenges such as climate change, scarcity of natural resources or even price volatility on the market for materials.

The construction and the use of buildings are themselves responsible for significant consequences for the planet and its resources. In the European Union, they represent 50% of the extraction of all materials, 33% of water consumption, 40% of energy demand, 36% of greenhouse gas emissions, and 38% of the waste generated.

With these changes and the growing awareness in mind, the regulatory context will be adapted, as both public authorities and clients will formulate new requirements for carrying out the construction works. Among these, the principles of circular economy have a significant place, and the reclamation of materials and reuse will be increasingly encouraged, and in some cases even mandatory.

Contractors who have already adjusted their practices before the coming into force of these new requirements will thus benefit from a competitive advantage.

...and new practices

In the area of construction, the circular economy is based on the application of many practices:

- Maintaining and refurbishing existing buildings (rather than demolishing them and rebuilding new ones).
- Reclaiming the materials before being cleared during demolition work and reusing them in new structures.
- Using sustainably managed materials of natural origin (in order that these resources have time to be renewed).
- Constructing buildings that can be adapted to changes of use over time (by applying techniques of reversible assembly).
- Better management of demolition waste to recycle it more and the use of materials containing recycled materials.
- Etc.

In this guide, we will concentrate on the questions of reclamation and reuse of the materials.

Before going any further, it is important to define what is meant by the term **reuse**, as against **recycling**. The definition of reuse is as follows: *any operation by which products or components that are not waste are used again for usage that is the same as that for which they had been designed¹. Reuse refers to a practice where a construction element that has been carefully extracted from a building during demolition or refurbishment work is being reused in a new context. During this process, the elements are preserved in an optimal way. Reuse differs from recycling as recycling implies recourse to mechanical or chemical processes with a view to converting an element to restore its status of raw material.*

In francophone countries and regions, the initial term "reuse" has sometimes been translated as "**reemployment**", and sometimes as "**reuse**". For example, in France and in Luxembourg, the legislator distinguishes "reemployment" and "reuse". In this case, reuse is used when the good concerned is checked in the "waste status" box (Naval, 2021). In Belgium, the two terms are generally taken as synonyms. In this guide as well, no distinction will be made.

Finally, the literal definition of reemployment implies "*usage that is the same as that for which they had been designed*". However, it may be considered that as soon as reuse of the material is certain, its holder can dispose of it as they wish, and of course staying in compliance with the law. In this guide the term 'Reuse' is used for both situations: where the element is reused for its **initial use** as well as where it is reused for a **different use** than for which it was designed for.



FURTHER INFORMATION

The booklet *Products or waste? Criteria for reuse* produced as part of the FCRBE project describes further the key concepts of waste, reuse, and preparation for reuse. It also explains why "change of use" is a practice compatible with reuse.

https://vb.nweurope.eu/media/15538/bookletfcrbe-4_waste_product.pdf

¹ Directive-cadre "Déchets" 2008/98/CE [1] - Art 3.13

Reuse has the advantage of contributing to significantly reducing impacts on the environment caused by the building sector. Reusing materials is firstly preventing the production of avoidable waste. It is also about avoiding the impacts that stem from the production of new materials, which can be considerable. Reuse also enables reduction of the extraction of raw materials, stimulates local economies, and conserves the patrimonial value of the materials.

What is changing for contractors

The idea of reclaiming materials and reusing them is of course not new and many companies already practice reuse, occasionally and even, for some, recurrently. The generalization of this approach however has several challenges. It is also accompanied by some changes for companies, including the following:

No more «all in the bin»

Today, during a demolition or renovation, much potentially reusable material continues to be thrown into the bin along with the rest of the waste. It is often the profitability (speed) or spatial restrictions (there's not enough room on site) that explains this waste. The absence of explicit request from project owners in calls for tenders also plays an important part.

However, new habits are finding their place:

- Performance of **pre-demolition reuse audits**
These are studies generally ordered by the project owner and most often performed by external consultants. These identify material lots with a high reuse potential in buildings (or parts of buildings) planned to be converted or demolished. These studies are sometimes coupled with a forecast of the waste flows generated by the demolition. This listing enables the planning of suitable treatment for the reclaimable lots (e.g. their removal in advance).
- **Prior cleaning work**
Increasingly, demolitions are carried out in separate phases, to ensure specific treatment for the different materials making up a building. This approach helps to ensure better treatment of the outgoing materials, by favouring high quality reclamation and recycling sectors.

- Missions of **careful removal for reuse**
Calls for tender increasingly include services for the careful removal of material lots to ensure their reuse (on the same site, or elsewhere). For these lots, bidders must plan, budget, and carry out careful removal and suitable conditioning. In some cases, they also have to ensure re-circulation of the elements (transactions with professional buyers, transport to a storage place, etc.).
- **Reclamation objectives**
A growing number of calls for tender will integrate reclamation objectives. These can be expressed as minimum reclamation thresholds (e.g. 80% of a surface in porphyry blocks). Potentially, they can also be the object of an assignment criterion: bidders then agree to achieve reclamation rates that they determine themselves and based on which they are compared with their competitors.

Other supply sources

Increasingly specifiers will plan for reused materials in their projects. Accordingly, companies must ensure the supply and/or use of these materials. Companies then have to get supplies from sectors alternative to new product dealers: via professional suppliers, online adverts, or simply by reusing lots reclaimed on the same site (reuse in situ) or on other sites.

New ways of preparing price offers

Integrating the logic of material reclamation and reuse can impact the way price offers are prepared.

The circular economy highlights a new model of value creation based on maintaining existing resources in circulation. Unlike the conventional economy, which is based on the sale of goods to generate higher value, which induces fast cycles of consumption and renewal, the circular economy is based on extending the lifetime of goods already present. In particular, the reuse of building materials favours local work of specialized demolition, restoration and reuse of existing materials, rather than the extraction of virgin resources, the industrial production of new materials and their transport over long distances.

So what does this change for contractors?

- The **cost of reuse materials**. The price of reuse materials on the professional market can differ from the price of new materials. They can be more or less expensive than new materials according to their age, rarity, and what they are compared with!
- For materials reused on site or reclaimed from other sites, the price of the material can be virtually zero. Indeed the materials are already present. However, the **cost of the operations needed for their reuse should be estimated precisely**: removal, cleaning, careful conditioning, storage, transport, performance studies, etc. Experience allows these amounts to be accurately established.

A new role for companies

Construction companies can play an important part in this transition towards more circular practices. Their knowledge of the business and materials, their knowhow and technical capabilities are crucial assets!

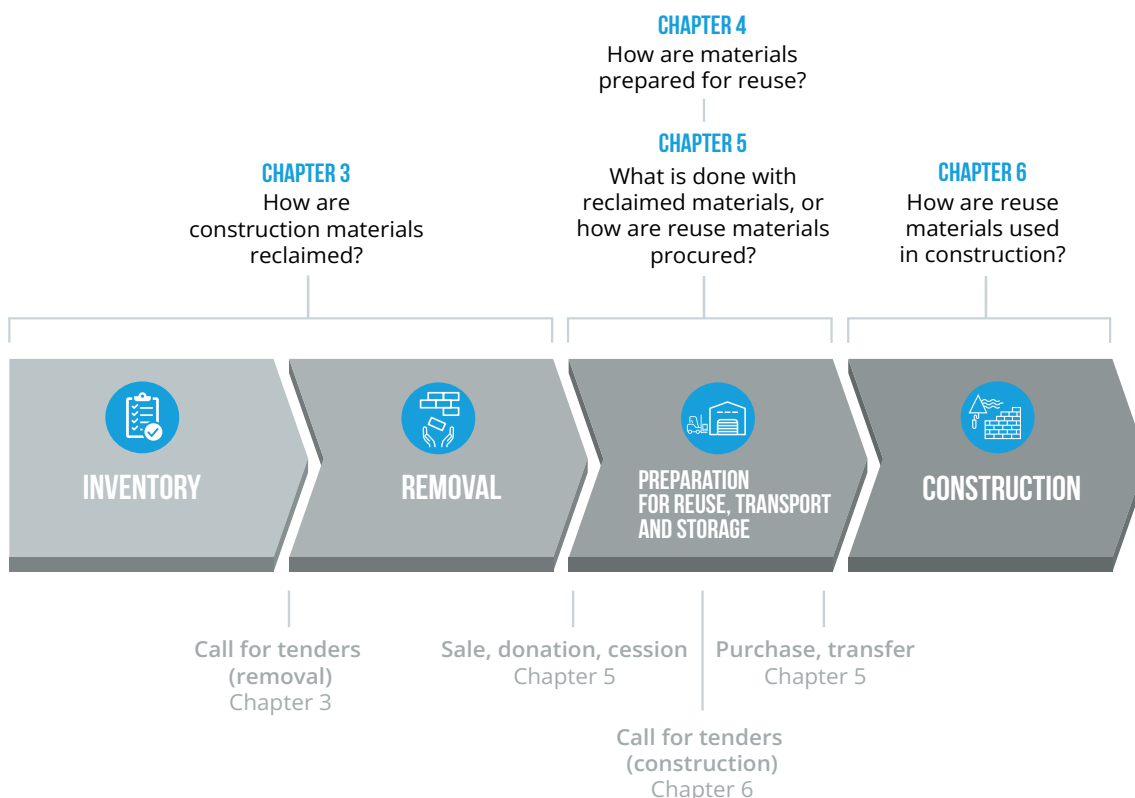
Here are some ideas for companies to become a driving force in the adoption of reuse practices:

- Drawing the attention of project owners and architects to the possibilities of **reclaiming materials on other worksites**. By their position and operation, companies

of the construction sector have privileged access to the sources of reusable materials which other interveners do not have.

- Developing and managing an **internal stock** of materials reclaimed during demolition work, which can be proposed for reuse on other work sites.
- Developing **privileged partnerships with local companies** specialized in the reclamation and resale of certain types of materials, to propose reliable reclamation and reuse solutions to customers and to answer customer demands.
- **Diversifying services**, be established on the market as a company that offers advice about material reuse, as well as solutions for deconstruction, renovation and/or sustainable construction, for example.

This guide aims to supply the answers to the main questions that entrepreneurs can have when they think about adopting practices of reclamation and reuse of materials. It is based on current knowledge in this field. The guide addresses the various key steps, in a practical way such as identification of the reuse potential, the removal processes, preparing materials for reuse, and the construction phase. It also covers aspects related to resale or supply. More theoretical aspects such as calls for tender, collaboration and the establishing of price offers will also be dealt with. Moreover, the guide deals with justification of the technical performance, responsibility, and insurance questions.



- Many roofing companies already practice reuse, occasionally and even, for some, recurrently. Roofers sometimes store roof tiles or slates from demolition work, for their resale or possible reuse on another worksite.
- Various dealers in reclaimed roofing materials (ceramic roof tiles and natural slate) have long been established. It is mainly for their aesthetic qualities (charm of old roof tiles/slates) that roofing materials owe, to date, their reclamation and reuse. Awareness that the reuse of materials helps to reduce environmental impact has accelerated in recent years. So it is expected that

- circular construction and the reuse of materials will gain considerably in importance in the coming years; this change will have a major impact for roofers.
- For more information about the above-mentioned project: Refer to the worksite sheet appended to the [report «Urban Mining van gebouwen»](#) at the following address: www.vlaanderen-circulair.be.



Now, only materials whose reuse or recycling is impossible finish their useful life in a skip.

© Buildwise, projet Tuighuisstraat, Courtrai

Example of removal and reuse, on the same site, of century-old ceramic tiles (produced in 1925): Tuighuisstraat project in Courtrai © Wonen Regio Kortrijk en Maker - Tetra architecten



Example of application of reclamation tiles: old blue Boom roof tiles, house of architect Callebaut in Sint-Denijs-Westrem / Saint-Denis-Westrem (<https://callebaut-architecten.be/project/jachttopzienerswoning>) © Callebaut Architecten





2.

Quels sont les matériaux de construction qui peuvent être récupérés et réemployés ?

- Roofers may be entrusted with several roles related to reusing materials: the deconstruction of certain elements, and construction with reuse materials. The contractors can carry out some of these tasks themselves, and subcontract some of them, for example to certain professionals.
- It is possible to intervene directly or indirectly on a number of different materials. The materials that will be more particularly dealt with in this guide are those related to roofing works. Other guides for demolition (deconstruction) companies, general contractors, interior finishing companies, wood workers and infrastructure companies have also been published under the Interreg FCRBE project.
- The following materials related to roof work can be subject to reuse:







FURTHER INFORMATION




Reuse Toolkit – Material sheets




A collection of 36 material sheets have been produced under the FCRBE project. They aim to gather the information currently available likely to facilitate reuse of the materials products of construction. Some information will be reproduced in this guide, but do not hesitate to read these very complete data sheets for more information about the materials to be reclaimed or reused!

https://opalis.eu/sites/default/files/2022-02/FCRBE-All_sheets_merged-EN.pdf

MATERIALS RELATED TO ROOFING WORK LIABLE TO BE REMOVED OR REUSED	DESCRIPTION ²	DOCUMENTATION
<p>CLAY ROOF TILES AND WALL COVERING</p>  <p>© Buildwise – Ekkow Photography</p> <ul style="list-style-type: none">  TO BE RECLAIMED  TO BE REUSED  FREQUENT ON THE REUSE MARKET 	<p>Ceramic roof tiles are widely reused in our countries. Reclaimed tiles are greatly liked for their charm and colour variations. Old or traditional models are often reused as roof covering for old or listed buildings, to ensure harmonious integration or to give new houses an old atmosphere. More recent models are also often reused.</p>	<p>Material sheet – Reuse Toolkit: https://opalis.eu/sites/default/files/2022-01/2.60_fr_-_tuile_de_toit_en_terre_cuite_v01_0_0.pdf</p> <p>Methods of diagnosis and evaluation of performance, developed by the CSTB: https://www.cstb.fr/assets/documents/cstb-guide-reemploi-des-tuiles-de-terre-cuite.pdf</p> <p>Sorting criteria for reuse tiles: https://luijngaarden.nl/uitsorteercriteria/</p> <p>Materiauteek - information on roof tiles: https://materiauteek.brussels/tuiles/</p>

² Some descriptions come from the website opalis.eu.

MATERIALS RELATED TO ROOFING WORK LIABLE TO BE REMOVED OR REUSED	DESCRIPTION	DOCUMENTATION
<p>NATURAL SLATE</p>  <p>© Opalis</p> <p>TO BE RECLAIMED</p> <p>TO BE REUSED</p> <p>FREQUENT ON THE REUSE MARKET</p>	<p>Natural slate is widely reused, especially in regions having a tradition of construction based on this material. Natural slate is liked for its old appearance and natural charm. It is generally reused as roof covering, and sometimes as wall covering.</p>	<p>Material sheet – Reuse Toolkit: Natural stone floor covering slab https://opalis.eu/sites/default/files/2022-01/4.10_fr_-_dalle_de_revetement_de_sol_en_pierre_naturelle_v01%20%281%29.pdf</p> <p>Material sheet – Reuse Toolkit: Natural stone wall covering slab https://opalis.eu/sites/default/files/2022-01/2.90_fr_-_dalle_de_revetement_mural_en_pierre_naturelle_v01_0.pdf</p>
<p>FRAMEWORK WOOD</p>  <p>© Opalis</p> <p>À RÉCUPÉRER</p> <p>TO BE REUSED</p> <p>FREQUENT ON THE REUSE MARKET</p>	<p>Wooden structural elements (beams, joists, rafters, etc.) are found on the reuse market. Pieces of wood can be reused, if certain conditions are fulfilled (measurements, strength, durability, etc.).</p> <p>In principle, old frameworks can be removed (connections of old framework and/or mechanical) and reused (ideally if the architect allows for the dimensions in the design phase).</p>	<p>Material sheet – Reuse Toolkit: Solid structural wood with rectangular cross-section https://opalis.eu/sites/default/files/2022-01/2.10_en_-_reclaimed_rectangular_section_solid_structural_timber_v01_1.pdf</p> <p>Material sheet – Reuse Toolkit: Laminated wood elements https://opalis.eu/sites/default/files/2022-01/2.11_en_-_glued_laminated_timber_structural_elements_v01_0.pdf</p> <p>Methods of diagnosis and evaluation of performance, developed by the CSTB: https://www.cstb.fr/assets/documents/cstb-guide-reemploi-des-charpentes-industrialisees.pdf</p> <p>Materiauteek - information on wood structures: https://materiauteek.brussels/structure-bois</p>
<p>INSULATION PANELS</p> <ul style="list-style-type: none"> • XPS and EPS • PIR • PUR • Mineral wool • Sandwich panels • Sound insulation  <p>© Opalis</p> <p>À RÉCUPÉRER</p> <p>TO BE REUSED</p>	<p>Reuse insulation materials are often reclaimed by demolition companies on their worksites. They include panels from floors, roofs, walls and partitions. The quantities available can be considerable. For reuse, their thermal performance must be ensured. Reclaimed products can vary from rolls to flexible rigid panels.</p>	<p>Mineral wool product-application sheet (justification of technical performance), developed by Buildwise: https://www.bbsm.brussels/wp-content/uploads/2022/07/BBSM-WP6-Fiche-produit-application-Isolant-laine-minerale-de-reemploi-VF.pdf</p> <p>Materiauteek - information on insulation https://materiauteek.brussels/isolant</p> <p>Research project - Isol'Ution (ULB & asbl La Rue, 2023)</p>

MATERIALS RELATED TO ROOFING WORK LIABLE TO BE REMOVED OR REUSED	DESCRIPTION	DOCUMENTATION
<p>ROOF WINDOWS</p>  <p>© Opalis</p> <p> TO BE RECLAIMED</p> <p> TO BE REUSED</p>	<p>In principle, roof windows can also be reused. Some professional suppliers are specialised and offer repair and re-installation. Like other exterior fixtures, special attention should be paid to their performance, especially thermal.</p>	<p>Materiauteek - information on roof windows: https://materiauteek.brussels/fenetre-de-toit</p>

- **Accessories** are more difficult to obtain (e.g. moulded parts with special shape such as junction tiles, gable tiles, curved tiles, etc.). Partly because they were less used in the past and, partly, because their frequent use on a bed of mortar made removal difficult. This situation can influence the nature of the work that can be done using reclaimed roofing materials. Ideally, the designer has to allow for this (e.g. is the fitting of a curved tile (convex) on a roof slope possible or not?)
- If the reuse of **many parts, mostly metal** (nails, hooks, strips, profiles, etc.), and with relatively reduced dimensions is not possible, in principle they can be sorted and, and to some extent, recycled. Nowadays, the recycling of metals like zinc and lead is already well underway.
- The work of demolition or modification of roofs could go along with the reclamation of small quantities of **bricks** or **natural stones**, following the demolition of old chimneys. However, as these elements can have traces of soot, their reuse is to avoid.



REUSE AND RESTORATION

For restoration, seeking a maximum reuse rate is also required, not just for environmental reasons, but to preserve as far as possible the ancient character of a building. In this sector, reuse has been a well-established practice for ages. Note: the underlying structure is often very precious, but the parties concerned do not always choose to fit new roof tiles, some even prefer to refuse them!

While it also deals with insulation and wood structural elements, this guide concentrates more on the reuse of ceramic tiles, because this is the most common practice and a good introduction to circular construction for roofers. But the reuse of elements by roofers does not have to be limited to tiles, it can extend to other elements and will only develop in the future.



3.

How can construction materials
be reclaimed?

A. How can you be sure that reclaimed materials will be reused?

Before starting their deconstruction, it is essential to carry out an evaluation of the reusable elements and the non-recoverable elements. The first thing is to evaluate the potential for reuse. Also the demountability can be tested at this stage. Then, elements with proven potential can be added to a reuse inventory. At the same time, it is important

to clearly define the ambitions of the project in terms of reuse. Various partners to the project can contribute to the different tasks whose execution is generally supervised by the architect or the project promoter.

Who takes the initiative?

Before any reuse, one or more actors have to take the initiative. Their motivations can be multiple. The table below gives a view of some of their motivations, which can vary from one project to another.

INITIATOR	MOTIVATION
Project Owner / Customer	Wants certain elements to be reused and requires this in calls for tender
Public Authorities	Implement reuse through political initiatives aimed at achieving climate and environmental objectives
Architects / Design Office	Can ask to reclaim certain elements with the aim of reusing these in a new project
Demolition companies	Are liable to dismantle certain elements easily (and without additional costs) and/or have opportunities for certain materials
Construction companies	Plan their reuse in new projects
Dealers	Purchase or take back certain items that are economically attractive for resale
Producers	Recover their products. Their reclamation enables repairs or improvements and the remarketing of their products

Evaluation of the reuse potential

Before starting deconstruction of materials for their reuse, it is important to know their potential for reuse. The evaluation of their potential is carried out in two complementary ways:

- **By analogy with frequently reused materials**

The frequent reuse of a given material means that the probability of successful reuse is high in this context and that the value attached to this material is significant. Section 2 gives a view of frequently reused materials.

- **Supporting criteria**

Various factors can affect, positively or negatively, the reuse potential of the materials. The impact of the different criteria varies from one project to another. Some factors are liable to make reuse harder, but never fully exclude the possibility to reuse. Sometimes it is a matter of getting off the beaten track to find an inventive reuse solution of a material whose potential seemed limited at first. The following factors are developed in the *guide devoted to reuse inventories*³.

+	-
Removability and simplicity of deconstruction	Health and safety risks
Good condition	Poor condition / damage / disintegration
Quantity (large)	Out of fashion
Considerable environmental benefit	New more interesting materials
High value (authenticity, historic interest, etc.)	Strict technical requirements
Economic value	High recycling value
Possible logistics	
Homogeneity and standard dimensions	
Management of risks	

Roofs

Specifically for roofing elements, the fixing method used (easy removal and elements undamaged) and the possible presence of asbestos fibres are very important. The availability of accessories (e.g. ridge tiles, curved tiles, etc.) can have an impact on reuse possibilities.

Clay roof tiles are great for reuse. They stand out for their exceptional durability and the long-term conservation of their functional and aesthetic qualities. Since they are removable, their removal and assignment to a new equivalent use can be quick and easy. Being modular, the easy combination of old and new ceramic materials is possible⁴. The useful life of ceramic roof tiles is more than a century. The roofs of historic buildings show that their lifetime is sometimes even longer (e.g. the Béguinage de Courtrai, the Villa Médicis in Rome, the Paravent de Blankenberge). Even if the outer face of a tile seems weathered, it can still be in excellent condition. For roof restoration, the coverings are only replaced if their conservation is impossible. In general, a (small) part of the roof tiles is only replaced, more than a century after intervention, while the proportion of original roof tiles still in use is significant⁵. The centenarian roof tile illustrated below is perfect for reuse.



Exemple de tuile de récupération centenaire (source : <https://www.stichtingerm.nl/kennis-richtlijnen/url4014>)

Old **Flemish or Boom** roof tiles are especially wanted for their «authenticity», like old flat roof tiles (French or Bourgogne tiles).

The useful lifetime of **concrete roof tiles** is more than 50 years. The reuse of this kind of tile is pretty rare in 2023. Because of their increased porosity, these roof tiles are usually subject to faster fouling with algae and lichens.

Roofers think that **nailed natural slates** are almost not reusable as roofing material in 2023. Existing obstacles include: high cost of removal, risk of breakage during removal, high cost of selection and sorting, difficulty of evaluating the performance of the removed product, performance responsibilities (ref. CT Couvertures, Buildwise).

³ <https://vb.nweurope.eu/projects/project-search/fcrbe-facilitating-the-circulation-of-reclaimed-building-elements-in-northwestern-europe/news/fcrbe-guides-extraction/>

⁴ Source: <https://www.wienerberger.be/duurzaamheid/duurzaamheidsrapport-2020/circulaire-case.html>

⁵ Source: <https://inventaris.onroendergoed.be/erfgoedobjecten/44891>

- In principle, **slates fitted with hooks** are easier to reclaim (less risk of breakage during removal). Given that slate is a relatively brittle natural material, you should be very careful with its removal and the proportion of reusable slates risks being relatively limited.

Wood structural elements

- For beams, check if the removal of large pieces is viable and, as required, decide on suitable equipment. The use of certain gripping tools risks damaging the fibrous structure of the wood and making it unusable. At this stage, you can evaluate if manual removal is viable and profitable. When removing wood beams for a new structural application, the potential for reuse can be estimated visually. For example, attacks such as rot and insect infestations will have a harmful impact on their structural integrity.



Example of roof tiles aged 115 years and still in use:
Blankenberge shelter (part renovated in 1993)
(<https://beeldbank.onroenderfgoed.be/images/25742>)

Insulation

- The reuse potential of insulation depends on the type of product, its condition and available information able to justify its performance, especially thermal. If they have been conserved in good conditions and have not been deformed, the thermal performance of mineral wools normally endures well..

Reuse inventory

An inventory is defined as a list of relevant information of the various elements. By definition, a reuse inventory only lists the elements whose reuse potential is significant. A crucial step, establishing a reuse inventory tells designers and building owners about the opportunities offered to them, sends information to the market and tells demolishers which elements to dismantle. Finally, looking forward, this inventory also has some potential for surveillance and monitoring of the quantities.

It is best to develop the inventory as early as possible. For example, establishing it can even be carried out during the use phase (in such cases, elements that disappear when moving should be considered) or when the building is empty.

Establishing the inventory can be entrusted to various actors. Normally, when a contractor is set to carry out the deconstruction of certain elements, the inventory will already have been established by the project owner, architect, consultants or a specialized company. Moreover, it can be useful for the contractor in question to produce a reuse inventory themselves. They can establish it according to their ambitions. And carrying out a personal analysis and estimation of the reusable or not materials can be useful.

- For a detailed inventory of roofing materials, the auditor should ideally at least be accompanied by a roofer, partly to profit from their expertise on the condition of the materials, and partly so that the inventory can be performed in good safety conditions.

Establishing this reuse inventory will be done when visiting the worksite. For this some arrangements should be made. A preparation antecedent to the site visit is worth considering. Moreover, it is worth thinking of submitting certain elements to possible deconstruction tests (see below) and as required, looking out for hidden defects. It is also worth having a camera and the required PPE. Apart from the practical aspect, nothing prevents a prior examination of the existing documents related to the building. Drawings, data sheets (FR: fiche technique de produit) and other documents for getting a more precise idea of the reuse potential.

Execution of the measurements required will be done when visiting the worksite. Taking clear photos of the elements having certain reuse potential allows colleagues, partners or potential buyers to get a precise idea of the situation. Submitted to deconstruction tests will be the elements for which some uncertainties remain as to the type of attachment (e.g. glued, dry, etc.) or the deconstruction techniques applicable. For elements whose performance is yet to be fully demonstrated, samples can be taken when visiting the worksite. In such cases, it is important to use clear marking to indicate the original position of the samples taken in the building. When visiting the site, it is important to show some curiosity, in safe conditions. In other words: It is worth examining materials under the covering plaster, unless they contain asbestos.

The inventory is liable to be divided into three parts. The first part gives information relative to the worksite. This part of the inventory will give among other things the contact details of the different actors. The address and nature of the building are also given. As far as possible, plans of the building are also added. All information about the machinery and equipment present (e.g. crane, lift, etc.) can help potential buyers estimate the workload involved should they have to carry out deconstruction themselves.

The second part is in the form of a database table. Minimal information for each element is given in this table. Identification, photo, quantity, dimensions, weight, condition and location of the elements in the building are liable to be listed here. The deconstruction tests and their results, the existence of any sectors, the dismantling phase, the fact that the element in question is already dismantled or that the buyer awaits the supply constitute additional information liable to facilitate the search for opportunities.




CAUTION WITH ASBESTOS!

Roofing products or sub-roof panels containing asbestos cannot be reused. These are mainly artificial slates, corrugated sheets and sub-roof panels made of fibro-cement, products before 1998 (in Belgium). For possible reuse, it is important to differentiate products containing asbestos from those free of it. This differentiation is not always easy to make with certainty in a building. The fitting date of the elements considered provides a serious indication of the presence or not of asbestos. The use of products containing asbestos has been prohibited since 1998. In principle, products made after 1998 do not contain asbestos. Products in fibro-cement containing asbestos were stamped with the mark "AT" and asbestos-free ones with the mark "NT". These marks still appear from time to time on old fibro-cement products fitted in roofs. For more information, refer to the Annexe devoted to asbestos.

In principle, beams and/or flexible insulation materials located under a sub-roof containing asbestos cannot be reused, because they are liable to contain asbestos fibres that are impossible to eliminate. An asbestos inventory must always be made before removing elements or a removal test carried out. If in doubt, do not hesitate to consult a specialist. Then, certain adhesive samples help to evaluate the presence (and concentration) of asbestos.

Example : Extract of reuse inventory (basic + additional data), produced under the Kasteelplein pilot project

BASIC DATA												
Identification		Photo	Quantity		Dimensions		Weight			In situ placing	Condition	Observation(s)
N°	assembly name		unit	quantity	unit	dim.	unit.	quantity	total			
1	Clay roof tiles		m ²	+/- 1.984	cm	22*30*5	tonne	79.35		All houses	Seems in good condition	Koramic pottelberg (made in Belgium). Consider a single lot. Easy to remove. Find interested supplier of reuse materials
2	Slates		m ²	677						gable wall of houses 5, 9, 11		Check the removability
3	Roof window		PC	6	cm	134*98				Houses 17, 19, 23		Velux GGL U04 (made between 2001 & 2012). Economic value estimated low

The third part consists of an additional sheet. The information it contains will be even more detailed. Here documents can be added such as data sheets, more

detailed photos, possible environmental benefits, possible applications, etc. The third part is optional. The relevance of this part will depend on the materials and ambitions.

IDENTIFICATION	
no.	Name of assembly / of elements
1	Clay roof tiles

ADDITIONAL DATA	
Additional photos	
	
Data about assembly	
Easy to remove	
Data about assembly	
Price info: on 2dehands.be, price per piece between 0.25 and 0.5 (can reach €2)	
Estimate: €0.25*30060 = €7515.	
For €0.4*30060=€12000	

It is useful to collect, as far as possible, all the technical information related to the roof tiles. The original plans and the special specifications are liable to contain information about the nature of the roof tiles (manufacturer, year of manufacture, type, etc.). If the type of tile is known, their manufacturer may be able to communicate the mechanical properties (initial). Information about their manufacturer and/or type is given on the back of some roof tiles.



Example of indication of tile provenance on its back (© Buildwise)

Other observations when making the reuse inventory can provide information about the reuse potential and the technical performance of the elements to be reclaimed. Angular deviations found regarding the perpendicularity and flatness of older roofs and covering materials can have an impact on the degree of reuse. Some tile roofs have become greatly curved over time. Any distortion (deviation from longitudinal axis) affecting wooden elements risks compromising reuse. Old roof tiles can also show strong shape inequalities, so in the case of reuse, the roof's tightness to precipitation may be much worse than new roof tiles. This is even more true for older types of pans without closure (e.g. Flemish or Boom pans).

For **insulation**, it is very useful to document the initial application type: does the insulation come from interior separations such as suspended ceilings, internal partitions, or fire walls? If it comes from roofs, front walls (cavity or interior lining walls) or from floors (under floating screed, between floor joists), special attention must be paid to the conditions of the initial application.

Deconstruction tests

For a deconstruction test, it is useful to check the fixing method of a given element, the dismantling of this element and the most appropriate dismantling procedure. Moreover, an estimate of the deconstruction time can also be made. Finally, an estimate of the expected loss rate can be given. This is the percentage of the materials which, despite their reuse potential, are not reusable because of damage suffered during their deconstruction.

As indicated above, a removal test can only be carried out if an asbestos inventory had been done, or if the building is sufficiently recent⁶.

It will be useful to perform a removal test for slates, to evaluate their ease of removal which varies according to the fixing method, and estimate the loss percentage according to their fragility.

Removing roof tiles is very simple. Tiles are usually fitted on the roof, the nose attached to a batten. The mechanical fixing of some tiles is done using hooks and nails or screws. These fixing pieces can be removed easily. A removal test is superfluous in most cases (unlike those required for other construction materials like bricks).



Source : <https://www.hornbach.nl/projecten/dakschade-repareren/se>

Special attention should be paid to the fixing method of ridge tiles (at the ridge top and any hips). In the past, these roof tiles were often placed on a bed of mortar (with cement). Therefore, their removal is arduous and the risk of breakage on removal is significant. Recent roofs are generally provided with a ventilation under-ridge and their ridge tiles are attached using screws or hooks. Nowadays, the use of soft mortars facilitates tile separation for their removal.

⁶ From 1998, in Belgium, the manufacture and use of many asbestos applications has been prohibited. In 2005, the marketing and use of asbestos have been completely prohibited. Since 1 January 2005, the use and marketing of products containing asbestos have been completely prohibited throughout the EU.



Example of traditional fixing (with mortar) of ridge tiles as part of a recent roof renovation (2023) while preserving the authentic appearance (photo F. Dobbels).

In the past, hip and ridge tiles were sometimes placed on a bed of mortar (with cement).



© F. Dobbels

- Detailed view of existing roof tiles, where some ridge tiles
- were attached with mortar on the ridge. It is also useful to
- look out for the presence of moss and lichens as well as
- any deterioration of the roof tiles due to the weather and
- frost, which risk affecting the reuse potential.

Definition of ambitions

The inventory's degree of detail can vary according to the ambition of the requesters.

The inventory can consist of a quick version, with little detail. This version will above all be used to produce inventories of the best-seller or high value materials. The aim is often to sell or give them away. General ambitions are more limited. Of course, if additional information is requested, the inventory can be completed.

Establishing a more detailed inventory requires additional information. This essential addition is due to high expectations, associated with a future clear goal or with possible reclamation of materials whose reuse is less current. Even when verification of technical properties is required, the inclusion of extra details and existing documentation (e.g. data sheets) is an advantage.

Carrying out a reuse inventory can be an iterative process. It is sometimes more interesting and economical to start with a less detailed inventory. Later, details (such as specific dimensions) can be added if the market demands it.

FURTHER INFORMATION



© Buildwise

A guide devoted to establishing a reuse inventory has been written under the Interreg FCRBE project. This [link](#) gives access to this guide combined with a model divided into three separate parts for consulting these documents.

Digitization and the use of digital tools in the construction sector are developing and are considered one of the main steps towards a more efficient and productive construction sector. Tools like «reality capture», scanning technologies, artificial intelligence, BIM models, applications and material databases also have the potential to help the sector to shift towards the circular economy. For example these tools can help us to produce reuse inventories.

A report produced under the FCRBE project describes how digital tools can support the production of reuse audits: https://vb.nweurope.eu/media/17603/fcrbe_digital-tools-for-reuse_final-version_compressed.pdf

The Interreg Digital Deconstruction project has also published many publications on this subject: <https://vb.nweurope.eu/projects/project-search/digital-deconstruction>

B. What are the key points when bidding for the reclamation of construction materials?

Types of contracts

There are two options for calls for tender covering the reuse of materials. It can be a performance obligation (ad hoc procedure) wherein the project owner requires certain quantities or percentages. Services, sales or donations can lead to establishing a public contract combined with a performance obligation. Or it can be an obligation of means requiring the contractor not to spare any effort for reuse.

- In the case of a public contract for **services**, the parties concerned focus on the deconstruction process. The materials used in this context do not usually have high value. The project owner assigns the contract to the bidder who agrees to dismantle the greatest quantity and the greatest variety of materials listed in the inventory. In return, the project owner pays a set amount to the assignee.
- In the case of a **sale**, the deconstruction process is secondary and the value of the materials is often higher. In this case, each article of the inventory will be sold to the highest bidder.
- In the case of a **donation**, the deconstruction process is also secondary and/or the value of the materials is higher. Each article will be given to the bidder able to take the greatest quantity.
- In the case of **obligation of means**, the bidder is required to spare no effort to reuse. This method holds less risk for the contractor. For example, certain technical problems can justify the absence of reclamation of a given material. (Rotor, 2015)

What can be asked?

According to the destination of the reclaimed materials, various activities will be included in the contract in question. For in situ reuse, the parties concerned will focus on the process of deconstruction and storage on site. For the deconstruction of elements for sale, donation or reuse on another site, the parties concerned can also be invited to evaluate the interest of the market, to look for opportunities and to establish a reclamation report.

A *reclamation* report is defined as a document giving a view of the reclaimed materials. This control tool for the project owner's use will be submitted to them prior to payment of the last tranche. Moreover, this tool also constitutes a practical means of communication of the results obtained.

The reclamation report gives the quantity of materials reclaimed and will be accompanied by a description and photos. This report will also be accompanied by a description of the steps taken to find opportunities as well as any supporting documents. (Rotor, 2015)

Possible technical clauses

It is important to carefully read the technical clauses describing the deconstruction of the materials, because they can differ in many respects from the more conventional clauses describing the demolition work. (Rotor, 2015)

- **Characteristics of the materials to be reclaimed**
What are the characteristics that the material in question must satisfy to be reusable?
- **Method of deconstruction and required information**
How does the deconstruction procedure take place? Do certain elements merit being paid special attention or treatment? Are dangerous substances present?
- **Sorting and selection**
Is the contractor responsible for sorting and selecting the reusable materials? Based on what parameters are the lots divided? Which elements are refused?
- **Clearing of non-reusable materials**
Do the non-reusable materials have to be cleared into separate bins? Is there, for certain materials, a direct opportunity which authorizes recycling as new materials?
- **Cleaning and preparations required before any reuse**
Is the contractor responsible for cleaning the materials? Which materials require cleaning? How should they be cleaned? What other operations have to be carried out? What is the final desired result?
- **Transport, storage and conditioning**
Should the materials be transported? What packaging method is to be applied? Against what risks should the materials be protected? Who is responsible for the storage? Where is the storage area located?
- **Ownership**
To whom do the materials belong after deconstruction?
- **Evidence and traceability**
How should the activities targeting reuse of the materials be documented? Which are the documents that the contractor should be able to produce?

Loss rate

In the case of a public contract concluded at the end of the ad hoc procedure, the parties concerned set a quantitative goal. This means that the parties concerned here will reclaim a set quantity or percentage of the recovered materials. In this respect, that a significant part of these materials will become unusable during the deconstruction process must not be ignored. This is what the loss rate covers.

Should a loss rate be communicated by the project owner, it is recommended to understand the situation well to confirm this estimate or request that it is revised as required.

The deconstruction tests provide a more precise idea of the situation. It is useful to entrust their execution to the project promoter. As contractor, it is important to carry out the verifications required. If no deconstruction test has been carried out, it is recommended to take the required percentages with a pinch of salt.

In the absence of loss rate communication, there are some options. Either the parties concerned ask the contractor to carry out a deconstruction test for estimating the loss rate, or the contractor offers to carry out a deconstruction test to evaluate this loss rate and the margin of error, or the contractor must show that they have used all the means and techniques necessary to reclaim a maximum of elements in a satisfactory condition. (Rotor, 2015)



FURTHER INFORMATION

Making possible the reclamation of construction materials in public buildings – this document gives a detailed explanation of the different procedures that may be applied:

[Vademecum_recuperatie_van_bouwmateriaal_Rotor.pdf \(rotordb.org\)](#)

CCTB (Cahier des Charges Types du Bâtiment) is the Walloon reference for public specifications for construction and renovation works. It includes standard clauses for the dismantling of certain materials.

[CCTB download \(wallonie.be\)](#)

Who do the materials belong to?

According to the destination of the materials, the provisions of the following are liable to be contractually decided:

- The removed materials remain the property of the project owner
- The contracting authority remains the owner of the materials listed in an appended inventory.
- Unreserved materials stored on land become the property of the contractor during their reclamation

⁷[NIT 240, Buildwise, 2011]

- The removed materials become the property of the contractor. This is also current practice as part of conventional demolition work. (Rotor, 2015)

- The quality of the reclaimed roof tiles must be adequate.
- They should be carefully checked over. It is important to make sure that they have no frost damage. Tiles covered with moss should be cleaned and dried before inspection.
- For ceramic tiles, this inspection consists in carrying out a visual inspection of apparent damage and a sound inspection of internal damage. For more information on the defects and characteristic appearance of clay and concrete tiles, refer to Addenda 1 and 2 of document TV 240-1 and 240-2 from Buildwise. Apparently intact clay roof tiles may have interior damage. To make sure, they should be knocked (dry) with a hard object (e.g. metallic).
- The roof tiles are accepted if they produce a clear clean sound.

[NIT 240, Buildwise, 2011]

- The special specifications can impose requirements on the method of deconstruction, to achieve a maximum rate of reuse. Points liable to be mentioned include:

Implementation:

- careful, to avoid any deterioration
 - Tiles should be removed with care to prevent any deterioration of these materials.
- selective (clearly damaged tiles can be discarded when dismantling the roof)
 - Selective process of the demolition in question: It is useful to conserve different materials separately or to sort them according to their specificity, shape, dimensions, colour and type of raw materials used to make them, provided that no mixing of these materials appears in the elements to be decomposed. On the roof, when removing tiles, the roofer can subject them one after the other to a «sound test».

Loss rate

- A loss rate of around 40% is realistic for roof tiles; i.e. the reclamation rate is most often at least 60%⁶.

- For natural slates, the loss rate is generally higher because they are often fixed with nails. Thus, the risk of breakage on careless disassembly is bigger than for roof tiles.

Cleaning roof tiles

- The materials should be cleaned (removal of moss, algae, lichen, bird droppings, other contaminants, etc.)
- After cleaning, the roofer can use a second quality control, consisting of a visual examination (presence of cracks and other defects, see NIT 240-1 & 240-2).

Storage (in crates or solid stacking cages)

- Demolition includes the following tasks: sorting, stacking on pallet, transport of reusable materials to the storage site, organisation and stacking of pallets.

It is useful to store demolition materials in a specific storage area in the worksite and defined together with the customer.

An example of neutral specifications and a concrete example of special specifications are appended to this guide. See Annexes 1 and 2.



Example of tile storage
© Buildwise

C. How do you collaborate with subcontractors, architects and customers?

Material deconstruction for its reuse still faces many challenges. Sometimes there is not enough time or no destination has been found for the dismantled materials. It is therefore essential to collaborate from the outset with the different parties concerned. The following advice may improve the conditions of this collaboration:

Rapid establishment of contacts

The reclamation and reuse of construction materials is not yet current practice for many construction actors. Activities and procedures different from the activities in everyday projects are unknown for many. Qualitative communication, transmitted opportunely, has crucial importance in this respect.

The meticulous deconstruction of a building takes more time than traditional demolition. According to the planning of the site, contact should be made on time with certain project partners. It is important to let the project owner know what time is needed for deconstruction of the planned elements. The other actors should also be told when it is convenient to carry out the deconstruction of certain elements. Finally, the fact of informing at an early stage the potentially interested parties lets them get a more precise idea of the materials whose opportunity outlooks are real. Section 5 gives some ways to help identify the actors liable to be contacted for this purpose.

For the deconstruction of materials for reuse, traceability is a matter of importance. Traceability is defined as the capacity to verify information relative to the life (previous) of the materials. Relevant information concerning their production and previous application can help the reuse process. Therefore, it is recommended to make contact rapidly with the former owners of the building, the actors involved in its construction or the producers of the materials concerned. Moreover, it is important to let the subcontractors, workers, etc. know clearly the method of distribution into lots of the materials considered.

In the case of reuse, control of the chain constitutes an important aspect. In the present case, control of the chain is based on the experience and expertise of the actors brought in to carry out deconstruction of the materials and to differentiate between the good and bad elements. If it is a matter of a new method of deconstruction or an element whose treatment the intervenors concerned have no experience of, it is recommended to seek the advice of specialists and to communicate, with supporting demonstration, the appropriate work procedure to the people present on site.

Satisfactory agreements

As shown in section 3.b, the clauses should precisely describe the elements whose deconstruction is required and to identify the people to whom the responsibility falls for certain tasks such as deconstruction, sorting, storage, transport, etc. Ownership and responsibilities should also be detailed. It should also be ensured that the information supplied in the specifications is sufficiently detailed. If not, it is recommended to contact the specifier before submitting a bid.

Who has responsibility for worksite safety?

In the case of deconstruction of elements for their reuse, the disappearance of certain factors which previously ensured the user's safety was not at all unusual. For example, the removal of staircases and windows increases the risks of falling and the removal of lamps increases the risks of exposing electrical wiring. Moreover, their deconstruction is often entrusted to different parties : the former owner wants to conserve certain elements, the neighbour is interested in a particular piece, a reuse organization has its eye on certain elements, etc. The presence of these different actors on a worksite can lead to dangerous situations, but who is responsible in the event of a problem?

It is always the site manager who is responsible for ensuring safety by keeping the worksite in a satisfactory state of cleanness and ensuring the supply of collective protective equipment (e.g. device for protection against falls).

⁸ Référence : fiche de chantier Thuighuisstraat Courtrai, banc d'essai Circulaire Bouwen

If the worksite is placed under the direction of a contractor, the latter takes responsibility for safety and obviously, any injury and damage inflicted on persons.

If the worksite is placed under the direction of an individual, the latter takes responsibility for any accident due to a badly maintained worksite. If the accident considered is related to the nature of the work (e.g. presence of dust in eyes following the performance of a drilling operation), the family insurance will intervene. In this case, responsibility largely depends on the situation.

Adapted work companies

Formerly called and social workshops, adapted work companies may be asked to contribute to support the reuse process. While their personnel may not enter the «normal» job circuit, they can provide a significant contribution at several levels of the reuse chain. Many tasks including deconstruction, sorting, cleaning, preparation and conditioning of the reusable materials may be entrusted to adapted work companies.

Again, clear agreements are crucial to ensure smooth cooperation. For example, agreements are best made around price. The work rate of a custom company may be slower than that of regular workers. A price based on the effective time can then increase, so sometimes a price per piece is chosen. In addition, agreements around the region in which they work and the flexibility of working hours are also important.

- The reclamation and reuse of roof tiles are not widespread, but this practice is not unknown to roofers.
- When the market value of roof tiles is high enough (strong demand on the reclamation market, relatively high price), roofers on demolition sites often plan to store tiles for resale. Some specialised companies have been performing these activities for decades (see list on opalis.be).
- As regards the nature of the work (on the building ridge, difficult access), dismantling should be entrusted to roofers, given the safety requirements (protection against falls, identification and handling of products containing asbestos, etc.) Ideally, the sorting operations should be entrusted to roofers and carried out alongside quality control (experience required).
- Cleaning of the materials can be entrusted to adapted work companies.

DECONSTRUCTION OF A HOUSE IN VINKT

Lippens Infra collaborated with HuisMus to dismantle the roof of a house in Vinkt. For the dismantling of the timber frame, HuisMus called on Labeur, an adapted work company. While most of the materials can still be recycled after their mechanical destruction, their dismantling requires more manual work. As these operations sometimes go too far for demolition companies, their partnership with an adapted work company constitutes a good solution. The Labeur staff carefully dismantled the roof quite safely so that the wooden beams could be reused by HuisMus as part of a new project.



© HuisMus & Labeur

D. How can construction materials be reclaimed?

Deconstruction

The deconstruction of a building can start while it is still in use and continues to the end of its demolition. If the building in question is empty, or even still in use, its owner can already carry out the deconstruction of certain simple non-structural elements. Contractors specialized in the sale and/or deconstruction of buildings can also themselves engage in these deconstruction operations, with or without the assistance of an adapted work company. They can also give their advice on the procedure to be applied or indicate the elements they are interested in. Since the demolition process is often intensive and limited in time, it is best to carry out the deconstruction of as many elements as possible before the start of demolition properly speaking. The deconstruction of structural elements can only be planned during demolition. In general the demolition company takes on this operation, but there is nothing to prevent specialized companies or adapted work companies from taking part.

The deconstruction method differs from one element to another. The execution of a deconstruction test helps determine the best deconstruction method for any element (see section 3.a). The parties concerned can also seek the advice of specialists or consult certain data sheets. After having identified the most suitable deconstruction method, it is important to share it with the people present on the worksite.

During any deconstruction, you must also consider the possible presence of dangerous substances. You must not carry out the deconstruction of materials before having carried out an asbestos inventory (and for dangerous substances) and the neutralization of any dangerous substance.



DANGEROUS SUBSTANCES AND PRECAUTION

Dangerous substances other than asbestos can be present in reuse roofing products. Then you must take care if in doubt and protect against them with appropriate safety measures during removal.

As regards **wood**, lead, copper, chrome, arsenic, PCPs and certain crucial germicides are some of the dangerous substances liable to be found in the composition of paints, fireproofing products and preservatives. Their concentration in wood and their residual harmful effect are difficult to evaluate without lab testing. Similarly, the release of dust when sanding or sawing wood pieces requires compliance with appropriate safety measures.

European directive CLP (Règlement CE), 2008) classes mineral wools as carcinogens type 2 (unless they fulfil certain conditions). However, it seems difficult in practice to check these conditions for reuse products, these concern their composition. Nevertheless, following this directive, it seems that since the 2000s, in France, all mineral wools have been manufactured to be non-biopersistent (in compliance with the conditions of the directive). It is very probable that the situation is the same in Belgium and in other neighbouring countries. Knowledge of the date of manufacture of the panels can lead to stating if this requirement is reached or not (Emmaüs & CSTB, 2016).

- It is useful to remind roofers that the dismantling of any
- roof inevitably compromises the tightness of the building.
- So deconstruction of pitched roofs can only be planned
- after finishing the dismantling of the building in question
- and just before demolition of the remaining structure.



FURTHER INFORMATION

The 36 material sheets developed under the FCRBE project describe further the techniques habitually used and best practices for the removal, sorting and storage of the materials. They are available using the following link: https://opalis.eu/sites/default/files/2022-02/FCRBE-All_sheets_merged-EN.pdf

The website reuse.brussels also describes in detail the various operations needed for removing certain materials.

EXAMPLE :

To study an example of tile removal for reuse, refer to the Tuighuisstraat project (Wienerberger, Courtrai, monitored by Buildwise)⁹.



*Example of submitting roof tiles to a "sound test" on removal
(© Buildwise, Tuighuisstraat worksite, Courtrai)*

⁹ <https://www.wonenregiokortrijk.be/nieuws-artikels/45-huisvestingsmaatschappij-wonen-regio-kortrijk-pioniert-met-hergebruik-van-materialen-bij-opwaardering-tuinwijk-kortrijk>

Sorting

For the deconstruction of elements, the first step consists in sorting out the non-reusable elements. However, the reusable elements will be distributed into various lots. A lot is defined as a set of elements whose properties are homogeneous. One lot will be composed of bricks of the same colour, wooden beams from the same application or doors with identical dimensions. The following factors enable these lots to be differentiated one from another:

■ Types of elements

It is useful to make a distinction between different types of elements. For example, wooden beams and steel beams will be grouped separately; but a replacement window produced by another manufacturer will be part of a lot different from that of the windows mounted in the building when constructed. Certain aesthetic characteristics can also influence the constitution of lots.

■ Location in the building

A different place in the building can also require the constitution of separate lots. Interior and exterior doors will be separated into two different lots.

■ Application

Elements whose application differs in a building will be distributed into separate lots if their prior use is likely to have affected the properties. Steel beams subjected to dynamic loads are put in a lot different from that grouping other steel beams subjected to static loads.

■ Influencing factors

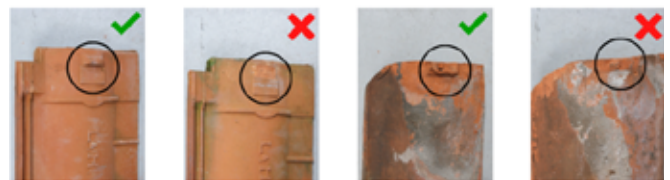
During their previous application, elements of the same type can have been affected in different ways. Bricks making up the south-west façade are liable to have been affected more by the weather conditions than bricks making up other façades. A leak, minor deterioration, residues of other substances or other forms of contamination can also justify the distribution of the elements in question between different lots, or even discharge them as non-reusable elements.

In the case of the distribution of elements between several lots, it is important that their provenance is and remains traceable. Marking per element or per lot ensures traceability. The reference to their provenance can be based, for example, on coding combined with indications supplied on the corresponding drawing.

- Tiles can be sorted according to a series of criteria, known to professionals working with these reuse materials. The website <https://luijtgaarden.nl/uitsorteercriteria/> lists these sorting criteria.



Example of sorting of remains of tiles not reusable during removal
(© Buildwise, Tuighuisstraat worksite, Courtrai)



Source : <https://luijtgaarden.nl/uitsorteercriteria/>

Transport

In some cases, specific regulations can apply to the transport of reclaimed materials. To know what they are, you should first determine if the reclaimed materials are to be qualified as “products” or “waste”. In general, “reusable construction materials should be considered as products (and not waste) when circumstances demonstrate a high probability of reuse (for example: careful removal for reuse, presence of solid market, short storage time, contract between the holder and the user of the materials, specifications of materials comparable to those of other products on the market, etc). It is up to the competent regional authorities (and not the holder of the materials) to confirm this interpretation case by case and in concreto, according to the circumstances specific to each case» (Billiet & Seys, 2016/1). There are also different cases for which the materials will be well reused, but will nevertheless involve the waste case, for example when the logistical process of treatment in several steps before reuse is not certain¹⁰.

If the reclaimed material is considered as «waste» under the regulations, it must then comply with the regulations of its region or country in terms of approval and registration as a waste transporter.

¹⁰ See section 4 for more information.

Storage

An important factor of reuse lies in the suitable storage of the materials. It often happens that immediate reuse of the materials in question is impossible or getting hold of reuse materials because of unavailability. This is why suitable storage constitutes a crucial step in the reuse process.

The storage place depends on the destination of the materials. In the case of material reuse in situ, you should identify, on the site or nearby, a suitable place for its storage. Materials to be reused ex situ will be stored on the other site or, as required, on an intermediate site. Materials dismantled but awaiting a new project have to be stored for longer, whether on the contractor's premises, in those of a reuse organization or on a site devoted to this usage.

The storage of materials on a worksite is often time limited. The precise storage method depends on the material in question, but certain basic principles generally apply. For example, certain materials should be sheltered from the weather during their storage. Any shelter should also be secure. Make sure that the storage does not interfere at all with the activities carried out on the worksite and that it presents no risk for the people present on the site. In this respect, a good solution is to assign a bounded area (covered) for material storage, if the worksite allows this. If space is restricted, the material in question can be stored in an existing building. Provided that the building can ensure its integrity until reuse. In the case of storage in the cellars of a building whose waterproofing is doubtful, some materials will become damp, or even unusable.

If the reclaimed materials are not yet the subject of any new project, they should be stored on a temporary basis. In such cases, you should not conserve materials whose reassignment is very uncertain. For long term storage, it is even more important to protect materials sensitive to the weather than for temporary storage.



Example of storing tiles for reuse

(© Buildwise, Tuighuisstraat worksite, Courtrai)



Stockage d'isolants en laine minérale provenant de cloisons intérieures, avant leur remise en œuvre comme isolation de toiture inclinée

© Buildwise

- **Wood beams** can ideally be stored on crosspieces
- together with spacers for maintaining gaps between the
- different elements. These beams can be stored sheltered
- from the weather or in a heated environment to control
- the level of moisture. In regions with a dry climate, beams
- can be stored outside, on large racks with sufficient space
- left between them. Adequate ventilation is also required
- for wood beams.

When the contractor does not have enough storage space, on the worksite, in their depot or that of the project owner, temporary storage space can be hired, like that offered by a consolidation centre. For example, the [BCCC](#) (Brussels Construction Consolidation Centre) allows the temporary storage of reuse materials coming from deconstruction worksites, before their reuse. It is also possible to carry out preparation operations for reuse of the materials there.





4.

How are materials prepared for reuse?

Unlike new materials, reclaimed materials often require the execution of some operations before being reusable in a new project.

Firstly, certain materials will need prior cleaning. Before any reuse certain materials have to undergo deep cleaning for aesthetic, hygienic or safety reasons. Cleaning can also be required for practical reasons, such as the removal of the mortar adhering to bricks or tiles before any reuse.

Second, it can be necessary to remove, apply and/or to replace coating or paint. For some materials, these operations are only done for aesthetic purposes. For other materials, these operations are done for health reasons, if a worrisome substance comes into the composition of the original coating or paint. Moreover, these operations can also be done in order to preserve the material, like the sustainability of wood.

Third, the new application is liable to require dimensions different from those of the initial application. To meet this requirement, elements like tiles, doors, metal profiles, wood parts, etc. should be sawn to size. Also, it may be that elements such as the nails used in the previous application have to be ripped out.

Finally, it may also be necessary to revise the elements to be reclaimed and, as required, to arrange for the supply of missing elements. For example, heating appliances, technical installations or sanitary equipment.

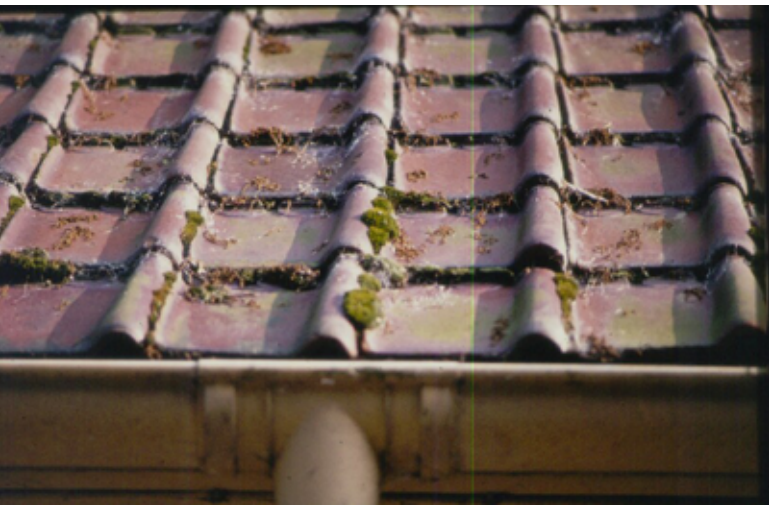


DOES THE MATERIAL REMAIN A PRODUCT OR DOES IT BECOME WASTE DURING THE OPERATIONS OF SORTING, CLEANING, TREATMENT, ETC?

To avoid the regulatory implications related to the qualification of **waste**, the final reuse must be planned and certain. For example, if the material is reused on the same site, if it is reused on another site belonging to the same owner, or if it is transferred to another actor for future reuse. However, in circumstances where the material is considered waste because of circumstances such as abandonment, an error or a logistical process of treatment in several steps before reuse is certain, we are in the scope of "**preparation for reuse**". The material is initially classed as waste, but it recovers its product status as soon as reuse is guaranteed (Naval, 2021).

Reclamation materials can nevertheless go by operations of cleaning, sorting, treatment, cutting, etc, before being again used, without having the status of waste! In this document we have chosen to use the terms "preparation for reuse" to describe all the operations of sorting, cleaning, treatment, etc, without taking account of the product or waste status of the material.

- Firstly the **roof tiles** should be cleaned to make them reusable. Moss, lichen, algae, etc. should be removed as necessary.



Example of moss forming on roof tiles
© Buildwise



Example of lichen formation on tiled slope of gentle pitched roof (note: The angle of this slope is less than the angle permitted for this roof type)
© Buildwise

- Cleaning is a simple yet laborious operation . Its execution is thus relatively costly. For a residential building, the project owner or an adapted work company can handle it.

Note: roof tiles cannot and should not recover a completely «new» appearance. While many project owners choose reclamation tiles, it is precisely for their specific character (patina, ageing, etc.).



Aesthetic appearance of tiles after removal from roof
© Wienerberger®

Certain operations are also needed to prepare **structural elements in wood** according to their condition:

- Removal of metal elements. Nails, screws and other metal parts are removed using suitable tools (pliers, pneumatic punch, etc.). This laborious process is essential if later matching of the wood is planned, at the risk of damaging the machinery. A metal detector can be used to locate metal objects.
- To ensure that the performance of the reuse wooden elements meets the requirements for their future use, visual sorting is carried out.
- Surface cleaning. Using a soft or wire brush, by sanding or blasting according to requirements.



© Rotor DC

FURTHER INFORMATION

The 36 material sheets developed under the FCRBE project describe further the techniques habitually used and best practices for the preparation for reuse of the materials. They are available using the following link: https://opalis.eu/sites/default/files/2022-02/FCRBE-All_sheets_merged-EN.pdf

The website reuse.brussels also describes in detail the different operations needed to prepare certain materials for reuse.

- Drying. According to the hygrometric state of the wood. The elements are usually dried naturally in hangar, with the required storage arrangements (spacing of elements, no contact with ground, blocks, etc.). Artificial oven drying can be carried out to reduce and stabilise the moisture. Artificial drying also contributes to removing potential pests (moss, insects).
- Preservation treatment. If usage requires it, wood elements can be treated to optimise their exterior durability and improve their use class. There are several types of treatments, e.g. dipping, spraying, brushing, autoclaving.
- Planing. Wood can also be left raw or planed on one or two sides to obtain flat constant cross-sections.
- Finishes. Wood can be left as is or receive a finishing coat (varnish, wax, oil, stain, paint, etc.) (Rotor, 2021).

5.

What is done with reclaimed materials, or how to procure reuse materials?



There are several **possible destinations for materials reclaimed by contractors**. It is important to analyse the different possibilities to make sure, even before removal, that the materials will have a chance of finding a buyer. The reuse potential will only be confirmed (or overturned) if the product is effectively reused in a project! It is useful then to check for the existence of a demand (or to create the opportunity) for this material.

Materials can be reused on the same site, on other worksites of the same contractor or of the same project owner, resold to other contractors or individuals, resold to professional suppliers, given to associations, etc.

Similarly, these different sectors can be used by companies responsible for **procuring reuse materials**, as an alternative to new product dealers.

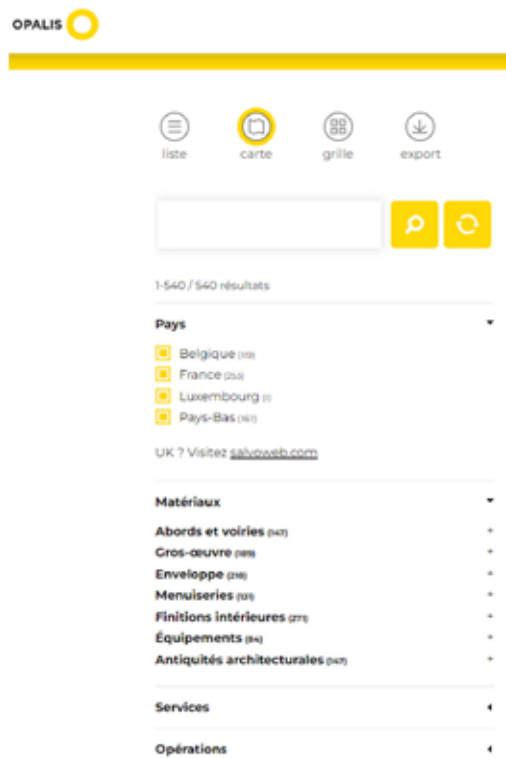
■ **Professional suppliers**

Only in North West Europe are there more than a thousand companies specialized in the sale of reclaimed materials. They reclaim and offer different types of

materials, from the oldest and specific to the more recent and standard. Some ensure careful conditioning of the elements such that, for the contractor, their installation is not really different from a new product. Above all it is a matter of expanding one's address book and including local retailers! Some of these companies have online marketplaces, giving a quick idea of the materials they are selling.

Some professional suppliers carry out removal of the materials, while others accept taking on already removed materials. It is a matter of contacting these companies to discuss their conditions for acceptance: accordingly, they can take in materials freely, purchase them, or even offer a deposit-sale service.

The directories Opalis.eu⁹ and Salvoweb.com¹⁰ make it easy to find professional suppliers in one's region.



¹¹ <https://opalis.eu>

¹² <https://www.salvoweb.com/salvo-directory>

Salvo directory

The world's best and most comprehensive architectural salvage directory online since 1995. Find your local salvage yard and specialist businesses dealing in architectural salvage - reclamation - decorative - garden - antiques plus craftspeople - reclamation friendly designers and architects.

1 000 results found in 33ms



3A Roofing Ltd



AB Reclamation Ltd



Abacus Stone Sales



REGIONS

Argentina
Australia
Austria
Belgium
Canada
China
Czech Republic
Denmark
Egypt
Estonia
Finland
France
Germany
Greece
Holland
Hungary
India
Ireland (Rep.)
Israel
Italy

■ Lots reclaimed on site

When buildings are to be renovated, converted or rebuilt, you can find materials liable to be reclaimed and reused in new arrangements, on the same site. In some cases, preparatory work may be necessary: cleaning of mortar remains, sizing, sorting of elements according to their dimensions or condition, etc. This work can be done on the worksite, or elsewhere. The same goes for storage of the elements, according to the space available on the worksite.

■ Specific lots

In some cases, specific lots will be identified by the project owner and/or the architects to then be removed and reused in a given worksite. For example, this can be materials still installed to be removed in another building, or again materials which will have been purchased beforehand by the sponsor. These cases can be accompanied by specialized consultants and tailored approaches. Sometimes a temporary storage place will have to be defined.

■ Online ads and platforms

For some years, digital platforms announcing lots of reclamation materials (still in place or already removed) have been multiplying. They can provide a useful source of supply, but also a means for finding professional or private buyers.

Some of these platforms are pretty generalist, free to access and have a large audience, such as <https://www.2ememain.be>, <https://www.marktplaats.nl>, etc. Others are more specific and only target construction materials. In general they have a more limited and

specialized audience. They can be free or operate with a commission on sales.

Here are some examples of these platforms in Belgium, France and the Netherlands:

- The [page of the Plateforme des Acteurs du Réemploi in Brussels](#) : this Facebook page aims to be self-managed by its users.
- [Backacia](#), Paris: marketplace for reuse materials and equipment in the construction sector.
- [Cycle Up](#), Paris: a digital platform (sellers/buyers) for all actors of the building sector (project owners, contractors, architects, builders, demolishers, etc.).
- [Excess Materials Exchange](#), the Netherlands: digital market where companies can exchange their surplus materials.
- [Oogstkaart Markplaats](#), the Netherlands: web platform which makes reuse materials available for sale or purchase and targets companies of the construction and building sector

■ Partnerships

Sometimes, certain deconstruction and construction companies set up a collaboration aimed at circulating the construction materials deconstructed by one, to provide a source of materials for the other. This symbiosis allows them to have a better idea of the demand, and of the stock of materials becoming available.

■ Donations

When the materials have little value or when the stakeholders want to for different reasons, reclamation materials can be given away. Donations can be made via the various sectors listed below, and to organizations with social and/or environmental aims.

For example, in France, the site <https://donnons.org> enables donations of construction materials and other things. In Belgium, the *Resources* federation makes available several collection points for construction materials in Brussels and Wallonia. The *Matériauthèque* of Tournai is on this list. It collects, removes (in certain special cases), stores and the sells reclamation materials at low prices.



Matériauthèque de Tournai, Belgique

© Buildwise

- **Clay roof tiles** are found steadily on the reuse market.
- Reuse slates can be found in regions that use this material traditionally: Wales, Scotland, Ardennes, Anjou, Corrèze, etc (Rotor, 2021).

- as pine, oak, jarrah, etc. Retailers generally have large stocks they can quickly renew. Currently used frame wood has a cross-section of 50 × 100 mm and length from 2.4 to 3 metres. It is mainly resinous and pine (Rotor, 2021).
- Laminated wood elements are not common on the reuse market. However, some suppliers complete their regular offer with lots of laminated elements (Rotor, 2021).



REUSE AND RESTORATION

The variety of historic roof tiles available is impressive. For partial repair of the roof of a monument, the tiles must be refitted in compliance with the existing situation. A contractor perfectly in tune with the reuse tile market will always find the best matched tile. For certain specific applications such as reconstruction or restoration, the parties "seeking authenticity" can turn to a number of specialised suppliers¹³.

- Reuse **insulation materials** are found with some demolition companies which reclaim them from their own worksites (Rotor, 2021).



© Buildwise

- While the professional sectors for reuse structural wood are less developed in France, Belgium and the Netherlands than in other parts of the world like the USA, many suppliers nevertheless offer these reuse materials (Rotor, 2021). Professional dealers generally have large stocks of reuse wood beams and can rapidly respond to medium and small orders. For larger orders, time may be required to develop enough stock. Reuse wood joists are available in most standard sizes and in species such

Detail on the sale of reuse materials and CE marking

CE marking is a regulatory requirement to legitimize the marketing of many construction products in Europe, especially those for which there is a harmonized European standard (hEN). With the development of the market for reuse materials and the revision of the CPR (Construction Products Regulation), the question of extending this requirement or not to reuse materials is currently on the agenda. In the revision of the CPR, reuse products are explicitly included. You should keep up to date on the changes in this matter!

However, the Construction Products Regulation, in its current version, does not yet specify if reuse products have to follow or not the same rules as new construction products. The subject is currently left to the interpretation of the countries. Meanwhile, Belgium has chosen the following approach, based on different cases:

- **If there is a harmonized technical specification (hEN¹⁴ or EAD¹⁵)** that applies to the construction products in question, for a well-defined planned use, **and that the reuse product is sold for this planned use**. In this case, the CE marking and a declaration of performance should be required. However, it is still worth clarifying the situation for this case, because it seems complicated to apply all the content of the harmonized standards to the reuse products. Indeed, the evaluation methods included in the harmonized standards assume, in general, continuous mass production of many almost identical products. In general it will not be possible to assume that the same goes for reuse. The products often have deviations (for example, impurities, slight damage...) Moreover, the requirements related to the quality control procedures are generally suited to the controls performed during production and/or in a production installation, in plant. Of course, this is not always the case for reuse.

An ETE (European Technical Evaluation) has already been delivered for reuse bricks, on a voluntary basis. A harmonized standard already existed for these new products, but was considered non-applicable to reuse bricks.

¹³ <https://www.vandemoortel.com/nl/Bouwmaterialen/Assortiment/Dakpannen/Oude-dakpannen-en-nokken>

¹⁴ Il s'agit des normes harmonisées qui servent à prouver que les produits ou services respectent les prescriptions techniques de la législation européenne correspondante. Elles décrivent entre autres les méthodes et critères d'évaluation des performances des produits de construction correspondant à leurs caractéristiques essentielles, ainsi que le contrôle de la production en usine à effectuer.

¹⁵ Le document d'évaluation européen (European assessment document) est une spécification technique harmonisée pour les produits qui ne sont pas couverts ou pas entièrement couverts par les normes harmonisées.

- **When a harmonized technical specification (hEN or EAD) applies** to construction products for a defined planned use, but the reuse product is **sold for a different planned use**. In this case, CE marking / a DoP is not necessary. However, it is worth saying that this different planned use could also be an application covered by a harmonized standard, which leads back to the previous case.
- **When a harmonized technical specification (hEN or EAD) applies** to the construction products, but that **the reuse product is not sold**, but removed and used by the same contractor in another structure. In this case, CE marking / a DoP is not necessary.
- **When the construction product is not covered by a harmonized technical specification (hEN or EAD)**. In this case, the CPR does not apply and CE marking and a declaration of performance will not be requested.

The background is a blue-tinted photograph of a construction site. In the foreground, there are stacks of materials, possibly insulation or drywall, with a person's hands visible on the right side, appearing to be working with them. A large, white, torn-paper cutout is positioned in the upper left and center of the image, containing the text.

6.

How do you build with
reuse materials?

While it sometimes requires additional steps or research, each contractor is capable to reclaim or reuse building materials. As described in 5, the process for procuring materials has to be adapted. The call for tenders for the supply and use of the materials can also differ from a conventional call for tenders, whether in the form of the contract, or its contents. As mentioned in section 4, in some cases, preparation of the materials for reuse will be required, or deemed necessary. This section also covers frequently asked questions about the absence of data sheets, justification procedures for technical performance and questions on distribution of the resulting responsibilities. Advice for improving collaboration with all the construction actors is also given, before dealing with the question of construction in practice, as well as questions on time and cost for the supply and use of the reuse materials.

A. What are the key points when bidding to implement reuse materials?

Calls for tender for using reuse construction products can – and should – differ from calls for tender for using new products. Just as for new materials, there are different contract types and they have an influence on the contractor's role. However, they can differ by their content, which sometimes specify the additional operations required to enable reuse of the materials, and be adapted to the nature and constraints related to the reuse materials.

Types of contracts

Just as for new materials, different contract types enable the use of reuse materials. They each have their specifics which can have an influence on the formulation of a reuse objective and its realization. They can be contracts of work, of Design & Build, contracts of acquisition of material lots, framework agreements of reuse directed work, or even of "reuse lots".

In practice, there are two scenarios:

- Either the contractor is responsible for the supply of the reuse material lots. They then have to procure it according to the technical clauses established by the project developers and the project owner.
- Or the lots are already present, because they are part of the original building, because they were removed in a previous work phase, or because the project owner already procured them on their side. In this case, the issues will then involve the use and any steps prior to this.



FURTHER INFORMATION

Reuse Toolkit – Procurement Strategies
Integrating reuse in large scale public projects and public procurements

https://www.nweurope.eu/media/16916/wpt3_d_2_2_procurement_strategies_20220208.pdf

This document, also produced under the Interreg FCRBE project, aims to provide tools to project owners and specifiers to help integrate material reuse in their construction and renovation projects.

Solutions of fallback, flexibility and alternatives

According to the types of material, provisioning in reuse products is not always ensured, whether for example because of unavailability of the target lot at the right time, or for damage caused during removal. So it will be important to check that the specifications provide for the possibility of using alternative products, whether other reuse material, or new material. These fallback solutions can take different forms:

- Mandatory or free technical options
- Unit price lists
- Re-examination or substitution clauses
- Variants
- Negotiating procedures

Technical specifications

Technical specifications for the supply and use of reuse elements should differ from those for new materials. Before offering a price, it can be useful to check that the specifications include no clauses contradicting the specifics of the reuse materials, and that all the operations required are clearly explained, otherwise it is necessary to request precisions from the specifier.

- As it is currently developed, the normative framework for construction materials describing how the technical performance of the materials have to be evaluated and declared is not always directly applicable to the case of reuse materials¹⁶. It will be useful to make sure that the technical specifications take account of this particularity and do not set requirements impossible to reach for reuse materials.
 - The clauses cannot require a **CE marking** for reuse materials as things stand. Indeed, today, apart from exceptions, reuse materials do not have CE marking¹⁷.
 - The clauses should also not require **classes of quality** which are not suited to the nature of the reuse materials, as well as **too specific characteristics**, unsuited to fluctuations of the offer of reuse materials. You should ensure that sufficient choice or room for movement have been left on the definition of certain (non-fundamental¹⁸) characteristics of the materials, such as:
 - margins of tolerance (e.g. dimensions),
 - aesthetic and defect aspects,
 - variations of hues and colours,
 - ...
 - The **methods of use**, especially assemblies, appliances or modes of composition, should correspond with the qualities and specifics of the reuse materials.
 - In many cases, the way of justifying and evaluating the technical performance of new materials is not suited to the case of reuse materials. The specifications should be checked for this¹⁹.

- It will also be useful to check that the **operations or results expected** by the specifier are clear.
 - Generally, in the case of a lot supplied by the project owner, the operations expected (especially preparation for reuse) will be specified, as the specifier knows the condition of the material. For example, they will specify that cleaning or sorting have to be carried out, if not already done by another service provider²⁰.
 - For a lot that is to be supplied by the bidder, the bidder should ensure that the expected results are sufficiently described in the technical specifications; the operations to be carried out depend on the lots that will be selected on the market.

- Reclaimed tiles won't always meet too precisely specified technical requirements. When describing the technical specifications in the special requirements, designers must show rather more flexibility than in the case of using new roofing materials. The specifications should be adapted to the reuse of materials or, at least, not exclude this option. Concretely, it is possible to combine various limit values with a number of requirements: "without evaluation (value by default)". This flexibility must not, however, threaten the health and safety of users (see point 6.c for further information). See example below.

Standard Specifications (CCTB 2022),
"reuse" article example:

34.11.1a Clay roof tiles with one or more cross and side interlocks

"Clay roof tiles with one or more cross and side interlocks (as per information on plans) are new (by default) / reuse."
»

"Reuse": this concerns reclaimed roof tiles as an alternative to new tiles. Tiles reclaimed on site or by a model proposed by the contractor and submitted to the project developer for approval.

¹⁶ The question of justifying the technical performance of reuse materials is further developed in 6.c.

¹⁷ See section 5 for more information.

¹⁸ The reuse materials must satisfy the same requirements as new materials for all regulatory requirements and/or related to user safety and health.

¹⁹ The question of justifying the technical performance of reuse materials is further developed in 6.c. Our position is that while reuse materials must satisfy the same requirements (basic) as new materials, how to justify and declare their performance should be able to differ.

²⁰ The operations of preparation for reuse are described in 4.

Reuse roof tiles are sorted on pallets per lot according to their variety, origin (including typology of wall of previous usage), dimensions, colour (level of firing or composition). Orientation tests (sounding tiles, absorption test, etc.) can help separation into lots. One lot in general contains 1 to 5 pallets.

Lot evaluation and approval targets two basic properties:

- Flexural strength: without evaluation (by default) / 600 N / 900 N / ***.
*** samples of 5 roof tiles per lot are lab tested according to [NBN EN 538].
- Impermeability as per method 1 or 2 of [NBN EN 539-1]: without evaluation (by default) / Level 1 / Level 2 / ***.

- **Note:** The requirements are liable to vary according to the use of the tiles. For example, for roofing a car port using reclamation tiles, the designer's requirements can be less rigorous than for roofing an historic city palace enclosing a high value interior. This increased flexibility can have an impact on the potential use of reuse materials, taking the specific risk into account.
- When using new materials, the technical requirements for the latter are generally the same whatever the case.
- But when using reclamation materials, the requirements can vary according to any consequences of inferior performance.

Traceability of materials

In order to prove the effective reuse character of the elements concerned, documents supplying information on the traceability of the materials can be requested from the contractor. These can be:

- Invoices from reuse material suppliers,
- Photos of the material in its original site (for reuse on site or from worksite to worksite),
- Information on any operations of preparation for reuse and reconditioning,
- ...

The label "Truly Reclaimed" being developed by the organisation Salvo Ltd. under the FCRBE project aims to attest that a product or lot of materials really comes from demolition work. Further information at trulyreclaimed.org.

Information on different steps can also be requested from the contractor for technical justification of the materials:

- Information on the origin of the material and its initial application,
- Information on the conditions of transport and storage,
- Information on any tests of fitness for use the material has undergone
- Information on any operations of preparation for reuse and reconditioning,
- ...



FURTHER INFORMATION

In Belgium, some 70 clauses enabling the specification of certain reuse materials have been included in the CCTB 2022 (Cahier des Charges Type du Bâtiment), used for public contracts (and some private) in Wallonia. These leave the choice between new or reuse materials to the specifier, and have been adapted in their requirements to facilitate the reuse of materials.

batiments.wallonie.be/home/iframe-html.html

The Opalis website also makes available extracts of the specifications for certain materials.
opalis.eu/en/materials

B. How do you collaborate with subcontractors, architects and customers?

It is often shown that the key to success of innovative operations lies in good collaboration between all the actors involved. Construction with reuse materials, while common before industrialization of the production of construction materials, can now again be considered as innovative in relation to the current organization of the construction sector, mainly adjusted to using new materials. The definition of everyone's roles and responsibilities can sometimes change and so it will be necessary to ensure good communication with all the stakeholders.

Collaborating with the project authors and project owners

Some contract types like Design & Build or consortiums can facilitate reuse operations by getting the various construction actors round the table as early as possible, enabling upstream preparation and the search for solutions meeting everyone's concerns, whether technical, economic or administrative. However, it is also possible to ensure good collaboration as part of more conventional contracts.

As defined at the section's start, it is necessary, before offering a price, to make sure that the clauses defined by the project developers and the project owner are well suited to the particularities of the reuse materials, whether the definition of the nature and the scope of the work, the expected results, or the room for movement and possible alternatives. The responsibilities concerning justification of the technical performance should also be sufficiently defined²¹.

If the other stakeholders are open to discussion and if the type of contract allows it, the contractor can also forward their knowledge of the materials and practices in the field and make proposals, whether suggestions on the choice of reuse materials, more suited use techniques, or the production of a mock-up to ensure the expected result.

Collaborating with professional suppliers

It is useful to improve knowledge of the stocks and type of reuse materials present on the market by contacting professional retailers, when responding to a call for tender, and thereafter, or even beforehand, to ensure the availability of the materials long term. It is also possible to ask them to update on certain opportunities, related to reclamation of the materials wanted.

Suppliers can also provide a series of information important for good worksite preparation. They can state if the materials are ready to use and what services can be offered. They can also supply information on the nature and provenance of the materials, advice for implementation, and possibly say if they can provide guarantees for the materials.

Collaborating within the company or with subcontractors

It is important to make sure that actors in the field, whether company or subcontractor workers, know the specifics of the reuse materials to be installed. This can require making them aware of the importance of the circular economy and more particularly reuse, training on possible operations of preparation for reuse to be carried out, and specifics of storage, handling, or implementation, and the performance of tests or mock-ups to ensure that the expected result can be achieved and is well communicated to everyone.

In some cases it will be necessary to seek out specialists, or to get additional information about materials less well known in the company. For example, this can be marks different from those to which the workers are used/trained, old materials that require specific techniques, or old or unknown materials for which the accessories have to be replaced.

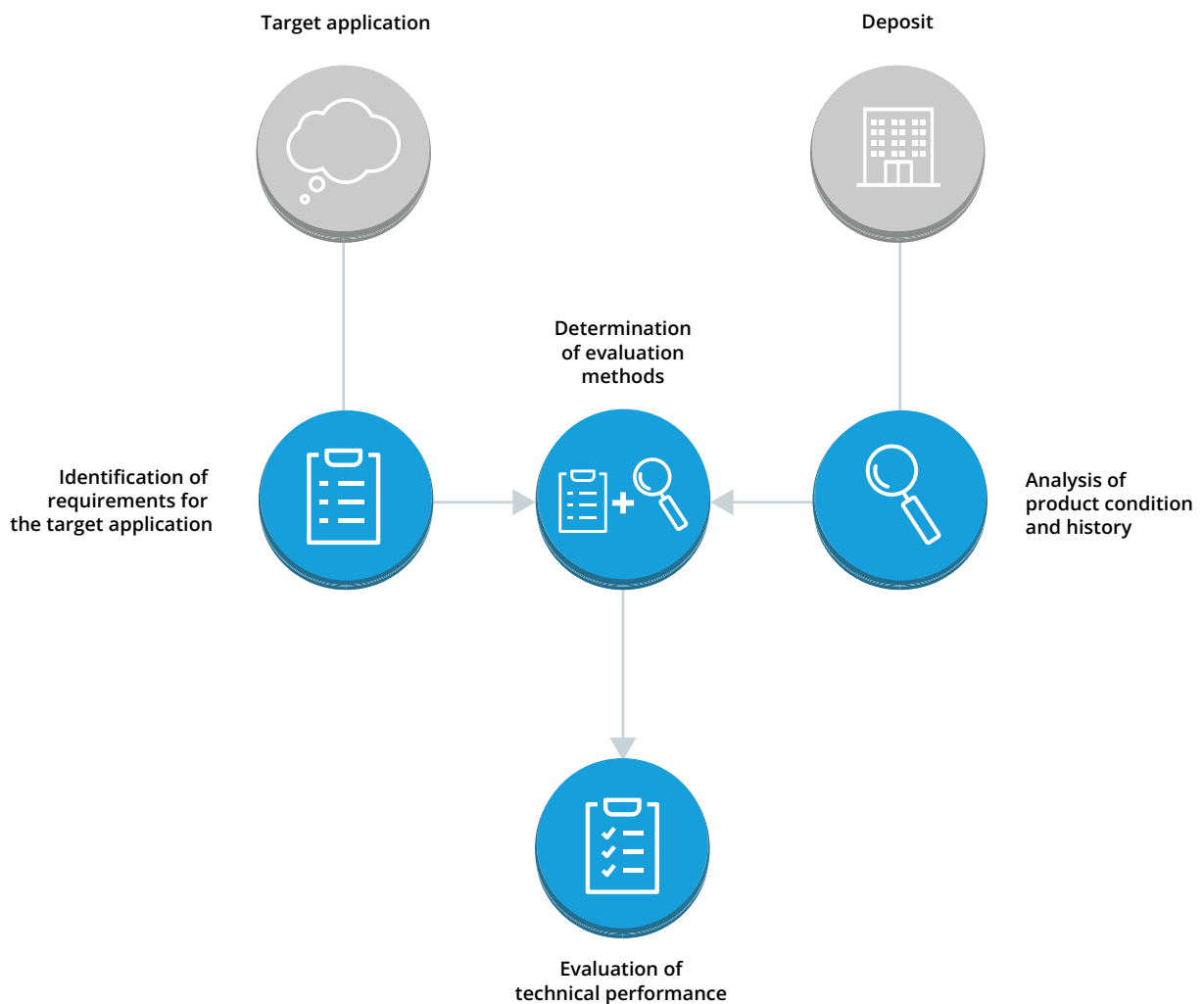
²¹ 6.d develops the question of responsibilities in justifying the technical performance of reuse -materials.

C. How is the technical performance of reuse materials justified?

One of the hindrances to the reuse of construction materials and components lies in the difficulty of justifying their technical performance. Unlike new products, reuse materials are not mass produced in a controlled environment and information about their properties is often lacking. However, they must have performance meeting the same regulatory requirements as new products to demonstrate their fitness for use. However, the way of measuring and declaring this performance should be able to differ. If construction actors have to put the same trust in reclamation products as new products, it is necessary to develop new methods for demonstrating their performance. It is also possible to increase trust in reuse actors through the development of certificates recognizing their knowhow.

Justifying technical performance based on a procedure related to the product

To counter the uncertainties related to the technical performance of the materials, a procedure for justifying it has been developed. Its aim is to propose different ways of evaluating and justifying the performance of reuse elements. It intends to be applicable to all cases (reuse in situ, supply from professional retailer or not, just-in-time reuse, etc.) and to all materials. There is a theoretical basis, for which certain evaluation methods have yet to be developed. The procedure is based on two concepts, the target application and the available material stock, and entails four steps.





FURTHER INFORMATION

The procedure summarised below is further developed in the following documents:

Under the FCRBE project, Buildwise and the CSTB issued a booklet describing a theoretical approach for justifying the technical performance of reuse materials: https://www.nweurope.eu/media/15541/bookletfcrbe-2_fitness_for_use.pdf

This procedure was also developed under the BBSM FEDER project (Bati Bruxellois Source de nouveaux Matériaux). It can be downloaded using the following link: www.bbsm.brussels/wp-content/uploads/2022/07/BBSM-WP6-Cadre-technique-des-materiaux-de-reemploi-VF.pdf and was summarised in this article: www.buildwise.be/fr/publications/articles-buildwise/2020-01.07

■ Identification of the requirements related to the target application

Like for new products, it is necessary to identify the future application of the reuse products, in order to define what requirements have to be satisfied. This application can be the same as or different from the initial application.

Two types of requirement related to the future application can be set:

- fundamental requirements, required legally and/or which are necessary so that the material is fit for the use it is intended for, given the health and safety of the persons concerned throughout the lifecycle of the structure. These are characteristics of mechanical strength and stability, reaction to fire, hygiene, health, environment and, as required, accessibility or acoustics.
- additional requirements, which are not fundamental and are specific to a project. They are determined according to the target application and/or the wishes of the project owner. For example, the dimensions or colour of a product or the wear resistance of a floor covering. According to the target usage, the project owner can be more tolerant about the requirement level of any additional performance.

■ Analysis of the condition and history of the products

As part of this procedure, a «deposit» is defined as a set of materials or elements found in a defined area and having characteristics and history in common. The concept of history is important in the reuse context

of a material or component, in so far as it can have influenced its original characteristics. This step aims to bring together a maximum of information about the original product in place, and can be carried out at the time of the reuse inventory (i.e. preferably before removal).

The information collected:

- concerns the product as it is, its implementation and maintenance, and its initial application;
- can be documentary (issues of drawings, data sheets, specification, etc.), historical (year of construction, methods used, etc.) or visual;
- concern the initial characteristics of the products (likely to have been modified), or current characteristics.

Special attention should be paid to the traceability of the information gathered, so that it remains associated with the corresponding products during removal and the later steps.

■ Determining the evaluation methods required

The list of requirements related to the target application is compared with the information collected about the products. The evaluation methods required are determined according to the level of detail required for performance evaluation (depending on the basic or additional nature of the requirements), the information available about the product, and the type of product. It is also possible to define in this step other strategies to increase the level of trust in the products, if it is not possible to evaluate their performance sufficiently accurately. Design strategies (over-dimensioning, etc.), limitation of applications (less demanding applications), or an adapted business model (plan maintenance and replacement of materials as required) can be envisaged.

■ Evaluation of technical performance

Three main types of evaluation methods enabling verification of the technical performance of reuse materials have been defined: direct evaluation, indirect evaluation and evaluation through testing. Two innovative methods are also proposed to reinforce user trust in reuse materials: control of the chain, and evaluation during the new application. These different evaluation methods can offer different levels of trust, and can sometimes be combined. They can be performed at different times, when the product is still in place, during removal, preparation for reuse or storage, and when the product is reinstalled.

■ Direct evaluation

If the performance wanted can be checked visually or via non-destructive technical means, it can be directly validated, when the product is still in place, or when it is removed. This is the actual performance of the material.

■ Indirect evaluation

Some performance can be evaluated from information related to the initial or historical performance of the



product which was collected during the documentary inventory. It can either be justified, or be gathered from the sheets or other technical documents, always considering the historic data collected.

- **Evaluation through testing**

As for new products, tests sometimes have to be performed on reuse materials. However, the following two points should be noted. Firstly, standards for new products often describe test methods aimed at evaluating their technical performance. However, the proposed methods are not always suited to reuse products and have to be adapted. Then, the application of a different statistical approach is sometimes required, since the test protocols are based on standardized production and not on a deposit.

- **Control of the chain**

In addition to product evaluation, control of the chain for reclamation, preparation and reuse can also be considered. The accent is then no longer placed on precise performance evaluation of the products, but on the procedures and skills that enable their reliability throughout the operations of preparation for reuse to be increased. In this way, elements whose performance is likely not to reach the level of requirement demanded can be eliminated during the control process by a practitioner who has the knowledge and experience needed to eliminate defective elements.

- **Evaluation during the new application**

With the project owner's agreement, some requirements can be evaluated once the product is implemented. For example, the homogeneity of the colour of reused carpet slabs can be evaluated after they have been laid on their new site. However, this method is riskier, because the product may not suit the project owner so that the process has to restart.

This procedure, still in the theoretical stage, however, provides a framework for thinking for developing methods of performance justification suited to reuse materials.

Relying on certificates to increase trust among reuse actors

Another approach consists not in evaluating the product itself, but in recognizing the skills of the actors responsible for the operations of removal, treatment and storage of the reuse materials.

In Belgium, the control office SECO has developed the "Safety In Circularity" certificate, which aims to increase trust in the ability of reclamation actors to offer reliable reuse materials. This certificate aims to "supply proof that the company which the project owner, architects and contractors are collaborating with controls the internal processes related to reclamation and re-marketing of construction materials. This certificate also recognizes the company's ability to declare information reliable for the materials concerned.²²" The certificate is broken down by typologies of materials, currently taps, sanitary fittings, technical sub-floors and guard rails.

In this section, we describe certain points of attention and recurring subjects. This document does not describe all the requirements and methods of evaluation, which are detailed further in the documents referenced in the box at the section end.

²² www.safetyincircularity.be

Roof tiles

When making or restoring pitched roofs, the following important principle in the case of using reclamation materials should be complied with:

Precipitation density is essentially realized by the roof covering. Only in exceptional circumstances (storms, drifting snow, etc.) is the combination of roof covering & shelter counted on.

This constraint raises some specific problems whose resolution is not always free of ambiguity in practice, if the share to be assigned to reuse is greater. Currently, the evaluation methods for these materials are not covered in any general technical framework. The first sketch of a possible approach for roof tiles is given below.

However, reuse materials have the following advantage: their fitting on an existing roof provides an indication of their fitness for the usage. If the tiles of an insulated roof show no trace of frost damage, in principle they will not show any more on a comparable insulated roof. Therefore, evaluation of the actual condition of the roof

tiles at the time of their dismantling constitutes a first demonstration of their technical performance. Additional tests may be necessary. The following table gives a view of the main criteria of performance as well as a proposal of evaluation in two steps of this performance, for ceramic tiles. As a first approach, this procedure has not yet been validated by the industry.

Separate standards govern other types of roofing products, but the same principles apply.

For reusing roof tiles (mainly ceramic), their frost resistance is a tricky question. In the past, these tiles benefitted from considerable ventilation, so that they were only exposed to relatively weak variations of temperature. For the reuse of these tiles on a current roof, it should be noted that the latter benefits from greater insulation and tightness. Thus, the frost resistance of reclamation tiles may be insufficient. This potentially reduced performance risks imposing an additional charge on the other components of the roof structure (the sub-roof), to the point of requiring additional measures.

Reclamation tiles are liable to satisfy the standardised

Table 1: identification of performance made reliable or to be made reliable for ceramic tiles (tweetrapsbenadering)

INITIATOR	EVALUATION DIRECT, INDIRECT, CONTROL OF THE CHAIN	EVALUATION BY TESTING
Mechanical strength (flexural)	In situ test for safety verification (put a weight of 100 kg on a tile between two battens on a flat surface*)	Lab test (test as per NBN EN 538) (Test 1 tile every 5 m ² removed, with minimum of 10)
Appearance and structure	Visually check on all roof tiles for the presence of cracks, craters on top, blisters, chips, cracks, fractures and loss of pin (see list of possible defects, NIT 240-1, Annexe 1).	
Frost resistance	For using roof tiles in identical or less severe climate conditions, natural ageing gives a good idea about performance maintenance. If these conditions are changed (e.g. insulation) or if the new use is different from the former, then it is necessary to perform verification tests of performance according to the relevant standards. Example : old roof tiles removed and reused on the same site with the use.	Lab verification test of performance according to relevant standards.
Impermeability	Recognition in-situ (before removal) of the presence of infiltration. Make a very careful examination of the area with possible infiltration.	In-situ test with Karsten pipette (Test 1 tile every 5 m ² removed, with minimum of 10) If in doubt, lab test (test as per NBN EN 539-1) (Test 1 tile every 5 m ² removed, with minimum of 10)

(*) apply force of 100 daN (see NBN EN 1304) to tile centre, at equal distance from battens at tile ends. The support surface must be a single point (approx. 25 cm², equivalent to a heel for example)

tests that new roofing products are subject to; but, in general (with a few exceptions), they are not as effective as new roof tiles available on the current market.

For the above reasons, ordinarily additional measures should be taken for safety reasons to ensure the roof's tightness, paying special attention to the sub-roof (see 6.e).

This observation deviates from the general principle mentioned at the start of this paragraph. To understand the scope, it is not useful to compare the use of reclamation materials with two other cases where roof tiles are found in a comparable situation and where the requirements are less strict in practice:

1. Post-insulation of existing roofs

Note: a similar situation arises in the case of post-insulation of an existing roof underneath (frequent situation). In this context, roof tiles are only rarely, or never, questioned or replaced. Often roof tiles stay in place. In most cases, the sub-roof undergoes no modification. While in theory, this lack of work means increased exposure of the tiles to frost-thaw cycles and thus to a higher risk of deterioration due to frost, damage of this nature found in practice is relatively rare. This lack of evidence may be due to the fact that this is a progressive process whose visible symptoms only appear after several years, for example when debris is found in the gutters.

2. Restoring historic roofs

For restoration work, it is important to preserve the authentic character of the building. The existing roofing elements are often conserved for this and/or reclamation materials used for this purpose. Moreover, the underlying interior spaces can be especially precious (think of a cathedral roof or another monument). In 2023, restoration work is often combined with the fitting of post-insulation. Yet, the parties concerned generally choose, as far as possible, to use authentic materials. A recent document published in the Netherlands²³ provides more detailed information about this:

«At first, we only replace cracked or broken tiles that are causing leaks. Tiles with superficial shrinkage cracks or whose glazing is flaked are not replaced. With careful reuse, we reckon some 25 years life for roof tiles before their next major maintenance. Refusal criteria are defined on this basis. It is often possible to reglue and refit special cracked accessories.

The following criteria should be applied when sorting and refitting: - All removed tiles should undergo a sound test, before storing or refitting them. Roof tiles in good

condition have a ringing sound. Cross cracks are found when the sound is muffled. The noses should be pretty much intact to enable fixing to the battens, with no risk of tiles falling or slates slipping. Some roof tiles of a very special type allow this rule to be waived. An equivalent solution should be found for the fixing. The bottom side of roof tiles must not be flaky or eroded. The following requirements apply to all suitable procedures:

- Preparation: It is useful to ensure that the number of reusable tiles whose shape, size and colour are adequate is sufficient. For stamped tiles, make sure that their top and side profiles are good to ensure tight interlocking.
- Broken and cracked tiles should be discarded as well as tiles with broken noses and then interleave the reusable tiles.
- When repairing a roof caused by a shortage of tiles of the same type, size, colour, top and side profile: Tackle first the visible surfaces of the original roof tiles, and then the other surfaces should be covered using tiles of an approximately similar type».

3. Gentle pitched roofs

While this roofing method is generally not advised, tiles are sometimes placed on roofs whose slope is less than the minimum angle required by the manufacturer. In such cases, special measures should be taken at sub-roof level to prevent infiltration (see NIT 240, 3.1).

To control as a roofer the risks inherent to using reclaimed materials, their area of application can be taken into account:

- Fitting reclamation tiles is possible in areas where weatherproofing has less critical importance, e.g. the roof of a car port.
- The choice of a suitable fitting method for reclamation tiles helps reduce the risks of infiltration through the building's envelope: these tiles are liable to be fitted on a roof whose slope is greater or to be used as wall covering (see NIT 240, 3.2)

²³ <https://www.stichtingerm.nl/kennis-richtlijnen/url4014>

Insulation

When it is reused for thermal insulation, the main concern with reuse insulation generally entails justification of its thermal properties. If the future application corresponds to cases²⁴ where local regulations apply, the levels of thermal conductivity and thickness of the insulation must be declared to verify that the coefficient of thermal transmission U of the different construction elements does not exceed the maximum value set by the regulations²⁵.

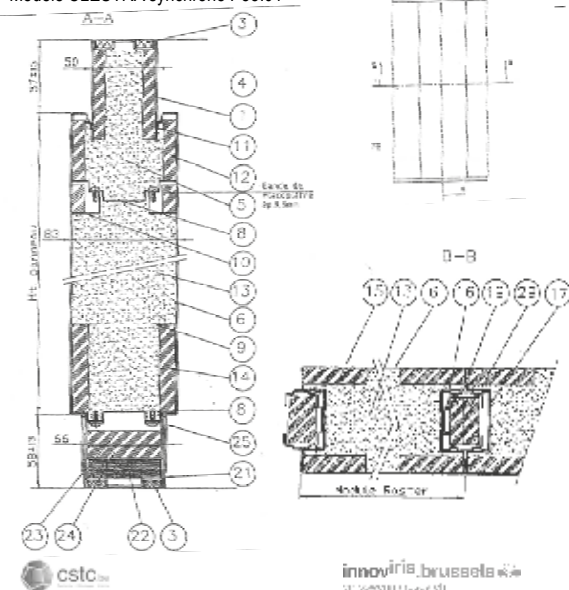
Different evaluation methods can be used. However, most of these methods are not yet recognized by the sector and it is necessary to check the approval by the stakeholders involved.

■ Indirect evaluation:

- If an original technical document gives the thermal conductivity (and if possible certain dimensional stability), the value of thermal conductivity given initially can then be justified again, provided having carefully checked the condition of the product (constant dimensions, intact product (no holes, no variation of thickness, etc.), and its implementation (deposit)).

Parois RF

Modèle CLESTRA synchrone P83.01



Example of technical information that can be collected (RF walls, Model CLESTRA synchronous P83.01 containing rockwool 40 kg/m³)

- Thermal performance decreases more or less rapidly according to the types of insulation. This is linked to the presence of inflating gas (more insulating than air), which can diffuse during use, and the structure of the panels as well as the presence of coating which can further prevent diffusion of this gas. The initial declarations of technical performance however take account of this ageing. Nevertheless, in the reuse case, a correction factor can be applied to the declared values or a maximum use time for the first life of the elements can be imposed.

- It is also possible to determine the thermal resistance of manufactured insulation by **testing**. While costlier than indirect evaluation methods, this method can have the advantage of providing more reliable results, if the statistical approach of the standards produced is correctly adapted to reuse.

- **Control of the chain:** For thermal conductivity, the good condition of the different elements must be checked. The absence of tears and large piercings must be checked. It can also be useful to check the dimensional stability of the elements; this has an influence on the thermal properties. Sorting of all the elements based on density differences can also be carried out; this is a good indicator of the ageing and loss of homogeneity of the thermal properties.

Structural wood

The reuse of wooden elements for structural use requires precise knowledge of the following performance related to the wood species: moisture, dimensional stability, natural durability, use class, mechanical strength, reaction to fire and emission of dangerous substances.

- The dimensional stability of wooden elements influences their swelling and shrinkage due to variations of moisture content. It is determined by factors inherent to the product, the method of manufacture and to the fitting techniques, and by factors depending on usage after fitting (e.g. internal climate). The dimensions can be measured by visual or detailed examination.
- The level of moisture recommended depends on its function and location in the construction. Different standards govern the recommended moisture levels. You should refer to these standards and measure the moisture level using a moisture meter.
- Natural durability evaluates the resistance of the wood to attacks by fungus and is determined by its species. This helps determine the use class of the wood elements. Natural durability can be increased by using suitable preservation treatments, but for reuse

²⁴ These requirements concern the (re)construction or renovation and extension of residential units, office and services and teaching units, industrial units and other destinations.

²⁵ In Belgium, this is regional regulations on the energy performance of buildings (PEB).

wood, it can be difficult to determine the exact nature of the substances present.

- The use class of the wood defines appropriate uses according to the related biological risks. Various European standards define the use classes of wood and recommend the application of protective treatments if necessary.
- The mechanical strength of wood is determined by its mechanical properties such as flexural strength, compressive strength, tensile strength, shear strength and elastic modulus. It is influenced by the wood species, its density and moisture level. Different classification methods, visual or «machine», can be used to establish the mechanical classes of wood pieces. Visual classification seems suitable enough for reuse materials.
- The requirements in terms of reaction to fire depend on national regulations and relate to buildings and applications. European standards define the classes of reaction to fire for solid wood according to its average density and thickness.
- When calculating the fire resistance of wood structures, geometric characteristics and the properties of the material are considered.
- Some wooden elements may have been treated with toxic products or have been in contact with dangerous substances. Visual detection of the treatments and finishes may be possible, but determining the exact nature of the substances present is often more complicated. Lab tests can be performed to evaluate the danger of any contaminants. If information is lacking, the principle of precaution should be followed for interior applications or applications in direct contact with people.

Many other requirements and evaluation methods can apply to these materials and are not listed in this document.

FURTHER INFORMATION

The procedure developed for the BBSM Feder project was applied to 5 products linked to an application, including:

Mineral wool insulation: www.bbsm.brussels/wp-content/uploads/2022/07/BBSM-WP6-Fiche-produit-application-Isolant-laine-minerale-de-reemploi-VF.pdf

Eight guides, including two on industrial wood frameworks and clay roof tiles, have been published by the CSTB, describing the different steps of a reuse diagnosis, including identification of the performances to be evaluated according to the use field and the associated methods of proof.

Clay roof tiles: www.cstb.fr/assets/documents/cstb-guide-reemploi-des-tuiles-de-terre-cuite.pdf

Industrialised wooden framework: www.cstb.fr/assets/documents/cstb-guide-reemploi-des-charpentes-industrialisees.pdf

The 36 material sheets developed under the FCRBE project list the technical characteristics established in the European standards corresponding to these materials. They are available using the following link: https://opalis.eu/sites/default/files/2022-02/FCRBE-All_sheets_merged-EN.pdf

For the reuse of ceramic tiles in particular, the following recent publications may be useful:

www.cstb.fr/assets/documents/cstb-guide-reemploi-des-tuiles-de-terre-cuite.pdf
(CSTB, France, 2020)

<https://www.stichtingerm.nl/kennis-richtlijnen/url4014>
(ERM, Netherlands, 2021)

Specifically for natural slates, we can refer to NBN EN 12326 which provides the technical specifications for new natural slates. It can inspire an adapted procedure for reused natural slates. Also the former Dutch procedure for acceptance of a batch of natural slates for application on historical monuments can inspire a future procedure for reused slates. See Brochure Technique No. 13 «Inspecting Natural Stone Slates» from the National Service for Archaeology, Cultural Landscape and Monuments of the Netherlands (2009).

D. Who takes responsibility for technical performance?

When a **new** product is integrated into a construction project, several stakeholders, such as the project owner, architect, contractor and the manufacturer or supplier of the product perform well-defined actions to comply with the national standards and regulations in force. Their responsibilities concerning justification of the technical performance are well defined. In particular, the manufacturer or supplier must provide accurate information in the data sheets, to guarantee conformity with the planned use and to signal any hidden defects.

For the **reuse** of construction materials, the situation is changing. Professional suppliers of reuse materials will not always be involved, and in this case, they rarely communicate and guarantee the technical performance of these materials. They may guarantee visual consistency and certain aesthetic characteristics. Other actors then will be responsible for the performance justification of reuse materials.

Who is responsible for the technical justification of reuse materials?

As described in 6.c, a whole series of actions, undertaken by various stakeholders, including contractors, are liable to have an influence on the process and results of the justification of technical performance, especially:

- Carrying out pre-demolition and reuse inventories
 - Collecting relevant visual, documentary, historical data
- Removal
 - Technical specifications describing the expected results and any removal methods
 - The removal itself, in a selective manner and according to appropriate methods (to conserve the properties of the material)
- Sorting, selecting materials
 - Technical specifications describing the expected results and any processes
 - Sorting and selecting the materials themselves
- Cleaning, preparing for reuse, conditioning, storage, transport
 - Any technical specifications describing the methods, conditions or expected results
 - Carrying out these operations themselves, performed appropriately (to conserve the properties of the material)

- Monitoring the evaluation procedures of technical performance
 - The proposal or specifications for the evaluation procedures of technical performance
 - Giving advice on the proposed procedures
 - Evaluation of performance itself (different possible methods, see 6.c)
- Implementation of the materials
 - Technical specifications describing the technical requirements, and implementation methods
 - Any design strategies and risk management
 - Selection of the materials meeting the technical requirements
 - Installation itself
- Traceability and transfer of the information collected during the different steps mentioned above

These tasks, depending on the project, may sometimes be carried out by different actors. In some cases, other specialists may be involved, such as reuse auditors or reuse experts, who may also have a role in performance justification. The scheme below illustrates at which point the related tasks and responsibilities can be distributed variably according to projects. It will then be important that the roles are well defined for each actor so that the responsibilities are clearly identified.

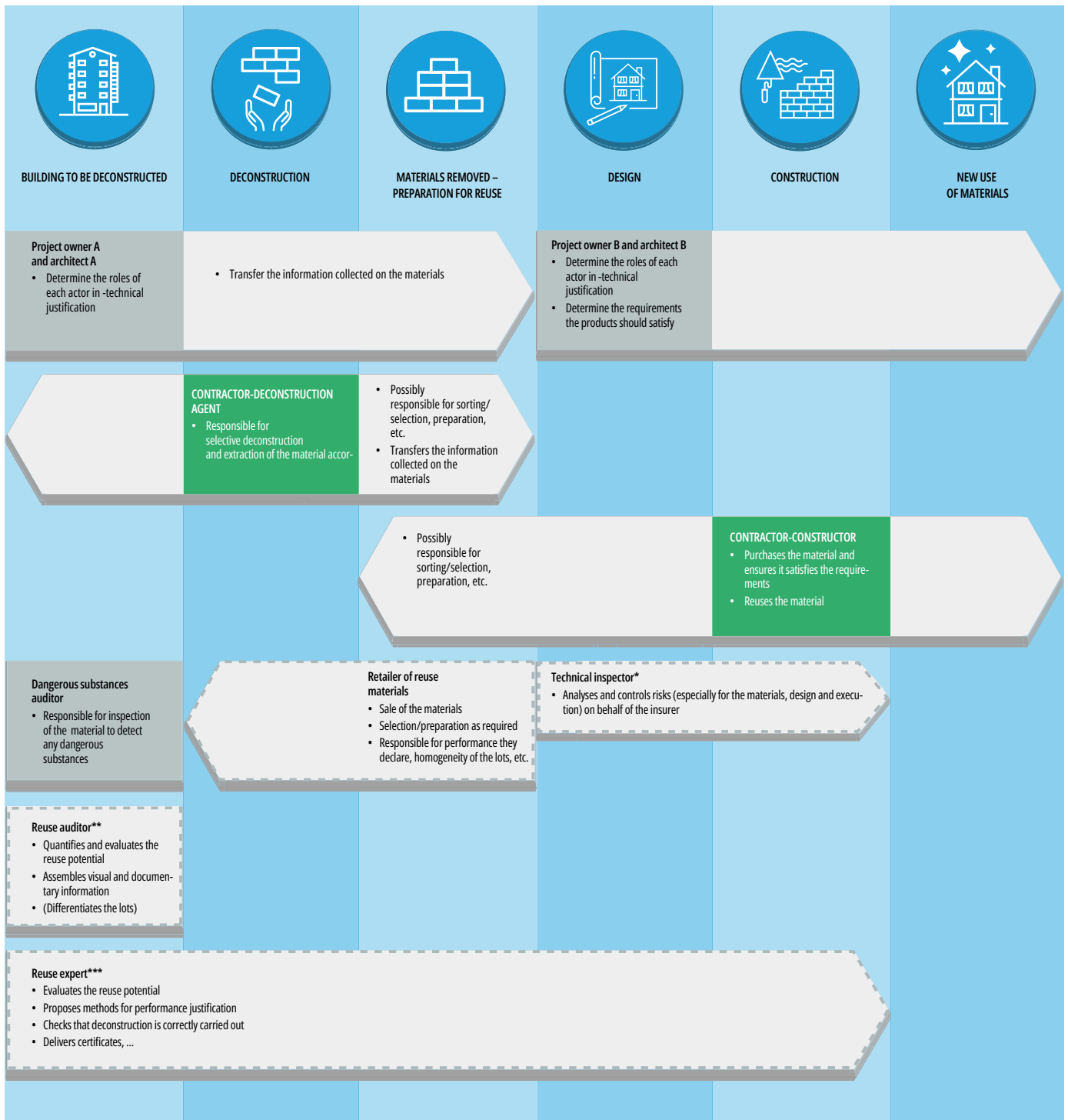
(See chart on next page.)

Managing risks and insuring the reused materials

Insurability is sometimes considered one of the main brakes to the reuse of construction materials, as this practice is still little developed and the quality framework is not yet adapted. Several types of insurance can be concerned when the insurance of reuse materials or related work is required. For example, this can be insurance for professional liability, decennial liability, control, worksite all-risks, or fire (Heirbaut & Van Dyck, 2023). Contractors are expected to be insured for their decennial liability. Several actions can be set up to remove the obstacle of insurability and have reuse practices insured as required.

■ Understanding the methods of one's insurance and talking to one's insurer

Each insurance policy includes conditions or exclusions. It is important for contractors to be informed about the methods of their insurance, because certain stakeholders may not be insured or not know their cover. (FCRBE, 2022). Talking to insurers and brokers is essential, and, while the premiums sometimes have to be adjusted for the practices considered as risky, it is often possible to negotiate the insurance conditions. Indeed, if the insurer is not informed and damage appears, this can result in partial or total loss of cover and rejection of the liabilities for the insured.



Roles and responsibility during the process of technical justification of the reuse materials

LEGEND:

On light grey ground: Stakeholders not necessarily involved in the process

On dark grey and green ground: Stakeholders generally involved in the process

* According to country, the missions of technical inspectors can vary:

In France, some building types must be submitted to technical inspection to ensure their quality and strength. By taking part in the analysis and control of the risks, they facilitate insurability for complex cases (especially reuse).

In Belgium, insurers can require an independent inspection performed by a control office. Other mission types can also be entrusted (especially by POs) to control offices (such as missions of certification, technical inspection and advice), some of which are given under this diagram in the "Reuse expert" boxes.

** In France, since 1 January 2023, significant building demolition and renovation operations are subject to the requirement for a diagnosis (inventory) called PEMD (products-equipment-materials -waste), enabling the PO to know the potential for reuse, recycling or other valorisation of the building. The diagnosis agent can be led to specify or at least propose specification possibilities for the reuse materials, which requires decennial insurance.

***Reuse expertise is still a function being developed. This function can go to design offices, architects, or control offices (in some countries) being specialised in the technical justification of reuse materials, or other actors emerging on the market and proposing suitable services.

■ Identifying the risks

The project team should identify the risks related to the reuse practice, which can be done by referring to a general quality framework (if available), and by involving other professionals in construction, such as project owners, architects, design offices, inspection offices²⁶, contractors, research organizations, knowledge centres, etc (Heirbaut & Van Dyck, 2023).

■ Managing risks

According to the identification of the risks incurred by the construction team, the project team can then decide if it is necessary or not (if not things for which insurance is mandatory) to take an insurance for the reuse practice in question, according to the risk management strategies set up (FCRBE, 2022), (Heirbaut & Van Dyck, 2023). There are several approaches according to the perceived risks:

- Coverage of the risks by the project owner, who finds them acceptable. An insurance is not taken (if not mandatory).
- Delegation of the risks to the contractor, to a subcontractor of the contractor, or to a supplier, who accepts bearing the risk, by means of additional guarantees (e.g. materials will be replaced if defective). An insurance policy is not taken out (if not mandatory).
- Resolution of the risks by adapted design (for example by adapted design or by evaluating performance). An expert or another stakeholder may be asked to take on part of the liability.
- Negotiation with the insurer to modify the terms of the insurance (negotiation of the premiums). A control office will monitor the elements.
- The choice of an alternative which does not have an insurability problem.



FURTHER INFORMATION

As part of the Interreg FCRBE project, a booklet has been produced on evaluating the technical performance of materials. It covers the subject of responsibilities for the technical justification of materials: https://www.nweurope.eu/media/15541/bookletfcrbe-2_fitness_for_use.pdf

The subject of insurance has been further developed as part of the FCRBE project. The results of this study are available on the website of the Interreg FCRBE project : <https://www.nweurope.eu/projects/project-search/fcrbe-facilitating-the-circulation-of-reclaimed-building-elements-in-northwestern-europe>

Seco Belgium nv/as and the advice bureau Common Ground have published a research report on the insurance of circular constructions, with the support of Vlaanderen Circulair:

<https://www.common-ground.eu/wp-content/uploads/2023/02/20230216-VlaanderenCirculair-eindrapport-WEB.pdf> (only in Dutch).

■ Controlling the risks

The insurer's main concern is to identify whether the risks are controlled by the project actors and what are the financial issues. This will enable validation of whether the reuse practices can or cannot be insured, and under what conditions. They will be receptive to different ways of ensuring the quality of the reuse practice (Heirbaut & Van Dyck, 2023):

- Satisfying a general quality framework (if available), such as standards, technical approval, quality labels, technical specifications, quality certificates.
- Satisfying an external quality framework, such as evaluation by an expert, a certification organization or a control office²⁷, evaluation through test reports performed in accredited labs, etc.
- Satisfying an internal quality framework, by proving internal knowledge and skills, or by demonstrating that processes are set up to reduce the risks.

^{26,27} As indicated in 6.c, the definition of the role that control offices can take may vary according to countries.

What are the specific technical risks, inherent to fitting reclamation tiles?

Because of their various origins and their archaic method of manufacture without control, old roof tiles have less dimensional stability liable to affect the weatherproofing of the roof. These tiles often come from roofs without thermal insulation. When fitting to a roof with thermal insulation, the basic function of the tiles (weatherproof roof covering) risks being affected. Damage caused by frost to reclaimed tiles can consist in the appearance of internal splits and cracks that are not immediately visible to the naked eye. When reusing on an insulated roof, the probability of visible deterioration arising due to frost is high. In the event of porosity or imperfect interlocking of tiles, instantaneous infiltration can occur. Such infiltration can also occur over time, because of deterioration due to frost (cracks and/or flaking) and caused by greater exposure to frost-thaw cycles on insulated roofs. For the above reasons, the risk of infiltration is in principle higher than when fitting new roof tiles. Note: in principle, it is possible that new roof tiles do not meet the requirements, but the development, in recent decades, of a quality framework combined with standards, CE marks and technical approvals have led to a considerable reduction of this risk and to a cleared definition of the responsibilities. Therefore, to fulfil their first function (weatherproofing), roofs covered with reclamation tiles have to rely more on their sub-roof than those roofed with new tiles.

E. How do you build with reuse materials in practice?

After their preparation and reconditioning (see 4), most reuse materials can be implemented in ways generally similar to new materials, thus requiring the same skills from contractors. However, it should be noted that in some specific cases, their installation can require special knowhow and require certain specific precautions. In general, you should refer to European and national standards for the products and to best practices in force (or installation standards).

Firstly, it is crucial to check that the elements intended for reuse have been **correctly prepared**, that they are in **good condition** and that a **margin of additional materials** has been planned. It will be necessary to plan for sufficient surplus of reuse materials, even more so if the supplier

is not able to guarantee absolute homogeneity or good condition of the lots. This surplus must also be planned for any cutting out (as for new materials), and to ensure later replacement or repair of some parts.

Some old materials can require **techniques or knowhow** that are not always current among artisans of the construction sector. In these cases, it can be necessary to involve specialists or to train personnel in the field. Additionally, **compatibility** between the reuse materials and the other construction elements can also raise issues. In some situations, it can be necessary to adapt the other materials for good overall compatibility.

The use of unusual materials, specific brands or for which information is missing can also require **awareness, training or the development of new skills**. For example, some professionals can be used to working with specific brands and then have to be trained to install the products of other brands. It is also possible that installation manuals are missing, which can require **preliminary research**.

It can be necessary **to adapt the methods of use** to take account of the particularities related to reusing materials, especially because of some uncertainty about their characteristics, such as less precise dimensions or greater tolerances than those for new materials.

Finally, as far as possible, it is recommended **to plan for the removability** of elements during construction, which will facilitate their later reuse.

- The method of fitting **reclamation tiles** and the principle of covering a roof do not differ fundamentally from those governing the fitting of new tiles.

- The general requirements that the construction of pitched roofs have to meet apply. You can refer to the relevant publications from Buildwise to understand best practice relative to fitting roof tiles. For example, NIT 240 applies to roofs covered with ceramic tiles²⁸. For any specific project, the applicable documents should be mentioned in the special specifications. This guide only refers to a number of specific points concerning reuse.

- When fitting, the least dimensional stability of some roof tiles should be considered. Therefore, their fitting will take a bit longer and the use of some of them may be compromised.

²⁸ In Belgium. Technical information note 240 = guide to design and satisfactory production of tiled pitched roofs.

- The second major difference compared with the use of new tiles lies in the fact that the sub-roof is expected to play a greater role, in the need to anticipate the increased risks of infiltration mentioned above.



Example of the application of reclaimed roof tiles (Flemish tiles) on a 1741 building rebuilt at the KampC in Westerlo; note the reduced rainfall density of the roof due to the lower dimensional stability of the tiles; the role of the under-roof becomes very important

Photo Filip Dobbels



Example of the application of recycled tiles, illustrating lower dimensional stability, with an impact on aesthetics (straight lines sometimes more difficult to achieve)

Photo Filip Dobbels



- According to the predicted performance, some recommend an adapted sub-roof (more effective). The parties concerned may rely on the rules applicable to tiled roofs with gentle slopes (whose slope is less than the minimum angle for which the manufacturer guarantees tightness to precipitation²⁹). See NIT 240 page 35 et seq. of Buildwise. In some cases, the sub-roof acts as a sealing layer, as in the case of fitting under a flat roof. It should be noticed that such a sub-roof can also affect the roof's hygrothermal structure and the choice of thermal insulation and vapour barrier (see NIT 240 & NIT 251 of Buildwise). With the roofing products that are on the market in 2023 it is possible to deviate relatively little from the known structure of pitched roofs, because there are roofing membranes that are sufficiently waterproof and UV-resistant and at the same time vapor-permeable. If vapor-impermeable products are used, the hygrothermal structure must be adapted and an appropriate execution technique is usually required (e.g. continuous rigid support, to enable correct execution of the seams by means of hot air or solvent welding).

- In general, the covering of a roof should be able, in all circumstances, of providing tightness to precipitation (the function it fulfils cannot be purely «decorative»), but to offer the customer the same level of security as with new roofing materials, the roofer may think it worth planning to fit a more effective sub-roof.

- As regards the UV stability of the sub-roof (according to NBN EN 4892-2), its fitting under reclamation tiles is equivalent to that practiced under a wall covering with open joints. In other words, when using reclamation tiles, you should allow for the fact that these tiles interlock less well than new tiles and it is probable that the sub-roof is more exposed to water (occasional infiltration between tiles) and to UV. When using reclamation tiles, the manufacturer of the sub-roof usually starts from the principle that weatherproofing cannot be ensured by these tiles and fits as condition the application, under the battens, of a butyl nail sealing tape, specially designed for this application, to make the fixing waterproof.

Example of the application of recycled tiles, illustrating lower dimensional stability, with an impact on aesthetics (straight lines sometimes more difficult to achieve).

Photo Filip Dobbels

²⁹ A sloped roof is never waterproof in the sense that it can withstand water pressure. This is in contrast to a flat roof, whose sealing membrane is waterproof. The whole roof covering & under-roof of a pitched roof ensures that rain and snow cannot penetrate into the space below. This is why we usually refer to the «precipitation density» of a pitched roof. Manufacturers of roof tiles test to what extent their tiles protect the underlying space from rain (as a function of roof pitch). In that case, we can talk about «rain density» because snow is not taken into account in that test, only rain.

- Apart from the selection of the products making up the sub-roof, certain other details are important. All the roof details must be carefully designed and executed, with special attention paid to preventing infiltration by the sub-roof:
- ■ correct jointing between the sub-roof and the gutter; make sure there is no stagnation of water at this place and infiltration through the joints placed between the membranes or the sub-roof panels;
- ■ correct jointing with the dormers;
- ■ correct sealing of perforations, e.g. by smoke or ventilation ducts.
- Excellent roof structure, using essential accessories like anchoring devices or creating solidly mounted sub-roofs adapted to the planned application are all factors likely to ensure, even prolong, with little difficulty, the lifetime of a roof. The lifetime of a roof considered overall is determined by the lifetime of the sub-roof. As regards the sub-roof membranes, their lifetime guarantee in 2023 is generally around 25 years. In this case, the rainproofing of the whole roof will only be guaranteed for 25 years (and not for a time equal to or more than a century). A quality sub-roof has major importance when using reclamation tiles and it determines the lifetime of the whole.
- **In brief:** it is technically possible to create, using reclamation tiles, a pitched roof whose performance and lifetime are comparable to those of a roof covered with new tiles, but the increased complexity of the operations risks affecting the cost price.
- **Reuse insulation** can be reinstalled in the same way as new insulation. If doubts remain about its thermal performance, the total thickness of the insulation can be increased by juxtaposing different layers.



Reuse of mineral wool insulation from interior partitions of an office building in Brussels (ONSS)

© Buildwise



7.

How are the costs of reclamation and construction with reuse materials estimated?

It is often heard said that deconstructing rather than demolishing, or constructing with reuse materials rather than with new materials costs more. However this is not always the case. Clearly this depends on the types of materials, and on many other factors.

You should, to offer a correct price for a call for tenders, or to propose a reuse alternative to a project owner, carry out a cost/benefit analysis of the reuse.

For this you should clarify what steps have to be carried out by the company. For example, will it be necessary to prepare the materials for reuse or will this be done by the supplier? It is also important to compare comparable things,

especially for construction with reuse materials, allowing for example the quality of the materials and the patrimonial value. Thus, it is not relevant to compare the costs of solid oak reuse parquet with those of new glue-down parquet.

In the case of purchasing materials from a supplier, or for reselling materials after deconstruction, it is generally the **cost of the supply** (or the **profit related to the sale**) that will be the main factor to tip the balance. The price of reuse materials on the professional market can differ somewhat from the price of new materials. Reuse materials are not a watertight category. There are several cases:

POINT OF COMPARISON: CURRENT NEW MATERIAL	EXAMPLES	CONSEQUENCE FOR REUSE
No current equivalent	Old materials, rare or depleted materials, materials with high cultural value...	The prices of reuse elements on the market tend to be high.
New equivalent rather expensive	Technical equipment, high-performance materials, top end materials...	The price of reuse elements on the market is often comparatively less expensive (but additional steps may be necessary before implementation).
Cheap new equivalent	Low level materials, mass produced industrial materials...	The reuse elements are generally more expensive and not competitive (except special cases).

The cost of the supply or the profit realized on sale however is not the only factor to consider when carrying out the cost-

benefit analysis of a reuse operation. The following pages include a non-exhaustive list of criteria to be considered.

The general costs and benefits from removal to reuse

COSTS

Labour (specialized)

In some cases, removal, preparation or installation of reuse materials (specific or old, for example) can require specialized skills or knowledge from contractors. This can entail extra costs related to training or the subcontracting of qualified personnel. Some project owners themselves require these costs to be estimated, by asking for separate prices for the supply and fitting, in order to identify any substitutions during the work (e.g. a lot of new materials replaced by reuse). This enables greater transparency between companies and their customers.

Adaptation of processes and practices

Whether careful removal, preparation for reuse or construction with reuse materials, these operations can require adjustments in the processes and practices of construction and demolition companies. This can include changes in the planning, coordination, logistics and even the practices of deconstruction and implementation. The adaptation of these processes can entail extra costs, such as consultation expenses to optimize the processes or adjustments of existing work methods. Research and tests about methods of removal, preparation or implementation adapted to the materials can also be necessary.

Additional logistics

The costs related to logistics sometimes have to be paid by the contractor company, if it is responsible for storage and transport. These costs vary according to the types of elements (dimensions, fragility, etc.). If the materials do not immediately find a buyer after their removal, or if they are acquired before construction, (e.g. if an opportunity occurs) it can be necessary for the contractor to store them. This can lead to extra costs related to the transport and hiring or storage places.

Justification of the technical quality of materials

Before implementing reuse materials, it is sometimes necessary to justify their technical performance, to match the requirements of the specifications and to ensure the reliability and durability of the materials. Some evaluation requires few means, while others can be more costly, like the performance of lab tests. It can also be necessary to engage a reuse expert, a design or control office to specify the procedures to follow. Justification is generally required at the time of construction, but some steps and information can (and should ideally) be required when removing and preparing for reuse.

Traceability requirements

Some proofs of origin of the materials, and the steps they employ can be required from the contractor, for different steps (reclamation of materials or supply of reuse materials). Administrative work then has to be carried out to gather these proofs.

BENEFITS

Development of skills

Working with reuse materials can require specific skills for the reclamation, preparation, evaluation and installation of these materials. By encouraging workers to acquire these skills, the company can gain several advantages:

- opening to commercial opportunities in the future.
- acquiring a competitive advantage in calls for tender that value relevant experience or which set reclamation and reuse targets.
- anticipating regulatory changes which increasingly stress circular practices.

Service diversification

The experience and skills acquired can allow a company to diversify its services. It can be able to offer solutions for deconstruction, renovation and/or durable construction, give advice about the reuse of materials or even position as an expert in the field of durable construction. This can lead to new sources of revenues and to competitive differentiation on the market.

Company image valorization

Durable environmentally-friendly construction is increasingly valued by customers and consumers. By opting for reuse materials, a (de) construction company can improve its image as a socially responsible company. This can attract customers sensitive to these values and new projects.

Costs and benefits specifically linked to careful disposal

COSTS	BENEFITS
<p>Identification of the reuse potential and searching for buyers If the reclamation of the materials is at the initiative of the contractor, they will have to evaluate whether the elements have a potential for reuse, and resale (if targeted). Then it will be necessary to produce a reuse inventory and consult the reuse market to find buyers. This can entail additional costs related to the time spent on these activities.</p> <p>Removal time and labour The reclamation of reuse materials can require more time and labour than conventional demolition. You must proceed with care to remove and reclaim materials without damage. This can entail additional costs for labour and project planning.</p>	<p>Sale of reclaimed materials In the case of selling reclamation materials, if the materials belong to the contractor responsible for their removal, they can get the benefits from selling off the materials. Some can be sold to specialised suppliers, to project owners or other companies. The sale price will vary according to many factors, in particular market demand.</p> <p>Reduction of waste management costs By removing and reclaiming materials, the company reduces the amount of waste produced, which can result in substantial savings in the costs of waste management.</p>

Costs and benefits specifically linked to preparation for reuse

COSTS	BENEFITS
<p>Sorting and preparation for reuse Before being reused, reuse materials must be sorted, cleaned and possibly repaired, treated or reconditioned. Sometimes, it is necessary to search for or produce missing or worn components. These activities can entail additional costs for labour, equipment and time. They will be either in the charge of the company doing the removal and resale, or in the charge of the company doing the construction.</p>	<p>Value of the work According to the circular economy model, the value produced is no longer just linked to the resale value but more to the impact on the management of resources and the work carried out. So it is possible to find benefits by anticipating circular models where it is no longer the extraction of materials producing goods which creates prosperity, but rather the work used to conserve existing goods.</p>

Costs and benefits specifically linked to construction with reuse materials

COSTS

Searching for materials and coordination

Searching for and locating reuse materials can take time and require additional efforts. This can produce indirect costs such as extra work hours, watching to remain aware of the arrival of lots on the market, travel costs or consultation with specialists to find the required materials.

Adjustments and adaptations of materials

Reuse materials can require adjustments or adaptations to integrate them correctly in the project. Even after having been prepared for reuse, some types of material can require additional adjustments, such as cutting, modifications or adjustments to ensure their compatibility with the other construction elements, which differs from certain new materials that can be ordered "tailor-made". This work can affect the time required for implementation.

Insurance and liability

When reuse materials are being used in construction, there can be additional considerations in terms of insurance and liability. Insurers can evaluate differently the risks related to using these materials, which can entail higher premiums or specific requirements for insurance coverage.

BENEFITS

Reduction of procurement costs

In some cases, reuse materials can be obtained at lesser cost from specialised suppliers. If the materials are obtained from another worksite, the balance can also be more interesting than purchasing new materials (to be calculated according to the costs-benefits related to removal and preparation for reuse).

In the case of reuse in situ, the procurement costs can even be considered as zero.

Reduction of transport costs

Reuse generally makes no sense (environmental and economic) unless it is carried out at local level. Reuse materials are often available locally, which reduces the transport costs associated with procuring new materials. This can produce extra savings, in more isolated regions or large-scale projects requiring a large amount of materials.

Reduction of long-term maintenance costs

If the company is also responsible for maintenance of the materials, it can also gain benefits at this level. Certain high-quality reuse materials can also be durable, even more durable, than some new materials. By using quality reuse materials, a construction company can reduce long term maintenance costs, because these materials have already been proven in terms of resistance and durability. This can produce significant savings by avoiding or reducing frequent repairs or early replacement of materials.

Other factors influencing the cost

Other factors will also have an influence on the company's costs and benefits:

- The presence of very specific requirements, or inversely of **allowed flexibility** in the clauses, can affect the difficulty or not of procuring reuse materials, or to remove and sort them.
- **The size of the lots** of materials can have an impact on the costs. On the one hand, large quantities can allow the contractor to save time thanks to economies of scale on a series of tasks. On the other hand, this can be a challenge for the company which has to procure homogeneous lots of materials.
- **The company's experience** in reuse material can affect the related costs. A company which is starting in reuse must devote more resources to finding best practices, to training and coordination, unlike an experienced company which also benefits from a well-established network. It should be noted that the time required in

the first experiences of reuse do not necessarily reflect the time required afterwards. As the company acquires experience and develops its skills and networks, the processes become more efficient, thus reducing the related times and costs.

- **The potential for future replicability**, which depends on the type of operation and the material concerned, can motivate a company to invest time and resources.

Detailed analysis of the benefits and costs specific to each project is therefore essential for making an informed decision on reclamation and construction with reuse materials and making a correct price offer. This estimate can be refined as the company acquires experience.

Estimated selling prices of reused materials

The figures below, from material sheets produced under the FCRBE project during 2019-2021, can help establish

a price offer for **the removal** of certain materials. These sheets also give indicative prices (ex-tax) **for the supply** of the materials below. These prices vary according to the condition, model, and quantities available.

WOOD STRUCTURAL ELEMENTS	INDICATIVE SALE PRICES OF REUSE MATERIALS	BRUSHING/CLEANING
Pine joists 6 × 16 cm	0.30 & 0.60 €/pc	~ €20 per linear metre
Pine joists 8 × 24 cm	0.25 - 0.35 €/pc	
Soft wood joists (6 × 16 to 8 × 20 cm)	4 at €10 per m according to cross-section	
Beams in wood from old spruce trusses 90 × 400 mm	~ €560 per m ³	
Beams in old pine ³⁰	~ €350 per m ³	
Old oak beams, cross-section 25 × 25 cm ³¹	between €700 and €2350 per m ³	
Laminated (BLC) beam	€200 - 450 per m ³	

Circular construction should lead to cost reductions. The demolition of an existing roof covering can be entrusted to the prospective roofer or to specialised subcontractors. When cleaning roof tiles, the project owner can lend a hand (see practical example of tile removal and cleaning for reuse, proposed by dobbit.be: <https://www.youtube.com/watch?v=uhRjMmyG3RU&t=56s>) Adapted work companies can also be used. The reuse of roofing elements helps reduce the costs of treating waste and generate additional revenues by selling the dismantled materials. In principle, roofing materials in scales such as tiles and slates can be reused. In the future, the value of existing materials should see prices rise.

However, in the experience of roofers active today, the purchase costs of reclaimed roofing elements are quite variable and often higher than that of new roofing materials. These fluctuations are caused by the extra efforts that the deconstruction, sorting, cleaning and storage of these elements requires. Because of their rarity, the accessories can be quite costly. When fitting reclaimed materials, some additional factors (see 6.e) are liable to involve additional costs (special type of sub-roof, impact on underlying layers, special type of vapour barrier, etc.). Because of potentially greater dimensional gaps, the fitting of reclaimed tiles can be more complex than for new roof tiles. This increased complexity extends the duration of the work. In the experience of roofers, a technically comparable roof, but created using reclaimed materials rather than with new materials is generally more costly at present. This situation may change in the future, when energy

becomes more expensive and the raw materials used in the manufacture of new products become scarce.

The importance and attention paid to circularity will probably result in an increase of reuse practices in the coming years. A similar trend has already come to light within the Sealing Work TC of Buildwise. Progression of the cost price of new materials and the extension of their delivery times are liable to increase the popularity of reclamation materials (for example, the tiles mentioned in the Tuighuisstraat project no longer cost 10 euros/m², as part of the study carried out a while ago, but 20 euros/m², an amount near the cost price of reclamation tiles, reuse included: 25 euros/m²). It is expected that circularity will increasingly be required in specifications. This has been remarked for flat roofs, for example. A few years ago, circularity only aroused a minor interest, while today many manufacturers are developing circular solutions, which are being discussed increasingly frequently in the TC Sealing work.

^{30,31} Prix variable en fonction de la finition (rabotées ou non) et de la longueur

8.

Conclusions



Reclamation or construction with reuse materials require an adaptation of the practices of construction companies. Several key points can facilitate this transition:

Reuse of materials often requires a longer **a period of preparation**, mainly related to the search for buyers or suppliers and longer deconstruction times. It is essential then to allow for this and to prepare the various steps in advance.

Several actors can intervene between removal and construction and **the scope of the mission** entrusted to contractors can vary. It is a matter of checking that the mission entrusted to one's company has been clearly defined by the project owner and being aware of the various implications, such as logistical issues, preparation for reuse or verification of fitness for use.

Good collaboration between the various actors involved will greatly facilitate the operations. It is essential to establish solid partnerships and to favour early open communication between the stakeholders. This helps to share knowledge, identify best practices and solve any problems collectively. With experience, the company can create its network with other reuse actors: professional suppliers, and other construction or demolition companies. This will especially facilitate the sale or search for materials.

While this can require initial time and effort, it is important to consider the reuse of materials as an **investment for the company's future**, given the coming regulatory changes. It is crucial to learn from one's own experiences, and to contact other actors of the field who can provide their assistance and services.

- In the roofing sector, reuse is not a new thing. If reclaimed tiles have been used for ages, it is essentially for aesthetic reasons. Given the evolution to circular construction, strong future expansion and the continuation of this evolution can be expected, which aims to reduce the environmental impact of the construction sector. This evolution also opens up new perspectives for roofers: Reuse becomes interesting, given the scarcity of new raw materials and the growth of energy costs, which entail long delivery times, material shortages from time to time, unprecedented price rises, etc. Apart from roof tiles and natural slates, other materials can also be reused, like wood parts and insulation materials. It is important to **facilitate** their future reuse by anticipating it from the fitting or mounting phase.



Concrete example of reuse of roofing products (natural slates):
see <https://opalis.eu/nl/inspiration/5599>

Note: If reclaimed tiles are only available in small quantities, the application of creative solutions enables their reuse, as the following example shows.



Concrete example of reuse of roofing products (natural slates):
see <https://opalis.eu/nl/inspiration/5599>



Another example of creative reuse: dormers made from reclaimed windows and covered with zinc from reclaimed gutters. See https://www.aannemervak.nl/duurzaam-bouwen/bouwafval-wordt-dakkapel?utm_source=nieuwsbrief&utm_medium=email&utm_campaign=04/20/2023&goal=0_2c2171aa1b-c57d485732-220064913&mc_cid=c57d485732&mc_eid=3df8f74e47

- **In conclusion:** roof tiles can also be used for other
- purposes than roofing. As an example, a wall section of the
- Ningbo Museum, in China is shown below. The walls are
- made up of reclaimed stones, bricks and roof tiles from
- buildings demolished on the site occupied by the actual
- museum. In this case, roof tiles from the demolished
- buildings were used to construct a naturalised garden wall
- (whose cavities shelter many insects and other animals).



Source: Clement Guillaume <https://materiauteek.brussels/nl/dakpannen>

- For future reuse, a number of principles should now be
- considered when fitting roofing materials:
- ■ Separability: avoid any irreversible or hard to reverse
- fixing of different materials one to another.
- ■ Removability: strive to prevent any removal problems
- of the materials used
- Pitched roofs already meet many requirements for
- circularity. However, it is preferable to prevent insulation
- or air sealing techniques involving spraying or gluing
- materials one on the other. Moreover, it is important for
- the future to document construction projects well and
- to ensure future access to the information (principle of
- passports for materials and construction) relative to the
- products used (brand, type, performance, etc.). Use of the
- BIM can facilitate execution of this task.
- The development of knowledge on the reuse of roofing
- materials and circular construction will continue in coming
- years. You can also contribute to this. The acquisition of
- any useful information, experience or trick, etc. should be
- shared with Buildwise³².
- The development of research and the evolution of
- practices will enable faster evolution towards circular
- construction, including for pitched roofs.

³² Email address: labo-duci@buildwise.be

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Annexes

Example of neutral specifications for reusing roof tiles

Find this article via the following link: https://batiments.wallonie.be/files/unzip/html_CCTB_01.10/Content/34-11-1a-Tuiles-en-terre-cuite-a-un-ou-plusieurs-embroitements-transversaux-et-lateraux.html

34.11.1a Clay roof tiles with one or more cross and side interlocks

DESCRIPTION

- Definition / Content

These are flat tiles or tiles with a relief or with a more or less pronounced curve. Flat gauge tiles have recessed side interlocking, such that no strip separates their runoff surface.

The work includes:

- supply (not materials reclaimed from the same site)
- Storage
- fitting
- recycling scrap

MATERIALS

- General characteristics

Clay roof tiles with one or more cross and side interlocks (as per information on plans) are new (by default) / reuse.

(By default)

New: Clay construction tiles, which satisfy [NBN EN 1304].

- Standard shape and model: *** (the model is submitted by the contractor to the project developer for approval)
- Colour and appearance: natural red (by default) / smoke blue / rustic / amaranth / patinated copper / brown enamelled / black enamelled / dark red enamelled / grey engobe / black engobe / brown engobe / slate colour engobe / ***
- Thickness: minimum *** / 11 (by default) mm
- Format (L x W): *** defined according to [NBN EN 1024]
- Mechanical strength: in conformity with [NBN EN 538]
- Reaction to fire: A1 (by default) / ***
- Impermeability to water: Level 1 (by default) / 2 as per method 1 or 2 of [NBN EN 539-1].
- Frost resistance: Level 1 (150 cycles) (by default) / 2 (90 cycles) / 3 (30 cycles) according to [NBN EN 539-2].
- Emission of dangerous substances: no requirements (by default) / ***

The contractor submits a sample, data sheet and

declaration of performance (DoP) of the material for approval by the project developer and the project owner.

(Or)

Reuse: it concerns reused tiles as an alternative to new bricks. Roof tiles reclaimed in place or model to be proposed by the contractor and submitted to the project developer for approval.

Reuse tiles are sorted on pallets per lot according to their variety, origin (including typology of wall of previous usage), dimensions, colour (level of firing or composition). Orientation tests (sounding tiles, absorption test, etc.) can help separation into lots. One lot in general contains 1 to 5 pallets.

Lot evaluation and approval targets two basic properties:

- Flexural strength: without evaluation (by default) / 600 N / 900 N / ***.
*** samples of 5 roof tiles per lot are lab tested according to [NBN EN 538].
- Impermeability to water as per method 1 or 2 of [NBN EN 539-1]: without evaluation (by default) / Level 1 / Level 2 / ***

When using reuse tiles, it concerns supply and fitting / only fitting of tiles.

(Or)

Supply and fitting: The roof tiles are supplied by the company.

(Or)

Fitting: The roof tiles are supplied by the PO.

EXECUTION / IMPLEMENTATION

- General specifications

Roof tiles placed in areas exposed to the wind (defined in [NIT 240]) are attached with hooks (by default) / nails / screws / ***.

Fixing means: nails, copper screws or hooks (by default) / stainless steel / galvanised steel / ***.

The attachment complies with [NIT 240], [NIT 175], [NIT 186].

ADDITIONAL REFERENCE DOCUMENTS

- Material

[NBN EN 1304, Clay roof tiles and accessories – Product definitions and specifications]

- Execution

[NIT 240, Tiled roofs (replaces NIT 175, 186 & 202, except for connection structures)]

[NIT 175, Roofs with tiles made of baked earth. Design – Implementation (replaced by NIT 240, except for connection structures).]

[NIT 186, Roofs with slates: conception et mise en œuvre (+ Addendum 1997) (replaced by NIT 240, except for connection structures).]

MEASURING

- unit of measurement:

m²

- measuring code:

Clean surface, with no deduction of specific occasional elements (aeration, etc.). Reservations less than 1 m² are not deducted. Distinction made between new and/or reuse tiles
- with or without supply for the latter.

- nature of contract:

QF

Example of practical application of neutral specifications for reusing roof tiles

03.80 MANDATORY OPTION: reuse of PM construction materials

General

The corresponding articles give the demolition materials to be stored for their

reuse. The other materials become the property of the contractor.

Measuring

- nature of the contract: Reminder (PM), included in Art. 03.81 and 03.82

Implementation

Roof tiles should be removed with care to prevent any deterioration of these materials.

Selective process of the demolition in question: It is useful to conserve different materials separately or to sort them according to their specificity, shape, dimensions, colour and type of raw materials used to make them, provided that no mixing of these materials appears in the elements to be decomposed. The materials will be cleaned: cleared of impurities, debris and damaged examples. The demolition includes the following tasks: sorting, stacking on pallet, transport of reusable materials to the storage site, organisation and stacking of pallets.

It is useful to store demolition materials in a specific storage area in the worksite and defined together with the Administration. The storage must not interfere with work inherent to the phase of new construction.

- The contractor should close off the storage spaces, stabilise stacked objects and protect them against heat, cold, moisture and fire risk.
- The contractor will take full responsibility in case of any theft of goods.
- The storage areas will be constituted at least with hard standing and enclosure.
- The type of this hard standing and its thickness will be suited to the predicted load and the nature of the support.

- Area assigned to storage areas: in compliance with information given on the plan and to be determined together with the Administration. The parcel located between streets Tuighuis 20 and 21 will be assigned to storage areas. The storage areas will be positioned to not affect the work inherent to the phase of new construction (the plans associated with this construction work are sent with the dossier, but they are not part of this call for tenders).
- The storage areas (and the construction materials to be reclaimed) remain the property of the Administration. They can be locked and adequately protected against the weather, theft and deterioration.
- For their enclosure: see Art. 02.41.

Non-reusable construction materials that have to be cleared:

The origin of the materials must have no risk of adverse effects. Whatever the case:

no material from stables or stalls and liable to release ammonia smells, no material from foundations, cesspits or tanks whose permanent contact with water has reduced the quality; and no charred material from chimneys and liable to give off black leaching. The materials must be free from any contamination by harmful substances (e.g. materials impregnated with engine oil or whose finishes contain asbestos, like plaster, are to be prohibited).

The contractor will submit an implementation plan to the Administration for approval.

The implementation plan includes the following elements:

- A general layout plan giving the position and dimensions of the storage areas for the materials to be reclaimed, and the cleaning area according to progress of the work.
- A layout plan of the storage area according to progress of the work and as it is completed.

03.82 MANDATORY OPTION: reuse of construction materials - roof tiles

Description

Roof tiles from building demolition. The roofs are demolished using environmentally friendly techniques. The tiles are sorted, cleaned and conditioned on pallets.

Measuring

Nature of the contract: Assumed quantity (QP)

Measuring method: m², area of tiles, allowing for their overlapping when fitted.

Sandpit, ridge and hip tiles are to be counted as so many tiles.

Materials

The contractor must supply the cleaned tiles and submit a representative sample for the prior approval of the Administration.

The tiles are always:

- Resistant to frost and sufficiently robust: too porous tiles that emit a muffled sound when tapped, flake when scraped or break when cleaned, will be eliminated during the cleaning and sorting process.
- The roof tiles should be cleaned and correctly sorted:
 - a. the tiles must be intact, free from any fragmentation
 - b. no cracks are allowed,
 - c. the tiles must be cleared of all impurities, moss, etc.

The roof tiles will be stored altogether on pallets and film wrapped. For protection, the pallets will have a metal cage to prevent tipping and enable stacking.

The roof tiles present on site will be stored on pallets also placed on a flat dry support. The roof tiles will be stored sheltered from the weather and protected against rising damp to allow drying in free air. Removal of the packaging is not planned.

Implementation

Target proportion of reclaimed tiles: 50%

The contractor reports on the situation of the roof tiles on the site and makes a first estimate of the quantity to be reclaimed.

After their removal, the contractor knows the number of reusable tiles.

The approximate proportion of ridge, hip or any other shape tile is known by the contractor and submitted to the Administration as a list.

Asbestos and reusing roofing

The asbestos issue is very important for roofers. Because of its complexity, it is the subject of specific publications (see below) and training (e.g. «training for asbestos removal – simple operations» for roofers, or « professional asbestos inventory» offered by various training centres). Offering a summary of certain interesting practical points, for potential reuse, this guide aims to give roofers a more precise idea of the materials that may be reusable or not.

In 2023 while some roofing materials contain asbestos, the roofer can rely on the asbestos certificate, a document now mandatory in the Flanders region and comprising a non-destructive asbestos inventory. A toolkit devoted to asbestos is also being developed. This work should make it possible to determine easily (without lab testing) if a certain fibro-cement contains asbestos fibres or not.

A distinction should be made between asbestos contained by roofing materials and the sub-roof. **Sub-roof panel made of asbestos-cement can contain more asbestos but less binder than roofing materials.** Sub-roof panels (called Menuiserite for Eternit products) have an asbestos content near 40% and products in slate-cement or corrugated sheets a content around 5 to 15%. Therefore, they can be more dangerous than roofing materials containing asbestos.

Sub-roofs: fibro-cement containing asbestos

These sub-roof panels come in different densities. As for the risks incurred, hard and dense panels are comparable to slates or corrugated sheets. However, some manufacturers are producing relatively soft fragile sub-roof panels. These panels are clearly more dangerous in terms of the risk of releasing asbestos: the asbestos fibres are less well anchored in a cement matrix and the panels are more inclined to deteriorate. Currently, the legislation in force does not indicate clearly if they should be considered as products «based on bound asbestos». If a sub-roof is made up of panels made of soft fragile asbestos, their removal should not be entrusted to the roofer. In such cases, a specialised company should be used. But in practice, this operation is often entrusted to the roofer, with all the risks involved.

Visually, the distinction is easy to make. In the past, fibro-cement sub-roofs were often the «Menuiserite» type. According to their manufacturer (Eternit), these sub-roof panels containing asbestos always had a high density. However, other manufacturers were also present on the market. Menuiserite of «NT» type (no asbestos) can be identified by the mention «NT» stamped on the outside (visible from outside, after removal of the covering).

Source : D.

Roofing: Slates or corrugated sheets in asbestos based fibro-cement

The marketing, on the Belgian market, of roofing materials containing asbestos fibres took place between 1948 and 1998. Slates and corrugated sheets are the two main types. Slates and corrugated sheets made of asbestos-cement found on roofs in Flanders mainly come from two large manufacturers:

- Eternit N.V. (this company has always dominated the market for asbestos-cement products)
- S.V.K. (Scheerders van Kerckhove's) N.V.

Also, some smaller manufacturers also marketed their asbestos-cement products in Flanders:

- Johns-Manville S.A. (Mol) (relatively important rival to Eternit on the slate market)
- Alfit
- Modernit (Tisselt, to around 1980)
- Novatech (Courbevoie, France).

As regards the exemption of asbestos, the main characteristics of asbestos-cement products are the following:

- type of asbestos fibres
- presence or absence of coating.

For all the manufacturers, corrugated sheets and slates combined, the main type of asbestos has always been chrysotile. During shortages of chrysotile and because of the higher mechanical strength of amphibole-based asbestos-cement, small quantities of crocidolite or amosite were sometimes substituted for chrysotile. These asbestos types are even more dangerous than chrysotile. The prohibition on using chrysotile, and others, in the manufacture of asbestos-cement products, only goes back to 1 October 1998. Between the early 90s and 1998 (SVK) or 1996 (Eternit), various ranges of products from an asbestos free technology («NT») and an asbestos technology («AT») coexisted in parallel. However, the marketing of asbestos-cement products mainly continued up to their prohibition (1998), because of their lower price, 10% less³³. In general, slates and corrugated sheets containing asbestos were given a coating, but not always.

On an existing building, it is very difficult to determine (without performing lab tests) the type of asbestos and the possible presence and thickness of a coating layer. The worst case should always be planned for.

When careful removal takes place, according to best practice, of roofing materials containing asbestos (not throwing it or drilling it, etc.), the risk of releasing asbestos is relatively low. This is found in tests in lab (crushing of slates in crates, measurement of asbestos release) and in situ (measurements made when dismantling roofs)³⁴. For reasons of public health and work safety, these rules must be followed. To help roofers about the complex treatment of asbestos contained in roofs and the changes registered in this field, given the growing attention paid to recycling and reuse, Buildwise is working on various projects devoted to this topic.

The Fibrefreecem study (2021-23?, Buildwise in collaboration with Tradecowall and Issep, supported by the Walloon government) aims to improve the recycling of asbestos-free fibro-cement by separating it from asbestos-cement during worksite waste treatment. Given the constant increase in quantities of dismantled fibro-cement, the parties concerned intend to work towards the setting up of a recycling chain (eco-circularity).

Another study (Adekit II, 2021-23?) looks at the development of a detection kit for asbestos in situ, including establishing reports and identifying obstacles to the risk-free recycling (asbestos-free) of fibro-cement and the creation of an Adekit database:



Example of removal, at foot of downspout, of material containing asbestos and coming from roofing containing asbestos (photo OVAM, 2018)

[Ref. : OVAM study day, 17/4/2018, presentation by Sven De Mulder "Asbestdaken veilig verwijderen" [Safe dismantling of roofs containing asbestos], use authorisation requested by FDO via LinkedIn]



Dismantling of roof covered with artificial slate containing asbestos (© G. Pierrard, 2008)

FURTHER INFORMATION

For more info on asbestos, refer to Buildwise publications:

- "Asbest, nog steeds alomtegenwoordig" [Asbestos, still ever-present]. Buildwise article 2019-03.03
- Identification of asbestos in buildings. Buildwise article 2005-02.07

³³ Ref. : final report titled «Onderzoek naar asbestvrijstelling van asbesthoudende daken» [Study on the release of asbestos from roofs containing it], WTCB/CSTC, 2002.

³⁴ Reference : Buildwise rapport